University of Strasbourg – Sant'Anna School of Advanced Studies

Bureau D'Économie Théorique et Appliquée – Laboratory of Economics and Management

Gender Equality and Economic Growth in the Long-Run

A Cliometric Analysis

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Economics – Docteur en Sciences Économiques

Defended on December 2, 2013

JURY

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À Christophe

Acknowledgements

This thesis would not have been possible without the guidance and the help of several persons. I wish to thank those who have been instrumental in the development of this thesis, who helped me in the completion of this task and who have supported me throughout these years.

Following the order of events, I would like first to thank Ragip Ege. I thank him for the interest and considerations he had for me (and for his students overall) while I was an undergraduate student. I am deeply indebted to him for having advised me to contact Claude Diebolt about my research project. Hence I started to work under the supervision of Claude in the frame of my Master thesis in 2008. I am deeply grateful to Claude for everything he has done for me during these years. I thank him for his constant and unconditional support and for the Force he has inspired me throughout this journey. I cannot express in strong enough terms all my gratitude.

I thank Patrick Llerena for encouraging me to attend the International Doctoral Program in Economics in Pisa. I have learned a lot. It has been an excellent experience and a great satisfaction for me to have been able to complete successfully the year and a half of lectures and exams. Beyond that, I met Alessandro Nuvolari, my Italian supervisor. I express my sincere gratitude to Alessandro for having accepted the supervision of this dissertation. In particular, I thank him for all his valuable recommendations, advices, ideas and references and for having always taken care of warning me in my research – about difficulties and problems I may encounter. These comments have been highly helpful and crucial in carrying out my work.

Hence, I thank my two supervisors for their time, guidance, patience, and particularly for having confidence in the progression of my work. I am greatly aware of how lucky I am to have been framed, formed and guided by them. I thank them for the interest they have brought to my work but above all I wish to thank them for their human qualities.

I wish to extend my profound gratitude to the members of my jury: Prof. Joyce Burnette, Prof. Jacob Weisdorf, Prof. Luigi Marengo and Prof. Ragip Ege, who provided their valuable time to participate to the evaluation process of this thesis. I thank them for accepting the invitation and for their comments that will contribute to enhance and deepen my work.

I thank the University of Strasbourg Institute for Advanced Study (USIAS) for the support provided to the project *Towards a Cliometric Theory of Unified Growth: The Role of Female Empowerment* in which this thesis takes part.

My PhD research has been carried out both at the Scuola Superiore Sant'Anna in Pisa and at the University of Strasbourg. I feel fortunate to have been surrounded by supportive professors who, in one way or another, have been part of the completion of this dissertation. I am also grateful to Laurent Weil and Régis Blazy with whom I had the chance to work with during my teaching experience as ATER at the *Institut D'Études Politiques*. In particular, I thank Nicolas Eber. The joy and enthusiasm he has for his teaching was contagious and extremely motivational for me. And of course I thank Blandine (Zimmer) for all the help she provided me and for her kindness. It was a real pleasure to work with her, and with Pierre.

I wish to thank my PhD fellow in Pisa, Ugo, Daniele, Emanuele and Giorgia. I thank Tania and Mafini for all the great moments we spent together, for their continued support and their friendship. I thank my team-mate Marco for always having been there for me in difficult times and for always having been here with me at best times. My special thanks go also to my PhD fellow in Strasbourg. I thank my mates of the office 126: Walliya, Qiao, Naouel, Tim and Ralph. I wish to thank also Oana, Christian, Xi, Nima and the PhD students of the offices 133, 148, 154, second and third floors. I thank them for having created an ideal working environment, for their support and all the good moments spent together. A special thank goes to Audrey and Fred for having taken great care of me and managed to make me laugh a lot during the final stage of thesis-writing, which was particularly challenging.

I am especially grateful to, Mickaël Benaim, Mafini Dosso, Charlotte Le Chapelain, Frédérique Lang, Audrey-Rose Menard, Frédéric Olland, Marianne Perrin, Walliya Premchit, Lionel Rischmann, Paul Sharp and Tania Treibich for the care they devoted to the correction of this thesis. I am thankful to Danielle Genevé for her help and for always having been supportive.

Je remercie mes amis d'avoir été patients et compréhensifs, et de m'avoir toujours soutenu. Merci à Oliv, Yoyo, Aline, Ju, Lulu, Gaël, Serdal, Lélé, Lo, Tom, Jen, Gilou, Élo, PA, Dudu, JC, Polo, Barbie, Oana, Manu et tous les autres ; merci à Laurène, Vincent et Cyrielle. Merci à Nus, Eric et Chacha. I cannot unfortunately mention everyone but I wish to thank those who enriched my life in these five years. And regardless of where you are today, I do not forget you.

Une pensée va à mon filleul Thomas. Un merci tout spécial s'adresse aux membres de ma famille qui m'ont donné le courage d'aller au bout de cette aventure. Merci à ma grand-mère. Merci à mes parents et à ma sœur d'avoir cru en moi tout au long de ces années. Merci à Mika pour tout ce qu'il est. Quelques mots, ni quelques lignes ne suffiraient pas pour exprimer tout ce que je leur dois. Je me contenterais donc d'un simple « merci pour tout » !

Gender Equality and Economic Growth in the Long-Run.
A Cliometric Analysis

Abstract. – This thesis studies the long-run relationship between gender equality and economic growth. In particular, it aims at understanding and explaining the mechanisms and determinants underpinning the development process which allowed economies to move out of a long period of stagnation into a state of sustainable economic growth. The scientific objective is to check the validity of the central hypothesis that improving equality between men and women is a key ingredient of the demographic transition and of the process of socio-economic development. Quantitative and empirical analysis of this relationship is based on a renewed cliometric approach. Hence we aim at producing a quantitative projection of social sciences in the past, structured by economic theory, mathematical modeling, and informed the statistical and econometric methods. The projected innovation is to build a bridge between the theoretical models of growth and economic history. This new line of research between pure empiricism and abstract theory allows to interpret economic issues taking into account the past and in so doing, to understand more deeply the economic and social historical processes.

Keywords: Cliometrics • Economic Growth • Demographic Transition • Human Capital• Gender

Parità di genere e crescita economica di lungo termine.
Un'analisi cliometrica

Sintesi. – Questa tesi studia la relazione di lungo termine tra parità di genere e crescita economica. In particolare, essa ambisce a comprendere e spiegare i meccanismi e le determinanti sottostanti il processo di sviluppo che ha permesso alle economie di muovere da un lungo periodo di stagnazione verso la crescita economica sostenibile. L'obiettivo scientifico è di verificare la validità dell'ipotesi centrale secondo cui la maggiore parità tra uomo e donna è stata un ingrediente chiave della transizione demografica e del processo di sviluppo socio-economico. L'analisi quantitativa ed empirica di questa relazione si incentra su un nuovo approccio cliometrico. In tal senso, si ambisce a produrre una proiezione quantitativa delle scienze sociali nel passato strutturata dalla teoria economica e dalla modellistica matematica, oltre che dai riscontri statici e dai metodi econometrici. Ci si attende che tale innovazione costruisca un ponte tra i modelli teorici di crescita e la storia economica. Questa nuova linea di ricerca tra pura analisi empirica e astrazione teorica permette di interpretare le problematiche economiche tenendo in considerazione il passato, potendo così comprendere più profondamente i processi storici ed economici.

Parole chiave: Cliometria • Crescita economia • Tranzione demografica • Capital umano • Genere

Résumé

Cette thèse porte sur les relations de long terme entre égalité hommes-femmes et croissance économique. Plus particulièrement, elle analyse le rôle joué par l'accroissement de l'égalité hommes-femmes sur le processus de développement qu'ont connu les pays occidentaux au cours des deux cent dernières années. Malgré quelques variations en termes de temps et d'espace, les pays aujourd'hui dit développés ont subi de profonds bouleversements d'ordre économique, démographique et culturel. Cette période a marqué un tournant de l'histoire économique et des évolutions démographiques. Ainsi, avant la Révolution Industrielle, l'ensemble des sociétés étaient caractérisées par une très longue période de stagnation du revenu par habitant et un taux de fécondité élevé. Suite à cette période fatidique, les pays occidentaux ont subis un renversement complet de situation avec un accroissement sans précédent, et à un rythme soutenu, du revenu par habitant et un taux de fécondité très faible – tous deux à des niveaux jamais atteints jusqu'alors. En parallèle des transitions économique et démographique se produisent de profonds changements dans la structure de la population : l'éducation formelle devient accessible à une vaste majorité de la population, tandis que l'on constate de fortes mutations dans les relations entre hommes et femmes. L'enjeu de ce travail, basé plus spécifiquement sur les faits stylisés du cas français, est d'étudier les interactions potentielles liant processus d'émancipation historique des femmes, transition démographique et développement économique. L'objet de cette étude se situe à la croisée de plusieurs domaines des sciences économiques et sociales. En effet, pour mener à bien notre étude et approfondir l'analyse des groupes sociaux, il est primordial de s'appuyer sur l'éclairage qu'apportent les sociologues, les démographes, les historiens ou encore les anthropologues, même si notre démarche restera, pour l'essentiel, celle d'une économiste. Pour ce faire, nous avons recours à la cliométrie comme trame de notre analyse. Littéralement, la cliométrie se définie comme la projection quantitative des sciences sociales dans le passé, structurée par la théorie économique et informée par les méthodes statistiques et économétriques. L'analyse cliométrique suit trois grandes étapes. La première étape consiste à reconstruire avec précision un ensemble de faits et d'évènements à partir de diverses sources documentaires. La deuxième étape a pour objectif de déterminer les causes et les conséquences des faits constatés dans la première étape de l'analyse. La théorie économique est ainsi mobilisée afin de modéliser et de transformer un système

complexe d'informations en un ensemble plus simple de manière à mieux comprendre et donc à mieux expliquer les mécanismes sous-jacents au processus de développement. La dernière étape de l'analyse fait alors appel aux outils économétriques avec pour objectif de confirmer ou d'infirmer la pertinence de la théorie en la confrontant aux données du passé.

L'organisation de la thèse suit les trois étapes de la démarche cliométrique. La thèse se compose de sept chapitres répartis en deux grandes parties. La première partie de la thèse est descriptive et s'attache à faire un état des lieux du processus de développement dans le cas français. Une attention toute particulière est portée à l'étude des différences hommes-femmes et de leurs évolutions. La deuxième partie de la thèse est analytique. L'enjeu de cette partie est double. D'une part, elle offre une théorie unifiée de la transition économique et démographique intégrant l'évolution des inégalités entre hommes et femmes. D'autre part, elle recourt aux outils économétriques afin de vérifier la validité de l'ingrédient clef de la modélisation théorique, à savoir l'arbitrage « quantité-qualité » (fertilité versus éducation).

La première partie de la thèse correspond à la ***première étape de l'analyse cliométrique*** qui consiste à reconstruire avec précision les faits qui ont marqués le processus de développement depuis la fin du XVIIIème siècle. Bien que notre ambition soit de comprendre le processus de développement dans son ensemble, une attention toute particulière est portée sur la France comme sujet d'étude. Deux raisons principales expliquent ce choix. D'une part, le cas de la France a reçu relativement peu d'attention de la part des économistes historiens et reste donc méconnu. D'autre part, alors que la France était le pays le plus peuplé d'Europe au tournant du XIXème siècle, elle constitue également le premier cas clairement identifié de baisse de la fécondité en Europe. Obtenir une meilleure compréhension de la transition démographique française et donc du processus de développement français contribue à mieux expliquer les mécanismes sous-jacents de la transition d'une longue phase de stagnation malthusienne à une phase de croissance économique soutenue. La partie I documente ainsi les faits stylisés et évidences empiriques de la transition démographique et économique ainsi que des évidences en lien avec l'évolution du niveau de qualification de la population et la transformation des relations entre hommes et femmes. Les variables sont étudiées au niveau national (données longitudinales) et départemental (données transversales). La plupart des données que nous utilisons proviennent de la Statistique Générale de la France. Depuis 1801, le recensement de la population est effectué tous les cinq ans, conformément à la loi 1791 Juillet. Il est cependant important de garder à l'esprit que les méthodes statistiques de recensement ont évolué au fil du temps. Il faut ainsi attendre 1896 pour que les formulaires de recensement soient dépouillés au niveau national et non plus au niveau des autorités locales. En plus de la méthode de comptage, il est important de prêter attention à la valeur elle-même des informations communiquées par les recensements. Depuis plus d'un siècle, les méthodologies et classifications ont évolué tout comme les limites du territoire. Cela soulève la question de la validité et la comparabilité des données. Nous nous efforcerons de prendre en compte et d'intégrer ces aspects tout au long de notre analyse. Les autres données que nous utilisons proviennent de diverses sources, principalement de livres.

La croissance économique n'est qu'un des aspects du processus de développement. De nombreux changements se sont produits en parallèle de l'accroissement sans précédent du PIB par habitant. Les évidences empiriques montrent que le passage à la phase de croissance économique soutenue s'est produit de façon simultané avec la transition démographique. Le **chapitre 1** met ainsi l'accent sur l'évolution des variables démographiques en France au cours des deux cents dernières années. Nous nous intéressons tout particulièrement à l'évolution des caractéristiques du mariage. L'étude des spécificités régionales au milieu du XIXème siècle montre la coexistence de deux grands types de régulation de la fécondité: le contrôle par le mariage et le contrôle au sein du mariage. L'étude de l'évolution des séries temporelles indique que la baisse de la fécondité s'est produite parallèlement au déclin du mariage traditionnel, au profit du contrôle des naissances dans le mariage. Afin de mieux comprendre les raisons de l'évolution des modes de comportements démographiques, nous étudions dans le **chapitre 2** l'évolution de la main-d'œuvre féminine. Nous nous intéressons notamment à la transformation du cycle de vie des femmes au travail. L'étude du marché du travail et plus précisément de la participation des femmes aux activités rémunérées révèle des changements significatifs au regard de la proportion des femmes actives et du type d'emplois occupés par ces dernières. Une attention toute particulière est portée à l'étude des différences entre les sexes. L'existence de fortes divergences entre hommes et femmes en termes de type d'emplois occupés et de salaires nous conduit à nous interroger sur la question de l'accessibilité des filles à l'éducation. Le **chapitre 3** est ainsi consacré à l'étude des investissements éducatifs. Les XIXème et XXème siècles ont tous deux été marqués par de profondes améliorations des dotations en capital humain des individus, en particulier des filles. L'accès massif et généralisé à l'éducation s'est fait de façon progressive : de l'enseignement primaire à l'enseignement secondaire, puis de l'enseignement secondaire à l'enseignement supérieur. Les tendances de long terme révèlent une forte amélioration de la qualité de la main-d'œuvre, et ce dans de plus fortes proportions pour la main d'œuvre féminine. L'incapacité des différences filles-garçons dans les investissements éducatifs d'expliquer la persistance des différences hommes-femmes dans l'emploi et au niveau des salaires pose la question des rôles socialement établies, des comportements et des activités que la société juge appropriées pour les femmes. Cela nous amène à nous concentrer, dans le **chapitre 4**, sur l'évolution des rôles et des relations entre hommes et femmes. Avec le développement des industries, il est devenu plus difficile pour les femmes de concilier sphère domestique et sphère professionnel. L'étude de l'organisation de la famille suggère qu'une transition s'est opérée d'une division sexuelle du travail à une répartition plus égalitaire des tâches au sein du ménage et du marché du travail.

L'enquête menée dans la première partie de la thèse, basée des données françaises au niveau national et départemental, produit une histoire complexe. Elle suggère l'existence de fortes interactions entre processus d'émancipation historique des femmes, transition démographique et développement économique. La seconde partie de la thèse est analytique et vise à mieux comprendre les mécanismes sous-jacents au processus de développement. La revue de la littérature en lien avec les théories de la croissance économique dans le **chapitre 5** met en évidence la nécessité d'une théorie unifiée de la croissance qui permettrait de capturer dans un cadre unique les principales caractéristiques du processus de développement. Également, le chapitre souligne également le manque (voire l'absence) de considérations en termes de genre dans les théories de la croissance. Rares sont, en effet, les modèles de croissance qui différencient le rôle des hommes et des femmes dans leur analyse, considérant plutôt l'effet des décisions des ménages sur la fertilité. Ceci nous amène à aborder la question du processus de développement par une approche sexo-spécifique renouvelée. La principale préoccupation de l'étude est précisément de montrer dans quelle mesure et par quels mécanismes le niveau de l'égalité hommes-femmes influe sur les décisions prises par les membres de la famille et agit sur les évolutions économique et démographique de long terme. Ainsi, le **chapitre 6** contribue à la littérature sur la théorie de la croissance unifiée en mettant en lumière de nouveaux déterminants du processus de développement. Ce chapitre correspond à la ***deuxième étape de l'analyse cliométrique***. Nous développons ainsi un modèle cliométrique de croissance unifiée qui capture l'interaction entre fertilité, technologie et revenu par habitant au cours du processus de transition de la phase de stagnation au régime de croissance économique soutenue. En particulier, nous construisons un modèle à générations imbriquées distinguant hommes et femmes, prenant en considération deux types de capital humain (qualifié et non-qualifié) et intégrant des aspects sexo-spécifiques. Les variables d'état clés pour la prise de décision des individus sont l'environnement technologique et le déséquilibre des rapports de pouvoir entre hommes et femmes. Un changement rapide de l'environnement technologique augmente le rendement de l'éducation dite « qualifiée » et accroit tout d'abord les investissements éducatifs des garçons et la fertilité (effet de revenu). Une plus forte égalité entre hommes et femmes, déclenchée par l'accélération du rythme du progrès technologique, augmente l'éducation des filles et par conséquent le coût d'opportunité d'avoir des enfants. De plus, la dotation de capital humain des mères est reconnue comme étant primordial dans le développement éducatif des enfants. Par conséquent, la hausse des investissements éducatifs des filles a en retour un impact positif de la dotation en capital humain des enfants. Au final, l'accroissement de l'égalité des sexes modifie l'arbitrage éducation-fécondité, de la « quantité d'enfants » vers la « qualité des enfants ». Le niveau moyen de fécondité dépend donc de la composition de la population en termes de compétences. Les différents éléments de notre modèle provoquent une boucle de rétroaction positive. Au niveau dynamique, l'amélioration de l'égalité hommes-femmes couplée à l'accroissement des progrès technologiques crée davantage de possibilités pour les femmes d'investir dans le capital humain qualifié. La corrélation négative reliant investissements maternels dans le capital humain et fécondité encourage les familles à avoir moins d'enfants mais qui seront mieux éduqués. Le capital humain étant un facteur à rendements d'échelle croissants, la réallocation des ressources vers ce facteur installe l'économie sur un sentier de dépendance croissant. Plus précisément, le modèle suggère que l'autonomisation des femmes est à l'origine de la transition démographique et a engagé le décollage qui a permis aux économies de passer du régime post- malthusien au régime de croissance moderne. En conformité avec les évidences empiriques, la théorie caractérise les conditions dans lesquelles le processus d'accumulation du capital humain s'est amorcé. L'augmentation de la part de population souhaitant acquérir du capital humain qualifié a un effet significatif sur les comportements de fécondité et affecte les conditions de vie des individus. Le système dynamique de l'économie génère la transition d'un état caractérisé par une faible technologie, de fortes inégalités entre hommes et femmes, et une fécondité élevée à un état caractérisé par de grandes avancées technologiques, une forte égalité entre hommes et femmes élevé et un faible taux de fécondité. L'ingrédient clé du modèle permettant le passage d'un type d'économie à un autre est l'arbitrage « quantité-qualité ». Le **chapitre 7** est consacré à l'analyse empirique de la relation entre éducation et fécondité. Ce chapitre constitue la troisième étape de l'analyse cliométrique. Plus précisément, le modèle suppose l'augmentation de l'éducation des femmes d'être à l'origine de la transition démographique. A l'aide des outils économétriques, nous testons séparément l'impact de la variation de l'éducation des femmes et des hommes sur la variation de la fécondité au XIXème siècle en France (données transversales). Nos résultats confirment l'importance du rôle joué par les femmes, et plus précisément par l'éducation des femmes, dans le processus de transition démographique en France au XIXème siècle.

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General Introduction

"*We know that everywhere in the world where women thrive, societies also thrive. It is in everyone's interest to include women in all aspects of the society.*" Catherine Ashton (High Representative of the Union for Foreign Affairs and Security Policy)

"*Equality between men and women is not only crucial in itself but is also a fundamental human right and a question of social justice. Similarly, gender equality is one of the cornerstones of growth and poverty reduction, and it is essential if we want to achieve the Millennium Development Goals.*" Communication of the European Commission

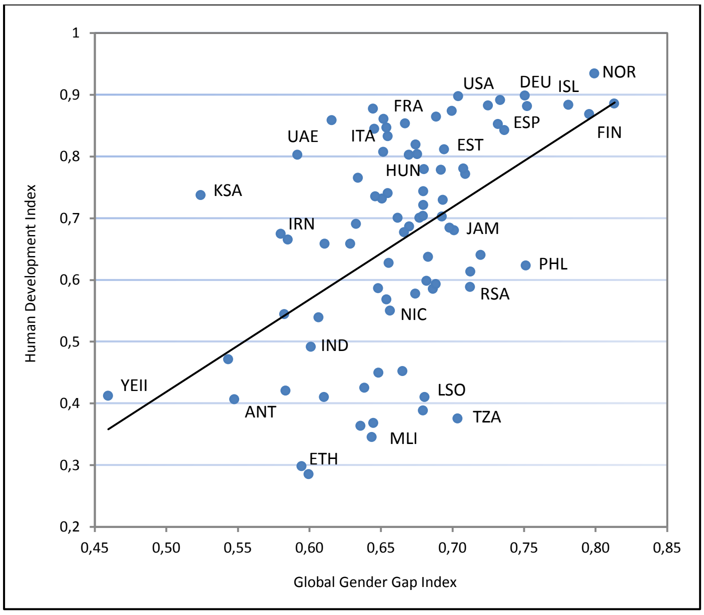
Gender equality is not just a women issue. On the contrary, it concerns the society as a whole. The promotion of gender equality together with economic and social empowerment of women is essential to achieve sustainable development. By removing barriers that prevent women from accessing – the same way as men – to human capital endowments, economic opportunities and human rights, the recognition of gender equality afford economies to result in better economic performance and to improve economic development. The principle of achieving equality between men and women is widely recognized today. Promoting gender equality and women empowerment became the third *Millennium Development Goal* adopted by the United Nations member states in 2000.

Gender refers here to the socially constructed roles, behaviors, activities and attributes that a given society considers appropriate for men and women. Women empowerment implies the ability for women to make choices and to act on their own life choices. In economics, it refers to the capacity of women to participate in the growth process. Women have traditionally been excluded from decision-making processes at various levels, be it the public sphere, labor market, household. Empowerment entails the idea of change intended to provide equal opportunities for both genders with the ultimate emphasis to achieve gender equality.

Current relationship – Gender Equality and Economic Development

Although gender equality may not be confidently considered as a causal factor driving economic development, there is persistent cross-country positive relationship between the gender gap index and the human development index. Figure 0-1 plots the relationship between Gender Gap Index (GGI) and Human Development Index (HDI) for 114 countries in 2006. The GGI examines the gap between men and women in four fundamental categories: economic participation and opportunity, educational attainment, health and survival, and political empowerment. A GGI equal to one reflects perfect gender equality while zero displays perfect inequality. The HDI is a comparative measure of life expectancy at birth, literacy, education and standard of living, which allows measuring the quality of life within a country.

Figure 0-1 : Relationship between Gender Gap Index and Human Development Index in 2006



Source: Global Gender Gap Report – World Bank
Note: Data are available for 114 countries – details in Appendix.

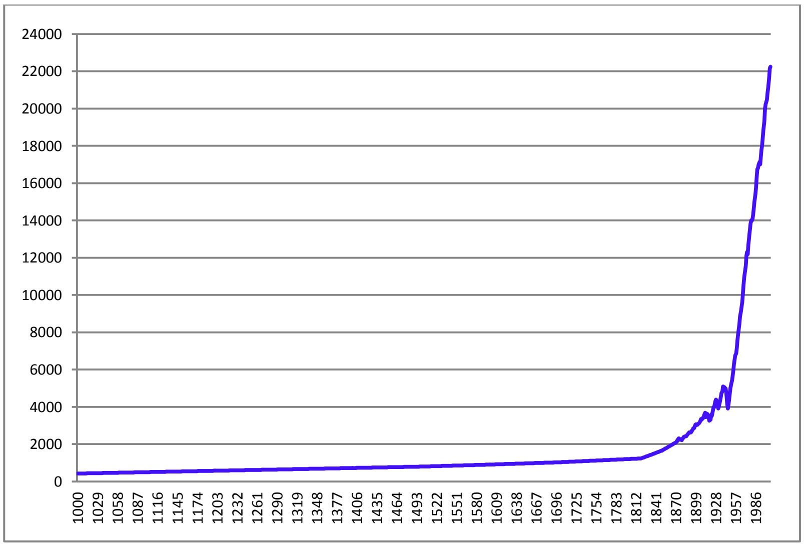
The cross-country plot shows a positive correlation of 0.55 between gender equality, measured by the GGI, and human development level, measured by the HDI. Countries with a high level of equality between men and women tend to have a high level of human development, characterized by high education, high literacy rates and high life expectancy. This is the case of OECD countries such as Australia, Canada, Denmark, Finland, Germany, Iceland, New Zealand, Norway and Sweden – located on the upper right part of the scatter plot (with a HDI around 0.8 and a GGI above 0.7). Conversely, countries characterized by large gender inequalities tend to show a weaker development index. This is the case of countries such as Afghanistan, Angola, Ethiopia, Mali, Nigeria, Turkey, Yemen, Zambia and Zimbabwe – located in the lower left part of the scatter plot (with a HDI below 0.6 and a GGI between 0.46 and 0.64).

Research Question and Motivations

The aforementioned positive relationship between gender equality and human development does not provide any information about the direction of causality. Does this empirical regularity imply that gender equality improves economic development? Or does the causation operate in the opposite direction from economic development to gender equality? What are the underlying mechanisms behind this relation?

Despite the recent recognition of gender equality and female empowerment as a key goal for economic development, gender differences still persist and continue to be a major challenge for both developed and developing countries. In fact, inequalities between men and women seem to be rooted in the cultural, social and political systems of many countries. So, in order to better understand the relationship between gender equality and economic development, it is essential to come back to the genesis of this relationship. The aim of this dissertation is to study the long-term relationship between gender equality and economic growth. This work is stimulated by a twofold motivation: on the one hand, the conviction that the understanding of comparative economic development requires a global view of the entire process of development; on the other hand, there is a strong belief that both female empowerment and gender equality have been one of the key driving forces behind the process of development, and that they have determined the timing and space of the transition from stagnation to sustained growth.

Figure 0-2 : Evolution of GDP per Capita in Western Europe, 1000-2008



Source: Data from Maddison (2008).
Note: Western Europe countries are Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden and United Kingdom.

There is evidence showing that throughout human existence, the process of economic development was characterized by stagnation of living standards around a subsistence level. The rise in the living standard from the late 18th century in Western countries considerably transformed the profile of society.[1] Figure 0-2 presents the evolution of Gross Domestic Product (GDP) per capita in Western Europe over the period 1000–2008. After a substantially flat evolution during centuries, per capita income displays a sudden and brutal increase, following a "hockey stick" shape. From about 1200 dollars (1990 international dollars) in 1800, it reaches 22 246 dollars in 2008. This impressive rise in GDP per capita is just one aspect of drastic changes that have characterized the evolution of Western countries over the past two hundred years. Simultaneously to these improvements in living standards, the Western world witnessed considerable socio-economic, demographic and cultural upheavals that have marked a turning point in economic history and demographic developments.

Moreover, the demographic transition in Western countries occurred at the same time as the transition from economic stagnation to sustained growth. Coupled with improvements in life expectancy, both mortality and fertility rates declined sharply within the space of a century. Despite an overall increase in the availability of resources, the number of offspring radically declined. Such demographic changes profoundly transformed the population structure in these countries. In addition, formal education became accessible to a vast majority of the population. While a huge share of the population was illiterate in the early 19th century, only a small fraction of the population was still unable to read and write a century later. At the same time, gender relations have undergone profound transformations. Through a long-run evolutionary process, women's status in the social organization of the society evolved significantly. The deployment of women from the home to the market place and their expanded contribution to family income marked unprecedented transformations in women's life and family organization. With the rise in technological progress, traditional feminine gender roles became less relevant. Over time, the frontier between the family and the professional sphere got thinner.

Before the Industrial Revolution, societies were characterized by a very long period of stagnation in per capita income, low education and high fertility rates. Since that fateful period, Western countries have experienced a complete reversal of the situation with an unprecedented sustained growth of per capita income, an increasing importance of human capital and low fertility rates – at levels that were never reached yet. Despite some cross-country variations in timing and speed of changes, all Western countries experienced similar trends.[2] Galor and Weil

[1] Economic historians disagree on the timing of the transition. Nuvolari and Ricci (2013) recently dated back the beginning of the process of modern economic growth in the English economy at the end of the 18th century but identified a "Smithian-phase" of positive economic growth preceding the industrial revolution.

[2] Similar contemporaneous patterns can also be observed in emerging countries.

(2000) emphasize the existence of three stages within the development process through the evolution of the relationship between the level of income per capita and the population growth rate. During the Malthusian Era (the stagnation), population growth was positively affected by the level of income per capita. The absence of significant changes in the level of technology trapped the income per capita around a subsistence level and population size remained relatively stable. The Post-Malthusian Regime (the take-off) is characterized by a significant increase in the output growth, driven by technological progress, and by an unprecedented increase in population growth. Finally, the Modern Growth Regime (the sustained economic growth) shows a reversal of the relationship between income per capita and population growth which signed a transition towards a state of sustained economic growth. With the demographic transition the economy leaves the Malthusian causality between economic growth and population growth, triggering large increase in standard of living. Common to most unified models is the rise in the rate of technological progress (through the emergence of new technologies) during the process of industrialization which, in turn, increases the demand for human capital and induces parents to invest more in the education of their offspring. Investing in education increases the opportunity cost of having children and implies for parents to choose between number and education of children (the child quantity-quality trade-off) that ultimately triggers economic and demographic transitions.

Theoretical Background of the Questioning

The simultaneity of economic and demographic transitions led researchers to investigate the causal relation between population and economic growth and to question the underlying forces behind economic and demographic developments. The theories aiming at explaining development and economic growth have, for a long time, found their inspiration in Malthusian and neoclassical conceptions. Inspired by the endogenous growth theory (Romer, 1986, 1990; Lucas, 1988), growth models with explicit microeconomic foundations of family have then been progressively developed from the 1990's (Barro and Becker, 1989; Becker, Murphy and Tamura, 1990, Ehrlich and Lui, 1991; Galor and Weil, 1996; Dahan and Tsiddon, 1998; Iyigun, 2000). The progress of endogenous neoclassical growth models improved the understanding of the modern experience of economic growth in developed economies. Hence Galor (2005) notes that traditional theories of growth (exogenous as endogenous) have been instrumental in highlighting the key role that technological progress and the accumulation of factors of production have played in Western countries during the 20th century (Diebolt and Demeulemeester, 2010). However, he criticizes them for failing to identify the forces that triggered the take-off from stagnation to sustained economic growth (Galor, 2011) and for not providing a global understanding of the entire process of development. Some mysteries persist about some of the most fundamental features of the process of development.

> "*What accounts for the epoch of stagnation that characterized most of human history? Why had episodes of technological progress in the pre-industrialization era failed to generate sustained economic growth? Why has population growth counterbalanced the expansion of resources per capita that could have been generated by technological progress? What is the origin of the sudden spurt in growth rates of output per capita and population in the course of industrialization? What was the source of the dramatic reversal in the positive relationship between income per capita and population that existed throughout most of human history? What triggered the demographic transition? Would the transition to a state of sustained economic growth have been feasible without the demographic transition? […] What are the underlying behavioral and technological structures that can simultaneously account for these distinct phases of development and what are their implications for the contemporary growth process of developed and underdeveloped countries?*" (Galor's Lecture, Jerusalem 2011)

This led growth theorists, headed by Galor (2000), to advance the idea of a theory that could capture in a single framework the transition from the Malthusian stagnation to sustained economic growth. The unified growth theory suggests that the transition from stagnation to sustained growth has been an "inevitable by-product" (Galor, 2011) of the process of development.

Empirical regularities raise numerous questions about the potential interaction between women empowerment, demographic transition and economic development. Insights from economics suggest the role of women to be a strategic variable in economic development. Changes in gender relations do not only concern demographic development but also social and economic development, notably through its effects on human-capital formation of the next generation. However, the relationship between gender equality and long-run economic growth has received little attention so far, in particular from growth theorists. Understanding gender roles is difficult in that it requires a global understanding of family organization and its interaction with the marketplace. Hence, the literature on the topic has mostly abstracted from the most profound changes that have affected household behavior, namely the changes in gender relations. Accounting for gender equality is an important challenge for theories of economic growth.

Beyond the importance of integrating gender issues in growth theory, challenging puzzles still have to be addressed. Western countries' demographic profiles are similar but they witnessed the demographic transition with different synchronization. The comparison between the French and the English cases constitutes an interesting paradox. While the Industrial Revolution begins in the 18th century and the demographic transition in the 19th century in England, conversely France experiences first its demographic revolution and then the Industrialization (Chesnais, 1992). Why did demographic developments have been so late in England and so early in France while economic developments have been early in England and comparatively late in France? What underlying aspects of the development process might explain these various timing? The exploration of changes in gender relations may provide plausible explanations of these issues and improve our understanding of the process of development.

This dissertation which aims at evaluating the role played by women empowerment in the transition from stagnation to sustained economic growth and the associated phenomenon of the demographic transition will notably seek to provide some answers to the following set of questions. Could changes in gender relations explain the dramatic reversal of the positive relation between income per capita and population? Could gender equality account for the endogenous interactions between education and fertility that result in the transition phase? Would the transition to the Modern Growth Regime have been feasible without improvements in gender equality? Could female empowerment account for the observed take-off from stagnation to sustained growth in Western countries? Did gender equality spur economic growth? What are the underlying behavioral forces behind the process of demographic transition? And more generally, to what extent and through what mechanisms gender equality triggered the transition from Malthusian stagnation to sustained economic growth?

Central to this dissertation is the consideration that the development process is linked with the changing economic role of women. While Rousseau argued that the domestic role of women was a structural precondition for a "modern" society, we argue on the contrary that the deployment of women from the home to the market place has been a necessary precondition to achieve sustained economic growth. Our hypothesis is that women empowerment has played a key and necessary role in the transition toward modern societies through its essential role played on the accumulation on human capital and the fertility transition.

Cliometric Analysis – Historical Approach

The purpose of this study is located at the crossroads of several areas of economic and social sciences. In order to carry out our study and deepen the analysis of social groups, it is essential to rely on insights from sociologists, demographers, historians and anthropologists, even if our approach will remain essentially that of an economist. To do so, we use a cliometric analysis – as frame of our analysis. Literally, cliometrics is defined as a projection of quantitative social science in the past, structured by economic theory and informed by statistical and econometric tools.[3]

> "*Cliometrics is too easily construed from the Greek to mean simply quantitative history, rather than the application of quantitative and theoretical techniques to the study of historical phenomena*." (Deirdre McCloskey)

The "New Economic History" emerged in the United-States at the turn if the 1960's, notably with the work done by Conrad and Meyer (1958) on *The Economics of Slavery in the Antebellum South*. McCloskey (1978) advocated the need to expand the frontier of cliometrics beyond America and Europe and noted that "Cliometrics has at least begun in the histories of Canada, Mexico, Brazil, Australia, Japan, China, India, Russia, West Africa, Israel, Italy, France, Central Europe, the Low Countries, Scandinavia, Ireland, and England". The award of the "Nobel Prize" of economics at Douglass North and Robert Fogel in 1993, "for having renewed research in economic history by applying economic theory and quantitative methods to economic and institutional change", marked the advent of this discipline. Fogel and North's key interest included notably the effect of changes in price of transportation (respectively railroads and shipping) and the economic impact of slavery (on the American South).

That cliometrics is an indispensable tool in the study of long run economic growth is no longer a very controversial statement (Diebolt, 2012). If formalization caused more uproar in economic history than in any other field of economics (Goldin, 1995), it is now generally agreed that economic theory, combined with historical, statistical and mathematical methods is necessary. At the theoretical level, it enables us to formulate problems precisely, to draw conclusions from postulates and to gain insight into workings of complicated processes. At the applied level, it allows us to measure variables, to estimates parameters and to organize the elaborate calculations involved in reaching empirical results. This dissertation that explores the role of gender equality over long-run economic and demographic development path of industrialized countries is an illustration of our belief in this principle. The projected innovation is twofold: first, building a bridge between the theoretical models of growth and economic history, and second, investigating more systematically these theories based on history, while seeking to formulate general laws. This new line of research, between pure empiricism and abstract theory could pave the way towards a better economic theory, allowing to interpret economic issues taking into account the past and in so doing, to understand more deeply the economic and social historical processes (Diebolt, 2012; Diebolt and Perrin, 2013).

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[3] According to Goldin (1995), the term "cliometrics" appeared first in the writings of the mathematical economist Stanley Reiter in 1960. Cliometrics comes from the combination of Clio – Muse of History – and the suffix "metrics" – measurement.

The cliometric analysis follows three steps. The first step consists in accurately reconstruct a set of facts and events from various documentary sources. The second step aims to identify the causes and consequences of the findings of the first stage of the analysis. Economic theory is then mobilized to model and transform a complex system into a simpler set of information in order to better understand the mechanisms underlying the stylized facts. The last step uses econometric tools to confirm or deny the relevance of the theory by comparing it to past data, the main objective being to better understand the present.

Outline of the Dissertation

The outline of the dissertation follows the three stages of the cliometric analysis. The thesis is made up of seven chapters distributed into two parts. The first part of the dissertation is mainly descriptive and aims at providing an overview of the fundamental changes that have characterized the process of development in France from the end of the 18th century. Particular attention is given to the study of gender differences and its evolution. The second part of the dissertation is analytical. The purpose of Part II is twofold. One the one hand, it provides a unified theory of economic and demographic transitions accounting for changes in gender equality. On the other hand, it resorts to econometric tools in order to check the validity of the key ingredient of the theoretical modeling that is the Quantity-Quality trade-off (concept addressed more fully in what follows).

The first part of the dissertation corresponds to the ***first step of the cliometric analysis*** that consists in accurately reconstruct the set of facts and events that have characterized the development pattern from the late 18th century. Although our incentive is to understand the process of development as a whole, special attention is paid to the French case for two different reasons. Firstly, France has received little attention so far and is not very well known yet. Secondly, while France was the most populated European country at the turn of the nineteenth century, it constitutes the first clear evidence of fertility decline in Europe. Getting a better understanding of the French demographic transition and then of the French development process may therefore contribute to better explain underlying mechanisms of the transition from Malthusian stagnation to sustained economic growth. Part I documents the stylized facts and empirical evidence of demographic and economic transitions, as well as regularities with regards to the evolution of the skill composition of the population and changes in gender relations. Variables are studied at the national and district levels. Most data we have been using come from the *Statistique Générale de la France*. Since 1801, the population census is conducted every five years– under the 1791 July Law.[4] Only the periods of war (1916 and 1941) and the year 1951 (because of a lack of funding) have departed from the rule. One, however, must keep in mind that the statistical method of census evolved over time and required improvements and adjustments. Hence it was not until 1896 that the census forms were stripped at the national level and not by local authorities anymore. In addition to the method of counting, it is important to pay attention to the value itself of the information reported by censuses. Over more than a century, methodologies and classifications have evolved and so did the territory. This raises the question of validity and comparability of data. We will endeavor to take into account and to integrate when possible these aspects throughout our analysis – especially while giving interpretations of data and findings. Other data we are using come from various sources, but mainly from books.

Economic growth is just one aspect of the development process. Numerous changes have occurred in parallel to unprecedented rise in GDP per capita. Empirical regularities show that the transition from stagnation to sustained economic growth occurred simultaneously to the demographic transition. **Chapter 1** focuses on the evolution of demographic variables in France over the past two hundred years. Particular attention is paid to the evolution of the marriage pattern. The investigation of regional specificities shows the coexistence of two types of fertility regulation during the mid-19th century: control via marriage versus control within marriage. Long-run trends indicate that the fertility transition occurred at the same time of the decline in the traditional marriage pattern in favor of birth control within marriage. To better understand the reasons of the changing patterns of demographic behavior, we investigate in **Chapter 2** the evolution of the female labor force. In particular, we study the transformation of the female life cycle at work. The study of the labor market and more precisely of the female participation in paid activities reveals significant changes in terms of involvement and types of jobs held by women. Special attention is paid to the study of gender differences. The existence of large gender differences in terms of occupation and wage raises the question of the access to education opportunities. **Chapter 3** is dedicated to the study of educational investments. Both 19th and 20th centuries were marked by deep improvements in individuals' endowments in human capital, especially for girls. The massive and widespread access to education occurred gradually from primary education to secondary education and from secondary education to tertiary education. Long-run trends reveal strong improvements in the quality of the labor force to a larger extent for girls. The inability of gender differences in educational investments to explain the persistence of gender differences in occupation and wage questions the socially established roles, behaviors and activities that the society consider appropriate for women. This leads us to focus, in **Chapter 4**, on the evolution of gender roles and relations over the past two

[4] The censuses were conducted every five years but with more or less regularity according to the years.

hundred years. With the development of industries it became more difficult for women to combine the domestic and professional spheres. The investigation of family organization suggests that a transition has occurred from a sexual division of labor to a more egalitarian distribution of the tasks within the household.

The inquiry conducted in the first part of the dissertation based on French data produces a complex story of national and regional variation. It suggests the existence of interconnected relations between the process of historical emancipation of women, demographic transition and economic development. The second part of the dissertations is analytical. The literature review on theories of economic growth in **Chapter 5** highlights the need for a Unified Growth Theory that could capture in a single framework the main characteristics of the process of development. In addition, it emphasizes the lack for gender considerations in growth theory. Rare are growth models that differentiate the role of men and women in their analysis, considering rather the effect of household decisions on fertility. This leads us to tackle the issue of the development process by a renewed gendered approach. The main concern of the study is precisely to show to what extent and through what mechanisms gender equality affects decisions taken by the members of the household and acts on long run economic developments. Hence, **Chapter 6** contributes to the literature on unified growth theory by bringing to light new determinants of the development process that would have triggered the transition from a long period of stagnation to a regime of sustained growth (***second step of the cliometric analysis***). We develop a unified cliometric growth model that captures the interplay between fertility, technology and income per capita in the transition from stagnation to sustained growth. In particular, we consider a two-sex overlapping-generations framework with two types of human capital and integrating gendered aspects. The key state variables for individuals' decisions are the technological environment and the power-imbalance ratio between sexes. A rapid change in technological environment increases the return to skilled education and increases both boys' education and fertility through an income effect. Higher gender equality, triggered by the acceleration of the pace of technological progress, increases girls' education and consequently the opportunity cost of having children what reduces the total number of children. Furthermore, maternal endowment in human capital is recognized as being primordial in the educative development of children. Therefore, the rise in women's educational investments impacts positively children's endowment in human capital in turn. Ultimately, higher gender equality changes the trade-off from "quantity of children" toward "quality of children". The average level of fertility hence depends on the skill composition of the population. The different elements of our model lead to a positive feedback loop. At the dynamic level, the increase in gender equality together with the rise in technological progress creates higher opportunities for women to invest in skilled human capital. The negative correlation linking maternal investments in human capital and fertility encourages families to have fewer children but better educated ones. Human capital being a factor with increasing returns to scale, the reallocation of resources toward this factor sets the economy on a growing path dependency. More precisely, the theory suggests that female empowerment has been at the origin of the demographic transition and engaged the take-off that allowed economies to move from the post-Malthusian regime to Modern economic growth. In line with empirical evidence, the theory characterizes the conditions under which the process of human capital accumulation initiated. Changes in the shares of population acquiring skilled human capital have substantial effects on fertility patterns and affect individuals' living conditions. The dynamical system of the economy generates the transition from a state characterized by low technology, low equality between men and women and high fertility to a state characterized by large technological progress, high gender equality and low fertility rates. The key ingredient of the model allowing the transition of economies from one state to the other one is the "quantity-quality" trade-off. **Chapter 7** is devoted to the empirical analysis of the relationship between education (quality) and fertility (quantity) (***third stage of the cliometric analysis***). More specifically, the model assumes the increase in women's education to be at the origins of the demographic transition (and the process of human capital accumulation). Using econometric tools and based on 19th century French county-level data, we test the impact of the rise in female (and male) education on the variation in fertility. Our results confirm the importance of the role played by girls and women education on the process of demographic transition for France.

Appendix

Table 0-1 : List of the 114 Countries

Eastern Europe		Asia		Europe		Latin America and Carribean	
BGR	Bulgaria	BGD	Bangladesh	AUT	Austria	ARG	Argentina
HRV	Croatia	KHM	Cambodia	BEL	Belgium	BOL	Bolivia
CYP	Cyprus	CHN	China	DNK	Denmark	BRA	Brazil
CZE	Czech Republic	GEO	Georgia	FIN	Finland	CHL	Chile
EST	Estonia	IND	India	FRA	France	COL	Colombia
HUN	Hungary	IDN	Indonesia	DEU	Germany	CRI	Costa Rica
LVA	Latvia	IRN	Iran	GRC	Greece	DOM	Dominican Republic
LTU	Lithuania	JPN	Japan	ISL	Iceland	ECU	Ecuador
MKD	Macedonia	KAZ	Kazakhstan	IRL	Ireland	GTM	Guatemala
MLT	Malta	KOR	Korea, Rep.	ITA	Italy	HND	Honduras
MDA	Moldova	KGZ	Kyrgyz Republic	LUX	Luxembourg	JAM	Jamaica
POL	Poland	MYS	Malaysia	NLD	Netherlands	MEX	Mexico
ROM	Romania	MNG	Mongolia	NOR	Norway	NIC	Nicaragua
RUS	Russia	NPL	Nepal	PRT	Portugal	PAN	Panama
SVK	Slovak Republic	PAK	Pakistan	ESP	Spain	PRY	Paraguay
SVN	Slovenia	PHL	Philippines	SWE	Sweden	PER	Peru
TUR	Turkey	SGP	Singapore	CHE	Switzerland	TTO	Trinidad and Tobago
UKR	Ukraine	LKA	Sri Lanka	GBR	United Kingdom	URY	Uruguay
		THA	Thailand			VEN	Venezuela
		UZB	Uzbekistan				

Table 0-1 : (*Continued*)

Middle-East and Arab World		North America		Oceania		Sub-Saharan Africa	
AFG	Afghanistan	CAN	Canada	AUS	Australia	AGO	Angola
DZA	Algeria	USA	United States	NZL	New Zealand	BEN	Benin
BHR	Bahrain					BWA	Botswana
EGY	Egypt					BFA	Burkina Faso
ISR	Israel					CMR	Cameroon
JOR	Jordan					TCD	Chad
KWT	Kuwait					ETH	Ethiopia
MAR	Morocco					GMB	Gambia
SAU	Saudi Arabia					GHA	Ghana
TUN	Tunisia					KEN	Kenya
ARE	United Arab Emirates					LSO	Lesotho
YEM	Yemen					MDG	Madagascar
						MWI	Malawi
						MLI	Mali
						MRT	Mauritania
						MUS	Mauritius
						NAM	Namibia
						NGA	Nigeria
						ZAF	South Africa
						TZA	Tanzania
						UGA	Uganda
						ZMB	Zambia
						ZWE	Zimbabwe

Part I

Understanding the Process of Development

An Economic History of French Women

The first part of the dissertation corresponds to the ***first step of the cliometric analysis*** that consists in accurately reconstructing the set of facts and events that have characterized the French development pattern from the late 18th century. Although our incentive is to understand the process of development as a whole, special attention is paid to the French case. France is particularly interesting to investigate. On the one hand, France has received little attention so far and is not very well known yet. On the other hand, while France was the most populated European country at the turn of the nineteenth century, it constitutes the first clear case of fertility decline in Europe.

Getting a better understanding of the French demographic transition and then of the French development process may therefore contribute to better explaining underlying mechanisms of the transition from Malthusian stagnation to sustained economic growth. Part I thus documents the stylized facts and empirical evidence of demographic and economic transitions, as well as regularities with regards to the evolution of the skill composition of the population and changes in gender relations. Variables are studied at the national and district levels. Most data we have been using come from the *Statistique Générale de la France*. Since 1801, the population census is conducted every five years– under the 1791 July Law.[5] Only the periods of war (1916 and 1941) and the year 1951 (because of a lack of funding) have departed from the rule. One, however, must keep in mind that the statistical method of census evolved over time and required improvements and adjustments. Hence, it was not until 1896 that the census forms were stripped at the national level and not by local authorities anymore. In addition to the method of counting, it is important to pay attention to the value itself of the information reported by censuses. Over more than a century, methodologies and classifications have evolved so did the territory. This raises the question of validity and comparability of data. We will endeavor to take into account and to integrate when possible these aspects throughout our analysis – especially while giving interpretations of data and findings. Other data we are using come from various sources, but mainly from books. Economic growth is just one aspect of the development process. Numerous changes have occurred in parallel to unprecedented rise in GDP per capita. Empirical regularities show that the transition from stagnation to sustained economic growth occurred simultaneously to the demographic transition.

Chapter 1 focuses on the evolution of demographic variables in France over the past two hundred years. Particular attention is paid to the evolution of the marriage pattern. The investigation of regional specificities shows the coexistence of two types of fertility regulation during the mid-19th century: control via marriage versus control within marriage. Long-run

[5] The censuses were conducted every five years but with more or less regularity according to the years.

trends indicate that the fertility transition occurred at the same time of the decline in the traditional marriage pattern in favor of birth control within marriage.

To better understand the reasons of the changing patterns of demographic behavior, we investigate in **Chapter 2** the evolution of the female labor force. In particular, we study the transformation of the female life cycle at work. The study of the labor market and more precisely of the female participation in paid activities reveals significant changes in terms of involvement and types of jobs held by women. Special attention is paid to the study of gender differences. The existence of large gender differences in terms of occupation and wage raises the question of the access to education opportunities.

Chapter 3 is dedicated to the study of educational investments. Both 19^{th} and 20^{th} centuries were marked by profound improvements in individuals' endowments in human capital, especially for girls. The massive and widespread access to education occurred gradually from primary education to secondary education and from secondary education to tertiary education. Long-run trends reveal strong improvements in the quality of the labor force to a larger extent for girls. The inability of gender differences in educational investments to explain the persistence of gender differences in occupation and wage questions the socially established roles, behaviors and activities that the society consider appropriate for women.

This leads us to focus, in **Chapter 4**, on the evolution of gender roles and relations over the past two hundred years. With the development of industries it became more difficult for women to combine the domestic and professional spheres. The investigation of family organization suggests that a transition has occurred from a sexual division of labor to a more egalitarian distribution of the tasks within the household.

ADMINISTRATIVE FRANCE

	Région boundary
	Département boundary
JURA	*Département* name Postal
39	Official number

PHYSICAL FRANCE

Postal Number	Name	Chef-lieu	Foundation	Remark
01	Ain	Bourg	1790	
02	Aisne	Laon	1790	
03	Allier	Moulins	1790	
04	Basses-Alpes	Digne	1790	Alpes-de-Haute-Provence since 1970
05	Hautes-Alpes	Gap	1790	
06	Alpes-Maritimes	Nice	1793	Suppressed in 1814 ; Refounded in 1860 including Monaco and San Remo
07	Ardèche	Privas	1790	
08	Ardennes	Mézières	1790	
09	Ariège	Foix	1790	
10	Aube	Troyes	1790	
11	Aude	Carcassonne	1790	
12	Aveyron	Rodez	1790	
13	Bouches-du-Rhône	Marseille	1790	
14	Calvados	Caen	1790	
15	Cantal	Aurillac	1790	
16	Charente	Angoulême	1790	
17	Charente-Inférieure	Saintes	1790	Charente-Maritime since 1941.
18	Cher	Bourges	1790	
19	Corrèze	Tulle	1790	
2A et 2B	Corse	Ajaccio	1811	Haute-Corse, Corse-du-Sud since 1975
21	Côte-d'Or	Dijon	1790	
22	Côtes-du-Nord	Saint-Brieuc	1790	
23	Creuse	Guéret	1790	
24	Dordogne	Périgueux	1790	
25	Doubs	Besançon	1790	
26	Drôme	Valence	1790	
27	Eure	Évreux	1790	
28	Eure-et-Loir	Chartres	1790	
29	Finistère	Quimper	1790	
30	Gard	Nîmes	1790	
31	Haute-Garonne	Toulouse	1790	
32	Gers	Auch	1790	
33	Gironde	Bordeaux	1790	
34	Hérault	Montpellier	1790	
35	Ille-et-Vilaine	Rennes	1790	
36	Indre	Châteauroux	1790	
37	Indre-et-Loire	Tours	1790	
38	Isère	Grenoble	1790	
39	Jura	Lons-le-Saunier	1790	
40	Landes	Mont-de-Marsan	1790	
41	Loir-et-Cher	Blois	1790	
42	Loire	Saint-Etienne	1793	
43	Haute-Loire	Le Puy	1790	
44	Loire-Inférieure	Nantes	1790	
45	Loiret	Orléans	1790	
46	Lot	Cahors	1790	
47	Lot-et-Garonne	Agen	1790	
48	Lozère	Mende	1790	
49	Maine-et-Loire	Angers	1790	

Postal Number	Name	Chef-lieu	Foundation	Remark
50	Manche	Saint-Lô	1790	
51	Marne	Châlons-sur-Marne	1790	
52	Haute-Marne	Chaumont	1790	
53	Mayenne	Laval	1790	
54	Meurthe	Nancy	1790	After 1871, parts of Meurthe and Moselle non-annexed by Germany are reunited in Meurthe-et-Moselle
55	Meuse	Bar-sur-Ornain	1790	
56	Morbihan	Vannes	1790	
57	Moselle	Metz	1790	Refounded in 1919 with parts of Meurthe and Moselle annexed by Germany in 1871.
58	Nièvre	Nevers	1790	
59	Nord	Lille	1790	
60	Oise	Beauvais	1790	
61	Orne	Alençon	1790	
62	Pas-de-Calais	Arras	1790	
63	Puy-de-Dôme	Clermont	1790	
64	Basses-Pyrénées	Pau	1790	Pyrénées-Atlantiques since 1969
65	Hautes-Pyrénées	Tarbes	1790	
66	Pyrénées-Orientales	Perpignan	1790	
67	Bas-Rhin	Strasbourg	1790	Refounded in 1919 with a part of Vosges annexed by Germany in 1871.
68	Haut-Rhin	Colmar	1790	Annexed by Germany in 1871; Refounded in 1919 without Territoire de Belfort
69	Rhône	Lyon	1793	
70	Haute-Saône	Vesoul	1790	
71	Saône-et-Loire	Mâcon	1790	
72	Sarthe	Le Mans	1790	
73	Savoie			
74	Haute-Savoie			
75, 92, 93 et 94	Seine	Paris	1790	Paris, Hauts-de-Seine, Seine-Saint-Denis, Val-de-Marne since 1968
76	Seine-Inférieure	Rouen	1790	Seine-Maritime since 1955
77	Seine-et-Marne	Melun	1790	
78, 91 et 95	Seine-et-Oise	Versailles	1790	Yvelines, Essonne, Val-d'Oise since 1968
79	Deux-Sèvres	Niort	1790	
80	Somme	Amiens	1790	
81	Tarn	Albi	1790	
82	Tarn-et-Garonne	Montauban	1808	
83	Var	Draguignan	1790	
84	Vaucluse	Avignon	1790	
85	Vendée	Napoléonville	1790	The chef-lieu is called La Roche-sur-Yon since 1870
86	Vienne	Poitiers	1790	
87	Haute-Vienne	Limoges	1790	
88	Vosges	Épinal	1790	
89	Yonne	Auxerre	1790	
90	Territoire de Belfort	Belfort	1922	

Chapter 1

Changes in Demographic Behavior

Content

« *Il n'y a ni richesse ni force que d'hommes* » Jean Bodin (1576)

« *Le contrôle de la procréation entre les mains des femmes elles-mêmes est la première marche vers l'égalité.* » Françoise Héritier

Introduction

Numerous demographic changes have occurred in France in parallel to the sharp increase in the GDP per capita over the past two hundred years. The demographic transition has played a key role in the economic development of Western counties. According to Chesnais (1992), the "*demographic transition consists of a logical succession of historical phases through which every population passes in the movement towards modernity*". Therefore, in order to better understand the process of development, we choose to focus on demographic changes.

France, as other Western countries, has experienced major demographic changes, such as decline in mortality, increase in population, decline in fertility and expansion of life expectancy at birth. France is an iconic case which is particularly interesting to investigate. While France was the most populated European country at the dawn of the 19th century (what accounted for its superiority in previous centuries), it also constitutes the first clear case of fertility decline in Europe. The French demographic transition can be clearly divided into two phases. In the first phase, before 1851, this was a rural phenomenon, rapid in its infancy and driven by prosperous departments (Van de Walle, 1986). In the second phase, from 1851, the process of demographic transition slowed down and fertility even increased slightly for almost half of the departments. France experienced a resurgence of its demographic transition (in parallel to the launching of the process in most European countries) during the final quarter of the 19th century.

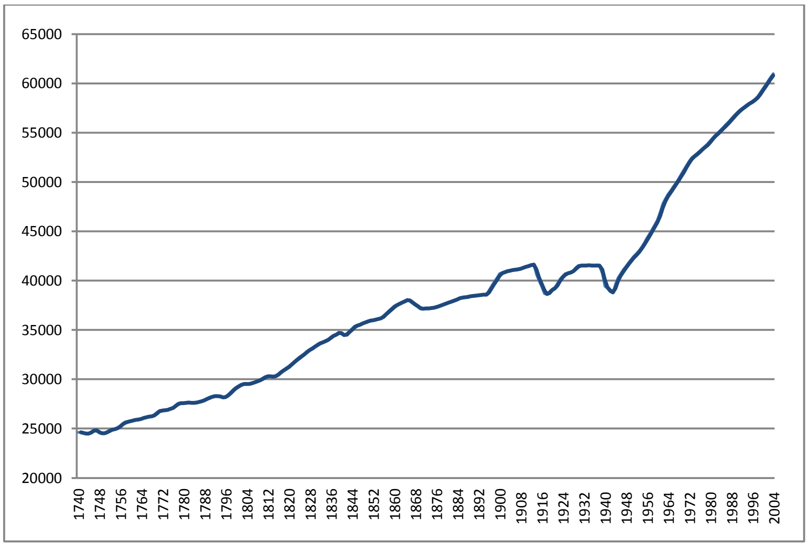
This chapter aims at improving the understanding of the process of demographic transition that was engaged in France by the end of the 18th century. The major question asked is: why did fertility decline? In order to answer this question, we investigate the long-run evolution of demographic trends. In order to understand why fertility declined at that period, we also need to understand how the fertility declined. Numerous factors are likely to have impacted fertility. But undoubtedly the decline in fertility reflects a transformation of individuals' reproductive behaviors. Different strategies are likely to have been used by households to reduce their fertility. From the study of demographic changes at the county level, we emphasize the existence of two main types of strategies to control births: control via nuptiality (Malthusian control) and birth limitation (early contraception). The control of births through marriage consists in delaying the age at marriage or remaining single. On the contrary, birth limitation consists in acting directly on births within marriage through births spacing or stopping early births. The phenomenon of fertility transition varies a lot across regions. It also reveals that the social, economic and cultural context significantly matters to understand spatial differences. The demographic transition did not occur at the same time across counties.

The accent is put first on the description of long-run demographic phenomena (Section 1). Secondly, attention is placed on the changing pattern of demographic behavior (Section 2). Finally, Section 3 studies the transformation of the French demographic landscape using county-level data.

1. The Demographic Transition

At the end of the 18th century, the French population was approaching 28 million inhabitants (Figure 1-1). Moheau (1778) noted a rise in the French population under the influence of increasing births, declining epidemics, improvement of living standards and the progress of food production. France was then the most important (and most powerful) European country by the weight of its population. However, on the eve of World War I (WWI), France was populated by less than 40 million inhabitants and was ranked at the 5th place of European countries. France was recurrently described as an "old country". What can explain this relative decline of the French Population? The answer lies in the evolution of mortality rates but most importantly in the fall in fertility rates as we will see later in this chapter.

Figure 1-1 : Evolution of Population between 1740 and 2004



Sources: Data from Chesnais (1992) – INSEE (2007)

The theory of the demographic transition is a spatio-temporal model describing the transition from high birth and death rates to low birth and death rates as a country develops from a pre-industrial to an industrialized economic system. More precisely, the process of demographic transition is characterized by four main phases. First, population is characterized by a stagnation of birth and death rates at high levels. In the second phase, we observe a decrease in death rates while birth rates remain constant. In the following phase, birth rates decline in turn. Finally, both death and birth rates stabilize at low levels in the last stage.

The study of demographic events and behaviors in France over the past two centuries aims at better understanding the fertility patterns and their transformations along with economic changes. How have demographic variables evolved over time? What can explain the causal structure of fertility decisions and behaviors?

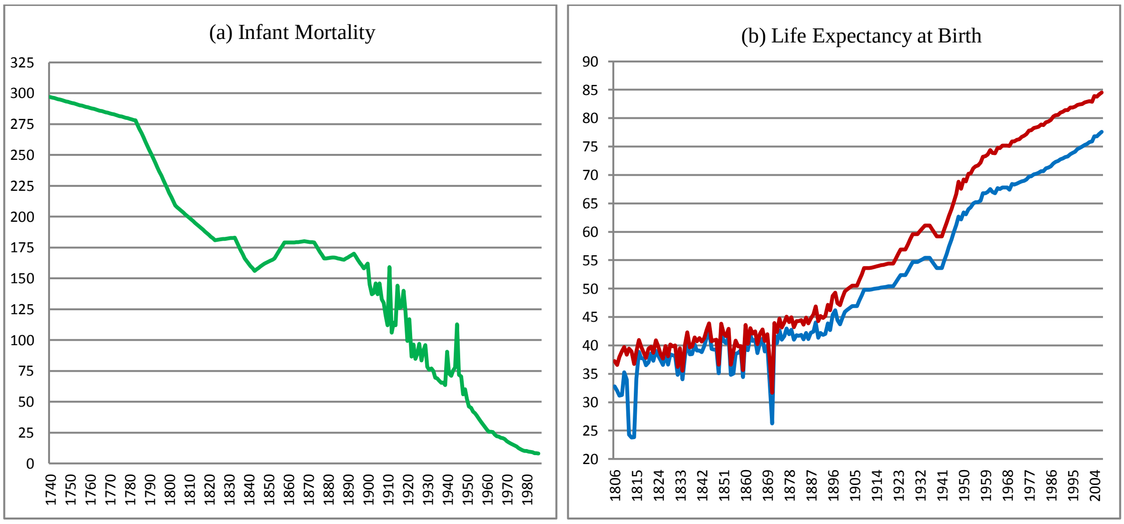
1.1. Evolution of Mortality Levels

The most currently used indicator to measure mortality levels are: the crude death rate, the rate of infant mortality and the life expectancy at birth. The crude death rate is the ratio between the number of deaths and the average population. The rate of infant mortality is defined as the number of children who died before age 1divided by the total number of living births in a given year. Finally, the life expectancy at birth is the expected number of years of life remaining at age 0.

Mortality in France underwent significant fluctuations during the second half of the 18th century and the 19th century (see Appendix Figure A-1). Numerous factors may have impacted mortality rates. Among them, wars, epidemics and famine arrive first. Several demographic crises can be observed over the sub-period 1800-1880 (Bideau, Dupâquier and Biraben, 1988). The bad crops of 1802 and 1803 may explain the variations observed in 1803-1804. However, the decline in wheat price does not seem to have had a negative impact on mortality and nuptiality (epidemic crises; dysentery). Several epidemic crises have succeeded each other’s during the 19th century. Between 1806 and 1811, wars seem to have strongly affected male mortality (Prussian and Spanish wars). In 1814, the typhus combined with foreign invasions affected the population and had a negative impact on the mortality rate. The first cholera epidemic (1832) occurred in parallel to other epidemics. These epidemics had serious consequences. Two years later, in 1834, the influenza combined with other epidemics caused severe complications for infants. Between 1847 and 1849, the French population was affected by strong crises. The year 1846 was particularly bad in terms of or crops production. In addition, economic crises occurred in 1847-1848 simultaneously to new cholera epidemics. The most lethal cholera epidemic lasted for ten years, from 1845 to 1855. Finally, major crisis happened in 1870-1871. It was triggered by a combination of war and epidemics (smallpox, measles – known as rubella, dysentery), which had the most important effect on mortality.

Infant mortality and life expectancy are two instruments allowing us to deepen our understanding of the evolution of deaths and mortality in France. Important progresses have been made in terms of health from the beginning of the 18th century. Figure 1-3 depicts the evolution of infant mortality between 1740 and 1986 and the evolution of life expectancy at birth by gender between 1806 and 2007. As expected, both curves follow a broadly symmetric inverted curve. While the rate of infant mortality dropped sharply that of the life expectancy at birth rose significantly. More precisely, infant mortality ranged from almost 300 deaths per thousand inhabitants in 1740 to less than 9 deaths in 1986. Despite a period of downturn during the 19th century, the decline was continuous over the whole period. Since 1950, infant mortality describes an asymptotic curve toward a limit close to one death per one thousand births.

Figure 1-2 : Evolution of Demographic Variables



Sources: Data from Chesnais (1992) – Meslé and Vallin (1989) and INSEE (2007)
Note: Figure (b), the red curve corresponds to women and the blue curve to men.

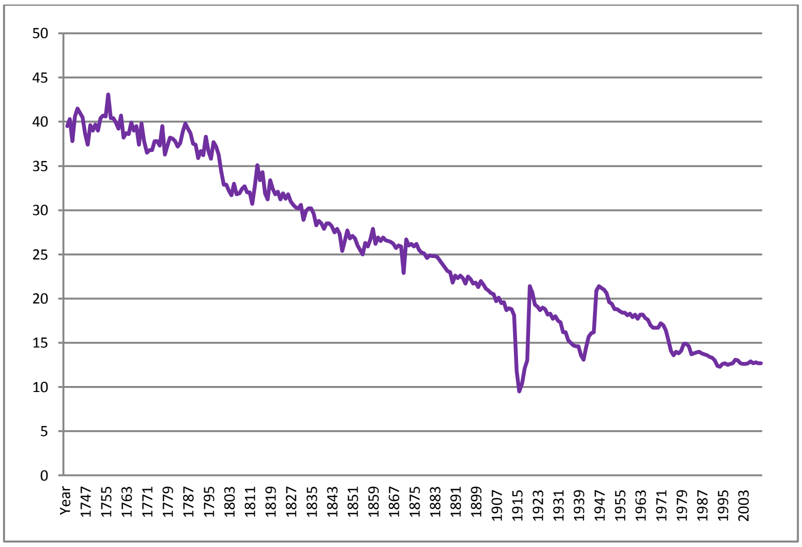
After a rather stable evolution during the 19th century, life expectancy at birth, as infant mortality, experienced a strong and continuous increase from the end of the century – with consistently higher life expectancy for women than for men. In 1806, the life expectancy at birth of men and women were 32.7 and 47.2 years old respectively. In 2007, they reached 77.6 and 84.5 respectively. This progress is likely to have been partly due to the decline in infant mortality.

The medical revolution engaged by the work of Pasteur during the second half of the 19th century may explain the increasing pace of life expectancy observed from the last third of the century. According to demographers, progresses in life expectancy accelerated in years of relative economic stagnation due to the decline in mortality. In this regard, life expectancy may be considered as a better indicator of technological and social efficiency than GDP per capita (Lebras and Todd, 2013). Both health and economic development contribute to the decline of (infant) mortality – through an increase of infrastructures, medical staff, transports, education and living standards. Infant mortality has a direct impact on fertility but also an indirect impact through individuals' fertility behavior. With the rise in the survival of their offspring, individuals have certainly adjusted their behavior.

1.2. Evolution of Fertility Levels

France is the first European country that experienced a decline in fertility. There is no consensus in the literature on the matter, hence no satisfactory explanations have yet been found to explain the reasons why it happened and why it started in France.[6] The decline in population growth seems to find its origin in the will of French people to contain the number of offspring from generation to generation over the course of the 19th century. This process accelerated with the "generalized" choice to limit births, and this phenomenon spread to other countries from the end of the 19th century.

Figure 1-3 : Evolution of Crude Birth Rates



Sources: Data from Chesnais (1992) – INSEE

[6] France is the first country to experience the demographic transition in Europe but at the worldwide level, Binion (2000) shows the correspondence with the American demographic transition that also started a long time before other Western countries.

Data availability leads us to use the crude birth rates as a measurement of long-run fertility levels. The crude birth rate is defined as the number of births per one thousand people. Figure 1-2 shows the evolution of crude birth rates between 1740 and 2008 in France. After stable fluctuations around 40 children per one thousand individuals, the crude birth rate started a first phase of decline before the turn of the 19th century. A crude birth rate of 40 children per one thousand individuals is already considered as a moderate fertility level.

It then reached a second level from the mid-19th century at which the crude birth rate oscillated around 26 children per one thousand individuals until the Franco-Prussian war in 1871, at what point it engaged a new decline. A crude birth rate below 30 per one thousand individuals is considered low. In Chesnais (1992), this criterion is retained as marking the entry into the modern regime of controlled fertility. This level was reached in France at the turn of the 1830's. Therefore, we observe a precocious, fairly regular and fast decline. Over a century, the crude birth rate has been divided by 1.6 (from 34.4 children per one thousand individuals in 1800 to 21.3 in 1900). Over the 20th century, two important drops are observed during WWI and WWII. A return to a rising scale occurred right after WWII, the so-called baby-boom. The downward trend resumed from the 1960's until reaching 13 children per one thousand individuals in 2008.

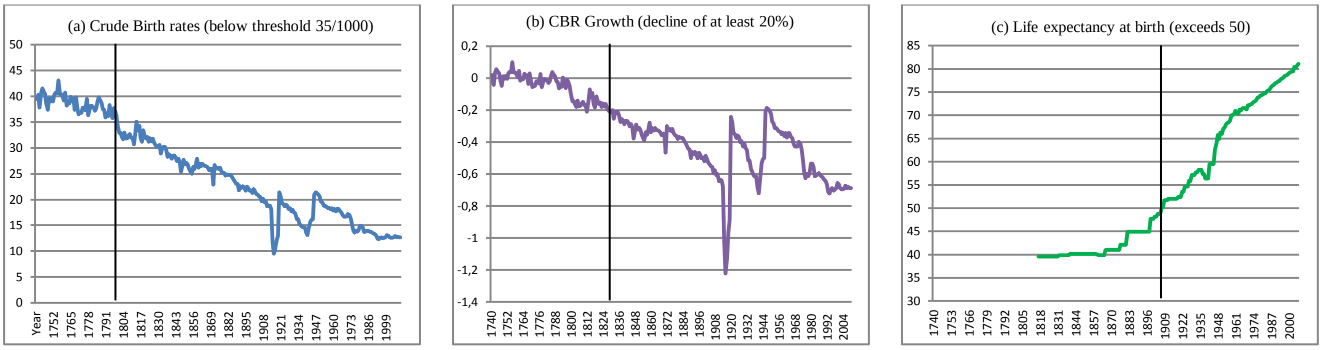
In accordance with Van de Walle (1986), we observe two clear phases in the French demographic transition during the 19th century. Before the mid-century, it consisted mainly in a rural phenomenon led by more prosperous districts, with no apparent link between industrialization and urbanization – with Paris as an exception (low nuptiality, high natural births as will be developed in Section 3). After a couple of decades of stagnation, the final quarter of the 19th century witnessed a renewed fertility transition, at the same time of the primer decline in other Western counties (identified around 1870). Bringing our attention to the 20th century, we identify a third phase in the process of fertility transition that engaged at the turn of the 1970's. From 18 children per one thousand individuals by the end of the baby boom, the crude birth rate fell to 13 children at the beginning of the 1990's.

Hence, we emphasize the existence of three major phases within the process of fertility transition in France. The first phase of the decline engaged a few years before the French Revolution. The second phase occurred in the early 1870's – right after the Franco-Prussian war. Finally, the last phase happened in the 1970's and marked the completion of the process of fertility transition.

1.3. Natural Balance of Mortality and Fertility

The understanding of the balance between variations in mortality levels and fertility rates is essential to determine the possible causes at the origin of the process of demographic transition. Chesnais (1992) advances three criteria to determine whether a country enter in the process of demographic transition (Figure 1-4). A country is considered as having entered the process of demographic transition if: *(i)* the crude birth rate declines below the threshold of 35 births per one thousand people; *(ii)* the growth rate of crude births experiences a sustained decline of at least 20%; and *(iii)* life expectancy at birth exceed the age of 50. Based on data from Chesnais and INSEE, the first criterion was already reached in 1800. The second criterion was reached in 1829. And finally, the third criterion was attained at the beginning of the 19th century – in 1907.

Figure 1-4 : Chesnais Criteria Determining the Entry in the Process of Demographic Transition



Sources: Data from Chesnais (1992) – INSEE (2007)

France is a peculiar case. We have already mentioned previously that France was the first country (with the USA) to enter the process of demographic transition but its natural growth pattern was also very different from that of other countries. During the transition, the natural increase was actually “fairly flat and maintained at around zero growth” (Chesnais, 1992). Both mortality and fertility rates declined at a similar pace. The dynamics of French population show that birth and death rates were in natural balance on three occasions between 1815 and 1914. The first demographic transition occurred in France between the French Revolution and the 1840’s (with low growth but regular – setback compared to neighbors). The following period going from 1850 to 1871 was a difficult time for the French population. This period has been strewed by crises, epidemics, wars, civil wars and hence witnessed a rise in mortality. Finally, the period going from 1871 to 1914 was characterized by the stagnation of the population around 40 million inhabitants.

Nonetheless, although the evolution of the level of the French fertility was indeed clearly different from its neighbors during the 19th century, this was not the case of the variables measuring mortality rates. Both infant mortality and crude death rates display similar pattern to those observed in other Western countries (such as England and Wales, Germany, Finland and Netherland). From now on, we focus primarily and more intensively on fertility levels. Such an important decline in fertility rates cannot be explained by a simple adjustment of individuals to mortality decline. Other factors must have come into play. In order to further our understanding of the forces underlying the fertility transition we need to understand how fertility declined Beyond the natural consequences of the decline in mortality, we choose to investigate the role played by individuals' choices. What changes in behavioral patterns can explain the evolution of fertility levels?

2. Changing Patterns of Demographic Behavior

During the demographic transition, fertility fell sharply in parallel to the decline in mortality. The data suggests the existence of significant fertility limitation in France during the 19th century. We emphasize the existence of two main types of fertility behavior according to the strategy adopted by individuals and households. Fertility regulation can be the result of traditional means of control such as sexual abstinence, delaying age at first marriage, celibacy, age at first birth. But it can also be the result of more "modern" behaviors consisting in a direct control of the number of births within marriage through spacing out interval between births or stopping child-bearing at a certain age.

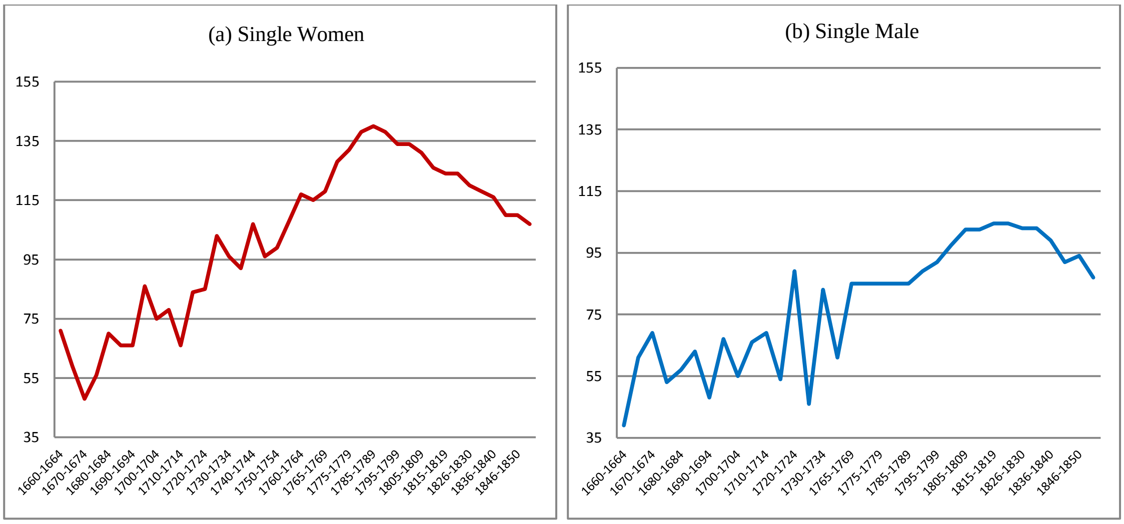
2.1. Marriage Pattern

Marriage patterns evolved over the course of the demographic transition. According to Hajnal (1965), three main features emerged from the Western European Marriage Pattern (EMP) which characterized western society in the Early Modern Period: *(i)* a high proportion of women never marrying; *(ii)* an unusually late age at first marriage for women; and *(iii)* a low rate of illegitimate births.

2.1.1. Celibacy

During the 19th century, France remained a country with an active nuptiality. However, women definitive celibacy rates were relatively high especially at the beginning of the century. Figure 1-5 depicts the evolution of female and male definitive celibacy rates. An individual is considered as definitively single when she reaches the age 50 without having ever been married. From Figure 1-5, we observe that the number of definitive celibacy increased substantially from the mid-17th century until the French Revolution, to a larger extent for women. From 48 single women per one thousand individuals in the 1670's, it reached 140 per one thousand individuals at the turn of the 1790's. In a little more than a century, the share of single women was multiplied by almost 3. Over the same period, the share of single men was multiplied by 1.3. The trend experienced a complete reversal for both genders at two different time periods. The downward trend settled clearly at the time of the French Revolution for women while it established thirty years later for men.

Figure 1-5 : Evolution of Single Women and Men



Sources: Data from Henry and Houdaille (1979)
Notes: The measure of definitive celibacy is made from the study of permanent celibacy built up from the classification of deaths of each sex for periods of five years, from 1740-1744 to 1825-1829, groups of five generations and marital status.

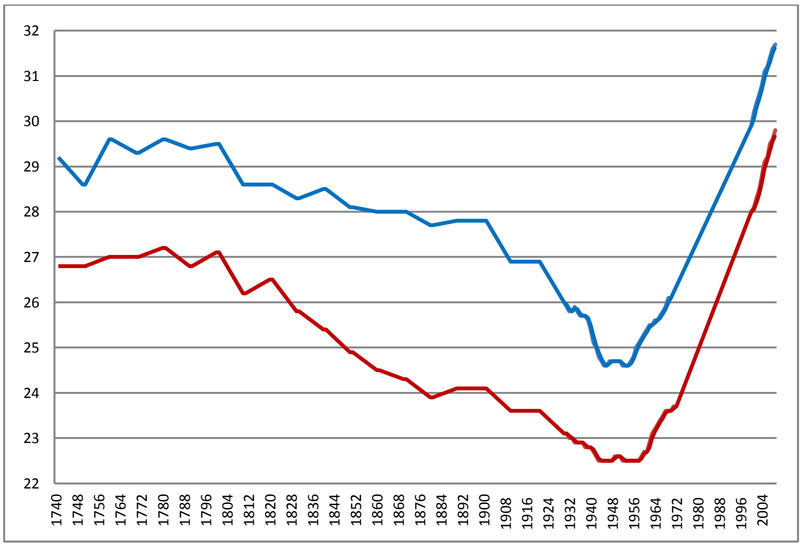
Section 3 looks more specifically at regional diversities. Section 3 shows that there exist a link between celibacy and female occupation. The increase in celibacy may be a feature of modernity contributing to an increase in individual autonomy.

2.1.2. Age at First Marriage

The second characteristic of the European marriage pattern is the rising age at first marriage. Figure 1-6 presents the evolution of the median age at marriage by gender between 1740 and 2004. The long-run evolution of the median age at first marriage for both male and female follows a U-shaped curve.

The female and male age at marriage follow a fairly similar evolution taking into consideration that men always marry older than women. The age of male at marriage reached 29 at the end of the *Ancien Régime*, while that of women reached 27. Relatively late during the second half of the 18th century, the average age at marriage dropped a few years before the turn of the 19th century – at a faster pace and to a greater extent for women (while it was briefly stabilizing around age 28 in the mid-19th century). The age at first marriage attained its lowest point in the 1950's with a median age of 22.5 for women and 24.6 for men. After a short period of stagnation at these lowest rates ever achieved (slightly longer for women than for men), the trend reversed again (from the sixties for women and a little before for men). From that moment, the rise was fast and sustained. Over the period of forty years, the median age at marriage increased by more than 7.5 years for both women and men, to reach almost 30 and 32 respectively in 2004.

Figure 1-6 : Evolution of Median Age at Marriage by Gender



Sources: Data from Henry and Houdaille (1979) – INSEE

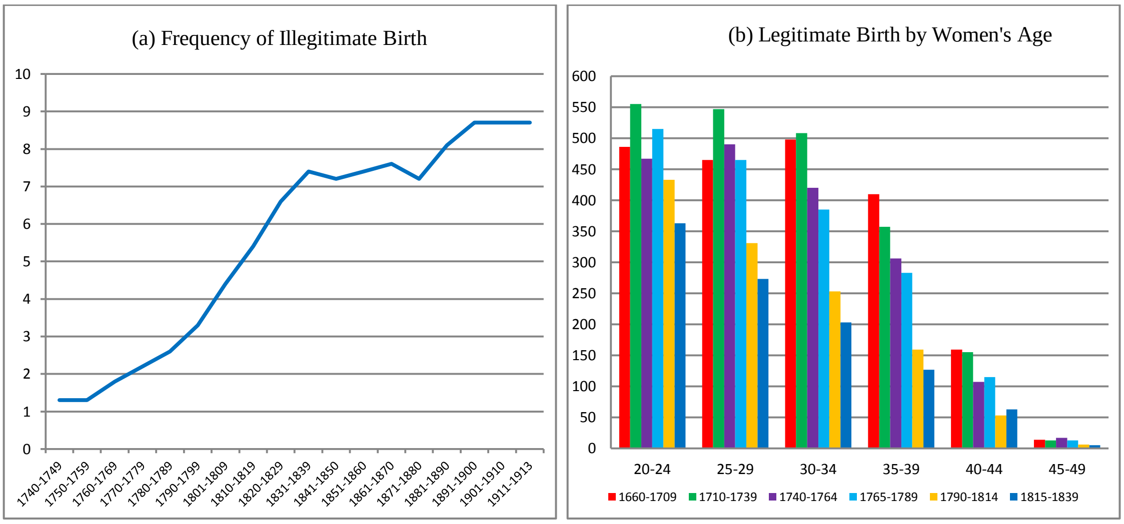
Note: Figure (b), the red curve corresponds to women and the blue curve to men

Hence, we distinguish three main periods in the evolution of age at marriage. Between 1740 and the French Revolution, we note a slight but continuous increase in the median age at marriage for both genders. Then, we observe a downward trend from the Revolution. This share can be put in perspective with the share of single women. The data we have on definitive celibacy do not allow us to investigate the evolution of celibacy during the second half of the 19th century. The data on age at marriage however show that the trend has continued to decline until the mid-20th despite a slight increase during the July Monarchy (Henry and Houdaille, 1979). Finally, the third period, starting at the mid-20th century, is characterized by a quick and drastic rise in the age at marriage.

2.1.3. Illegitimate Births

The last feature of the European marriage pattern is the low number of illegitimate births. Figure 1-7 shows the evolution of the share of illegitimate births (between 1740 and 1913) and the evolution of the number of legitimate births by women's age for six periods (between 1660 and 1839) in the city of Meulan for 1000 families. Focusing first on illegitimate births, we note that prior to the French Revolution the share of illegitimate births was fairly low. Over the 1780-1789 period, only 2.6 per one hundred births were illegitimate. The increase in the frequency of illegitimate births began already before the fateful period of the Revolution. The growth rate accelerated from that period until the 1830's. The frequency of illegitimate births then oscillated around 7.4 per 100 births. The resumption of the rise occurred in the 1870's and stabilized at 8.7 at the turn of the 20th century. Therefrom, the frequency of illegitimate births increased sharply between the mid-18th century and the beginning of the 20th century. Close from 1% on the period 1740-45, it reached almost 9% in 1911-13.

Figure 1-7 : Evolution of Illegitimate Births and Legitimate Births by Women's Age



Sources: Data from Segalen and Fine (1988) – Dupâquier and Lachiver (1969)

The decline in legitimate births occurred in parallel to the rise in the share of illegitimate births, as expected. For the first two periods, namely 1660-1709 and 1710-1739, we observe that the share of legitimate births was fairly high and relatively similar between the three first classes of women's age. The share of legitimate births is continuously decreasing for other classes of age, e.g. as women become older. Period after period, a continuous decline settled in regards with both the number of legitimate births and by women's age. Two features emerge from Figure 1-7. On the one hand, we note a continual increase in illegitimate. On the other hand, we observe a decline in fertility within marriage for women of all age groups.

Important transformations have affected the marriage pattern in France over the course of the demographic transition. We distinguish three main periods in the evolution of marriage practices since the 18th century. The **first period** – prior to the French Revolution – was characterized by the classical features of the European Marriage Pattern as it was described by Hajnal (1965). The data indicate the existence of a very large number of individuals who never married at all. More precisely, we observe a large share of definitive celibacy, to a larger extent for women (although men and women's curves follow broadly the same trend). In addition, the age at marriage was late for both genders and the frequency of illegitimate fertility was low. The **second period** started after the Revolution (in the 1790's) and lasted until the 1950's. We note a reversal in the trends observed so far. The share of definitive celibacy fell sharply (especially for women), the median age at marriage engaged on an impressive downward path. And last, the share of illegitimate births rose at a sustained pace. Therefore, over the course of the 19th century and until the mid-20th century, more people married and married younger while at the same time the number of illegitimate births was rising.

Table 1-1 : Recent Evolution of Illegitimate Births and Celibacy

Year	Illegitimate Births (in %)	Male Celibacy (Age 15 and more)	Female Celibacy (Age 15 and more)
1965	5.9	--	--
1970	6.8	--	--
1975	8.5	28.6	21.8
1980	11.4	29.2	22.4
1985	19.6	31.5	24.5
1990	31.1	34.4	27.3
1995	37.6	36.1	28.9
1998	40.7	37.2	30

Sources: Data from INED – INSEE

Finally, we emphasize the existence of a **third period** in the evolution of marriage pattern from the 1960-70's. This third period is characterized by a sharp increase in the median age at marriage for both genders but to a larger extent for women. Simultaneously, the number of births outside marriage exploded and the share of single individuals (aged 15 and more) increased significantly (see Table 1-1).

The characteristics of the marriage pattern during the first period easily explain why French women had fewer children. More women remained single their whole life or married older, the fertile period was then reduced and consequently the number of births declined. However, the effects of the downward trends observed in the second period are not as obvious – at least at first sight. Indeed, while both the number of single women and the age at marriage were falling, the fertility rate pursued its decline. Following the same reasoning as the one used for the first period, one might have expected to observe the opposite effect, e.g. a rise in fertility. In reality, the persistence of fertility decline together with the growth rates of illegitimacy suggests the evolution of fertility control (and cultural norms). The transformation of the marriage pattern would therefore reflect a deeper change, that of French society.

2.2. Birth Limitation

The evolution of the French marriage pattern since the mid-18th century suggests the existence of fertility control within marriage. The data emphasize the increasing importance and its strengthening of fertility control during the second period of the French marriage pattern.

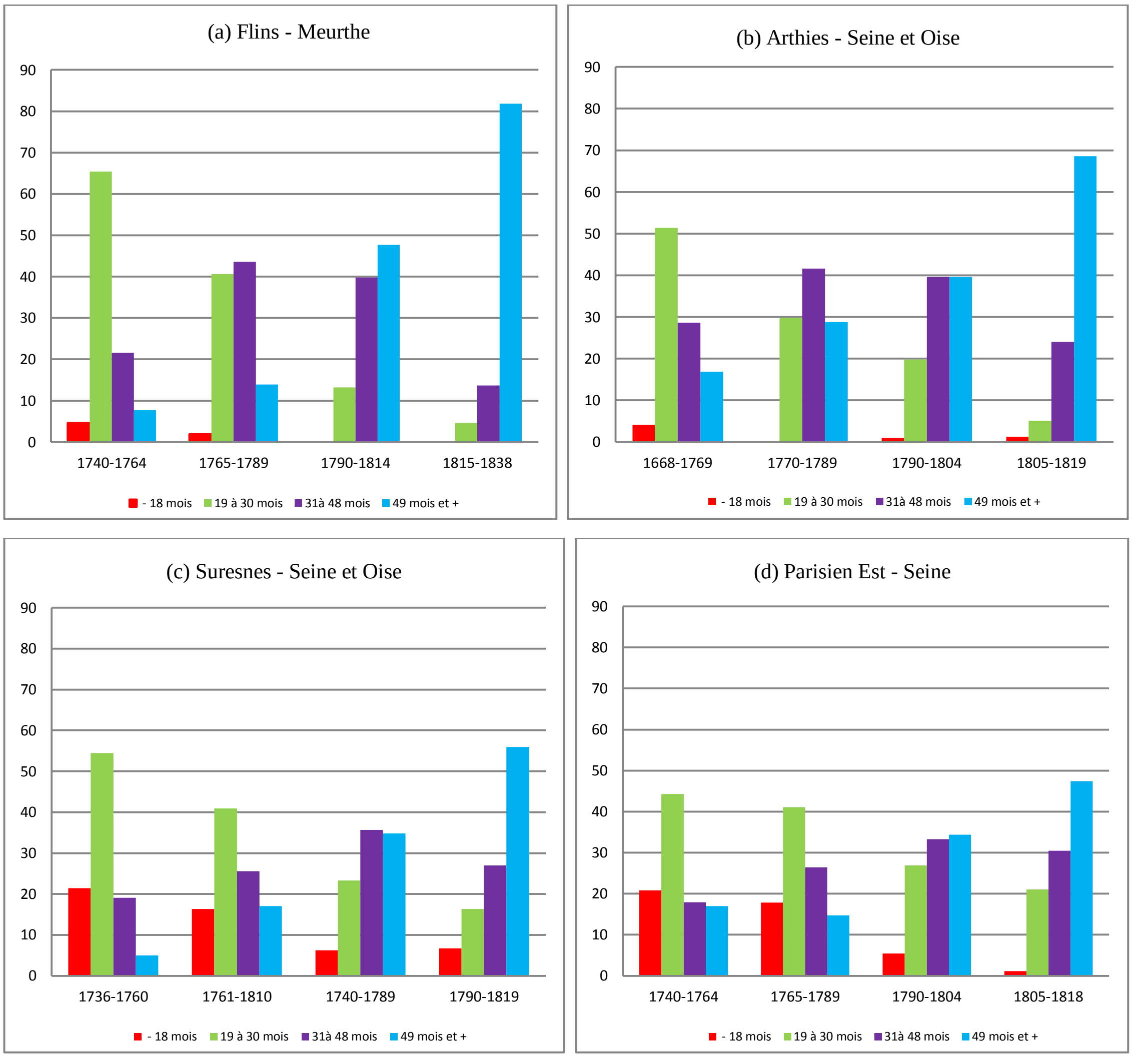
2.2.1. Early Contraception – Birth Control

An alternative method of fertility limitation via nuptiality is to act directly on the number of births within marriage. A classical measure of birth limitation consists in investigating birth intervals and age at last birth. The study of the evolution of birth interval reflects changes in households' behaviors regarding fertility.

Dûpaquier and Lachiver (1969) have highlighted the existence of early birth control and notably an incipient of flexure from the mid-18th century in their study of families living in the city of Meulan (Seine-et-Oise). From the mid-18th century indeed, the share of couples displaying close (less than 18 month) and medium (between 19 and 30 month) birth interval declined. Between the periods 1669-1709 and 1790-1814, the share of couples with short birth interval dropped from 11.6% to 2.9% and that of couples with medium interval from 60.2% to 23.5%. On the contrary, long (31 to 48 months) and very long (49 months and more) birth interval increased, from 18.8% to 27.1% and from 9.4% to 59.4% respectively.[7] Meulan is not an isolated case, similar trends are also observed in other cities such as Flins, Arthies, Suresnes and Paris-East, as can be observed in the following set of figures. Figure 1-8 presents the evolution by periods of births spacing in these four cities between the 18th century and the early 19th century. It is important to specify that all these cities are located in three of the most urbanized and early industrialized areas of France. We can imagine that the demographic behavior and the timing of birth limitation may differ from other regions of France with other characteristics, for instance more rural and agrarian areas. The study of the geographical distribution of Malthusian behaviors in Section 3 will help us with the understanding of the specificities of French areas.

[7] Couples with birth-to-pregancy interval higher than 49 months are considered either infertile or controlling births.

Figure 1-8 : Evolution of Birth Spacing in Four Cities



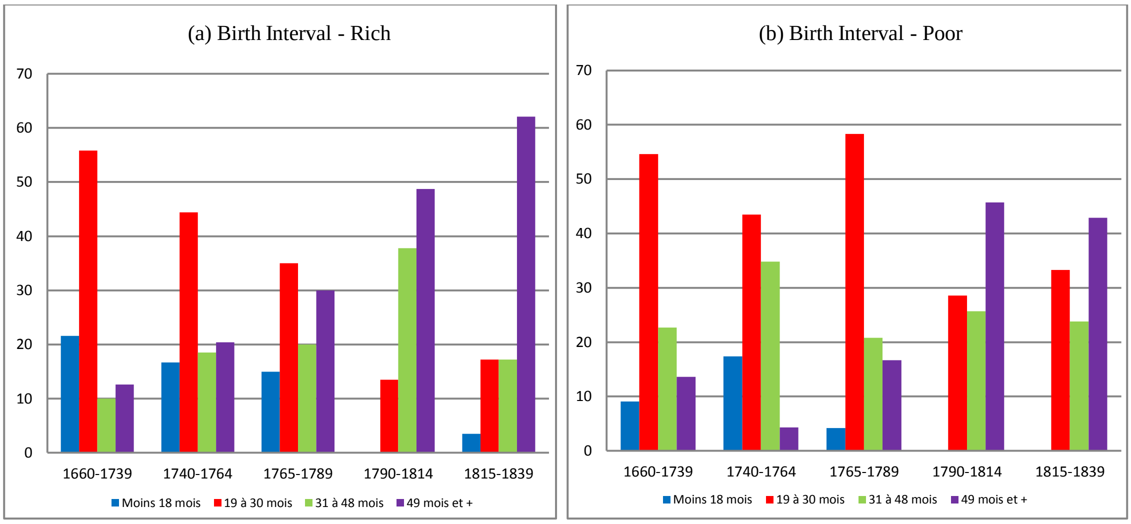
Sources: Data in Flandrin (1984)

Although the behavior of couples started to change from the middle of the 18th century, the break occurred during the last decade of the century. Hence, the share of couples with long and very long birth-to-pregnancy intervals exceeded that of medium intervals that dominated so far. The data suggest that about half of the couples started to adopt the behavior of controlling births within marriage from the beginning of the 19th century.

2.2.2. Birth Intervals between Rich and Poor

As suggested by Clark (2007) and empirically investigated by Boberg-Fazlic, Sharp and Weisdorf (2011) for England, fertility behavior might have differed between individuals according to their social status or to the social group they belong to. As a consequence, changes in fertility behavior in France might also differ between individuals according to their (socio)-economic status.

Figure 1-9 : Average Birth Interval by Economic Status in Meulan



Sources: Data from Lachiver (1969)

Figure 1-9 shows the differences on the average length of birth interval between rich and poor individuals. Two main phases, as seen in the previous sub-section, emerge from the study of spacing interval by economic status: a decline in shorter intervals in favor of longer intervals. However, we observe that the trends are much more clear (fewer variations) for rich than for poor individuals. Over the period 1660-1739, the share of wealthier households had shorter intervals between consecutive births than poorer households similar to what Boberg-Fazlic, Sharp and Weisdorf found about England. Hence, 22% of rich households against 9% of poor households had spacing intervals below 18 months. On the contrary, poorer couples displayed larger intervals: 23% of poor households against 10% of rich households had spacing intervals between 31 and 48 months. Hence, wealthier individuals were more likely to have a larger fertility than poorer individuals. This was also probably linked to the habits of wealthier individuals to send their infants to nurses (Flandrin, 1984).

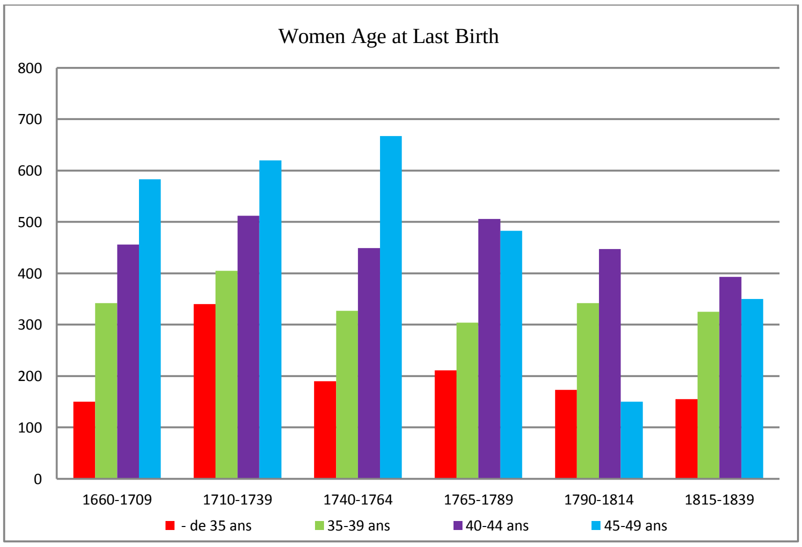
This pattern reversed over time. Wealthier households then had longer birth-to-pregnancy interval. Over the period 1815-1839, 62% of wealthier households exhibited very long spacing interval (above 49 months) against only 43% of poorer households. The share of poorer households with medium birth spacing (19-30 months) reached 33% against 17% for wealthier households. As a consequence, one might expect wealthier individuals to have had a lower fertility than poorer individuals during this time period. Birth regulation through birth spacing seems to have occurred earlier for wealthier couples than for poorer ones.

2.2.3. Women Age at Last Birth

Fertility may also depend on the length of fertile period and on the moment at which individuals decide to stop having children. Figure 1-10 illustrates the average mothers' age at last pregnancy in four villages of the Morvan (Côte-d'Or) between 1660 and 1839. More precisely, it displays the maximum number of living children at last pregnancy per 100 households.[8] We observe that if the number of women with a short (stopped before the age of 35) or medium (stopped at class age of 35-39) fertile period remained rather stable over the considered time period, that of long (stopped at class age of 40-44) and very long (stopped at class age of 45-49) fertile period decreased significantly during the second half on the 18th century. Couples who stopped to have children after class age of 35-40 are considered as limiting their fertility (Bardet, 1988).

According to Dupâquier and Lachiver (1969), in a situation of generalized Malthusianism resulting from a decline in infant mortality, households should exhibit about the same dimension at last pregnancy. Therefore, if all children survive, this situation should occur at young age for women. From Figure 1-10, we observe that the gap in terms of number of living children indeed reduced over time between female age-groups – suggesting the existence of Malthusian behaviors. However, the persistence of a difference even smaller suggests that not the entire population behave in such a way.

Figure 1-10 : Women Age at Last Pregnancy in Four Morvan Villages



Sources: Data from Dupâquier and Lachiver (1969)

[8] Number of living children at the last pregnancy for a 100 households during the last five years of conjugal life (women married before age 30)

Decline in adult and infant mortality has probably been a necessary condition for fertility decline but is not a sufficient condition to explain the drop in fertility rates observed in France. The data tend to suggest that the fall of fertility would mainly result from a behavioral change of individuals regarding fertility.

To summarize the observations made in this section, we have found that fertility transition occurred in three steps: *(i)* a little before the turn of the 19th century, fertility started to drop certainly triggered by a combination of "traditional" limitation of fertility (via nuptiality) additionally to early contraceptive behavior (within marriage); *(ii)* the second phase of fertility decline, around 1871, suggests a "generalization" of early contraception: deployment of birth spacing and stopping early births; *(iii)* the last stage of the fertility transition occurred in the sixties-seventies linked to the commercialization of chemical contraception, sexual and cultural revolution – in parallel to sharp increases in female educational investments (this is discussed in Chapter 3). Hence during a large part of the 18th century, individuals have authentically acted in a Malthusian way, accepting more and more late marriage and definitive celibacy in parallel to the fall in infant mortality – to maintain a sustainable number of offspring (adaptation behavior). This may explain why the fertility decline was not observed before the French Revolution. The decline in the median age at marriage as well as the decline in the proportion of celibacy can be explained by the adoption of contraceptive behaviors within marriage to maintain the "virtuous system". But this does not explain why fertility declined. Why did individuals decide to have fewer children than in previous time? The implications of the transformation of the marriage pattern suggest an increasing equality between genders within the household, maybe due to the integration of women into market activities (this is discussed in Chapter 2). The evolution of the marriage pattern could reflect the timing of the foundations of the female emancipation movement that occurred during the 19th and 20th centuries (this issue is discussed in Chapter 4).

Having a better understanding of the French fertility transition is complicated at the national level. France combines an important diversity on various aspects and at several levels. Section 3 aims at providing a more complete picture of the diversity of situations in France based on a county-level analysis.

3. Transformations of the French Demographic Landscape

The study of the diversity of regional behaviors provides a better understanding of the dynamics of demographic behaviors based on the heterogeneity of the French districts. The recourse to spatial distribution enables us to draw a more complete and accurate picture of demographic changes. Therefore, it may help capturing some of the possible causes and determinants of the transformation of France along the economic transition, and the associated socio-economic, anthropological and cultural changes.

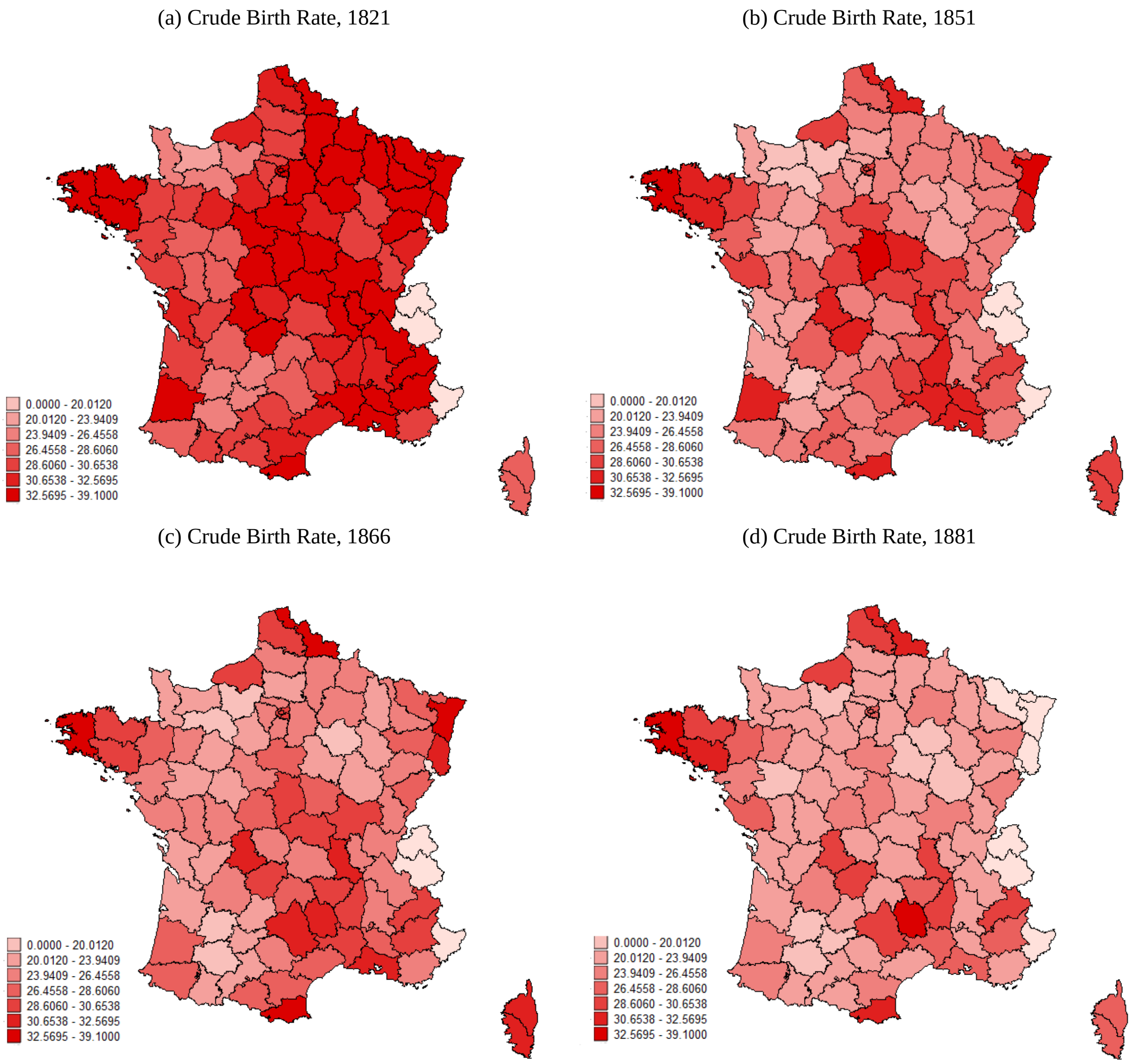
3.1. Geographical Distribution of Fertility Rates

The spatial distribution of French population displays an opposition between Northern and Southern France (French Revolution increased the distortions at the expense of the Western part of the country). In 1801, 25% of the population lives in 12 departments (there is 86 departments in total) located in the Northwest of France, from the Loire estuary to the North, Bretagne, Normandie and the North of the *région parisienne* (Garden and Lebras, 1988). In 1911, the population of 7 counties only was necessary to get the quarter of the French population, namely Seine, Seine-et-Oise, Nord, Pas-de-Calais, Gironde, Rhône, Seine-Inférieure (most urbanized and industrialized areas of France). The increase in population has certainly been triggered by the urban expansion. The development of industry and trade goes hand in hand with the expansion of cities.

The crude birth rates are mapped for 86 French districts for four years between 1821 and 1881. The crude birth rate is built up by taking the ratio between the number of births in a year and the population (results are expressed per one thousand individuals). Empirically the demographic transition is characterized by the decline in both birth and death rates from a range of 30 to 40 per one thousand individuals to less than 10 (Livi-Bacci, 1997). A crude birth rate close to 40 can be considered as a natural level of fertility. The natural fertility is the level of fertility that would prevail in a population making no conscious effort to limit, regulate or control fertility (Henry, 1961). Hence the populations practicing fertility control should have lower fertility rates than the populations with natural fertility levels.

Figure 1-11 illustrates the decline in fertility among French districts over the course of the 19th century. Almost all counties show clear downward trends. In 1821, 33 counties over 86 exhibited a crude birth rate below 30 children per thousand individuals. A lighter red band emerged on the Western part of the country despite a few districts or region displaying high fertility rates, such as Landes and Bretagne. Calvados is the district displaying the lowest crude birth rate with 22.7 children per one thousand inhabitants. Sixty years later, in 1881, only Ardèche, Corrèze, Finistère, Lozère, Morbihan, Nord and Pyrénées-Orientales remained above 30 children per 1000 inhabitants. A crude birth rate of 30 children per one thousand individuals is a level by which we can distinguish counties using birth control from those that do not. Above this level, it is likely that only a very small share of the population use fertility control. Conversely, a crude birth rate below 20 children per one thousand individuals suggests that a large share of the population practice birth control (Chesnais, 1992). Hence counties experiencing a fertility transition should exhibit intermediate crude birth rates ranged between 30 and 20 per one thousand individuals.

Figure 1-11: Evolution of Crude Birth Rates between 1821 and 1881



Sources: Own calculations – Using data from Statistiques Générales de la France – Censuses

We observe a fertility transition for most counties over the studied period. The maps of France become clearer over time.[9] Districts located in the center as well as on the coasts and borders of the country took more time to experience the transition. In 1851, three-quarters of the counties had a crude birth rate below 30 and among them 27 were already below 25 children per thousand people (with Calvados, Eure and Orne below 20). Fertility decline continued, and even

[9] Darker red corresponds to higher fertility rates; clearer red corresponds to lower fertility rates.

accelerated for South-Center districts. On the other hand, strong demographic growth was observed in Bretagne, Limousin and Cher during the 19th century. In 1881, eight counties exhibited a crude birth rate below 20: Aube, Cote-d'Or, Eure, Gers, Lot-et-Garonne, Maine-et-Loire, Tarn-et-Garonne and Yonne.

Counties located in the extremities of the country tend to have a higher fertility rate. This might not be a coincidence but rather result from a higher autonomy of these areas – giving a higher importance to cultural factors such as family attachment or Church (which inhibits new habits coming from Paris or other big cities). The two coexisting types of counties (one with low fertility and the other with high fertility) could be explained by a temporal lag of evolutions. The geographical distribution of crude birth rates suggests that the decline in fertility engaged in the Northeastern part of France (see Figure A-2 in Appendix) and then diffused to the rest of the country.

Rural and urban areas seem to have mattered in the evolution of birth rates. During the 18th century, the decline in fertility tended to be an urban phenomenon. The decline started in urban areas a long time before countryside. The social status of individuals also seems to have mattered. Richer urban individuals who were more used to send their children to nurses in the countryside managed to control their fertility (Flandrin, 1984). More modest individuals only managed to correct theirs. We observe a staggering contrast between the contraceptive advances of elites and the generous fertility of urban popular classes (who have a sensitive propensity to control birth). This difference increased during the 19th century. Rural people tended to be more inclined than urban people to choose a restriction of their offspring. Rural areas were in advance in terms of birth control. In some places like England, Germany or Northern France, the growth of industry stimulated fertility. In other places, such as the Parisian region or in Southern big cities, migration has been stimulated in a context of low fertility. Therefore, they are not stable equilibriums but two different steps evolution with two repulsive areas and two attractive areas (Garden and Lebras, 1988). Everywhere the transition toward low fertility has then been increasing. Ultimately, the joined effects allowed jumping the demographic equilibrium zone that separated Northern France and Southern France (line from Vendée and Loire-Inférieure to the region of Lyon with positive imbalance until 1891, followed by a demographic collapse) and brought to the unification of the territory. In any case, both urbanized and rural areas reduce their fertility during the 19th century.

The beginning of the 19th century was characterized by a strong heterogeneity between counties. Several successive demographic transitions have occurred within France over the course of the century. In addition to the delay of some districts to go through demographic transition, we note distinctive behavioral patterns – constituting geographical areas with specific levels of fertility (very different among them). The first counties to experience the fertility transition are likely to have undergone social, economic, cultural and institutional changes that have encouraged fertility limitation. The homogenization of fertility behavior seems to be growing over time. From the 1880's, fertility behavior were standardized. Counties evolved over time closer to the national pattern.

What does the heterogeneity of French counties observed during most of the 19th century explain? Why did the fertility decline differ in terms of timing and speed among districts? Why did the fertility decline differ in terms of space?

3.2. Explaining Geographical Differences in Fertility Decline

3.2.1. Specific Initial Demographic Characteristics

Over the course of the 18th and 19th centuries, we have seen that the crude birth rates were adjusting to infant mortality. At the county-level, differences in infant mortality should also have an impact on fertility. Other demographic reasons may have impacted fertility rates such as the sex ratio.

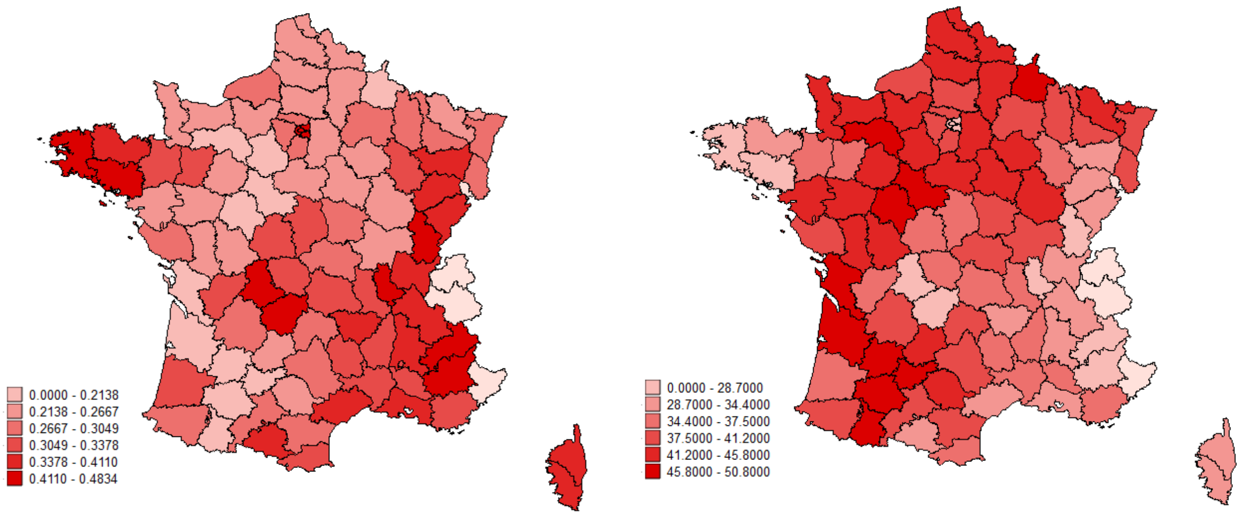
Mortality

Figure 1-12 shows the geographical distribution of the infant mortality and life expectancy at birth in 1851. Infant mortality is measured as the number of deaths of children under the age of one per live births. Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of his birth were to stay the same throughout its life (World Bank).

In 1851, the average level of infant mortality was of 30 deaths per 100 births. That of life expectancy at birth was 38.79. Regional variations were important. On the one hand, several areas emerged from the study of Figure 1-12: Seine, Bretagne, Center and the East border (to the exception of Alsace) of France indicate higher infant mortality rates and life expectancy than in the rest of France – above national levels. In particular, Hautes and Basses-Alpes, Corrèze, Finistère, Jura, Rhône, Seine and Haute-Vienne show infant mortality rates above 40 deaths per 100 births and a life expectancy below the age of 30. On the other hand, counties such as Charente-Inférieure, Gers, Gironde, Indre-et-Loire, Lot-et-Garonne, Orne, Hautes-Pyrénées and Tarn-et-Garonne were characterized by low level of infant mortality, below 20%, and a life expectancy above the age of 47 (even above the age of 50 in Gironde, Lot-et-Garonne, Orne and Tarn-et-Garonne).

Figure 1-12 : Geographical Distribution of Infant Mortality and Longevity, 1851

(a) Infant Mortality (b) Life expectancy at Age 0



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851; Data from INED

Furthermore, infant mortality rates and life expectancy present significant similarities with the map of crude birth rates in 1851. Counties characterized by higher fertility levels tend to display higher share of infant mortality and lower life expectancy at birth. Nonetheless, if we compare carefully the map of infant mortality with that of crude birth rate, we note that this positive causal relationship does not work for all counties. For instance, counties lying on the Eastern border such as Ain, Doubs, Haute-Saône, Isère, Jura and Vosges display high infant mortality but low fertility rates (Figure 1-11(b)).

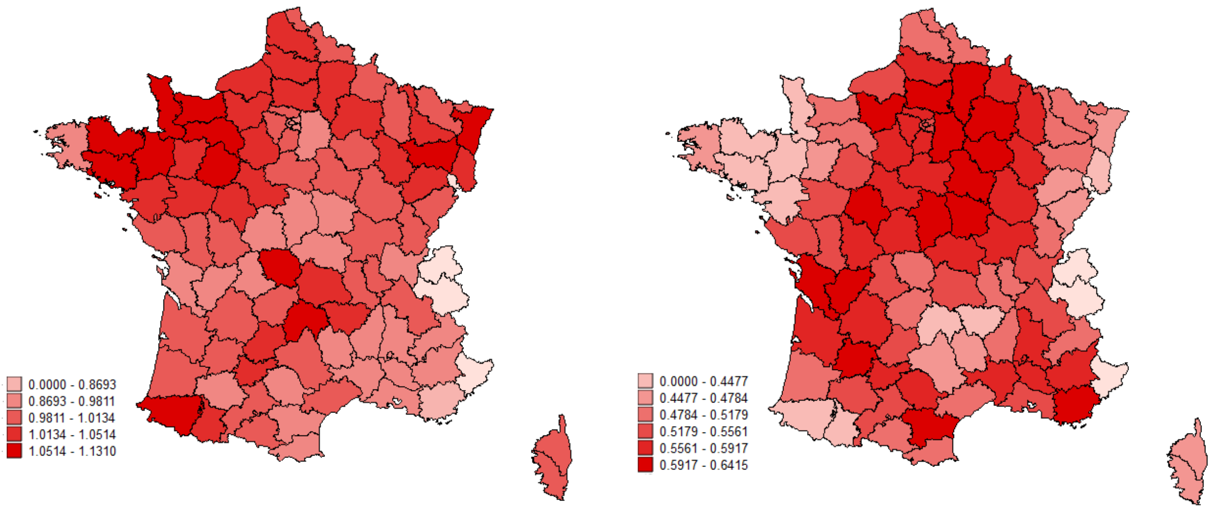
Sex Ratio

Other demographic reasons may be advanced to explain fertility differential among districts. Hence, the sex ratio is likely to have played negatively on fertility by inducing a female-to-male matching problem. Figure 1-13 shows the geographical distribution of the sex imbalance ratio and the share of married women in France in 1851. The sex ratio is the ratio of number of female divided by the number of male in the French population.

For most societies, the average sex ratio is 0.9 (Fisher's principle, see Fisher, 1930). The 1851 average national level was 1.01. The existence of "male scarcity" can be a reason explaining geographical differences of fertility. Important differences in the level of sex-ratio are observed at a disaggregated level. Darkest counties (Figure 1-13 a) indicate a gender disequilibrium in favor of women. Among these districts, we find mainly Northern, Center and Southwestern counties, such as Calvados, Cantal, Côtes-du-Nord, Ile-et-Vilaine, Morbihan, Orne, Basses-Pyrénées, Bas-Rhin, Sarthe and Vosges.

Figure 1-13 : Geographical Distribution of Sex Ratio and Share Married Women in 1851

(a) Sex Ratio (b) Share of Married Women



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851

This gender disequilibrium may have induced a problem of marital matching likely to explain some of fertility discrepancies observed among districts. Nonetheless, the geographical distribution of the share of married women indicates that some counties with a sex-ratio close to the equilibrium yet exhibited a low share of married women. This was notably the case of Ariège, Aveyron, Corse, Doubs, Finistère, Hautes-Alpes and Moselle. On the contrary, counties such as Calvados or Sarthe had a large sex imbalance ratio but still high share of married women.

According to the adaptation hypothesis (Bonneuil, 1997), individuals might resort to fertility control in reaction to changes in economic and social circumstances, such as decline in infant mortality among others; this hypothesis is confirmed in this section. However, it cannot fully explain the intensity of the fertility decline. Most importantly, some counties exhibit low infant mortality and balanced sex-ratio but display low fertility while other counties depict high infant mortality, balanced sex ratio and low fertility rates. Therefore, additional factors to initial county-level demographic specificities, such as infant mortality and sex ratio, must have had an impact on fertility. Before going further in the investigation of these additional reasons influencing fertility behaviors, we will first study how French people have regulated their fertility.

3.2.2. Fertility Regulation

Section 2 discussed the different strategies of access to fertility control. The two main strategies of fertility limitation are usually advanced when trying to explain fertility transition. A more traditional way to regulate fertility consists in acting on marriage: Malthusianism. A more modern way of controlling fertility consists in playing with the level of fertility within marriage: birth control.

Malthusianism – "Adaptation" – Traditional mean/mechanism of control

In the traditional family economic system, marriage was considered as the ultimate control mechanism on fertility (Van de Walle, 1986). For Malthus (and contemporaneous authors), the share of single and the age at marriage were the perfect mechanism allowing individuals to adjust their fertility. The geographical distribution of fertility rates depicted in Figure 1-14 shows a strong heterogeneity of fertility rates among French counties. Such differences in fertility levels might be explained by the existence of several system of nuptiality. As emphasized in Section 2.1., the marriage pattern changed in the course of demographic transition. Marriage patterns differ also considerably across counties. In this section, we examine evidence from county-level data, for the year 1851, in order to determine whether particular characteristics observed about French counties in terms of celibacy, age at marriage and illegitimate births might have indeed impacted fertility rates. Figure 1-14 shows the geographical distribution of marriage patterns across French districts in 1851. More precisely, it maps the celibacy of young women, definitive celibacy[10] and the age at first marriage for both women and men. The celibacy of young women represents the share of women aged 15-35 who are single per 100 women.

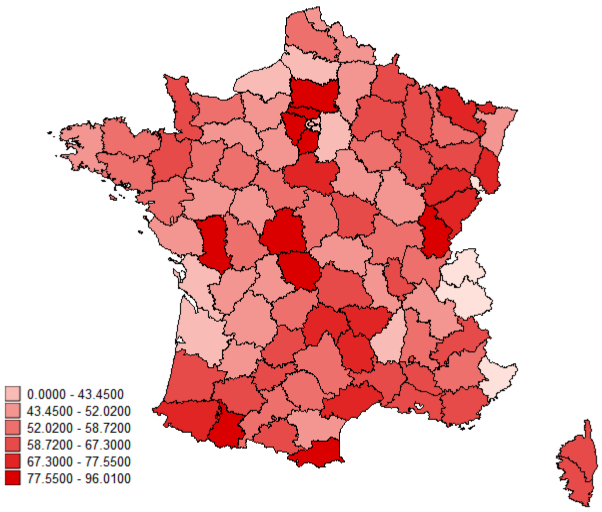
Celibacy. – The gap in female definitive celibacy was large between French districts. With the migrations toward cities, the share of single women tended to be lower in rural areas and higher in urban zones. Old single women were two to three times more numerous in urban than in rural areas (Henry and Houdaille, 1979). Three main regions emerge from the study of female definitive celibacy: *(i)* 14 counties, mainly located in Bretagne, Normandie, Pays de la Loire; Massif-Central and Southwest, displayed a share of female definitive celibacy above 17%; *(ii)* in Nord Pas-de-Calais, Northeast, and Parisian Region, the share of female definitive celibacy ranged between 12% and 15%; *(iii)* in the rest of France (Midi Mediterranean region, Centre,

[10] The definitive celibacy is the share of women aged 50 and more who are single per 100 women.

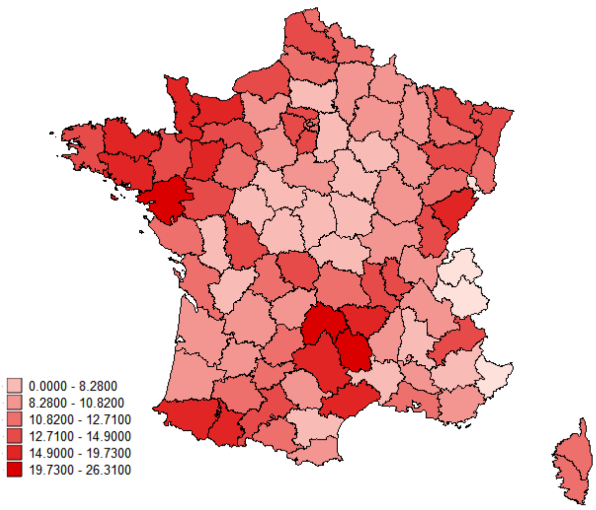
Bourgogne), the share of female definitive celibacy was very low. Depending on the counties, from 5 to 11 women over 100 remained single their whole lives.

Figure 1-14 : Geographical Distribution of Marriage Patterns in 1851

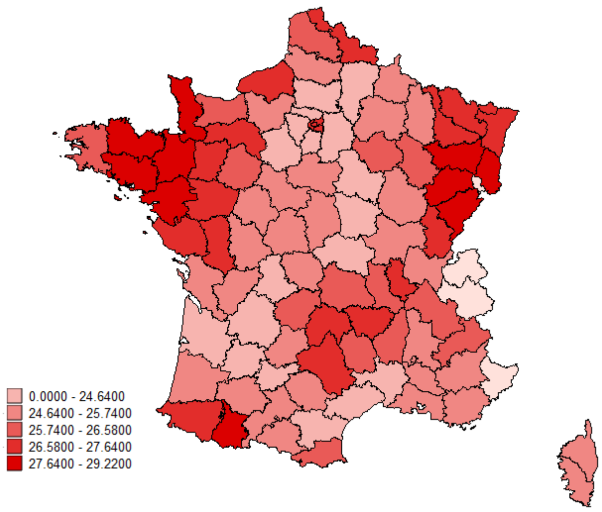
(a) Celibacy of Young Women



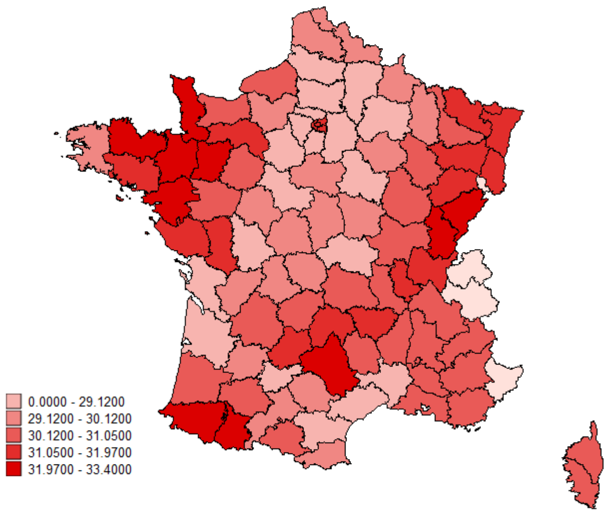
(b) Women Definitive Celibacy



(c) Female Median Age at Marriage, 1859



(d) Male Median Age at Marriage, 1859



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851

Median age at marriage. – As already observed at the aggregate level, the age at marriage differed greatly between genders. Women married on average four years younger than men, 26.13 against 30.5 respectively in 1859. However, the distribution of median age at marriage across districts was strongly similar. Both men and women were marrying at an older age in some parts of France, namely in Paris, Northwest, Northeast and South-Center of France. Strong differences appear between counties as well as between countryside and urban zones. In 1854, the medium age at marriage was nearly 28 for boys and 24 for girls in rural areas, and 28 and a half for boys and a bit more than 24 and a half for girls in urban zones (Segalen, 1988). The geographical distribution of median age at marriage (Figure 1-14 c and d) is somewhat similar to that of female definitive celibacy. Areas with higher proportions of female definitive celibacy tend to exhibit later medium age at marriage. Focusing on female median age at marriage, we distinguish three main regions: *(i)* areas with late female median age at marriage – above 27.64 composed by Northwest counties: Ille-et-Vilaine, Côtes-du-Nord, Loire-Inférieure, Morbihan, Manche; Northeast counties: Haut-Rhin, Doubs, Haute-Saône, Vosges; Southwest: Hautes-Pyrénées; *(ii)* areas with an age at marriage ranging between 26.7 and 27.64, which is mainly composed with counties having a border with the ones quoted in *(i)* in addition to Seine, North and Massif Central; *(iii)* the rest of France exhibit a lower median age at marriage belonging to the interval [23.6-26.5].

Therefore, several particular characteristics emerge from the study of marriage patterns across French districts in the 1850's. Marriage at a significantly later age together with high share of female definitive celibacy can explain fairly large variations in fertility from one district to another. The geographical distribution of county-level data also suggests that the age at marriage and definitive celibacy might have been influenced by the sex ratio and by the share of married women (Figure 1-13). In the traditional family economic system, marriage was considered as the ultimate control mechanism of fertility (Van de Walle, 1986). However, the mapping shows that births are also limited in counties where the share of married women is among the highest. This finding suggests that early birth control might have been used in specific French areas in parallel to the use of traditional "Malthusian" regulation in others.

Birth control – "Innovation diffusion" – Modern mean of control

According to the innovation diffusion hypothesis (Carlson, 1966), fertility transition is the consequence of new behaviors and new knowledge, changes in culture or attitude toward fertility. This new behavior is reflected by fertility limitation within marriage.

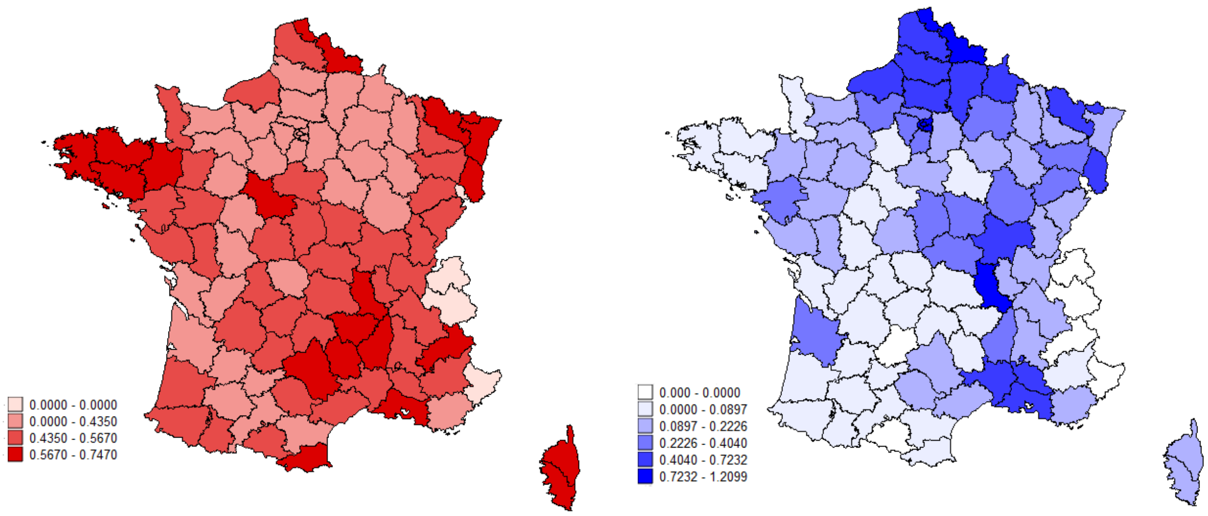
Figure 1-15 displays the geographical distribution of the index of marital fertility in 1851. The I_g index is a standardized measure of fertility. It measures how close is the marital fertility of a population comparatively to the fertility of Hutterites.[11] An I_g equal to 1 indicates that individuals married early and did not practice birth control. As long as the index is above 0.6, the population is considered as not controlling its fertility; below 0.6 indicates that the population is practicing marital fertility control (Wetherell, 2001). In greater details, a county with an I_g belonging to the interval [0.7-0.8] is considered has having a population with very

[11] Hutterites are Christians of the Radical Reformation of the 16th century in Europe – Anabaptists. Hutterites are male-managed. Women take care of traditional rules. Hutterites families are characterized by very high fertility rates, around 10 children per family.

high marital fertility. A county with an I_g belonging to the interval [0.3-0.4] indicate large childbearing restrictions within marriage – the marital fertility of the considered population is 30% to 40% of Hutterites marital fertility.

Figure 1-15 : Geographical Distribution of Marital Fertility Index and Proto-industrialization

(a) Index of Marital Fertility (I_g), 1851 (b) Proto-industrialization, 1861



Sources: Data from Coale and Watkins, 1986 – Statistiques Générales de la France, 1861

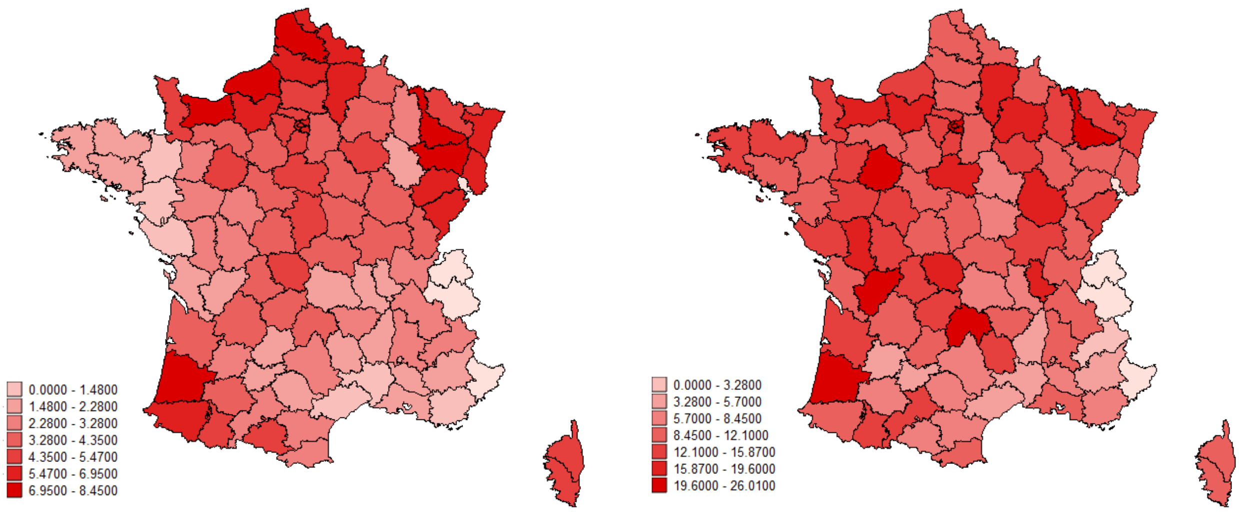
Several counties do not seem to control their fertility and exhibit an I_g index above 0.6, namely Haut-Rhin[12], Bas-Rhin, Côtes-du-Nord, Ille-et-Vilaine, Finistère, Ardèche, Morbihan, Lozère, Nord, Loire, Bouches-du-Rhône, Corse, Loir-et-Cher, Pyrénées-Orientales, Hautes-Alpes, Haute-Loire, Aveyron. On the contrary, birth control is clear in the areas surrounding the region of Paris as well as in the Garonne river valley and on some part of the Mediterranean. Some counties display very low marital index, below 0.4. It is notably the case for Aisne, Seine-et-Oise, Charente-Inférieure, Orne, Sarthe, Charente, Calvados, Oise, Seine, Indre-et-Loire, Gironde, Aube, Gers, Tarn-et-Garonne, Eure and Lot-et-Garonne. We have already raised evidence on the fact that individuals leaving in the most urbanized and industrialized areas of France, particularly in Seine marry younger and have a high fertility rate. Nonetheless, looking at the geographical distribution of birth control, we see that individuals living in Seine seem to control the number of births within marriage. The index of marital fertility in Seine for instance is low: 0.35. The high level of fertility observed in this county is then likely to be due to high levels of illegitimate births rather than an absence of birth control. The need for workforce is an argument often used to explain the large fertility rates in urbanized areas. In working class families, having more children is a result of an economic need to bring wages, hence to increase family budget. It may have been the case in Loire, Nord or Bouches-du-Rhône – where the

[12] Haut-Rhin is the district with the highest I_g: 0.747; Lot-et-Garonne is the district with the lowest I_g: 0.298.

textile industry is highly developed (Figure 1-15 b; the proxy for proto-industrialization is calculated by taking the ratio of steam engines per thousand people).[13] These three districts indicate large fertility and high index of marital fertility (above 0.65) suggesting no birth control. However, evidence observed in Seine highlights a different pattern. After 1850, with the dislocation of the family pattern of proto-industrialization starts the industrialization. This is the end of dispersed industries and the beginning of emigration toward manufactures of cities from the 2nd half of the 19th century.

Figure 1-16 : Spatial Distribution of Illegitimate Births in Rural and Urban Areas

(a) Illegitimate Births, Rural Areas (b) Illegitimate Births, Urban Areas



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851

Figure 1-16 maps the share of illegitimate births in rural and urban areas. The share of illegitimate births is calculated by taking the ratio of illegitimate births per one hundred births. The share of illegitimate births differs sharply between rural and urban areas. The proportion of illegitimate birth in rural areas is fairly lower than the one observed in urban areas. 65 counties exhibit a share of illegitimate birth in rural areas below 5% while only 3 counties display a share below 5% in urban areas (Basses-Alpes, Hautes-Alpes and Tarn-et-Garonne). Districts with the highest share of rural illegitimate births are mainly located in Northeastern France and to a lesser extent in the Southwest. Hence Calvados, Landes, Meurthe, Pas-de-Calais, Seine-Inférieure and Vosges exhibit a share of rural illegitimate births above 7.5 per one hundred births. The demarcation line Le Havre-Geneva which was already observed in previous sections tends to appear here again.

[13] The degree of industrialization and urbanization differ across counties in France. The North of France is characterized by industrialization with human concentration; elsewhere industrialization made on a rural basis, closer to proto-industrialization with no wild urbanization.

The share of illegitimate births is much larger in cities than in villages. Half of the counties display illegitimate births rates higher than 12% in urban areas. Though counties with a higher proportion of large cities and which are more industrialized are more likely to have a higher proportion of illegitimate births. It is notably the case of Landes, Meurthe, Sarthe and Seine with a share of illegitimate birth larger than 20% in urban areas. High share of illegitimate births in urban areas might be linked to the rise of the poor workforce in those areas (what increases most importantly in Northern France with the industrialization).

Therefrom, we can distinguish between two ways of limiting fertility: the effect of nuptiality (in Bretagne for example) – the one advocated by Malthus through celibacy and late marriage – and the effect of birth limitation (in the region of Paris or Garonne valley) – a rare case of intermediate strategy combining late age at marriage and fertility limitation is also observed, for example in Manche. According to Alter (1992), the fertility transition can be interpreted as "a shift in the mechanism of population control from restriction of marriage to limitation of childbearing within marriage". But what triggered this shift? What accounts for the persistence of Malthusian behavior in some counties and the shift to birth control in other counties? Numerous factors might have impacted the marriage pattern and fertility rates: socio-economic constraints, occupational opportunities, cultural factors, customs, religious practices and system of inheritance.

3.2.3. Explaining Geographic Differences in Marriage Pattern

Some counties seem to have experienced an ordinary Malthusianism, others not. The diversity observed among French counties could find its source in the originality of the socio-economic structure of France. What county-level specificities can explain the existence of different patterns of fertility limitation?

Role of the religion

To understand the evolution of demographic patterns, it is important to know more about family, sexuality and sexual practices. Hence, we need to investigate the evolution of religious practices and their geographical disparities; these two variables being deeply linked to individuals' behavior. The Church marriage is sacred. Contraception is forbidden and sex is not allowed outside marriage. However, taking into account the difficulty of life for peasant families and their limited resources (Lebras and Todd, 2013), the Church allows women to delay their marriage in order to avoid having too many children. There exists a demographic ideal type of catholic family characterized by a late age at marriage, high fertility and low illegitimate births. Hence, the rise in illegitimate births together with the decline in the “traditional” marriage pattern marks a break in religious practices.

Figure 1-17 maps county-level religious practices. The study of the spatial distribution of the share of Catholics and Protestants as well as the share of juror priests in 1791 should give us a fairly good idea of regional specificities in terms of religious practices. The share of juror priests is likely to be a better measurement of religious sentiment as it may reflect the greater or lesser pressure exercised by inhabitants on the priest. In more religious areas we can indeed expect the faithful of the parish to pressure their priest not to pledge allegiance to the Constitution.

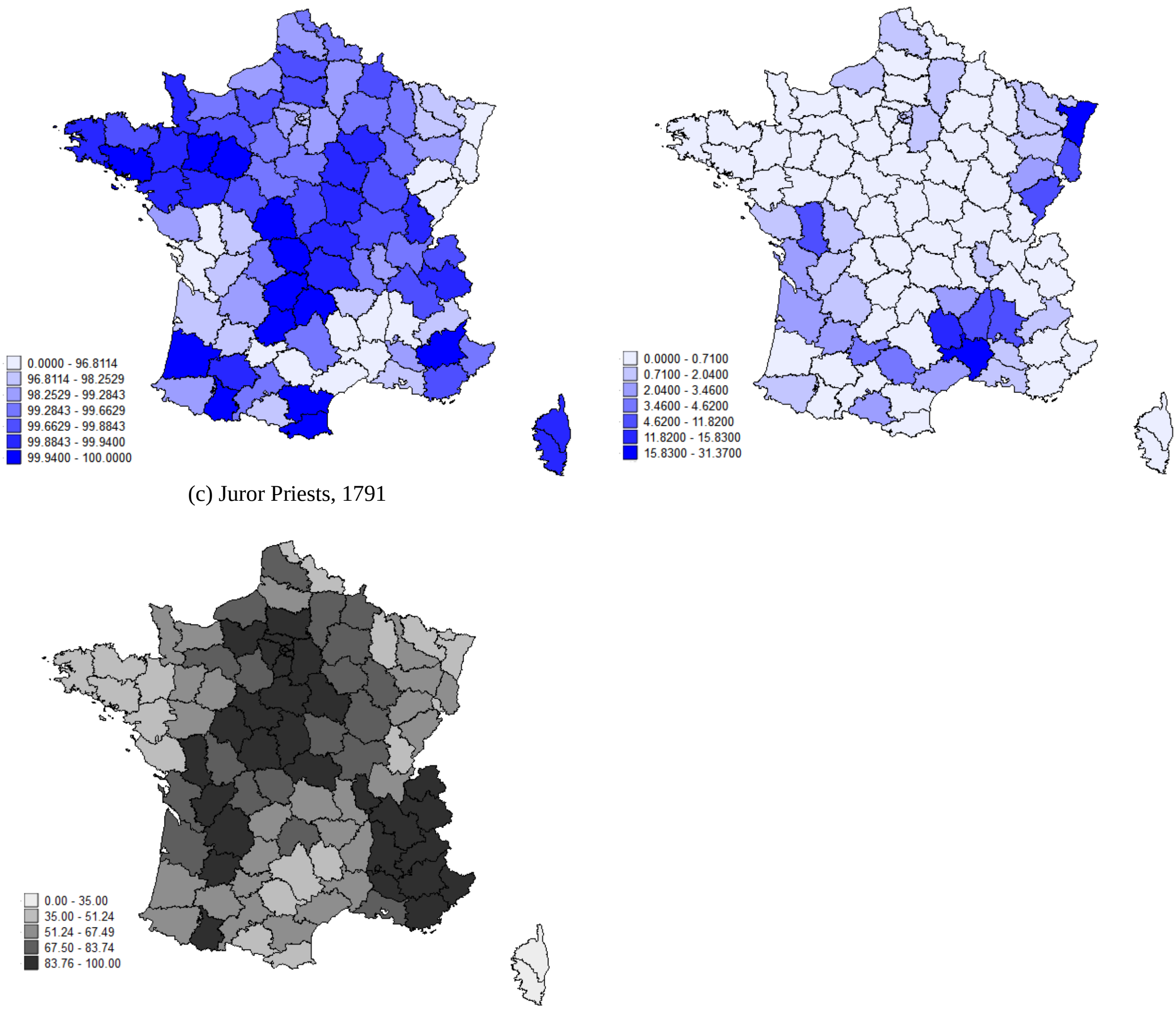
Civil Constitution of the Clergy

After the French Revolution, the government required all clergy to swear an oath of loyalty to the Civil Constitution of the Clergy. Constitutional priests are priests who chose to accept the Civil Constitution. Their status then became that of a State worker. This measure mainly aimed at removing Christianity from everyday life in France. About 50% of the priests have accepted the Constitution.

By comparing the map of juror priests with the maps of women definitive celibacy and of the mean age at marriage, we observe close geographical distributions. Areas presenting the largest share of priests who refused to swear allegiance to the State exhibit a later age at marriage and a higher share of female definitive celibacy and the inverse observation is also true. In other words, districts in which religious practice is of paramount importance display later age at marriage, higher definitive celibacy and lower share of illegitimate births in both rural and urban areas. This finding suggests the decline in religious sentiment in districts surrounding the capital, in the Southeast of France and close to the Atlantic coast (Garonne river valley). The enlightenment seems to have spread around/outside urban centers. At the exception of Southwestern France, the map of juror priests is very close to that of birth control. In addition, we note that more religious areas of France are characterized by a control of fertility via nuptiality. The collapse of clerical institutions in some parts of the country led to the disappearance of the traditional framework of religious life, notably regarding fertility. However, the “dechristinization” do not fully explain the specificity of France.

Figure 1-17 : Geographical Distribution of Religious Practices

(a) Catholics (b) Protestants



Sources: Data from Statistiques Générales de la France – Census 1851; Tackett (1986)

Family structure and inheritance system

Past family rules are important in order to understand county-level demographic trends. The inheritance system and its official rules in force in some counties appear as having impacted individuals' demographic behavior. There exists a geographical diversity of family systems and systems of inheritance. Two opposite inheritance systems stand out: the unequal system and the egalitarian system. In addition to these two systems is a third one: the intermediate system.

Unequal system of inheritance. – The unequal system seems to have had effects on individuals' behavior regarding fertility. The unequal system of inheritance is one of the rules characterizing the stem-family system. In this family system, one child only (usually the eldest) inherits the assets and property of the family. Other children have to leave the family home when getting

married and may stay if they remain single. This type of family dominates in the Southern half of France: Aquitaine, Midi-Pyrénées, Massif Central, and Rhône-Alpes; but also in Alsace. According to the inheritance system applied in this type of family, households tend to have fewer offspring.
Some of these counties are highly religious others not. Based on the geographical distribution of both religion and system of inheritance, we see that means of controlling fertility differ. In more religious areas, fertility limitation by nuptiality is used while in less religious areas birth control seems to be preferred.

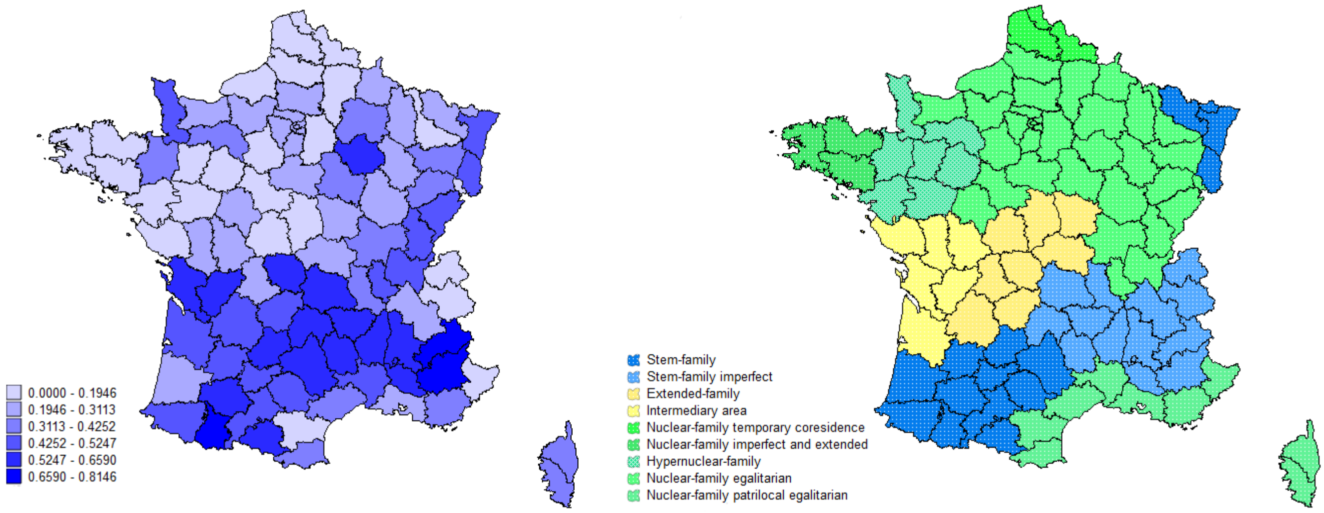
Egalitarian system of inheritance. – Bretagne (as well as Seine-Inférieure) is a particular case; this region is more egalitarian than any other region of France in terms of inheritance. In Bretagne, the principle of equal division is applied to children of both genders on movable and immovable properties (Segalen, 1988). During the 19th century, households of this region were not – most of the time – owners of the land they were working on. Accordingly, they did not have the same incentive as other egalitarian household to limit their fertility. Breton egalitarian households are usually nuclear families. Within this type of households, the sexual division of labor is better shared among households' members than in the stem-family type. In addition, Bretagne is amongst the most Catholic region of France. It exhibits late age at marriage, high infant mortality and high fertility (Figures 1-14, 1-12 and 1-11 respectively).

"Egalitarian" gendered system of inheritance. – In egalitarian system of inheritance, the distribution of inheritance is equal among male children. A gendered distinction is made regarding the inheritance principle. Land is always given to boys, while girls inherit furniture or wood for instance in Jura. According to Le Play (1884), the Egalitarian Napoleonic Code (*Code civil*), that set up the equality of children in inheritance, would have played negatively on fertility. We note that peasants of the Parisian Basin already practiced deeply egalitarian share - what was not asked by any legislation (De Brandt, 1901) during the 17th century. For non-owner peasant families, the establishment of the egalitarian system of inheritance does not seem to affect fertility behaviors. However, for landowner peasants it would have indeed played negatively. In counties where peasants were willing to divide their holdings for their children, we note that young people married earlier and establish quicker their own family than in farms which were held undivided. Nonetheless, a strong decline in fertility is also observed in egalitarian areas. Adjustments of the descendants to land needs are translated into a stronger decline in descendants in more egalitarian areas (agrarian Malthusianism). Having an extra child might be considered as dangerous for a good renewal of the heritage. Though, compulsory division of heritages would have induced a voluntary birth restriction in areas of large landownership in order to obtain a unique heir in order to avoid an excessive division of land.

Figure 1-18 : Geographical Distribution of Landownership Inequality and Family Structure

(a) Landownership inequality, 1851

(b) Typology of Family Structure



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851; Lebras and Todd (2013)

Figure 1-18 illustrates the geographical distribution of landownership inequality in 1851. Landownership inequality is measured as the share of landowners in the population working in agriculture. We observe that land inequality is higher in "egalitarian" areas than in the rest of France. The share of small landowners is higher in the Northern half of France than in the Southern half (more agrarian and with larger lands likely to be linked to the inheritance system limiting the division of lands). Counties of Northern half of France – to the exception of Bretagne, Seine-Inférieure and Alsace – are characterized by egalitarian system of inheritance. Nevertheless, we see that at the beginning of the 19th century, Nord and Pas-de-Calais (industrialized counties) were fecund regions. The availability of a homogenous labor force could have been a factor of industrial development which increased the supply of labor and increased fertility in turn (no over-fertility – children employed in manufactures). In addition, fertility differs among these counties according to religious practices. In Catholic areas with strong religious practices, fertility is higher.

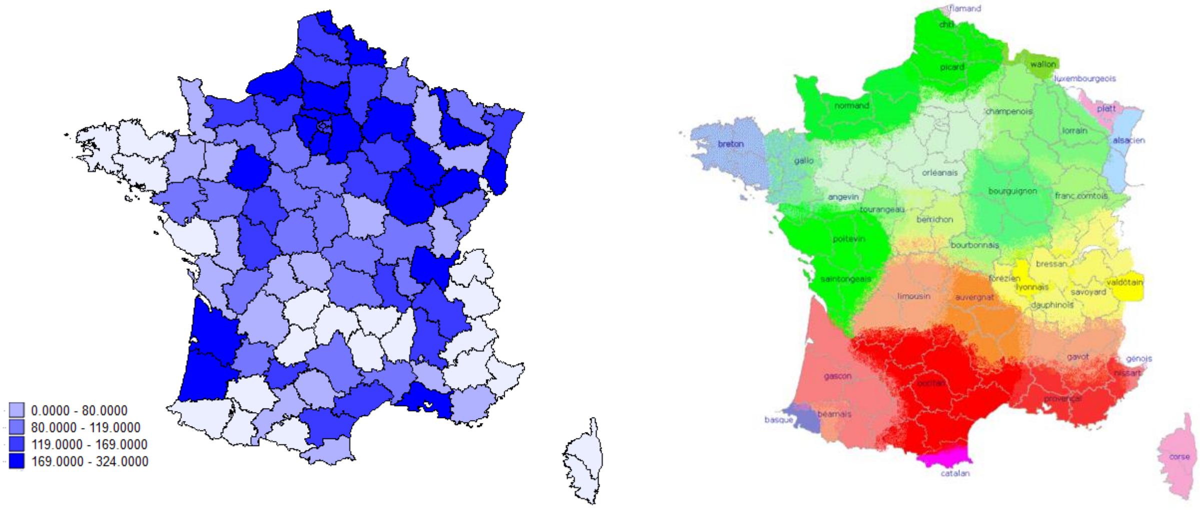
Speed of Diffusion

The speed of fertility changes and the diffusion among districts might also have been impacted by the communication and transportation infrastructures, as well as by the language and dialects (Figure 1-19). The mapping reveals a concentration likely to be due to the diffusion phenomena triggered by the lines of communication and the dissemination of ideas. Counties better served in terms of railroads infrastructures in 1854 were mainly concentrated in the Northeast part of

France as well as in Bouches-du-Rhône, Isère, Landes and Gironde. The role played by the capital (Paris – through legislative policies) may have also been central in the diffusion of "ideas" and norms.

Figure 1-19 : Geographical Distribution of Railroads and Dialects

Railroads, 1854 Dialects



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851

Policies derived from the French Revolution primarily concerned two main aspects: the implementation of measures allowing the spread of revolutionary ideas (and ensuring the rights of citizens) and the diffusion of French language through education (schools). For the Jacobins, the French language has to be the only language spoken across the whole country as the "idiom of freedom" (Abbé Grégoire, Speech to the National Convention, June 4, 1794). Therefore, it needs to be taught. Talleyrand in his report on the organization of schools (1791) deplores the survival of dialects and concludes to the necessity of a common and free primary school, where French would be taught. According to the traditional classification, *Oïl* and *Franco-provençal* dialects are dialects close from French language (mutually intelligible). On the contrary, *Oc* language is closer from Catalan language (mutually intelligible). However, French was the language taught in public schools, this was a political will which was introduced after the French Revolution. Consequently, the spread of education among French counties could have been faster in the parts of the country speaking dialects close from French. Figure 1-19 b presents the geographical distribution of dialects across France. Shades of red refer to *Oc* languages, shades of yellow to *Franco-provençal* dialects and shades of green to *Oïl* languages. The spatial distribution shows a France – broadly speaking – cut into two parts, with on the North side *Oïl* and *Franco-provençal* dialects and on the South side *Oc* language.

Bringing together socio-economic and cultural diversities of French counties helps providing a better understanding of fertility pattern and its development across France. The speed of the fertility decline within these linguistic or cultural groups suggest that individual fertility decisions may have been interdependent. It appears that individuals choose their fertility not in isolation but relative to their reference group. Once a critical number of individuals within the group adopt a smaller family size "norm", the other members are bound to imitate them (Cummins, 2009).

Conclusion

The study of the evolution of long-run trends tells us that the fertility transition occurred at the same time than the decline in the traditional marriage pattern. Important transformations have affected the marriage patterns in France over the period of the demographic transition. We distinguish three main stages in the evolution of marriage practices since the 18th century. Prior to the French Revolution, marriage practices were characterized by the classical features of the European Marriage Pattern: large share of definitive celibacy, late age at marriage and low frequency of illegitimate fertility. We observe a reversal after the French Revolution. The share of definitive celibacy falls sharply, the median age at marriage engages on an impressive downward path and illegitimate births rise substantially. Finally, an impressive increase in the median age at marriage, to a larger extent for women, occurred from the 1960-70's while the number of births outside marriage exploded so did the share of single individuals. Despite the change in marriage pattern fertility declined continuously from the end of the 18th century. The decline in fertility reflects a change in habits with regards to fertility regulation. On the topic of controlling births through nuptiality, households resorted more and more to birth control within marriage. During a large part of the 18th century, individuals have authentically acted in a Malthusian way; they have been accepting more and more late marriage and also accepted a larger proportion of definitive celibacy in parallel with the fall in infant mortality. This was done in order to maintain a sustainable number of offspring. This explains why fertility decline was not observed before the French Revolution. The decline in the median age at marriage and the decline in the proportion of celibacy together with the decline in fertility can be explained by the adoption of contraceptive behaviors within marriage.

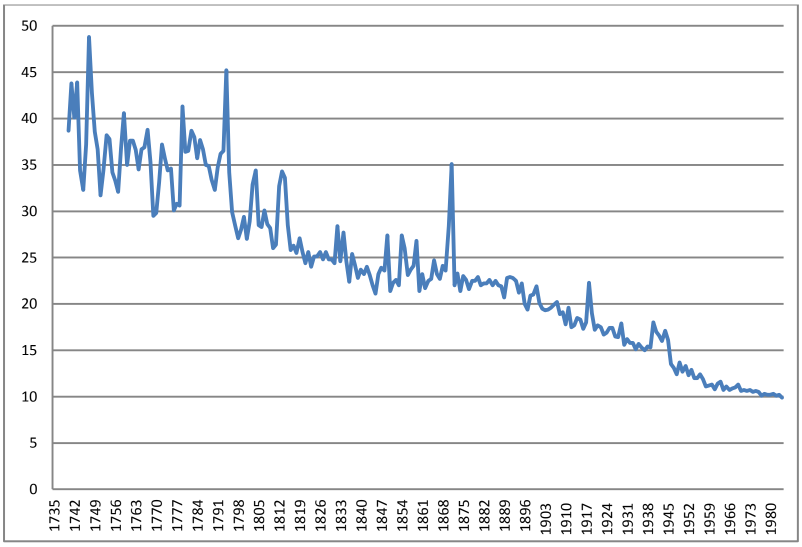
The geographical distribution of fertility rates highlights strong heterogeneity among French counties. Two main regions emerge according to the type of fertility control used: Malthusian regulation (control via nuptiality) versus birth limitation (control within marriage). Therefrom, we have shown that both religion and family system of inheritance can help understanding regional dynamics of nuptiality and birth control within marriage. Data indicates that Catholic counties use Malthusian regulation while secular counties are more likely to use birth control. Until the beginning of the 20th century, Malthusian regulation continued to play a higher role in Catholic counties that took an important delay in the use of contraception and in fertility transition. In some secular counties, the Malthusian regulation was early replaced by birth limitation that progressed quickly and led earlier to fertility transition. Difference in systems of inheritance also affected the geographical distribution of fertility decline, which can in broad line be distinguished between a Northern France more egalitarian and a Southern France preferential. Nevertheless, no clear causality emerges between fertility and system of inheritance (Berkner and Mendels, 1987).

From the study of regional diversities, we get a better comprehension of geographical trends observed across France. But this does not explain the general and massive decline of fertility that has triggered the demographic transition. The entire process of demographic transition cannot come from regional specificities; the trigger must be “bigger” than only regional specificities. Landownership, inheritance system or religious practices cannot explain generalized fertility decline. It has to come from a deeper change affecting the vast majority of households through the diffusion of underlying mechanisms across France.

So why did individuals choose at some point to restrict their fertility at a certain point? What underlying mechanisms have encouraged households to reduce the number of offspring? What factors can explain the onset of the fertility transition? What triggered fertility transition all over France? In order to provide explanations of demographic mutations that occurred during the 19th century, we should investigate and give more importance to the understanding of social and economic changes that occurred throughout the past two centuries.

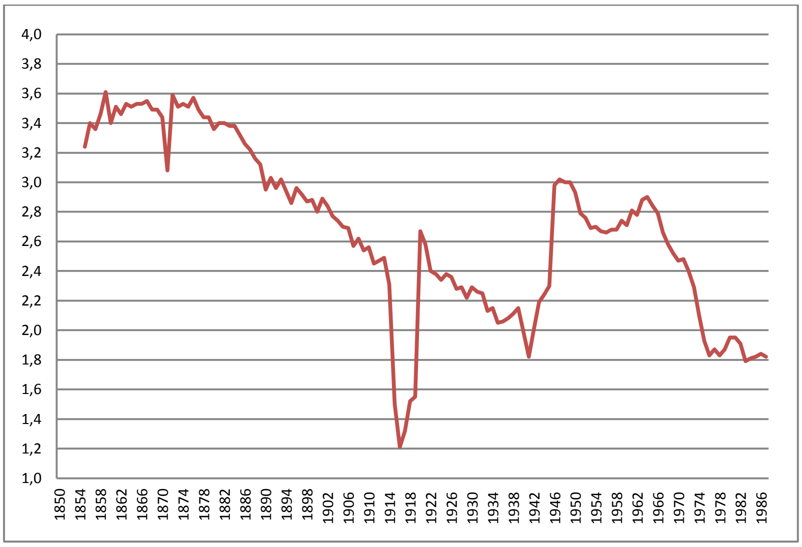
Appendix A

Figure A-1 : Evolution of Crude Death Rates



Sources: Data from Chesnais (1992) – INSEE
Note: The crude death rate is the total number of deaths per year per 1000 people.

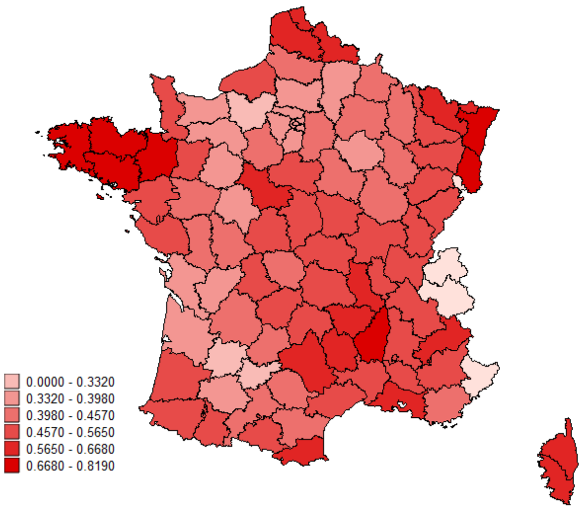
Figure A-2 : Evolution of Total Fertility Rates



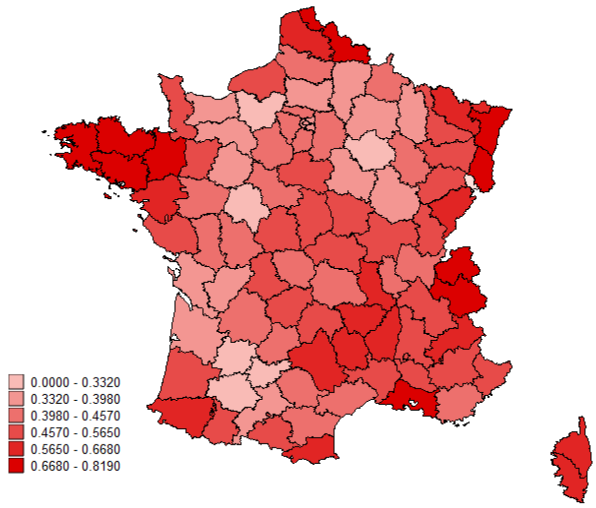
Sources: Data from Chesnais (1992) – INSEE
Note: The total fertility rate is the average number of children per women.

Figure A-3 : Geographical Dynamics of Marital Fertility Index between 1851 and 1901

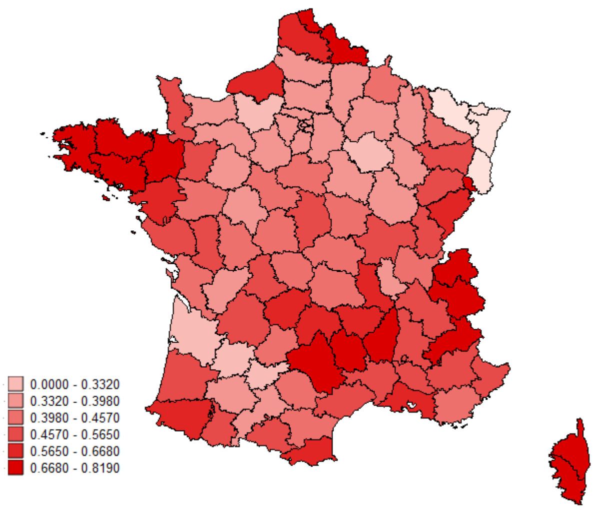
(a) Index of Marital Fertility, 1851



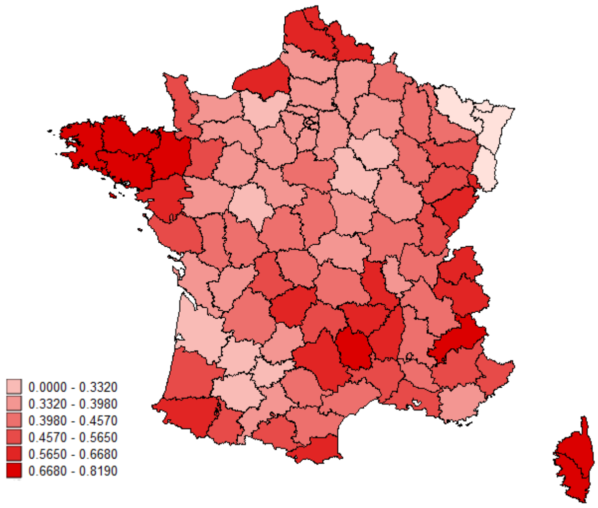
(b) Index of Marital Fertility, 1861



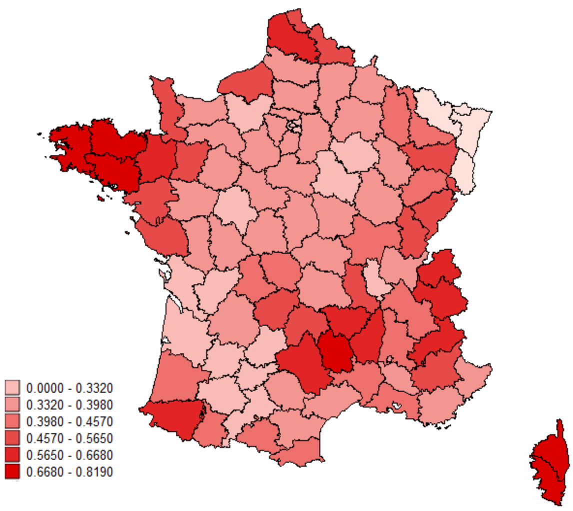
(c) Index of Marital Fertility, 1871



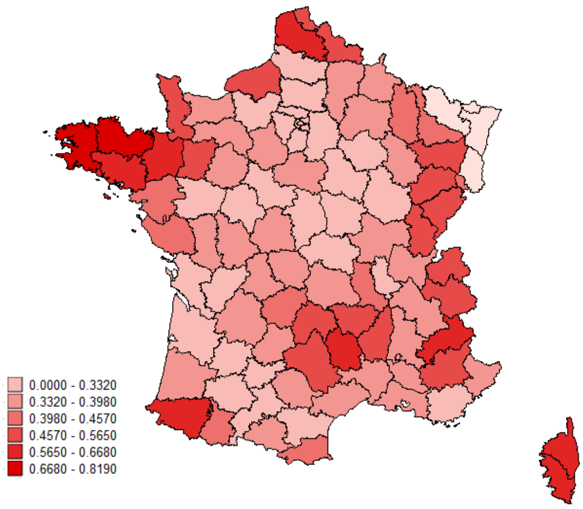
(d) Index of Marital Fertility, 1881



(e) Index of Marital Fertility, 1891

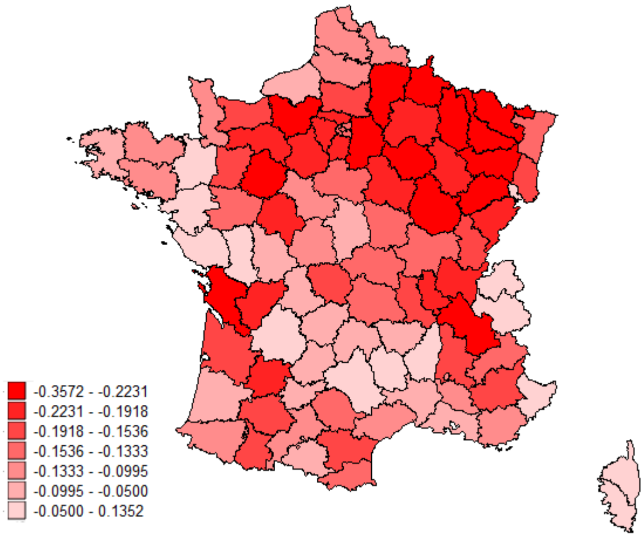


(f) Index of Marital Fertility, 1901



Sources: Data from Coale and Watkins (1986)

Figure A-4 : Geographical Distribution of Variations in Fertility between 1821 and 1851



Sources: Own calculations – Using data from Statistique Générale de la France – Censuses

Chapter 2

Changes in the Labor Force

Content

« *Les deux piliers de la domination masculine résident dans le contrôle social de la fécondité des femmes et dans la division du travail entre les deux sexes.* » Françoise Héritier

Introduction

Understanding the development of working condition in particular for women is very important for understanding the French demographic pattern over the past two centuries (and even more from the second half of the 19th century). Two opposite profiles emerge both from the study of long-run trends and from the investigation of county-level differences. On the one hand, we find a peasant and rural France in which a large share of individuals are illiterate. This is the France of the early 19th century. The situation changes deeply over the course of the century. Nonetheless, we observe a persistence of this profile in the Southwest part of France well after the emergence of changes found in the Northeast of the country. On the other hand, we find an industrialized and urbanized France in which the vast majority of the population in able to read and to write.

The aim of this chapter is to make the link between these two opposite pictures of France; to track the story behind these changes that have shaped the profile of France. For this purpose, we choose to focus more specifically on the evolution of the pattern of women's work as well as on variations in the contributions of women to family incomes across sectors and over time before and during the industrialization of France. Before discussing the possible reasons for and factors behind the origin of the transformation of the profile of France, we first need to have a better understanding of the evolution of labor force participation from a gendered point of view and the evolution of its structure. We will first strive to provide some answers to the following set of questions. How did the share of the labor force within the total population evolve over time? Why did women enter the paid labor force at a certain point? What can explain changes in participation by age? Did the distribution of occupations between men and women evolve as well over time? What has been the impact of economic development on the economic and social role of women and the other way around?

The vast majority of the long-run data we have used in this chapter come from Marchand and Thélot (1997). The authors did a massive job aiming at elaborate homogenous time series of the labor force and its structure, based on the observation of an important discontinuity between censuses – mostly before 1896 (refer to chapter 1 of Marchand and Thélot for more details about the reconstitution of the labor force). Other data come mainly from the *Statistique Générale de la France*.

Women of working age are the demographic group whose labor evolved the most over the past two centuries. Various details are examined in this chapter. The chapter is divided into two sections. Section 1 describes and analyzes the evolution of the female labor force at the national level and then focuses on the regional dynamics of the labor force. Section 2 discusses the evidence for the gender gap both in terms of occupations and earnings, both at national and county levels. The transformation of female labor occurred in several steps. The first key findings concern the differences in the share of active women among women of working age during the early 19th century and among women of working age at the end of the 20th century. The share of active women increased significantly in this time period despite some important variations during the war and the interwar period. Other findings concern the structure of the female labor force. Their activity shifted first from agriculture to manufacturing (over the course of the second half of the 19th century) along with we note an increasing separation between family work and market work. The activity then moved from manufacturing to services (during the interwar period). Finally the evidence points to important changes in the life cycle of women. In the late 19th century and 20th century, the vast majority of active women were married. Nonetheless, the share of married active women among the population of married women remains lower than the share of single active women among the whole population of single women. The early 20th century emphasizes the larger increase of the share of married women taking part in the workforce. But the share ends up collapsing right after WWI. More compelling is the impressive increase in the share of women of childbearing age within the active population from the 1970's. These evolutions do not solely highlight the increase in female employment over time but above all reflect the transformation of the role of women both in the economy and within the household.

The examination of the evolution of the female labor force is necessary to enhance our understanding of the transformation of the economic role of women. Nevertheless, it is not sufficient in order to get a better comprehension of the transformation of both the economic and social roles of women. For purpose, we must also get a better understanding of the changes from a gendered perspective. Section 2 aims at clarifying long-run changes in gender differences that could have been hidden by simply studying the evolution of the female workforce. Investigating the ratio of female-to-male employment reveals that the gap was not constant over time. On the contrary, the ratio began to rose slowly but constantly during the second half of the 19th century before experiencing a reversal from the 1920's. The ratio then started a new rise at an increasingly fast pace from the 1960's. The closing of the gender occupational gap occurred mainly through the development of the tertiary sector. However, if the gender gap remains relatively constant in the secondary sector, occupational census data from the manufacturing sector suggests that the segregation may have continuously increased between 1866 and 1962. The study of the ratio of female to male wages reveals significant improvements from the mid-20th century. This section will then aim at describing in greater details how the gender gap both in employment/occupation and wage changed over time and will try to determine to what extent the gender wage gap may rather reflect differences in productivity or in custom.

1. The Evolution of the Female Labor Force

Before 1896, the counting of census forms was made at the municipal administration level. The *Statistique Générale de la France* was simply responsible for gathering county-level summaries sent by the Prefects. The counting became centralized from 1896. The 1851 census does not give any explanation about the methodology used to collect information. However, that of 1856 describes precisely how the census was conducted and what questions have been asked. It is thereby notified that the number of individuals in the category of professionals is likely to be underestimated because of the neglect of the census staff responsible for the occupation survey. A significant number of people working in these occupations were classified wrongly in the category of individuals without a profession. In addition, it is also important to note that, in 1856, the administration did not yet introduce any distinction specifying whether individuals were engaged in the occupation or were living from the occupation. Similar to the British data, for the census collected in the first half of the 19th century the "assumption that the household, rather that the individual, was the working unit is reflected in the way the data were collected" (Burnette, 2008). As a consequence, the labor force is likely to be substantially over-estimated in some branch of activities and under-estimated in others (certainly a small proportion) especially for women. Corrected data by Marchand and Thélot (1997) indicate that the female labor force participation should rather be around 40% and the male labor force close to 80% while our non-corrected data suggest a female and a male labor force participation of 89.74% and 92.27% respectively.

Table 1 shows the occupational distribution from the 1856 census. More precisely, it displays the top 8 sectors in terms of female labor force participation and the main occupations for each sector (most popular occupational categories for women), and the corresponding male labor force in each sector. Despite the errors in the counting, Table 1 can give us a broad picture of the occupational distribution of major female occupations in 1856.

Table 2-1 : Main Female Occupations by Sectors, in 1856

Occupations in 1856	Women	Men	Percent FLFP	Percent MLFP
Agriculture	**9 551 979**	**9 512 092**	**58,62**	**57,73**
Propriétaires exploitants	3 664 287	3 611 326	18,45	18,88
Journaliers	3 291 380	3 275 208	16,57	17,12
Fermiers	1 240 297	1 266 366	6,24	6,62
Métayers	678 595	678 314	3,42	3,55
Propriétaires résidents	277 341	272 623	1,40	1,42
Clothing	**1 221 395**	**734 304**	**7,50**	**4,46**
Tailleurs	421 634	190 773	2,12	1,00
Cordonniers	269 158	315 596	1,35	1,65
Mode	250 073	27 658	1,26	0,14
Autres habillements	64 729	27 920	0,33	0,15
Textile	**1 046 827**	**8 313 66**	**6,42**	**5,04**
Coton	262 676	251 809	1,32	1,32
Lin	234 519	193 836	1,18	1,01
Laine	192 066	177 828	0,97	0,93
Soie	160 041	116 391	0,81	0,61
Dentelle	109 723	10 444	0,55	0,05
Construction	**840 579**	**1 102 426**	**5,16**	**6,69**
Maçons	789 165	1 033 868	3,97	5,40
Bâtiment	18 673	22 530	0,09	0,12
Food	**710 636**	**747 436**	**4,36**	**4,54**
Restaurateur	343 105	324 744	1,73	1,70
Boulanger	118 388	132 004	0,60	0,69
Meunier	78 512	97 636	0,39	0,51
Boucher	76 287	84 442	0,38	0,44
Transport General	**435 512**	**592 376**	**2,67**	**3,59**
Carrossier	154 390	199 698	0,78	1,04
Marins	60 670	100 848	0,31	0,53
Routes	50 708	60 553	0,25	0,32
Construction	50 356	77 692	0,25	0,41
Food General	**389 566**	**338 379**	**2,29**	**2,05**
Epicier	166 819	145 585	0,84	0,76
Crémier	86 963	58 734	0,44	0,31
Vin	63 603	61 536	0,32	0,32
Grains	22 638	24 181	0,11	0,13
Administration	**210 276**	**236 968**	**1,29**	**1,44**
Administratifs Etat	115 423	130 694	0,58	0,68
Administratifs communes	48 181	54 981	0,29	0,24
Administrations privées	28 862	31 924	0,15	0,17
Total	**16 293 486**	**16 477 726**	**100**	**100**

Sources: Statistiques Générales de la France – Census 1856

From Table 2-1, we observe that almost three women over five were working/living from agriculture, which was also the most common occupation for men. Agriculture represents the first occupation for women well ahead of all other occupations. The second highest branch of activity is the garment-clothing industry acting for 7.5% of the female participation, closely followed by the textile factories reaching 6.42%. Surprisingly, the building sector comes just next, involving 5.16% of the total female labor force. According to data limitations briefly discussed above, the number of women working in the building sector is likely to be overestimated by the fact that the occupation of women might have been related with that of the head of the household (often considered as sufficient). On the other hand, more “feminine” occupations such as employment in textile industries are subject to be undercounted for the same reason. Despite possible mistakes, errors of counting and misallocation of the major trends of the occupational distribution it should nonetheless reflect the distribution.

1.1. General characteristics of the Labor Force Participation by Gender since 1806

Since the early 19th century, the number of women in the paid labor force significantly increased in France. Between 1866 and 1906, the pace of the increase in the female labor force accelerated: 38% between 1866 and 1896 and 20% again between 1896 and 1906. The strength of the increase must be kept in perspective. Uncertainties persist about the female labor force especially in agriculture and personal services making it difficult to compare with the years preceding the 1896 census. Keeping this in mind, we nonetheless acknowledge that the 19th century witnesses a feminization of the labor force, reinforced within the last third of the century. Several changes might be at the origins of the transformation of the labor force. Although the share of individuals working in agriculture and domestic services remains more or less constant over time, there is a real take-off of industrial and tertiary sectors with massive female employment (in industry and merchant services with about 2 million additional active women).

1.1.1. The Expansion of the Female Labor Force Participation

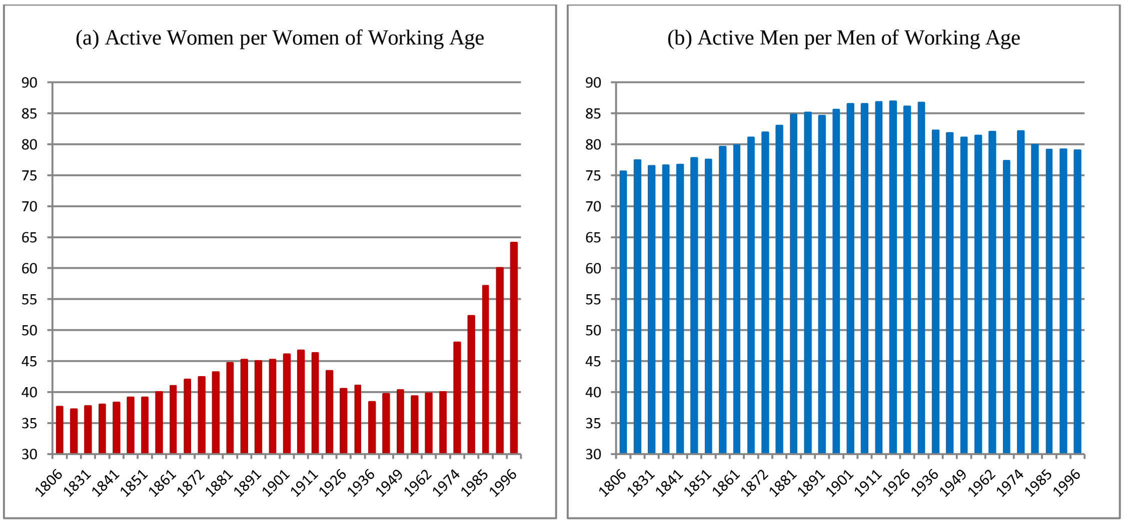
At the beginning of the 19th Century, the labor force reached 12.9 million people, of which over a third were women. Figure 2-1 describes the evolution of the shares of active women (men) in the female (male) working population of between 1806 and 1996.[14] The female labor force

[14] The population of working age is defined with reference to the evolution of the age of compulsory schooling and to that of the removal from activity: until 1841 population from age 10 and more, from 1841 to 1881 population having a certain age (evolving linearly from age 10 to 13), from 1881 to 1936 population from 13 years and more, in 1946 and 1955, population from 14 years and more, in 1962 and 1968 population from age 14 to 74, in 1974 and 1980

participation experiences a dramatic increase going from 38% to 64% in a little less than two centuries, while the male labor force increased solely by 3 points. The almost doubling of the female labor force did not follow a continuous path. It took place in three steps: first a steady and continuous increase, followed by a period of decline and finally a recovery in the increase in the share of active women at an accelerated pace.

The share of women within the population of working age progressed regularly from 1806 until it reached 46% on the eve of World War I – long before the "baby boom" and the take-off of female paid employment which occurred in the 1960's. An important decline is then observed during the war and the interwar period. Employment rates started to drop dramatically reaching their lowest level in 1931 with only 38% of active women – similar to what was observed at the beginning of the period in 1806. The periods after WWI and WWII witnessed what looks like an exit of women from the labor market. Both periods exhibit stronger decline in women's participation. Then from the end of the 1960's the trend reverses. The female labor force participation then grows impressively, ranging from 40% to 64% of the population of working age within just a few decades.

Figure 2-1: Labor Force Participation by Gender



Sources: Data from Marchand and Thélot (1997)

Comparing the evolution of the female and the male labor force, we note that the trends of the participation rates are similar during the first period. The two curves representing the ratio of the working population within the population of working age for each sex are almost parallel. The similarities observed in the evolution of active men and women during the second half of the 19th century suggest increasing opportunities for both genders to participate to the labor

population from age 16 to 69, in 1985 population from age 16 to 64, in 1990 population from age 17 to 64 (Marchand and Thélot, 1997).

force – what tends to underline a change in the demand for labor. The beginning of the 20th century witnesses a sharp decline in the share of active women. However, the male labor force experiences a decline only from the 1930's. The male labor force seems less sensitive/volatile than the female labor force during the war and the inter-war period. Right after war periods, women seem to be push back into the home. But it is during the last period that gender differences emerge clearly. While the share of active men remains stable the share of active women explodes. We observe a productive deployment of women that suggests an expanded contribution of women to family income – which rather tends this time to underline a change in the supply of labor.
From the end of the 18th century to the beginning of the 19th century, women worked outside the home mainly because they had to. During the second half of the 19th century, the share of active women increased continuously. After a decline from the 1910-20's, the pace of growth accelerates within the last third of the century. The evolution of the share of active women among women of working age indicates that the proportion of active women would have been increasing during the early phases of the industrialization in France. Then, with the acceleration of the pace of industrialization, women's opportunities to participate to the labor force would have declined.

Why did this change occur? Is the increase in the participation of women in the labor force due to an increase in female economic opportunities? Is it rather a change in women's attitude toward the family interest? Is it a result of a cultural change allowing women to enter in higher proportion to the labor market and to achieve financial self-sufficiency? In other words, does change in the participation of women in the labor force reflect gender empowerment? In addition, to what extent can the massive entry of women in the labor market explain the second wave of birth control (2nd fertility transition) observed after 1871. To answer this set of questions, we first need to investigate the evolution of the structure of the labor market and of the labor force.

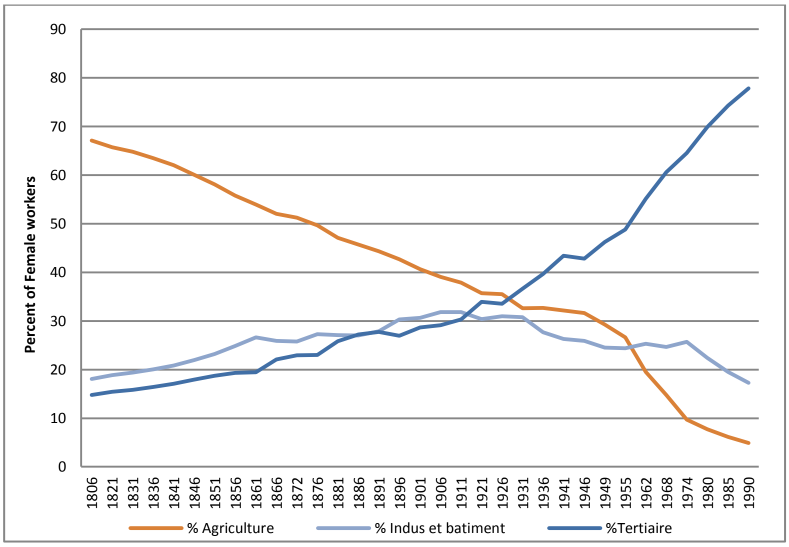
1.1.2. Changes in the labor force by sectors

Based on US data, Colin Clark identified typical evolutions of primary, secondary and tertiary sectors. According to his model, the main focus of an economy's activity shifts from the primary to the secondary and finally to the tertiary sector.[15] In other words, the trends should highlight a slide of the labor force from agriculture toward industry and then from industry to

[15] The primary sector includes agriculture, fishing, logging, mining, oil and gas exploration and production. The secondary sector brings together manufacturing, both durable and non-durable goods and construction. The tertiary sector is composed of service providers (government employees, federal, state and local, are not included).

services. This move is observed everywhere but at different speeds. It results from the diversification of human needs and unequal improvement in productivity in the diverse sectors. We find similar patterns for France over the period 1806-1990.

Figure 2-2 : Evolution of the Structure of the Female Labor Force by Sector



Sources: Data from Marchand and Thélot (1997)

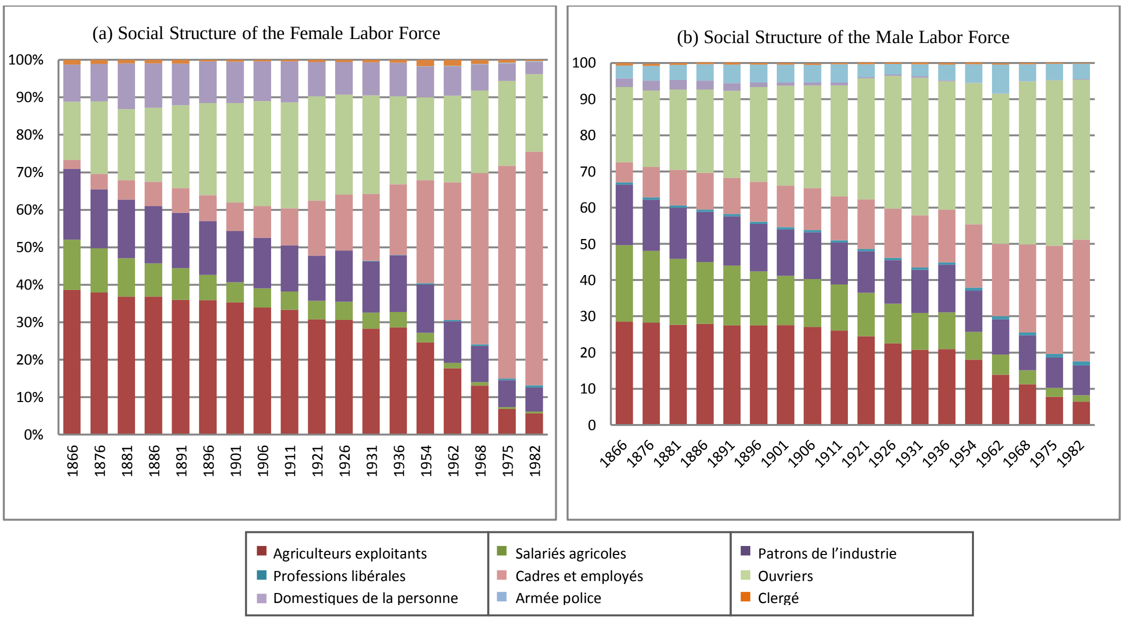
Figure 2-2 depicts the evolution of the female labor force participation by sectors (primary, secondary and tertiary) for France. The picture reveals three main periods: the supremacy of the primary sector, the rise in both the secondary and tertiary sectors and the take-off of the tertiary sector while primary and even secondary sectors decline. At the beginning of the 19th Century, more than two-thirds of the female labor force was working in the agricultural sector (primary sector). In 1806, of over a hundred women in the workforce, 67 were working in agriculture. Thereafter, the share of female workers in the agricultural sector started to decrease slowly and consistently. In 1875, half of the female labor force was working in agriculture while the share of the industrial labor force took-off to approximately 30%. Nonetheless, contrary to what can be observed in Great-Britain, the first country to experience the Industrial Revolution, 19th century France remains predominantly agricultural. In addition, the figure shows that between WWI and WWII, female labor force participation exhibits an almost equal partition between the three major sectors. In 1931, for instance, 32% of the female workforce was part of the primary sector, 31% of the secondary sector and 36% of the tertiary sector. During the interwar period, the economic structure of the female labor force changed significantly. The share of women in agriculture collapsed, the trend in the industrial sector (manufacturing) reversed and the tertiary sector rose dramatically. At the end of the 1980's, only 5% of the female labor force participation was working in agriculture (thirteen times less than in 1806), about 18% in the secondary sector (similar to the beginning of the 19th Century), and 75% in the tertiary sector.

Even if the evolution of the male and female labor force participations display similar patterns (decrease in agriculture, reversal of the share in industry), sectorial structures differ between them. On the one hand, we note a stagnation of the share of female workers in industry during the “*Trente Glorieuses” (*1945-1975) contrary to that of males. On the other hand, the share of the workforce in the tertiary sector increased much more significantly for women than for men. In 2008 France, almost nine women out of ten were working in the tertiary sector against only three men out of five. Conversely, only 11% of employed women were belonging to industry (and construction) against 32% of employed men.

1.1.3. Transformation of the Social Structure of the labor force

The previous sub-section focused on the general evolution of the female labor force within the three major sectors of the economy. However, throughout French economic development, dramatic changes occurred in the social structure of the labor force itself. Henceforth, we aim at going deeper in the analysis of the social structure of women’s employment by focusing on the evolution of the employment rate within each social group (distribution of the female employment among the social categories). This classification allows for a distinction between agricultural laborers and agricultural owners (farmers), captains of industry and trade, workers, officers and employees, domestics and then between three smaller categories: liberal professions, army-police and clergy. The evolution of the social structure of the female and male labor force participation between 1866 and 1982 is presented in Figure 2-3.

Figure 2-3 : Social Structure of the Labor Force by Gender



Sources: Data from Marchand and Thélot (1997)

Agriculture. – The main phenomenon observed in the agricultural sector is a relative decline in the number of agricultural workers (*salariées agricoles*) – in a larger proportion for farmers (*fermiers* and *exploitants agricoles*) and sharecroppers (*métayers*). With the increase in the ownership in agriculture most individuals living from agriculture were farm managers and their family. The decline in the agricultural labor force was the result of a rural exodus that began from the end of the July Monarchy (mid-19th century).[16] This phenomenon affected first individuals less attached to the land, such as agricultural workers and servants. The share of individuals leaving rural for urban areas increased continuously from 1850 until WWII. For farm managers, the phenomenon happened later in time. We distinguish two main characteristics of the evolution of the share of farm managers. The number of farm managers remained relatively stable until WWI. From that period, the phenomenon of rural exodus expanded. A high share of farm managers left, in turn, rural for urban zones at a fast pace.

Independent workers. – As emphasized by Marchand and Thélot, we observe close links between workers and craftsmen, but also between commercial employees/workers and merchants (*commerçants*). The evolution of the share of independent workers follows a hump-shape within the first step the ascension of this type of workers, followed by a phase of stabilization and, last, a period of continuous decline. The drop in the share of craftsmen, merchants and industrial workers started during the Second Empire. Since that period, their number has been divided by two and a half. This decline might have, notably, been triggered by the increase in wage earners (*salariat*), although this decrease was not always at the expense of independent workers. It is only from the 1950's that we indeed observe an inverse evolution between wage earners and non-agricultural independent workers.

Workers. – Until the end of the 19th century, a close frontier and complementarity can be observed between agricultural work – mostly performed in the summer and the beginning of the fall – and industrial work – concentrated during the winter and spring months.[17] One of the most striking features of the evolution of the social structure of the labor force is the constant increase in the number of workers of both genders during the second half of the 19th century. During the whole 19th century (and until WWI), the share of female workers (*ouvrières*) is larger than in any other activities. We observe a drastic change: while the number of male workers continues to progress (except during the 1930's and the 1980's), the number of women begins to decline. The female workforce starts to move to the tertiary sector from the beginning of the 20th century. The feminization of the tertiary sector tied that of the working class at the down of

[16] The rural exodus happened late but was fast.
[17] Such a frontier also appear with craftsmen and merchants, as already advanced previously, at least until 1880, although the urban work remains dominated by different forms of craftsmanship (Lequin, 1983). Similar evidence is found with employees and executive workers (*cadres*), as well as with service workers in a minor proportion.

WWI with the decline in textile industry. The textile industry similar to old rural industries indeed faced a sharp decline along with industrialization. Right after WWI, the share of female workers in services dominates. At the end of the 1990's, we count three times more women working in the tertiary sector than working from the manufacturing sector.

Services to individuals. – The decline in domestic workers started in the 19th century. The almost complete disappearance of this socio-professional category occurred during the 20th century. This process was achieved in two steps. The disappearance of male domestic workers happened first. This phenomenon was then followed by changes in the share of women working from domestic activities. The domestic activities of women had its peak at the beginning of the 1880's and remained rather stable until WWI. Female domestic workers did not completely disappear, but their number strongly declined from WWI and reached very low levels after WWII.

Employees and executives. – The arrival of women in the tertiary sector only occurs from the beginning of the 20th century, notably with the appearance of the typewriter, and accelerates after WWII (for executive work but not for supervision work). Their number constantly increases until the interwar period, but always at a slower pace than that of workers. The industrialization of France lasted at least until WWII, thereby revealing the increase in the number of workers. The explosion of the tertiary sector started from the 1960's. Its impressive rise made employees and executive workers the most important group from the beginning of the 1970's. In the 1920's, France only had a very low number of female executive workers. Nowadays, women are much more numerous than they have ever been in any previous periods. Working conditions in this type of jobs allow a better reconciliation of family and professional life. In the current state of domestic division of labor, we observe an evident highly professional equality between men and women.

Throughout the 19th century, most women were working in "traditional" occupations, namely in agriculture but also to a lesser extent in domestic services, garment making and textiles. Women moved slowly into modern occupations. Due to the persistence of the agricultural sector during the second half of the 19th century, the country was not hit by a complete overhaul but displayed economic and social mutations. For most of the 19th century, women's manufacturing work was mainly concentrated in the textile industry. Nonetheless, at the end of this century, factory employment was still very low and the number of women employed in industry represented a small proportion of the whole female labor force. From a holistic view point, the main phenomenon observed is the constant decline in the agricultural sector toward very low rates (5% in the eighties). At the turn of the 20th century, female integration within the labor force in not yet complete. If female factory employment almost doubled between 1866 and 1906, the number of women working outside of this sector is only about 400 000 workers in 1906. In the other branches, female employment represents only 10% of industrial employment, 30% in merchant services and about 30% in other services. Young women are almost completely excluded from some sectors such as banking and are weakly represented in the administration. In absolute value, the industry remains very largely the main sector of employment both for men and women (almost equally shared between them). The growth of female employment in industry remains however limited in most branches, except in the textile industry (with the rise of drapery and clothing).

At the same time, the share of executives and employees exploded: from 2.4% in 1851 to 62.4% in 1982 (multiplied by 26 in only three decades). Nonetheless, until WWI, the feminization of the working-class was much more pronounced than that of the white collar jobs. It is with the decline of textile mills in the 20th Century that the situation reversed.[18] In addition, the decline in domestic activities, started in the 19th Century, continues to decline consistently during the 20th Century (changes in the structure of domestic staffs, e.g. from maid to cleaning ladies, as employees). Then, the post-WWII period marks a turning point in the evolution of the structure of women's work, with a fantastic increase in the number of female executives and employees. In 1982, almost two-third of the female labor force came from the tertiary sector. In order to have a better understanding of the evolution of the social structure of the labor force, this sub-section is dedicated to the study of trends in socio-professional categories' (as done by Marchand and Thélot, 1997).[19]

1.2. Life Cycle Labor Force Participation

We observe an opposite evolution of agricultural and industrial sectors during the 19th century. A deeper analysis of the evolution of the female labor force participation in terms of age and marital status enables us to better understand the life-cycle of the workforce. The number of working women is not stable and strongly differs by age. A gendered comparison highlights large differences, especially in the younger age. In addition, the analysis of its evolution in time suggests a profound change in gender relations from the 1960's.

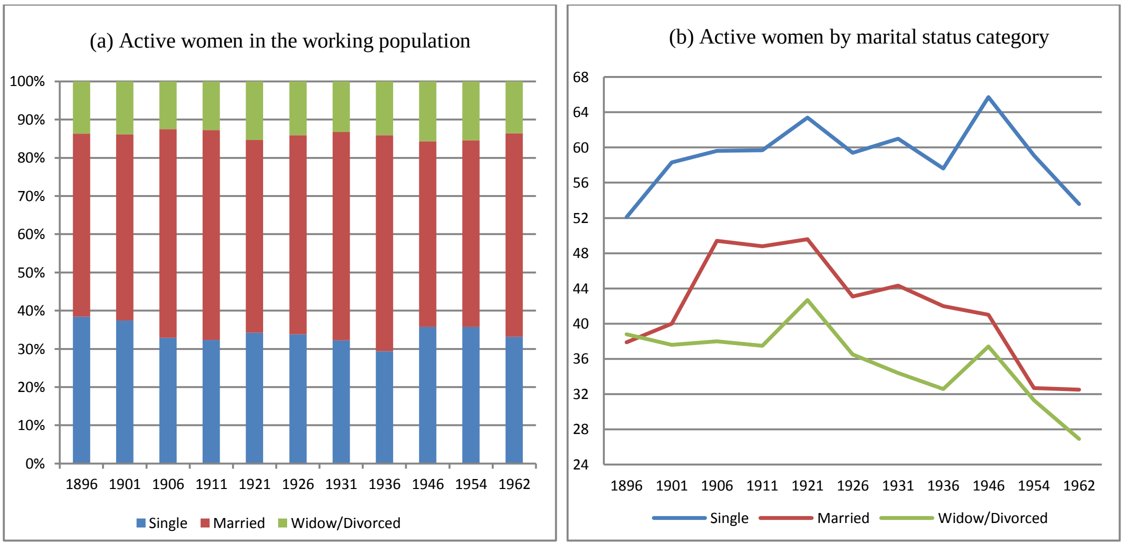
[18] The decline in textile mills will benefit to industries specialized in the fields of metal, mechanics or building, which have never been feminized.

[19] The classification of nine socio-professional categories was developed by Jean Porte in 1954, officer at the national office of statistics (*Institut National de la Statistique et des Éudes Économiques*). The nomenclature is the following: *agriculteurs exploitants, salariés de l'agriculture, patrons de l'industrie et du commerce, professions libérales et cadres supérieurs, cadres moyens, employés, ouvriers, personnel de services et autres catégories*.

1.2.1. Female Labor Force by Marital Status

Censuses only give the labor force participation by marital status from 1896. Therefore, data from Bairoch (1968) allow us to investigate the evolution of female employment by marital status between 1896 and 1962.

Figure 2-4 : Evolution of the Female Labor Force by Marital Status



Sources: Data from Bairoch (1968)

Figures 2-4(a) and 2-4(b) present the evolution of the share of active women in the working population by marital status (single, married or widow) and the share of active women by status category respectively. The composition of the female labor force by marital status varies significantly over the life cycle. We observe clearly that married woman is the most common category within the female active population before single and widow (Figure 2-4 a). On average the share of married women represents 40% to 50% of the total working female population against 30% to 40% for single women and 10% to 15% for widow. The number of working married women increased continuously between 1896 and 1921 – before experiencing a decline during the interwar period and WWII. The increase in the participation in paid activities of women who are married and certainly mothers reflect a change in behavioral attitudes toward gender roles. In addition to their role as wives and mothers, they also undertake a part of the breadwinner role. The decline in the share of single working women is in line with this finding.

Nevertheless, when we focus on the share of married women labor force over the total number of married women (Figure 2-4 b), we see that this share is substantially lower than that of single women. This reflects the persistence of a gender division of labor, through what looks like a consequence of marriage bars (see Goldin, 1988).[20] In 1896, only 38% of married women (and 39% of widows) were working while 52% of single women were. During the period prior to WWI, between 1896 and 1911, the share of employed married women rises substantially from 38% to 49%, while that of single working women pass from 52% to 60% and that for widows decline slightly from 39% to 37%. In view of the global rise in female employment observed in Figure 2-1 over the same period, we can say that this increase was triggered to a large extent by the rise of married women in the labor force. Certainly linked with the industrialization and the urbanization of the country more women work outside the home. Afterwards, the trend reverses and the gap between married and single women increases over time during the war and the interwar period. We observe a return of married women at home. It is surely no coincidence with the implementation of a pro-family policy encouraging an increase in the birth rate and reinforced by the Vichy regime (Vichy France). In 1962, married women were only 32% to be part of the labor force, while single women where 53% working on the labor market. Similarly, the share of active widow and divorced women within the total number of widow and divorced women drops from 39% to 26% over the same period. The pace of the decline in married and widow/divorced active women both accelerated from the beginning of the 1920's, despite a quick increase for widow and divorced women during the Second World War.

It is important to note in addition that the labor force by marital status differs a lot between sectors and also within sectors. In agriculture for instance, the two main categories of laborers – farmers and landowners – exhibit large differences in the share of single individuals. Therefore, in 1906, 66% of male employees and 61.5% of female employees were single while the vast majority of landowners (employers) were or have been married (only 8.4% of men and 1.7% of women are single). In the rural world, already 25% of women are married at age 25. On the contrary, in the manufacturing sector, in 1906, celibacy is almost a common "rule" for women. Workers are usually young: 42% of male workers and 54% of female workers are less than 30 years old. Less than 6% of men and 13% of women below age 25 are married. After 30 years old, there is only 7.7% of single male workers and 10.1% of single female workers. The number of single women aged 30 and more is higher in industry and services than in agriculture. These women have a family situation very different from each other's. While at the turn of the 20th century 80% of women in agriculture are married, almost one woman over two is single, widowed or divorced in the industrial sector.

[20] Marriage bars were a practice adopted from the late 19th century to the 1960s restricting married women from employment in many professions, especially teaching and clerical jobs. Marriage bars did not affect employment in lower paid jobs, and therefore lowered incentives for women to acquire education. (Borjas)

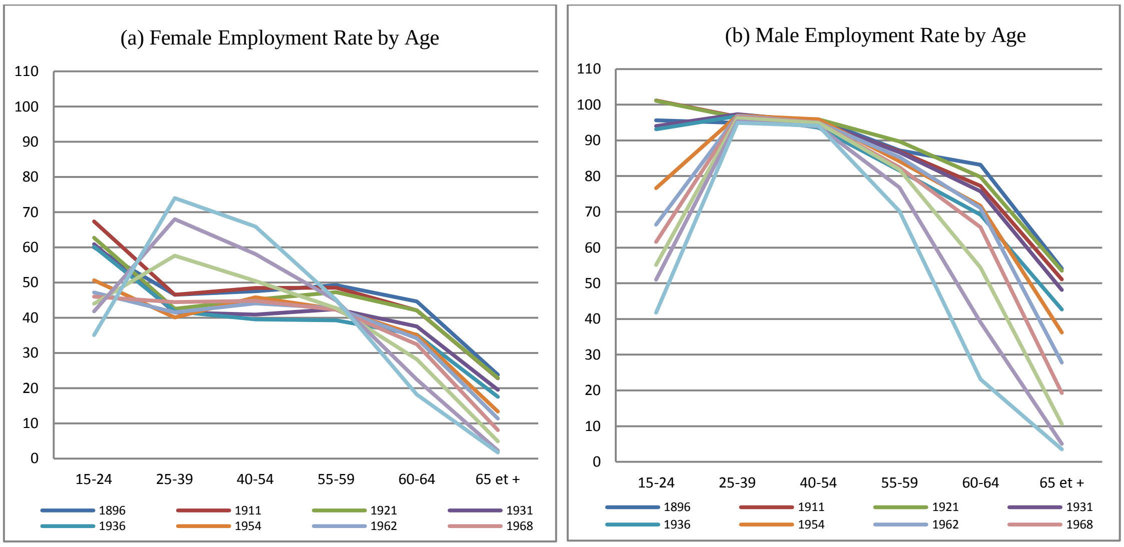
Marital status impacts clearly female labor force participation. The large share of women enrolled in the labor force is single. The trend of single working women is rather stable over the studied period – despite slight fluctuations during the wars and an incipient decline from the 1950's. Prior to WWI, the share of married working women increases substantially. However, contrary to what was observed for single women, the share of both married and widowed/divorced working women undergo a decline at a sustained pace from the 1920's. Fluctuations in the share of widowed and divorced working women during WWI and WWII suggest a higher volatility of this workforce than that of married women (that practically does not react). Unfortunately, we do not have data on labor force by marital status for subsequent periods. Nonetheless, based on the study of labor force participation by age, we can get more information and complementary evidence.

1.2.2. Female Labor Force by Age

We explore now the average participation of women (and men) of working age by looking at the rates by age for different years between 1896 and 1989. The study of life cycle labor force participation is very instructive for the understanding of the evolution of gender relations over time. Figure 2-5 presents the evolution of female and male employment rates by age. The figure depicts a complete reversal in female employment rates for age groups ranged from 15 to 54. Three key periods can be highlighted within the evolution of the female employment rate by age over the last century. The vertical axis represents age that is ranked in six classes and the left axis accounts for the labor force participation (in percent). The first key moment goes for the years 1896, 1911, 1921, 1931 and 1936. The age trend follows an "inverted S-shape". Data show fairly high rates for women belonging to the age group 15-24, between 60% and 67%. Afterwards, the rate declines for women over 25 years (around 45%) and remains stable until the age of 55, before experiencing a new descent at a higher pace for the later ages (around 20%). Within the second key period, which includes the years 1954, 1962 and 1968, as far as we move forward in time, the share of women being part of the labor force at age 15-24 decreases: from 65% previously to around 48%. Therefore, for age groups between 15 and 54, the shape of the curve flattens. Then, comparatively with previous periods, the employment rate falls down for approximately all age groups. The third moment debuts round about the late sixties-early seventies. It is characterized by a strong resumption of the employment rate for women aged 20 to 55 years (and is concomitant with the decline in fertility), which declines slightly in later ages; conversely, decline in labor force for young age with the increase in the compulsory schooling between 14 and 16 years old. From a global perspective, the trend follows an inverted U-shape, with a peak in the female employment rate around 30 years old.

These evolutions reveal deep changes in the organization and in the allocation of time of women throughout the course of their working life – suggesting changes in the role of women.

Figure 2-5 : Evolution of Female and Male Employment Rate by Class of Age



Sources: Data from Marchand and Thélot (1997)

If we compare the structure and the evolution of the female labor force by age with that of males, we see that the trends are acutely different for the first two periods. The male labor force participation is very high. The share of male employment is already very high for young men aged 15-24 as well as for older men (60-64), even if over time the rate for these age classes tends to decline. However, it remains very high (close to 100%) and constant over time for the ages 25-64. On the other hand, the female labor force reaches its maximum for low ages (between about 43% and 68%), always at a lower rate than that of the male labor force.

The trends become strongly similar when we focus on the third period in the evolution of the female employment rates (and especially for the years starting from 1954 for males). From the seventies and as we move forward in time, the inverted U-shape that follows the male employment rate emerges more clearly. The convergence in the shape of female employment by age toward that of male shows closer gender behavior regarding the labor force life-cycle and therefore suggests possible improvements in terms of gender equality.

The convergence results from changes taking place at two levels: on the one hand from a decline in the female labor force for younger individuals and on the other hand from an increase in the female labor force for women aged 25-49. The decline in employment rates for individuals aged 15-24, observed first for males and then for females, indicates an improvement in educational investment in higher education. According to data on employment by age, a large increase in enrollment rates in higher education is likely to have happened from the 1940’s for males and from the 1960's for females. This is what we will try to determine in Chapter 3 dedicated to the study of the educational investments and its evolution.

In addition to the decline in the female labor force participation for women of younger ages, we observe an increase in the female labor force for women aged 25-49. Considering that on average women were married around age 25 and were widowed around age 60[21], the profile for single women should be rather close to that of women of the age 15-24, the married profile of women of childbearing age from that of the class age 25-49, the married profile of women not of childbearing age anymore from class age 50-60 and the widow profile from the class age 60 and more. From there, the decline in the employment of women aged 15-24 is likely to be similar to the one we would observe for single women. Furthermore, the increase in employment of women aged 25-49 suggests the expansion in the employment of married women of childbearing age. Both changes seem to reflect a deep change in the life-cycle position of women over that time. Indeed, in the previous period the female labor force was reaching its maximum for low ages (15-24 years old). This was likely to reflect the barriers for women to remain part of the labor force while getting married - "marriage bars". This was notably the case for female sellers in big stores, as highlighted by François Parent-Lardeur (1984):

> *"Female sellers must be and remain unmarried because marriage is always a cause of sacking… Under no circumstances, of course, is a pregnancy tolerated."* (in *Madame ou Mademoiselle ?*).

Similar rules were applied in different branches. In postal administration, for instance, women had to quit their job from the moment they were getting married.[22] The transition from S-shape to inverted U-shape indicates that women continue to work despite marriage and pregnancies (or family-related responsibilities) suggesting a change in the economic role of married women.

1.2.3. Impact of Variations in Labor Force

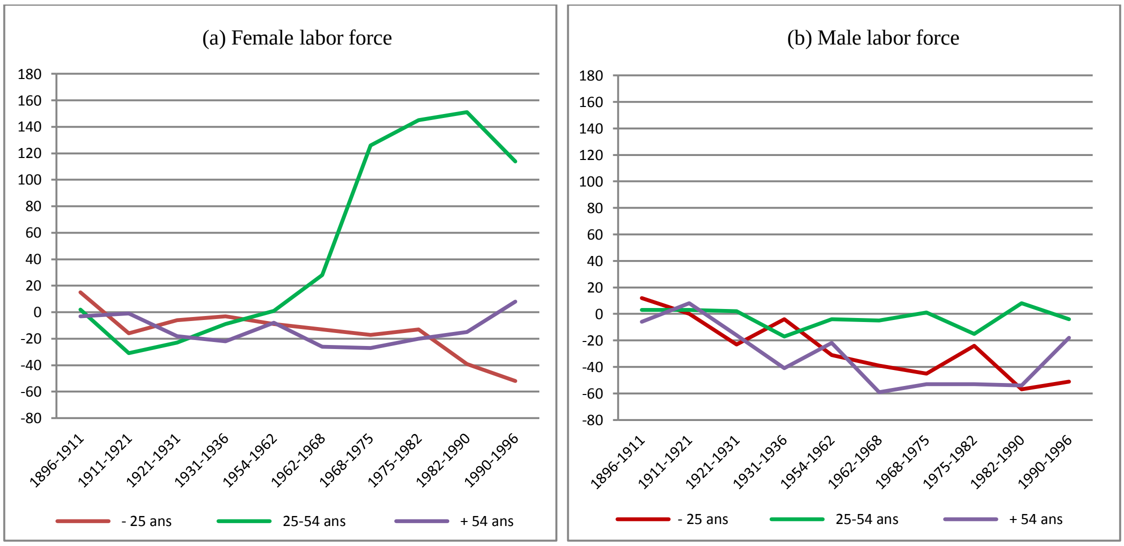
Female labor force, marriage and fertility nurture a complex relationship. In order to have a better comprehension of the evolution of life cycle at work and the underlying potential changes in gender relations, we investigate the impact of variations in the male and female labor force on the evolution of the total labor force participation (Figure 2-6). Between 1896 and 1911, this is largely the variations in the labor force participation of young people (less than 25 years old) for

[21] The average age at marriage and widowhood are calculated using 1851census data.

[22] On the opposite, a totally different situation is applied in textile industries in the North of France. The tradition is such that families combine multiple employments and wages within the family. Married women continue to work despite pregnancies (or family-related responsibilities).

both genders which positively affect the total labor force. Over the period 1911-1960, both variations in the female and male labor force are substantially stable (accounting for some fluctuations) and impact negatively the labor force. If we look at the effect by age, we observe that variations in the share of men and women among young active men and women are those affecting less negatively the global labor force. However, these remain minor changes in comparison to the dramatic upheaval of the role played by the 25-54 female labor force from the 1960's.

Figure 2-6 : Impact of Variations in Labor Force by Age



Sources: Data from Marchand and Thélot (1997)

The deepest change indeed occurred during the sixties and seventies for females aged 25-54 (green line). The variations passed from 0 in 1954-1962 to 150 in 1982-1990. On the other hand, the variations observed both for younger and older active men negatively impact the global evolution of the labor force. The variations drop to -60 in 1962-1968 for older men and to -58 in 1982-1990 for the younger ones.

Dramatic changes occurred in women's work. The strong variations of the female labor force tend to confirm the presence of improvements in gender equality from the sixties, at the same time as both sexual and cultural revolutions. Is it indeed a result of the social movement that challenged traditional codes of behavior and was marked by the emancipation of women and the affirmation of gender equality? If for previous generations pregnancy and other family-related responsibilities could negatively impact women's work and induce a sexual division of labor within the household, data clearly suggest that from the sixties-seventies women could handle both activities in parallel.

But if social codes now accept that women to handle at the same time both their family and professional life, why does fertility continue to decline over time? Women do not need any more to remain single to be part of the paid labor force. This should increase the incentive for women to marry and to have a family. Why is this not the case? The answer is certainly to find in the important decline of the impact of females aged less than 25 on the global labor force. Why did the share of younger working women decline significantly? First intuitions make us believe that these changes are likely to be due to improvements in higher education for girls inducing girls to stay longer at school and to delay the age at first marriage. This is what we will try to determine in the next chapter.

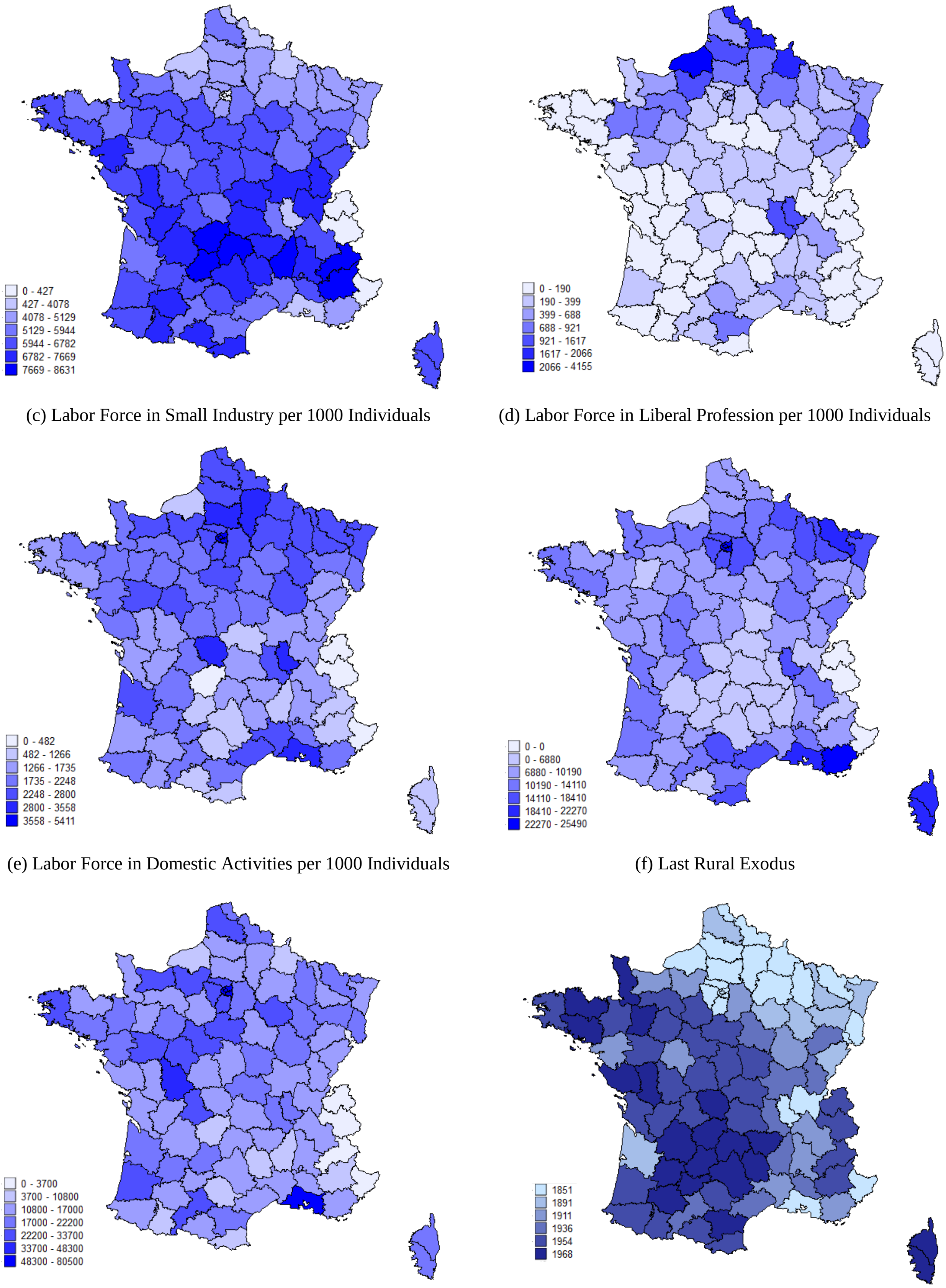
The analysis of Garden (1988) of the labor force by age in 1911 shows that the peak in industrial employment occurs before 20 years old for women and decline regularly as they get older. In 1911, the number of active women in industry is cut in two for women aged between 15 and 60 years old. Instead, the number of active women in agriculture continuously increases as women get older.

1.3. Regional Dynamics of the Labor force

An opposition tends to emerge between an aging agricultural France and a younger France in the industrial and service sectors. It seems now necessary to investigate the geographical trend and the geographical distribution of the labor force across French districts. Our purpose consists of focusing on the heterogeneity of French counties by branch of activities in order to better understand the global dynamic of the country. Figure 2-7 shows the geographical concentration of the labor force by branch in 1851. We distinguish five sectors: agriculture, large-scale industry, small-scale industry, liberal professions and domestic activities.

From Figure 2-2, we noticed previously that the agricultural world declined between the first and second half of the 19th century. Focusing on the geographical distribution of the labor force, we observe a strong heterogeneity between French districts. The most visible geographical difference concerns agriculture and industry. A line of demarcation appears between the Northeastern part of France which is more industrialized and the other part of the country which is more agrarian. The map of the agricultural labor force also appears opposite to that of liberal professions. We clearly see that counties with the largest number of agricultural workers (center of the Southern half of the country – *Massif Central*) exhibit the lowest number of individuals working in a liberal profession. Conversely, counties with the highest number of liberal workers exhibit low rates of agricultural workers (with the exception of Corse).

Figure 2-7 : Geographical Distribution of the Labor Force by Branch of Activity in 1851



(a) Labor Force in Agriculture per 1000 Individuals

(b) Labor Force in Large Industry per 1000 Individuals

(c) Labor Force in Small Industry per 1000 Individuals

(d) Labor Force in Liberal Profession per 1000 Individuals

(e) Labor Force in Domestic Activities per 1000 Individuals

(f) Last Rural Exodus

Sources: Using data from Statistiques Générales de la France – Census 1851; Data based on Lebras and Todd (2013).

The industrial labor force is concentrated in a few parts of the territory. The 1851 map reveals a sort of opposition between rural Western France and a more economically dynamic France combining districts of Northern France, the Paris region and a few clusters around large cities (namely Lyon, Saint-Etienne, Guéret-Aubusson, Marseille and Montpellier for the major clusters). We observe the persistence of the supremacy of Northern counties over decades. At the turn of the 20th century, half of the industrial population is in just 14 counties. The Seine represents itself just over a quarter of total workers. Differences appear across districts or regions but also by level of industrialization or urbanization. A rural emigration is associated with the collapse of the agricultural sector. Large correspondences are observed between the map of rural emigration and agricultural labor force.

Figure 2-7 (f) shows when the last rural exodus occurred in each district. We consider that there is an exodus from rural to urban areas when the share of agricultural workers in the total labor force drops below 50% (Lebras and Todd, 2013). The map illustrates the timing transition from rural to urban areas, such as the timing of the transition from the primary sector to the secondary sector (as seen in section…) for all districts. The timing differs a lot between districts. Highly industrialized counties exhibit earlier rural exodus (and the other way around). This map shows that the industrial society has been very quick in some districts. This is notably the case in Western and Southwestern France where rural exodus occurred late – around mid-20th century. Industrialization and urbanization renewed and enlarged the urban working class by generating new opportunities for individuals and families. Both agricultural and technological changes had impacts on rural exodus. Agricultural changes triggered the migration of rural laborers and peasants toward cities. Technological change brought about artisans and their families into the ranks of the unskilled (Tilly and Scott, 1989). A clear difference appears between Southern France – more rural – and Northern France – more industrialized. Similarly to the correspondence observed between mapping of rural exodus and of areas at agrarian dominance, we also note deep similarities with the mapping of literacy rates and enrollment rates in education. This is what we will develop in the next section.

The study of the evolution of the labor force and its geographical distribution highlights that drastic changes occurred over the course of the 19th and 20th centuries. The female labor force changed substantially in several aspects: in terms of number, occupational distribution, marital status and age. Work patterns changed significantly in parallel to the industrialization and the tertiarization of employment in France. The labor force differs also significantly between genders. The next section focuses specifically on the female-to-male gap in earnings and occupations. More precisely, we will examine to what proportion women's work differs to that of men and how it evolves over time. In addition, we will investigate to what extent it affects and explains the wage gap.

2. General Characteristics of the Gender Gap

This section is an attempt to clarify the long-term evolution of gender differences. In the next section, we will try to gain a better understanding of the reasons for the gender gap and its reduction.

2.1. The Gender Gap in Earnings and Occupations

2.1.1. The Gender Gap in Occupations

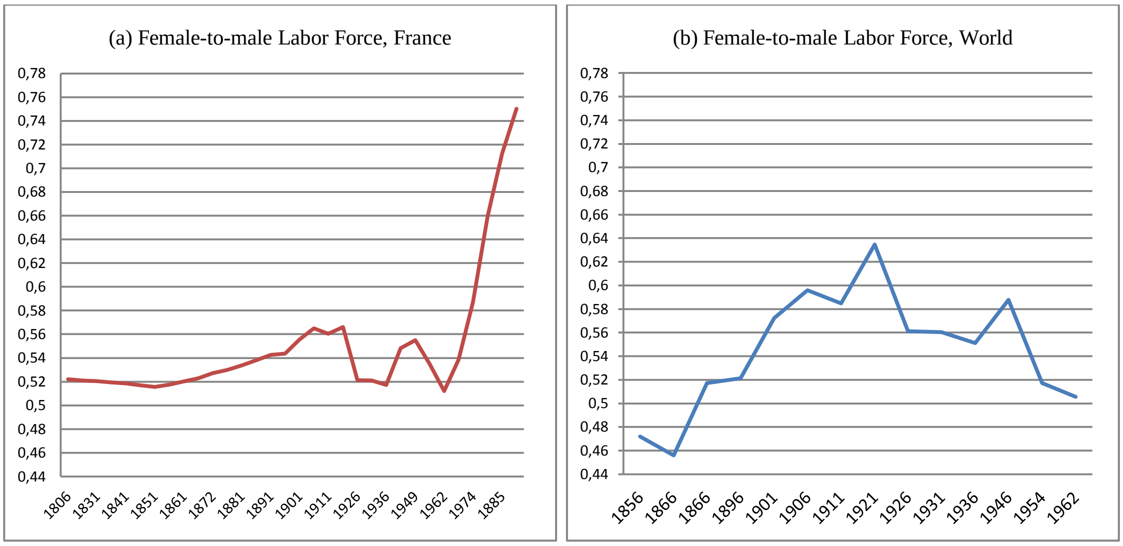
The participation of women in paid activities allowed them to gain economic independence with regards to the household. However, as already seen previously the integration of women into the labor market took more time and was less favorable to them than to men. To better understand gender relations and its evolution, it is necessary to better apprehend changes that have affected the division of labor between men and women.

Female-to-male Labor Force Participation

During the period 1856-1962, the world ratio between the female and the male labor force participation follows an inverted U-shape. We can clearly notice the presence of two picks – indicating a quick improvement in gender equality in terms of employment during WWI and WWII followed by a degradation of the situation right after.

Figure 2-8 depicts the evolution of the employment gap in France between 1806 and 1985. The evolution of the ratio of female to male labor force participation follows more or less the same evolution than that of female active women. A first slight rise is observed during the second half of the 19th century. The 1920's marks a turning point, characterized by large volatility in the gender employment gap. Finally, in coherence with what was suggested previously, we note a strong and fast decrease in the employment gap from the sixties. Between 1962 and 1990, the ratio between women and men in the labor force has multiplied by almost 1.5, from 0.51 to 0.75. Comparing France with the rest of the world, we observe that the female labor force of working age seems to be relatively higher in France than in the rest of the world during the second half of the 19th century. Moreover, at the dawn of WWI, the share of the female labor force was about 20% (of the total labor force) while it was only between 13.5% and 15.5% in England, Germany and Italy (Garden, 1988).

Figure 2-8 : Evolution of Gender Employment Gap in France and in the World



Sources: Own calculations – Using data from Marchand and Thélot (1997); Bairoch (1968)

Table 2-2 gives the number and the ratio of female and male labor force participation in four main European countries, namely France, England, Germany and Italy at the down of WWI. France displays a higher female-to-male ratio than in any other country. In addition, big differences are observed regarding marital status. Deldycke *et al.* (1968) specify that in 1911 69% of single women were working in Great-Britain against only 9.6% of married women while our data on France show that in 1896 already 38% of married women were working on the labor market, and 52% of single women.

Table 2-2 : Share of the Labor Force per 1000 inhabitant, around 1911

	Men	Women	Total	Ratio
France	337	197	534	0.58
England	318	134	452	0.42
Germany	302	155	457	0.51
Italy	325	148	473	0.45

Sources: Garden from Michel Hubert (Afterword, p. 507)

What factors can explain such a relative over-activity of the French female labor force? Could this explain differences in fertility behavior observed in France and other European countries? In Great-Britain, the early and quick industrialization could have promoted the development of a family organization with a breadwinner. This could also have increased the “marriage bar” –

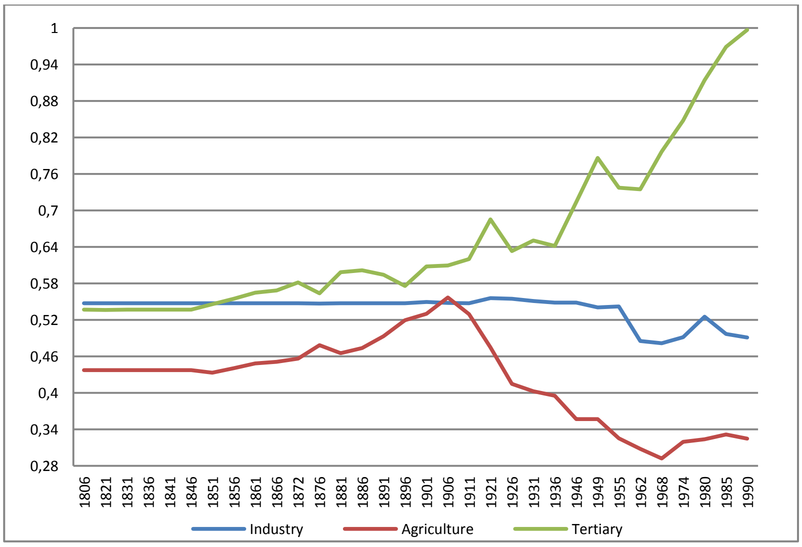
which consists of women renouncing their paid job when getting married. This rule was applied from the mid-19th century to the 1960's and excluded married women from the labor force.

The particularity of the French case could have played a considerable role in the transformation of the marriage pattern (different between regions, Malthusian behavior versus birth limitation). Could higher gender equality in employment explain the earlier fertility decline observed in some areas within France, as well as between France and other European countries? Section 4 will aim at providing answers to this question.

Occupational Segregation by Branch

As expressed by Goldin (1990): "*There is no a priori reason why men and women should or ought to be distributed identically across occupations. But there is a presumption that movements over time in the index should reflect changes in the attributes of the two groups that make them more alike*". We will explore in this sub-section the occupational segregation by branch of activities and more precisely between the three major sectors. From Section 1, we noticed that the labor force came from agriculture to industry and then from industry to services. As far as the agricultural sector loses weight within the global activity, the female-to-male participation declines. We observe similar trends for the industrial sector but to e lesser extent. Oppositely, as far as the tertiary sector gains weight, the gender gap in employment declines.

Figure 2-9 : Female-to-Male Labor Force by Sector



Sources: Own calculations – Using data from Marchand and Thélot (1997)

Figure 2-9 shows the evolution of the gender gap for each sector between 1806 and 1985. The gender gap remains very stable during the first half of the 19th century. This stability continues in the manufacturing sector – around 0.54 – over the whole period, despite some variations at the end of the period. However, we observe a consistent increase in both the agriculture and the tertiary sectors during the second half of the century. Between 1851 and 1901, the ratio between the female and the male labor force rises from 0.44 to its peak at 0.56 in agriculture and from 0.54 to 0.61 in services. The most pronounced change occurs at the dawn of WWI. We observe an opposite evolution of the female-to-male labor force in agriculture and services. The gender gap increases sharply in the primary sector, ranging from 0.56 to 0.3, while it declines at an increasing rate in the tertiary sector to reach perfect gender equality, namely 1, in 1985.

There exists a large occupational segregation between men and women among sectors. Men occupy a larger proportion of the primary and secondary sectors. However, the shape of the curves tends to suggest an early improvement in primary and secondary sectors and a strengthening of improvement in the tertiary sector from the sixties. The study of gender occupational gap by sectors is likely to hide large imbalance ratios within each sector. Focusing first on segregation in manufacturing, we observe that there is an important occupational segregation by type of industries. Some are clearly female-intensive (textile, wearing apparel) others are clearly male-intensive (wood-furniture and manufacture of metal products). Changes in occupational segregation by gender are given in Table 2-3.

Occupational Distribution between Genders

The occupational distribution varies a lot between genders. Women and men did not have equal access to all occupations. At the global level, gender segregation (differs between 2 periods) tends first to decline until the interwar period: from 0.44 to 0.58 (especially triggered by improvement first in manufacturing, then in agriculture). Then, the trend experiences a slight reversal and stabilizes around 0.52. The reversal hides important transformations at a more disaggregated level. In female-dominated activities (clothing, personal and domestic services), the segregation in favor of women appears to be increasing over time; while in manufacturing male-dominated activities, the segregation to the detriment of women increases.

Table 2-3 shows the evolution of gender segregation by branch of industry for six years between 1866 and 1962. The ratio is measured as the number of women in a specific branch of activity over the number of men. The percent of female (male) workforce is the number of women (men) working in the branch of activity per a hundred active women (men). Numbers in blue represent the most important branch of activity for both genders. Numbers in red highlight female-specific activities.

Some occupations were important for both genders; others appear to be clearly gendered specialties. Despite its declining role, agriculture remains the dominant activity for both genders until the mid-20th century. From 50% of both female and male activity in 1866, it still represents more than a quarter of their respective activity in 1954. Women appear to be concentrated in a few occupations outside of agriculture (more than men): wearing apparel, textile, personal and domestic services, and to a lesser extent commerce. In 1866, only four occupations in secondary and tertiary sectors represent 40% of the female labor force. Men are more equally distributed among occupations: textile, wood and furniture, manufacture of metal products, construction, commerce, armed forces, personal and domestic services, transport and communication, beverage and tobacco, leather, professional occupations. Eleven occupations in secondary and tertiary sectors are needed to account for 40% of the male labor force. This trend continues over time, even if female occupations move towards the tertiary sector. In 1962, activities of women are concentrated in commerce, professional occupations, governmental services and personal and domestic services. Activities of men are distributed amongst construction, commerce, machinery, transport and communication, governmental services and professional occupations.

Relatively more active women are working in industry than men: in 1866: 25.65% of the female labor force against 21.97 of the male labor force. But the female-to-male ratio remains high: 1 woman for 2 men. Relatively speaking, the distribution of active men and active women is highly similar amongst several manufacturing activities: textiles, rubber, paper, precious metals – contrary to what could have been expected. Despite the fact that the 1866 census is recognized as having been done with great care and as being highly detailed, we cannot underestimate the fact that the number of females in personal and domestic services is likely to be overestimated (because of the classification that ranked people according to their livelihood rather than their working activity during the period 1856-1891). The problem of classification lies in the counting of farmers' wives who were used to be ranked in the wrong category. Strong differences appear between 1851 and 1866 censuses. In 1851, farmers' wives were counted in the active population working in agriculture however in 1866 the low number of women working in agriculture suggests that they could have been counted as inactive individuals or more certainly as people working in personal and domestic services given the high number of women recorded in this category. Therefore, it is more plausible that the number of female working in personal and domestic services exceeds that of wearing apparel from the 1930's.

Table 2-3 : Gender Segregation by Branch of Activity

	Year 1866			Year 1896		
	Percent of Male Workforce	Percent of Female Workforce	Ratio	Percent of Male Workforce	Percent of Female Workforce	Ratio
Agriculture, fishing	**50,56**	**47,98**	**0,42**	**45,62**	**43,29**	**0,48**
Mining and quarrying	**1,38**	**0,30**	**0,10**	**1,78**	**0,09**	**0,03**
Manufacturing	**21,97**	**25,65**	**0,52**	**23,07**	**26,92**	**0,59**
Textiles	5,48	10,34	0,84	3,81	7,73	1,03
Beverage and Tabacco	2,43	0,88	0,16	3,04	1,57	0,26
Wearing apparel and footwear	1,45	10,81	3,32	2,60	14,95	2,91
Leather except footwear	2,43	1,14	0,21	0,75	0,42	0,28
Wood and furniture	5,00	1,35	0,12	5,09	0,60	0,06
Paper	0,47	0,36	0,35	0,77	0,60	0,39
Rubber	---	---	---	0,03	0,03	0,50
Chemicals	0,18	0,09	0,21	0,28	0,06	0,11
Non metallic mineral products				1,46	0,27	0,09
Basic metal industries	0,48	0,11	0,10	0,44	0,02	0,02
Manufacturing of metal products	3,75	0,58	0,07	4,40	0,50	0,06
Transport, equipment	---	---	---	0,12	---	0
Electrical apparatus	---	---	---	0,06	---	0
Precious metal	---	---	---	0,14	0,13	0,44
Construction	**5,35**	**0,39**	**0,03**	**4,32**	**0,03**	**0**
Electricity, gas, water	---	---	---	**0,21**	**0,02**	**0,04**
Commerce, banking, insurance	**5,01**	**5,58**	**0,50**	**6,22**	**8,00**	**0,65**
Commerce	4,57	5,53	0,54	5,70	7,92	0,70
Banking, insurance	0,44	0,04	0,04	0,52	0,08	0,08
Transport and communication	2,63	0,30	0,05	4,39	2,53	0,29
Services	**13,09**	**19,80**	**0,67**	**14,39**	**19,12**	**0,67**
Governemental services	2,23	0,41	0,08	4,00	1,38	0,17
Armed forces	3,58	---	0	4,50	0,02	0
Professional occupations	2,32	3,11	0,60	2,30	3,17	0,70
Hotel industry, drinking places	1,89	1,50	0,35	1,87	3,70	1
Personal and domestic services	3,07	14,78	2,14	1,72	10,85	3,19
Economically active population	**100**	**100**	**0,44**	**100**	**100**	**0,51**

Table 2-3 : (*Continued*)

	Year 1926			Year 1936		
	Percent of Male Workforce	**Percent of Female Workforce**	**Ratio**	**Percent of Male Workforce**	**Percent of Female Workforce**	**Ratio**
Agriculture, fishing	**35,47**	**43,25**	**0,71**	**33,09**	**39,91**	**0,68**
Mining and quarrying	**3,19**	**0,20**	**0,04**	**2,70**	**0,11**	**0,02**
Manufacturing	**27,89**	**25,48**	**0,53**	**25,84**	**23,07**	**0,51**
Food manufacturing	2,49	1,73	0,40	2,80	2,10	0,43
Textiles	3,07	7,49	1,41	2,52	5,87	1,32
Beverage and Tabacco	0,51	0,31	0,35	0,51	0,25	0,27
Wearing apparel and footwear	1,95	10,55	3,13	1,82	9,22	2,87
Leather except footwear	0,69	0,45	0,38	0,54	0,41	0,43
Wood and furniture	4,86	0,77	0,09	3,73	0,57	0,09
Paper	1,16	1,02	0,51	1,24	1,05	0,48
Rubber	0,29	0,27	0,54	0,26	0,25	0,55
Chemicals	0,72	0,32	0,26	0,71	0,38	0,30
Non metallic mineral products	1,62	0,51	0,18	1,20	0,40	0,19
Basic metal industries	1,09	0,06	0,03	1,00	0,07	0,04
Manufacturing of metal products	6,93	1,33	0,11	6,65	1,31	0,11
Transport, equipment	1,54	0,20	0,08	1,10	0,18	0,09
Electrical apparatus	0,71	0,20	0,17	0,91	0,31	0,19
Precious metal	0,18	0,17	0,54	0,12	0,10	0,47
Construction	**5,14**	**0,08**	**0,01**	**5,25**	**0,11**	**0,01**
Electricity, gas, water	**0,65**	**0,03**	**0,02**	**0,76**	**0,08**	**0,06**
Commerce, banking, insurance	**8,80**	**9,95**	**0,65**	**9,83**	**11,73**	**0,68**
Commerce	7,49	9,07	0,70	8,40	10,59	0,71
Banking, insurance	1,31	0,88	0,39	1,43	1,15	0,45
Transport and communication	6,42	2,04	0,18	6,99	1,80	0,15
Services	**12,43**	**18,97**	**0,88**	**15,55**	**23,19**	**0,84**
Governemental services	4,34	2,56	0,34	5,10	3,37	0,37
Armed forces	2,59	0,00	0,00	3,93		0,00
Professional occupations	2,62	3,85	0,85	3,25	5,46	0,95
Hotel industry, drinking places	1,71	3,78	1,28	1,89	4,62	1,38
Personal and domestic services	1,17	8,78	4,33	1,38	9,74	3,98
Economically active population	**100**	**100**	**0,58**	**100**	**100**	**0,57**

Table 2-3 : (*Continued*)

	Year 1954			Year 1962		
	Percent of Male Workforce	**Percent of Female Workforce**	**Ratio**	**Percent of Male Workforce**	**Percent of Female Workforce**	**Ratio**
Agriculture, fishing	**26,74**	**27,32**	**0,54**	**20,88**	**19,31**	**0,48**
Mining and quarrying	**2,89**	**0,14**	**0,03**	**2,41**	**0,12**	**0,03**
Manufacturing	**27,60**	**24,33**	**0,47**	**29,46**	**25,05**	**0,45**
Textiles	2,27	5,40	1,26	1,92	0,43	0,12
Food manufacturing beverage	2,97	2,50	0,45	3,01	2,64	0,46
Clothing	0,72	5,71	4,22	0,60	4,68	4,11
Lumber, wood, furniture, fixture	1,69	0,50	0,16	1,58	0,58	0,19
Paper, printing, publishing	1,44	1,42	0,52	1,69	1,70	0,53
Leather, skin	1,20	1,37	0,60	0,88	1,32	0,78
Chemical, tabacco	1,75	1,51	0,46	2,04	1,72	0,44
Petrolem, oils	0,21	0,05	0,14	0,29	0,11	0,19
Stone, clay and glass products	1,20	0,49	0,22	1,35	0,54	0,21
Primary metal industries	2,03	0,35	0,09	2,28	0,43	0,10
Machinery	7,19	2,09	0,15	8,44	2,99	0,19
Electrical machinery	1,15	0,99	0,46	1,57	1,74	0,58
Fabricated metal products	3,11	1,07	0,18	3,16	1,18	0,20
Construction	**10,61**	**0,79**	**0,04**	**12,62**	**1,07**	**0,04**
Electricity, gas, water	**0,95**	**0,24**	**0,14**	**1,08**	**0,40**	**0,19**
Commerce, banking, insurance	**10,07**	**13,09**	**0,69**	**11,32**	**15,45**	**0,71**
Commerce	8,32	11,14	0,71	9,42	12,71	0,71
Banking, insurance	1,75	1,95	0,59	1,90	2,75	0,76
Transport and communication	6,69	2,65	0,21	7,07	3,28	0,24
Services	**12,95**	**29,24**	**1,20**	**14,28**	**33,86**	**1,24**
Governemental services	4,40	6,14	0,74	5,00	8,81	0,92
Armed forces	2,74	0,44	0,08	2,82	0,66	0,12
Professional occupations	3,77	9,76	1,37	4,53	12,65	1,46
Hotel industry, drinking places	1,81	4,64	1,36	1,70	4,48	1,38
Personal and domestic services	0,23	8,26	18,89	0,22	7,26	16,95
Economically active population	**100**	**100**	**0,53**	**100**	**100**	**0,52**

Sources: Own calculations – Using data from Bairoch (1968)
Notes: 1866: footwear is included in leather industry; electricity, gas and water are included in mining and quarrying; 1936: unemployed males: 624.7, females: 239.4, total: 864.2, i.e. 4.3% of all population.

A few occupations experienced a reversal in the gendered-domination. This is the case for professional occupations and hotel industry that switched from male-dominated to female-dominated activities. Gender equality in professional occupations and hotel industry increased continuously over the studied period, from 0.60 in 1866 to 1.46 in 1962 and from 0.35 to 1.38 respectively. The gender gap in commerce however remained impressively stable over time around 0.7 between 1896 and 1962.

The gender gap varied a lot over time by sectors but also within each sectors, i.e. by branch of activities. Data clearly highlight the existence of a sexual division of tasks and occupations. This compartmentalization tends to reinforce over time in some specific types of jobs – as if certain occupations were more feminine (and not recognized as requiring specific skills) and others more masculine. The Law of November 1892 increases the gender compartmentalization in factories by preventing women from working in specific industries namely mines, mining and quarrying (article 9) and in jobs presenting sources of danger, requiring excessive strength or dangerous to life (article 12-13) – not applied to workshops.

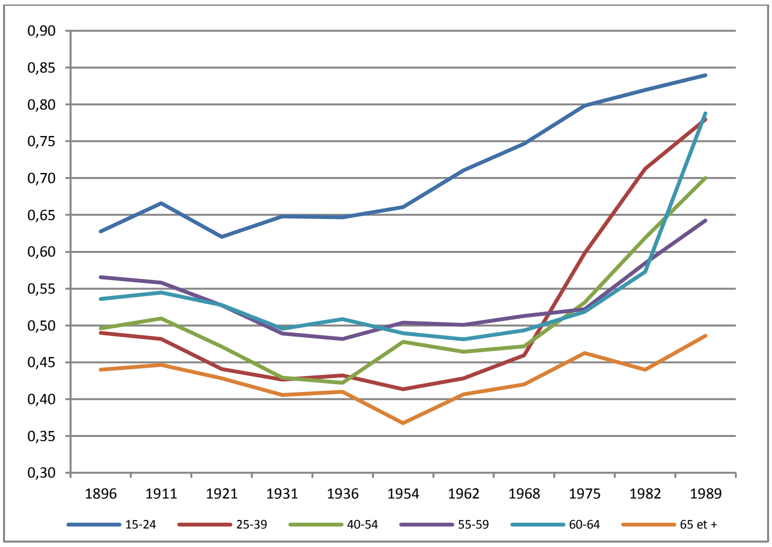
As already emphasized previously, the female labor force participation changed a lot not only in its structure by also by status and age. How and to what extent do these transformations reflect changes in gender relations? If these changes are the expression of an improvement in gender equality, we should notice increases in the occupational gender gap index by age measured by the ratio of female labor force participation at different ages and the male labor force participation.

The Labor Force Gap by Age

Figure 2-10 presents the female-to-male labor force participation by age between 1896 and 1989. Individuals aged 15-24 display the lowest occupational gender gap ratio over the whole period. Until the 1950's the ratio is rather stable. It fluctuates slightly around 0.65. From that period, the number of women aged 15-24 increases continuously compared to that of men to reach 0.84 in 1989. The advancement observed for younger individuals seems to reflect the decline in the male labor force rather than the improvement in the female labor force. Indeed, as shown by Figure 2-5 (by age), employment rates of girls aged 15-24 declined constantly in the course of the 19th century; similar trends are observed for boys. Though the rise in gender occupational equality would result from the proportionally larger decline in the share of the male labor force aged 15-24 than that of female. As already suggested earlier, the decline employment for younger individuals and now the increase in gender equality is likely to have been triggered by increases in educational investment that seems to have occurred from the second half of the 20th century.

While the ratio of young female and male labor force had already reached 0.63 in 1896, other age groups struggled to reach 0.56 and did not exceed 0.44 for individuals aged 65 and more. In addition, while, the level of the female-to-male labor force remains relatively stable for the age class 15-24 between 1896 and 1954, the gap in employment increased for all other age groups. It is for women in reproductive age (and for older women – 65 and more) that the gap is the most pronounced – from 0.41 in 1954 to 0.77 in 1989. But it is also for this age group that the improvement is the fastest and most intense. We indeed observe a clear improvement in female-to-male labor force participation that starts from 1954, especially for age groups 15-24, 25-39 and 65 and more. This improvement intensifies for age group 25-39 from the end of the sixties and spreads to age groups 40-54, 55-59 and 60-64 from the mid-seventies.

Figure 2-10 : Evolution of the Gender Employment Gap by Age



Sources: Own calculations – Using data from Marchand and Thélot (1997)

From the main observations derived from Figure 2-10, we note that the situation improved the most for individuals aged 25-39 from the 1960's. This result confirms once again the existence of a change in gender relations and notably in family organization by encouraging female employment for women of reproductive age. This suggests henceforth a change in the economic role of (married) women through the possibility for women to combine both family and professional life. This also suggests that individuals start to increase their investments in higher education.

If the relationship between men and women really changes over time toward higher equality, the decline in the female-to-male gap in employment over time should have occurred together with a decline in female-to-male wage inequality.

2.1.2. The Gender Gap in Earnings over the Long Run

In fact, training and activities tend not to be paid identically to all laborers. This seems notably to be the case when comparing male and female labor force participation. One first explanation is that men and women do not turn toward the same types of jobs (as seen in Table 2-3) but also do not choose the same type of studies and training (industrial versus tertiary sector, literary versus scientific fields, university versus "*Grandes Écoles*"). Nonetheless, even for similar activities – *ceteris paribus* – the gender wage gap tends to persist.

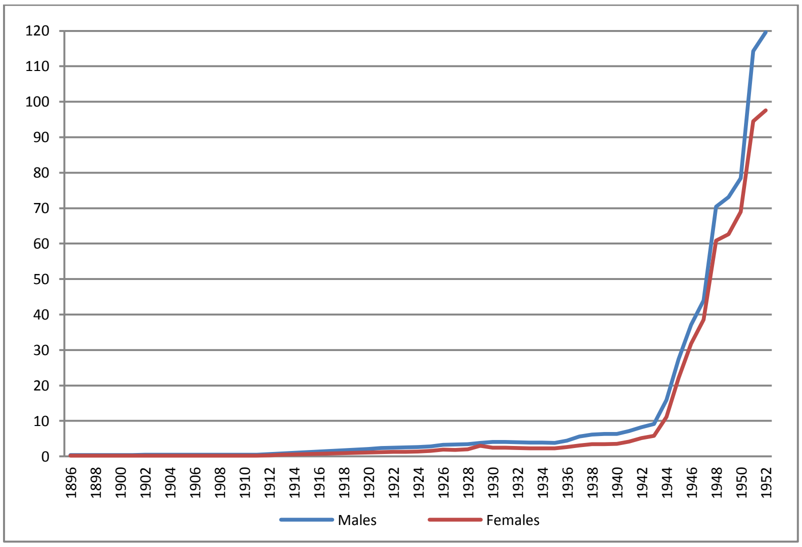
Hourly Wages in Manufacturing

During the 19th century, workers professions were highly gendered. The female workforce was concentrated on "feminine" jobs such as ironer, seamstress or laundress while male workers were dedicated to tasks such as masonry, stone cutting and chiseling or wall-painting.

Figure 2-11 displays the evolution of average hourly wages in main towns within districts (except Paris) for both men and women between 1896 and 1952.[23] We observe that both male and female wages increase significantly in the manufacturing sector. In 1820, an average worker earned about 1000 francs in a month for 10-11 hours worked a day. After a period of stagnation, until the middle of the 19th century, the net wage doubled between 1856 and 1906 after a stable and regular evolution. The first half of the 20th century is marked by strong instability of the purchasing power of workers. After fifteen years of stagnation (between 1896 and 1911), hourly worker wages enter in a first phase a continuous growth until WWI where a fluctuating slowdown begins. Between 1896 and 1944, both male and female wages increased by 10. Right after WWII, the upward trend continues again at an increasing pace. Between 1944 and 1952, the male hourly wage increased from 16 to 120 francs and the female hourly wage from 11 to 98 francs.

[23] Hourly worker wages were higher in Paris than in the rest of France. In 1896, for instance, the average hourly male wage was 0.73 in Paris against only 0,39 in average for the rest of France (0,2 for female workers).

Figure 2-11 : Evolution of Worker Wages by Gender



Sources: Data from Mitchell (1975)

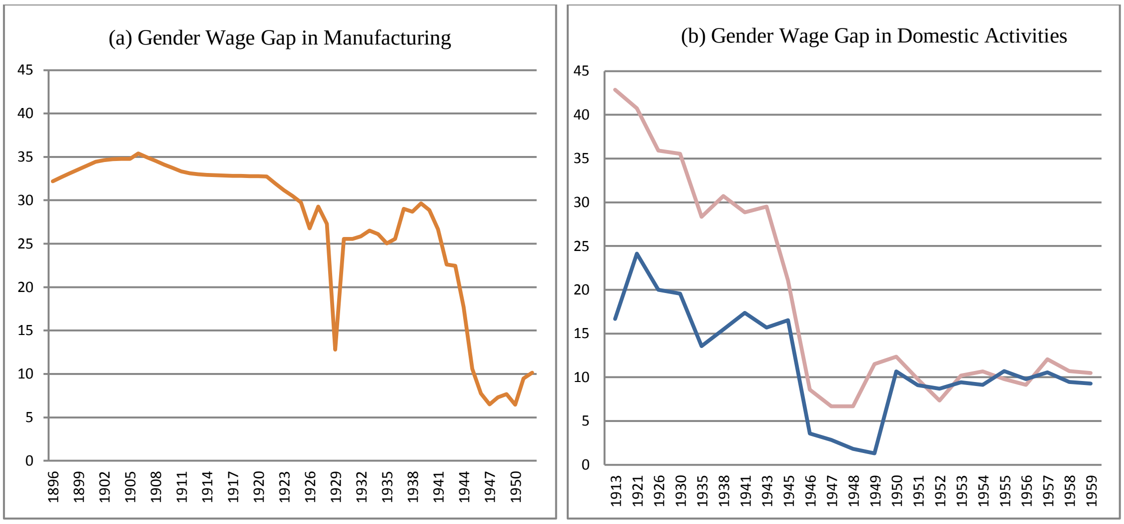
Therefore, Figure 2-11 shows a strong progression of worker wages for both genders. This evolution accounts for improvements in purchasing power of workers (but does not tell us about living standards). This evolution takes place in four main steps. We first observe a phase of stagnation up to 1911. In a second step, both male and female wages progress constantly, before exhibiting a slowdown during a period combining the interwar years and WWII. Finally, wages start to move up again at an increasing pace right after WWII.

Female-to-Male Earnings

At the national level, the average gender wage gap declined significantly from the mid-20th century. The female-to-male average wage increased from 64.9% in 1951 to 83.6% in 2009 (Insee). The real improvement begins from the early seventies. Just a couple of decades were necessary to reduce the gap to almost 20%.

What can explain the female-to-male differences? Are women employed in lower-paid jobs? What is the role played by occupational segregation on the earning gap between male and female? With economic progress (and industrialization) and the rise in the share of female workers, one might expect a reduction in the gender earning gap. Despite clear improvements, the gap still persists. Throughout the 19th century, female wages were rather considered as supplementary wages for the household. Data on wages shows that female wages were always far lower than that of males. In industry during the mid-19th century, female hourly wages represented half of that of men. This phenomenon persists during the 20th century despite a rather pronounced decrease from the second-half of the century.

Figure 2-12 : Gender Wage Gap during between 1896 and 1953

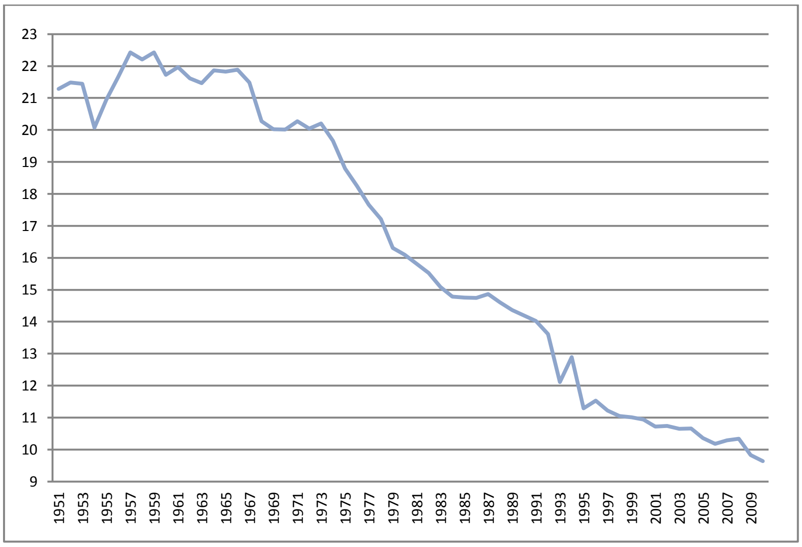


Sources: Own calculations – Using data from Mitchell (1975) – Annuaire Statistique, 1966
Note: The pink and blue lines (in Figure b) represent the gender wage gap for cookers and housekeepers respectively.

It is rather difficult to compare male and female wages because of a "compartmentalization" of tasks, already observed during the 19th century, with the idea that some jobs would be more feminine. Figure 2-12 (a) compares wages of female-intensive labor to wages of male intensive labor in manufacturing sector between 1896 and 1952. Female wages cover seven "feminine" activities: ironer, seamstress, laundress, "*giletière*", lacemaker, embroidery and millinery (*repasseuse, couturier*, *lingère*, *giletière*, *dentellière, brodeuse* and *modiste*). Male wages cover "male activities": stonecutter, mason, navvy, roofer, painter, sculptor-ornementalist, brickmaker, potter, glazier and maneuver (*tailleur de pierre*, *maçon*, *terrassier*, *couvreur*, *peintre en bâtiment*, *sculpteur-ornementaliste*, *briquetier*, *potier*, *vitrier* and *manœuvre*). Figure 2-12 (b), however, presents the wage gap ratio within the same type of jobs for two types of personal and domestic services activities: cooking and housekeeping, between 1913 and 1959.

Both figures highlight a significant gender wage gap. Women's wages were clearly lower than those of men. In 1913, male workers earned 32.8% more than female workers; male cooks 42.8% more than female cooks, and finally male housekeepers 17.6% more than female housekeepers. For both manufacturing and domestic activities, an important decline in the wage gap occurred with WWII. At the end of WWII, it reaches 7.6% in manufacturing, 6.6% for cookers and 1.29% for housekeepers. Right after the war, the difference between male and female wages for both sectors increase a few points and stabilizes around 10%.

Figure 2-13 : Gender Wage Gap between 1951 and 2010



Sources: Data from INSEE

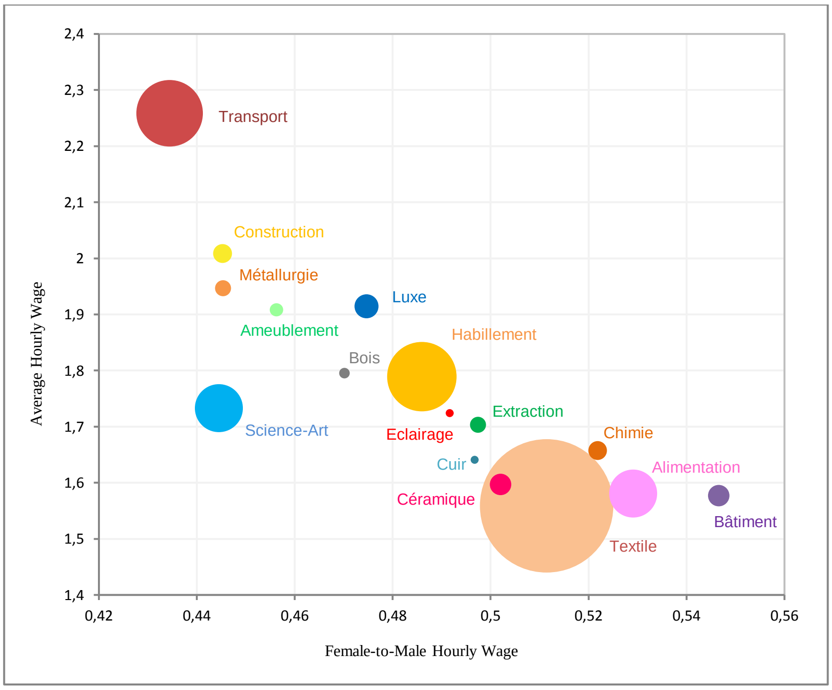
Figure 2-13 presents the evolution of gender wage gap between 1951 and 2008. This figure confirms the continuation of the decline in gender wage gap, at an increasing pace from the end of the 1970's. While, all professions taken together, men earned on average 22% more than women in the 1950-60's, the difference dropped to less than 10% in 2009.

Gender Pay Gap by Industry Type

The following chart represents the gender pay gap sorted by industry in 1861. It links the average hourly wage to the female-to-male wage gap for 16 different types of industry. Therefore, each bubble in the chart represents one industry. The size of bubbles depicts the number of female employed in the industry.

At the aggregate level, the average hourly wage in industry reached 1.77 Francs in 1861 (1.14 Francs for women and 2.41 Francs for men). On average, female workers were paid two times less than male workers (53%). Nonetheless, as can be seen from Figure 2-14, there are considerable variations between industries. The scatter plot links the average wage to the gender wage gap for each industry. Furthermore the further a bubble is to the right, the higher is the female-to-male wage (horizontal axis); the higher a bubble is on the chart, the higher the industry pays its employees (vertical axis). The chart indicates an important negative correlation between the average wage and the gender wage gap. The lower the average wage is in an industry, the higher is the female-to-male wage. The building sector, for example, has the lowest difference in terms of male and female wages: women earn 55 centimes on the Francs of what men earn. It also exhibits one of the lowest average hourly wages. On the other hand, the transport industry is far up on the chart indicating that individuals who work in this sector are paid relatively well (average hourly wage of 2.26 Francs). Surprisingly, the female-to-male employment ratio in the transport industry is higher than in any other industry (1.75); next are clothing (1.38) and textiles (1.02). In all other industries, the female-to-male number of employees is clearly to the disadvantage of women, below 0.47 and even below 0.1 in building, leather, metallurgy and extractive industries.

Figure 2-14 : Gender Pay Gap by Type of Industry in 1861



Sources: Own calculations – Using data from Statistiques Générales de la France – Statistique Industrielle 1861

A part of the gap within given industries could be explained by the different types of jobs that men and women may go into, either by choice or opportunity (e.g. secretaries versus managers). If the gender wage gap is explained by occupational segregation, one should not be able to observe wage differences for similar activities. In the case of manufacturing, it is difficult to give a reliable explanation/interpretation of such a difference as the types of jobs are difficult to compare. Nonetheless, the persistence of a gender gap for similar activities in domestic services suggests that such differences could be related to the existence of discrimination against women. What can explain differences between male and female wages? Does it reflect differences in productivity? Is it rather a result of discrimination against women? And then, why did the gender wage gap decline over time?

Before trying to provide answers to this set of questions, in the following chapter, we will first focus on occupations and wage inequalities both in agriculture and in industry among districts.

The study of maps allows us to identify areas or regions displaying low or high employment, low or high wages, gender disparities and ought to help increasing our understanding of the reasons for county level differences. Understanding regional diversity should enable us better to comprehend national-level evolutions.

2.2. Regional Dynamics of the Gender Gap

2.2.1. Gender Differences in Occupations

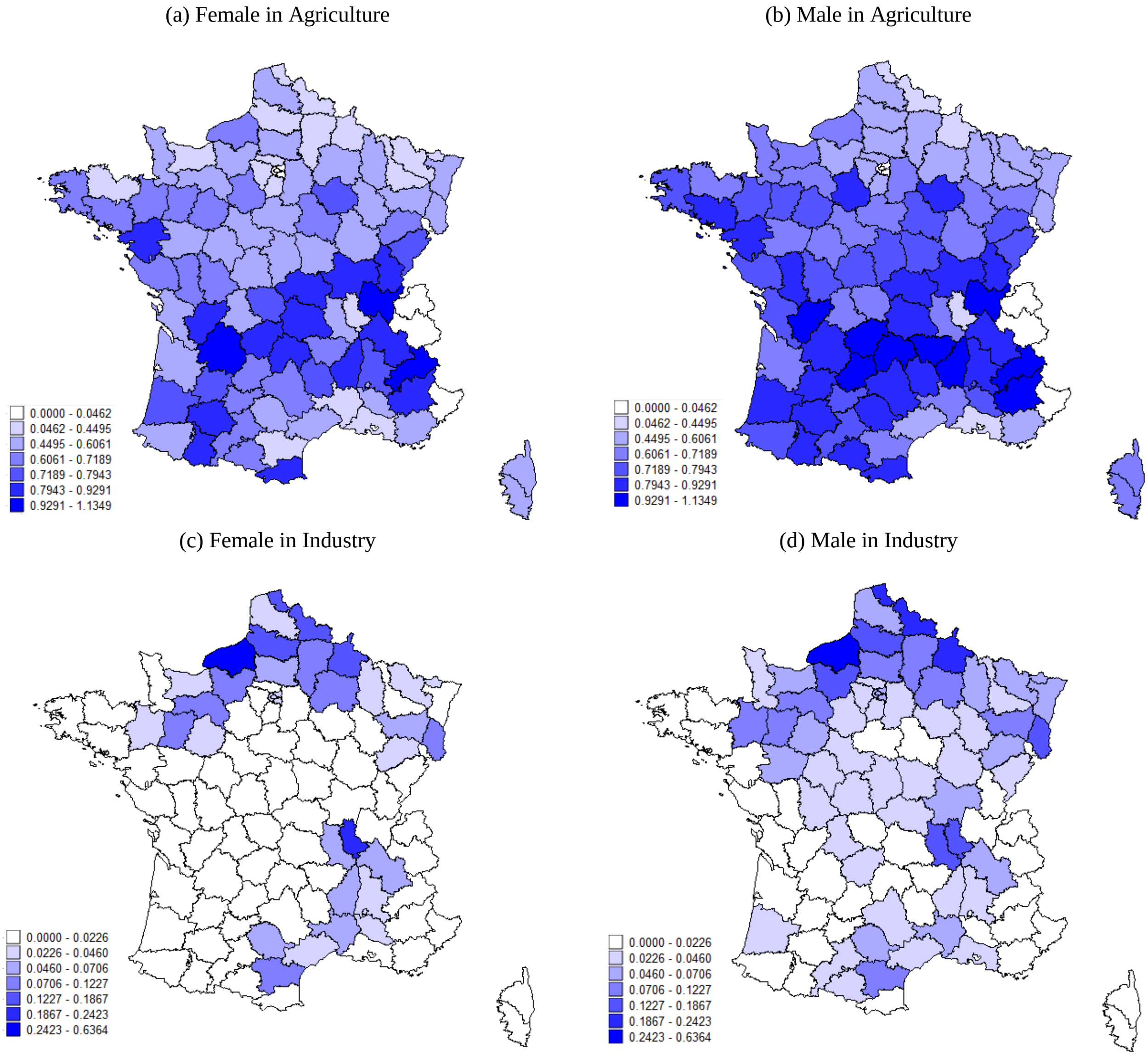
Labor Force by Sector

Figure 2-15 represents the geographical distribution of the female and the male labor force in agriculture and industry in 1851. Mapping female and male employment in the industrial and agricultural sectors enables us to investigate gender differences in terms of the representation in the two most important sectors of the mid-19th century. As already emphasized previously, agricultural labor is geographically more present in the Southern half of France while industrial labor in relatively more important in the Northern part of the country (arcing around the Bassin Parisien) and along the Rhône Valley (until the Pyrénées).

Based on data from the *Statistiques Générales de la France*, we observe that in 1856, the manufacturing sector is the largest employer for only a few counties. In terms of male labor force participation, industries are the first employers in the following counties: Ardennes, Bouches-du-Rhône, Creuse, Morbihan, Nord, Haut-Rhin, Rhône, Seine, Seine-Inférieure and Somme. In terms of female labor force participation, we find the same counties, except Creuse and Haut-Rhin, and Meurthe in addition. Concerning Creuse, the male workforce is the most important in construction and masonry. We observe the same specialization in Seine with at the top positions construction and masonry manufactures, followed by clothes industries. All other counties are specialized in the agricultural sector.

Nonetheless, despite a rather clear distinction between agricultural and industrial France and an obvious domination of agriculture in the mid-19th century, there exists a complementarity between both sectors. Thus, industries were used to employ peasants and farmers during winter and in summer, especially during the harvest period, agriculture employed more individuals – coming notably from industries – to work in the fields. At that period of the year and because of increasing demand for the labor force, agricultural daily wages were used to exceed those of industry (Chanut *et al.*, 1995).

Figure 2-15 : Geographical Distribution of Labor Force by Gender in 1851



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851

Industrial Specialization

The type of industry differs significantly across districts and between genders. Figure 2-16 presents the most popular occupation in industry for both men and women in 1861.[24] For most counties, industries hire the most in textile industries (for instance cotton in Haut-Rhin and silk in Rhône). We indeed find here similarities with Figure 2-15 (c) and (d). Counties exhibiting the highest share of individuals working in industry correspond to areas where the textile industry dominates, namely the Northern and Southwestern part of France. Table 2-3 emphasized the importance of the textile industry for both genders at the national level. This finding is

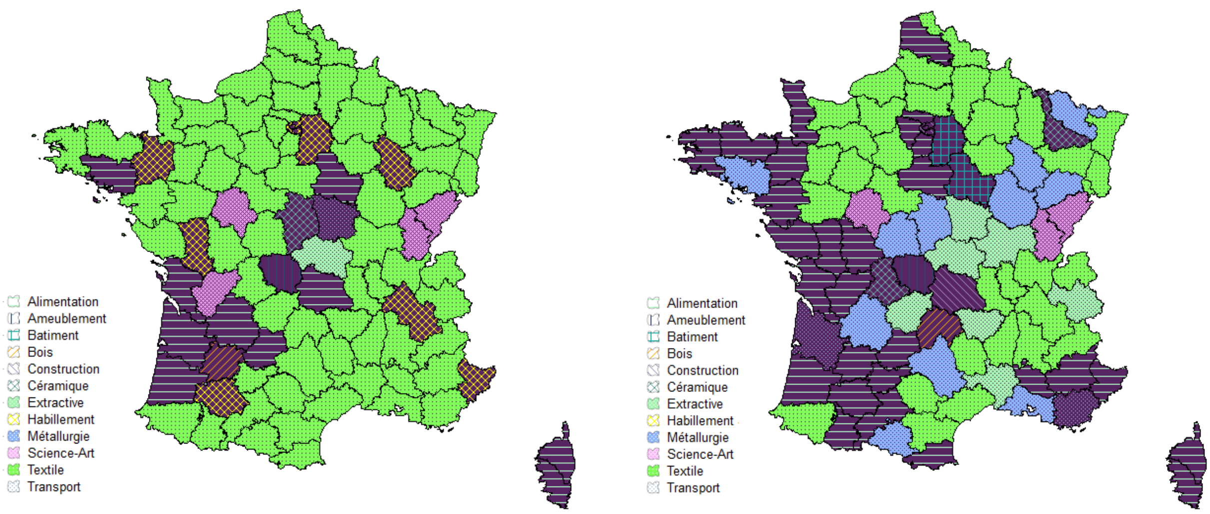
[24] The most population industries are: food, building, furniture, wood, construction, ceramic, extraction, clothing, metallurgy, science-art, textile, transport.

confirmed by the presence of numerous counties colored in bright green on the mapping of top female and male industrial occupation (as well as on top child industrial occupation, Figure in appendix). The result is even more acute for women. Three quarter of the map of top female occupations is colored in green – against one third for men. Nonetheless, the mapping reveals even so certain heterogeneity within French counties that the analysis at the aggregated level did not allow us to see. However, we note the importance of alimentation for counties located along the Atlantic coast, Bassin Parisien, Pas-de-Calais, Vaucluse, Basses-Alpes, Alpes-Maritimes and Corse for men and in the Bassin Aquitain for women. Others with top industrial occupation look more dispersed across France. Clothing, another important employer for women in industry, dominates in Ile-et-Vilaine, Seine, Seine-et-Marne, Haute-Marne, Deux-Sèvres, Alpes-Maritimes, Isère and Gers. Metallurgy and extractive industries are part of the largest male employers and dominate in counties colored in blue and green water. A few counties are specialized in Science and Art: Jura, Doubs, Indre-et-Loire and Charente for women; in furnishing: Creuse; in wood: Lot-et-Garonne for women and Cantal for men; in ceramics: Cher for women, Moselle and Haute-Vienne for men; in transport: Nièvre for women, Gironde and Var for men; construction in Puy-de-Dôme for men.

Figure 2-16 : County-level Industrial Specialization in 1861

(a) Top Female Industrial Occupations

(b) Top Male Industrial Occupations



Sources: Own calculations – Using data from Statistiques Générales de la France – Statistiques Industrielles 1861

In terms of number both Seine and North are the largest employers for several types of industries. Thereby, Seine is the top position in construction, leather wood, chemistry, building, lighting, furnishing, clothing, science-art and luxury. North dominates in textile (for men), extractive industry, ceramics and food. Seine-Inférieure is the main employer in textile for women (and children).[25] In pre-industrial society, "traditional" families of rural areas are organized as domestic families. Family members work all together with sex-differentiated tasks. Women play a key role within these types of family. Women's main tasks consist in taking care of the house, of barnyard and dairy. In addition, women are also in charge of the management and finances of the household (Scott and Tilly, 1989). In landless families, the role of women role is even more important. They are engaged in additional activities such as agricultural work, spinning or petty trading.

In urban and industrialized areas, men and women (and children) are enrolled in different types of work according to their age and their genders. Women and children mainly perform tasks related to the textile industry such as spinning, carding, weaving when men are engaged in activities such as running the looms. In craftsmen families (weavers, bakers, shoe-makers, tailors…), women are in charge of assisting their husbands in their work. In less prosperous spheres women paid activities consist in an extension of their household chores (sew, make lace, laundresses, street cleaners, servants…).

The distribution of the female workforce and the gender occupational gap shows that women tend to remain in established occupations with no economic independence – serving the interests of the family. Non-agricultural employment of women is relatively scarcer with the exception of a few counties – and remains mainly confined to the same three fields, namely textiles and garment making, and domestic services.

Gender Gap

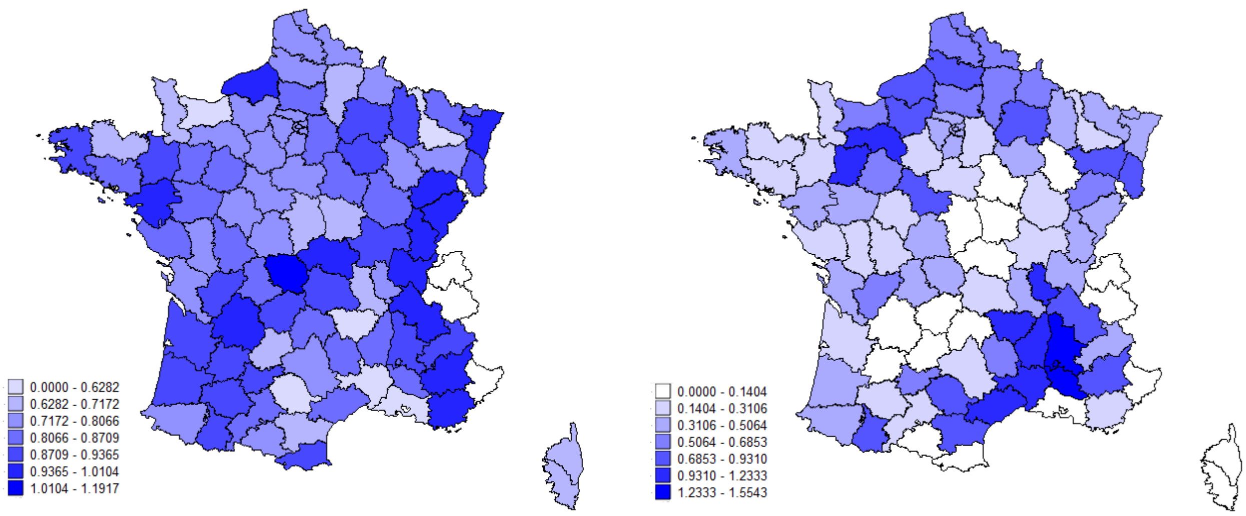
The number of women working from agriculture is a lot higher than women working from industry. In terms of gender, with the exception of a few counties, men are always more numerous in both activities. Only a few counties exhibit equal or even higher female workforce in industry, such as Ardèche, Drôme, Gard, Hérault, Haute-Loire, Mayenne, Orne, Rhône, Vaucluse. Nonetheless, the average gender gap remains a lot larger in industry than in agriculture – respectively 0.48 and 0.83 – as evidenced by Figure 2-17 (a) where colors are more intense and more equally distributed across the territory. The spatial dispersion of the gender occupation gap is much larger in industry than in agriculture. In industry, the occupational gender gap is 37 times larger in Ariège than in Drôme (0.04 versus 1.55). In agriculture, the standard deviation between extreme counties is only 2.19 (0.54 in Bouches-du-Rhône versus 1.19 in Creuse). Almost all counties display a gender occupational gap index above 0.62 in agriculture, namely Tarn, Haute-Loire, Gard and Bouches-du-Rhône. Oppositely,

[25] Aveyron and Moselle are respectively the main employers of women and men in metallurgy. The main female employers are Marne in building, Saône-et-Loire in extractive industry, Vaucluse in Wood and Haute-Vienne in ceramics. The main employer of men in transport is Var.

to the exception of Bouches-du-Rhône, these counties are characterized by high gender occupational gap in industry. Tarn and Gard have both large share of female and male employment in industry. Haute-Loire and Bouches-du-Rhône however present only large male employment rates respectively in agriculture and industry.

Figure 2-17 : Gender Occupational Gap in Agriculture and Industry

(a) Gender Occupational Gap in Agriculture, 1851 (b) Gender Occupational Gap in Industry, 1851



Sources: Own calculations – Using data from Statistiques Générales de la France – Census 1851

From Figure 2-17 (b), we note that the gender occupational gap in industry is higher in counties where the workforce is larger that corresponds, in addition, to counties specialized in the textile industry. In the rest of France, the female-to-male labor force is really low. More than half of the counties display a gender occupational gap below 0.5 (one-third below 0.2) mainly in less industrialized areas. Nonetheless, this does not imply that these counties exhibit a larger female-to-male occupational gap in agriculture. In reality, the comparison of the two maps shows that there is no correspondence between the geographical distribution of the gender gap in agriculture and industry. The correlation of the gender occupational gap between the two sectors is about -0.026. In other words, some counties display large (or low) gender equality in both sectors, others show high equality in agriculture and low equality in industry and the other way around. However, there exists an important correspondence between the spatial distribution of female employment in agriculture and the gender occupational gap (0.634) that we do not find in industry. This finding is likely to be due to the different stage of development of the agricultural and industrial sectors.

2.2.2. Gender Differences in Earnings

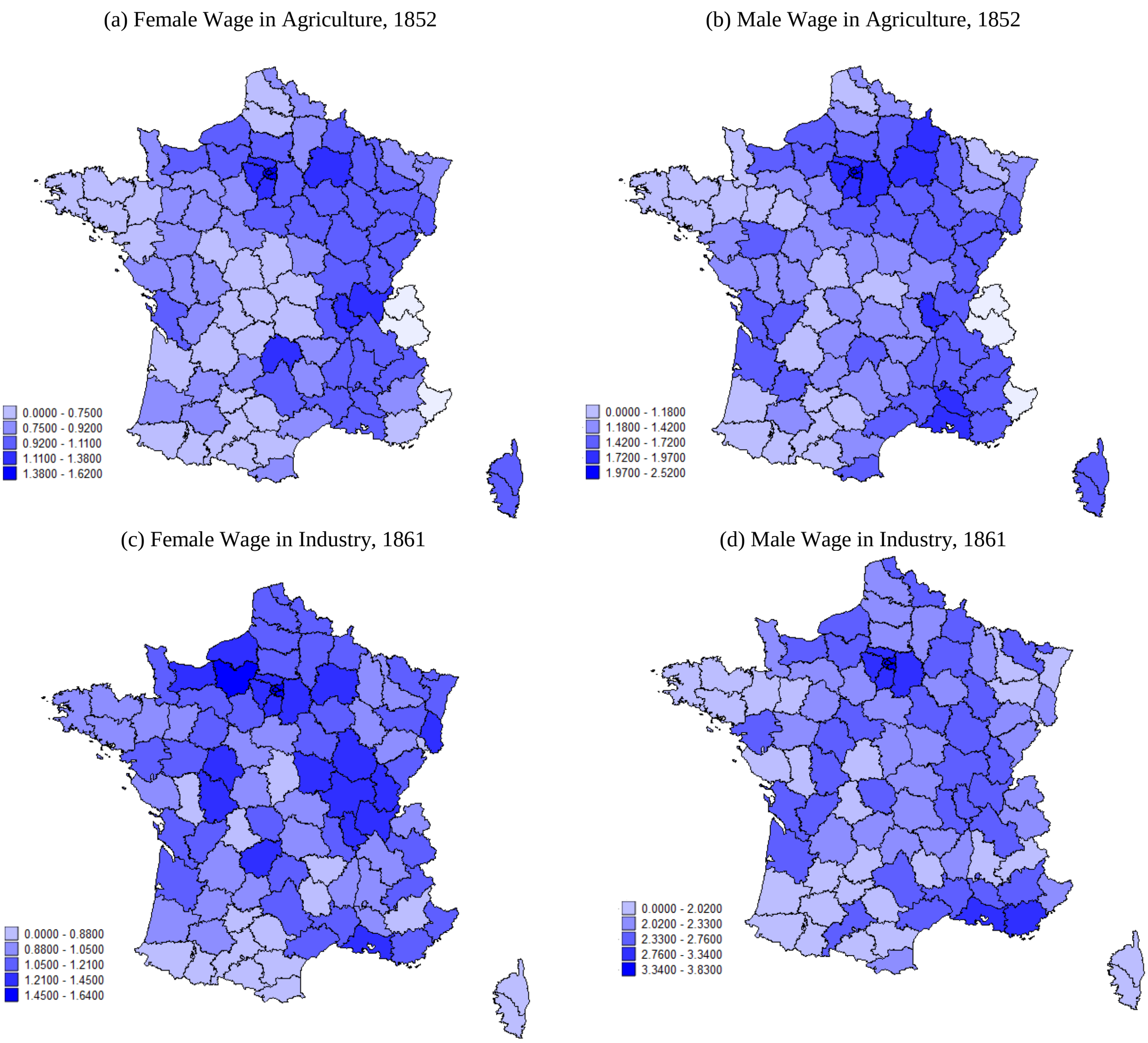
As seen in the previous sub-section, the geographical distribution of occupations differs across counties. Similarly, the distribution of wages varies significantly from one region to another, from one sector to another as well as between men and women. Figure 2-18 shows the geographical distribution of wages (time-rate wages) by gender in agriculture for the year 1852 and in industry for the year 1861.

Agriculture

The geographical distribution of wages in agriculture varies significantly across counties. Between the two extreme opposite areas, Seine and Bretagne, the difference is the order of 2.7 for female wages and 3.15 for male wages. But the geography of female and male wages is highly similar; the hierarchy of average wages by county holds relatively well between genders. Both maps depict higher wages on the right part of a circular arc going from Saint-Malo to Montpellier (included Corse). From that area, only a few counties located in the top North (Nord, Pas-de-Calais, Somme) and Moselle tend to exhibit lower wages. On the other hand, a few counties located on the left part of the arc display higher wages, among those Charente-Inférieure and Cantal. The distribution is reminiscent of the famous line of Saint-Malo Genève (already described in the previous chapter) added this time to the Southeastern band of the country.

The spatial distribution of wages does not seem to be linked with the distribution of employment in agriculture or with land inequality (Figure 1-18 – Chapter 1). However, the distribution suggests the existence of wage homogeneity by region. From the standard deviation of female wages, we distinguish three main areas: *(i)* Seine, characterized by very high wages; *(ii)* the right part of the line Saint-Malo-Avallon-Montpellier exhibiting high wages (more Charente-Inférieure, Cantal and Aveyron including Corse; minus Var, Nord, pas-de-Calais, Somme and Moselle); and *(iii)* counties located on the left part of the line displaying low wages. For male wages, the standard deviation shows the three main areas but the line goes a little further inland: Caen-Avallon-Annonay-Perpignan. In addition to the area of high wages are Charente, Gironde, Lot-et-Garonne and Maine-et-Loire while Vosges and Bas-Rhin belong to the area of low wages. The distribution of agricultural wages shows strong similarities with the map of the last rural exodus (Figure 2-7 (f)). These similarities suggest that male and female agricultural wages respond to supply and demand conditions. Areas offering higher demand for alternative occupations (namely in textile industries for women) should offer higher wages in agriculture so as to avoid an excessive decline in the supply of labor in agriculture. This finding confirms that made by Joyce Burnette (2008, p. 128) in the case of Great-Britain where she shows that the appearance of textile factories in the Northwest of the country increased female agricultural wages.

Figure 2-18 : Geographical Distribution of Daily Wages in Agriculture and Industry by Gender



Sources: Statistiques Générales de la France – Statistiques Industrielles, 1861 and Enquête Agricole, 1852

Table 2-4 : Comparison between Women and Men Average Hourly Wages in Agriculture, 1852

County	Female Hourly Wage	Rank Women	Male Hourly Wage	Rank Men	Female-to-male ratio	Rank ratio
Seine	1,62	1	2,52	1	0,643	39
Rhône	1,38	2	1,95	4	0,708	13
Seine-et-Oise	1,26	3	1,96	3	0,643	40
Marne	1,24	4	1,84	5	0,674	28
Cantal	1,20	5	1,60	23	0,750	4
Ain	1,15	6	1,62	19	0,710	11
Aube	1,11	7	1,64	16	0,677	27
Loiret	1,10	8	1,60	24	0,688	21
Jura	1,10	9	1,69	12	0,651	35
Ardennes	1,07	10	1,75	8	0,611	56
Yonne	1,06	11	1,64	17	0,646	37
Seine-Inférieure	1,06	12	1,67	14	0,635	45
Seine-et-Marne	1,06	13	1,82	6	0,582	67
Doubs	1,05	14	1,69	11	0,621	49
Meuse	1,04	15	1,53	31	0,680	26
Haut-Rhin	1,03	16	1,46	39	0,705	14
Calvados	1,03	17	1,51	34	0,682	24

Sources: Using data from Statistiques Générales de la France – Enquête Agricole 1852

Table 2-5 : Comparison between Women and Men Average Hourly Wages in Industry, 1861

County	Female Hourly Wage	Rank Women	Male Hourly Wage	Rank Men	Female-to-male ratio	Rank ratio
Seine	1,641	1	3,826	1	0,428	68
Eure	1,591	2	2,507	17	0,634	2
Rhône	1,447	3	2,623	10	0,551	8
Seine-Inférieure	1,402	4	2,604	12	0,538	14
Seine-et-Oise	1,388	5	3,147	3	0,441	64
Seine-et-Marne	1,372	6	2,878	5	0,477	47
Saône-et-Loire	1,337	7	2,454	23	0,545	13
Indre-et-Loire	1,331	8	2,522	16	0,528	21
Marne	1,305	9	2,556	14	0,510	33
Calvados	1,299	10	2,454	24	0,529	18
Haut-Rhin	1,294	11	2,276	45	0,569	6
Nièvre	1,258	12	2,282	44	0,551	9
Vienne	1,258	13	2,456	21	0,512	32
Ain	1,251	14	2,564	13	0,488	40
Bouches-du-Rhône	1,247	15	3,338	2	0,373	85
Jura	1,244	16	2,399	30	0,518	27
Côte-D'or	1,242	17	2,734	7	0,454	61

Sources: Using data from Statistiques Générales de la France – Statistiques Industrielles 1861

Industry

Working in industry gives higher wages both for women and men. At the national level, the average female hourly wage in agriculture is 0.89 against 1.08 in industry; for men, it is 1.41 against 2.27. The standard deviation between extreme counties is lower in industry than in agriculture: 2.52 for female wages (Seine versus Aude) and 2.49 for male wages (Seine versus Lot). Nonetheless, gender disparities are far more important than in agriculture. The average difference between industry and agriculture is only 0.19 francs per hour worked for women against 0.86 francs for men. However, men and women are better paid in industry than in agriculture. Wage differences between counties are lower. But the gender wage gap is clearly higher in industry than in agriculture; relatively to men, women earn less in industry than in agriculture.

At first sight, the maps look relatively similar. Counties with higher wages for men in industry exhibit also higher wages for women. There still exists a wage correspondence by region but the different areas appear less clearly than in agriculture; counties with high wages are more scattered across France. Men and women have higher wage opportunities in the Paris region (*Seine*, *Seine-Inférieure*, *Seine-et-Marne*, *Seine-et-Oise*, *Nièvre*, *Marne*, *Indre-et-Loire*, *Eure*, *Calvados*…), in the Center-East region (Bourgogne and Lyon region: *Côte-D'Or*, *Nièvre*, *Jura*, *Ain*, *Rhône*,). Other counties with high wages are more isolated, such as Creuse, Loire-Inférieure. A few counties exhibit high wages for men only: Var, Gironde, Haute-Marne, Haute-Garonne and Isère; for women only: Corrèze, Vienne, Indre-et-Loire, Haut-Rhin, Haute-Alpes. Nonetheless, men wages are always greatly higher than that of women. Wages in manufacturing pass from one to two according to gender. For instance, in *Seine* – that is the district where wages are the highest – the average hourly male wage reaches 3.83 francs against 1.64 for average hourly female wage. From the spatial distribution of the standard deviation of female wages three areas emerge: *(i)* Seine and Eure have very high wages; *(ii)* counties located on the right part of a line Saint-Malo-Montargis-Saint-Etienne-Bourg-St-Maurice (minus Meurthe, Meuse, Haute-Marne, Haute-Saône and Haute-Savoie), at the mouth of the Loire and Garonne and counties arcing from Creuse to Var through Hérault exhibit high wages; and *(iii)* the rest of France has low wages.

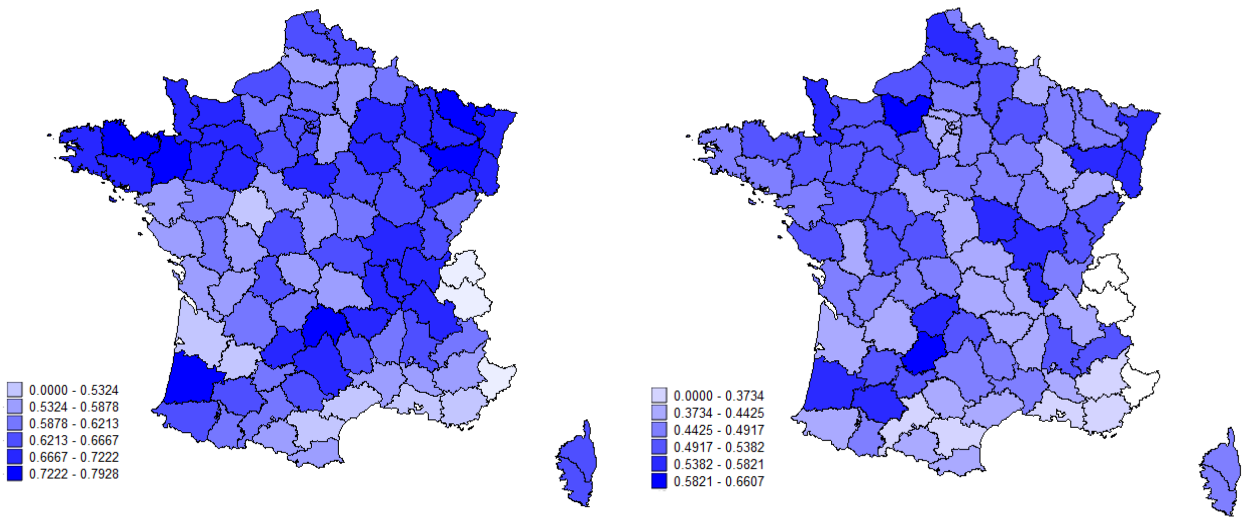
Could wage differences be explained by inter-industrial differences? Are industrial wages higher in some regions because their industrial specialization is better compensated? Or are they higher because of their location? The distribution of female top industrial occupations shows that higher female wages are displayed in counties specialized in textile industries. Nonetheless, several other areas specialized in textile exhibit low female wages. Therefore, could have other factors affected wages and give more clues for the understanding of the geographical distribution of wages? The Northeastern part of France exhibit higher wages for both genders and both sectors. This suggests that the geographical distribution of wages might be linked with a factor able to positively affect wages without sectorial and gendered consideration. Spatial and sectorial wage disparities are large. What about the differences between genders? We already emphasized the existence of large wage differences between men and women. The geographical distribution of wages is highly similar: areas with high male wages tend to exhibit high female wages and the other way around. Nonetheless, it may hide significant regional differences in terms of the gender wage gap.

Gender Wage gap

The female-to-male wage gap is relatively higher in industry than in agriculture. On average, women earned less than half of what men earned in industry (0.48) and two-third in agriculture (0.63). Although the geographical distribution of wages is very similar for men and women both in agriculture and in industry, spatial differences in the gender wage gap varies significantly across regions, as shown in Figure 2-20.

Figure 2-19 : Gender Wage Gap in Agriculture and Industry

(a) Gender Wage Gap in Agriculture, 1852 (b) Gender Wage Gap in Industry, 1861



Sources: Own computations – Using data from Statistiques Générales de la France – Statistiques Industrielles 1861

Figure 2-20 (a) and (b) maps the female-to-male wage gap in agriculture in 1852 and in industry in 1861 respectively. As noted previously, the intensity of the gender wage gap differs significantly between both sectors. The female to male differences in wages are larger in industry than in agriculture. The spatial distribution of both measures looks broadly similar in some areas and rather different in other areas. Gender wage inequalities tend to be higher on the Mediterranean coast, the Atlantic coast and in the center of France.

Agriculture

The different areas appear more clearly on the map of the wage gap in agriculture. We distinguish three areas exhibiting large inequalities and three others with a higher female-to-male ratio. First, the gender agricultural wage gap shows a large area stretching along the Atlantic coast and spreading toward the inner part of the country. We also observe larger inequalities along with the Mediterranean perimeter and the Spanish border; and finally, the Northeastern part of the Ile-de-France and Bassin Parisien. The rest of France displays higher gender equality (above 0.6), namely the diagonal band going from Landes to Genève (including Rhône-Alpes and Southern Bourgogne), the area composed with Bretagne and Normandie and the Northeastern quarter of France.

Table 2-4 ranks counties according to female top wages in agriculture and reports the corresponding male wages and female-to-male wage gap. All counties show a wage ratio above 0.5 with the exception of Bouches-du-Rhône, Gironde and Var. Women are never paid at the same average hourly wage as men. At the national level, women are on average paid 37% less than men in agriculture. Moselle reaches the top position with a wage gap of 12% between men and women. At the bottom of the ranking, Var exhibits a wage ratio of 0.447; women are paid less than half of what man earn.

Industry

The different areas appear less clearly on the map of the gender wage gap in industry. Fewer counties exhibit a "large" female-to-male ratio and tend to be more isolated than in the agricultural sector. On the other hand, we can distinguish four areas displaying large gender inequalities. The most visible area is the Loire Valley going from Orléans to Saint-Etienne and catching up the Rhône Valley until Avignon. Then, we find here again a band on the Mediterranean coast (larger than the one observed for agriculture) extending to the Pyrénées, as well as the Atlantic coast (smaller zone). In addition, Ile-de-France (except Seine-et-Marne) is part of the counties with large gender inequality in industry together with a few isolated counties such as Ardennes, Haute-Marne, Haute-Saône.

Surprisingly, counties with higher female hourly wages do not clearly exhibit higher gender wage equality. *Lot* reaches the top position in terms of female-to-male wage (0.66) while it is rank 56 in terms of female wage and 89 in terms of male wage. *Lot* is then followed by *Eure*, *Corrèze*, *Gers*, *Bas-Rhin*, *Haut-Rhin* and *Pas-de-Calais*. *Seine* reaches only the 68th position in terms of gender equality. *Haute-Marne*, *Bouches-du-Rhône*, *Var*, *Garonne*, *Basses-Alpes* and *Aude* are at the lower range of the ranking.

Table 2-5 ranks counties according to female top wages in industry and reports the corresponding male wages and the female-to-male wage gap. Several counties have a wage ratio above 0.5, but women are never paid at the same average hourly wage as men. At the national level, the average hourly wage gap is 0.48. This means that on average women are paid 52% less than men. At the top position – in *Lot* – the difference is 34% and at the last position – in *Aude* – the difference reaches 68%. From this, we see that the female-to-male wage is not necessarily larger is areas where female wages are higher. If this is indeed the case in some counties such as Côte-D'Or or Rhône, in Bretagne for instance female workers have lower wages but gender wage equality is higher. Then, one might expect female-to-male wages to be higher in counties where the textile industry is more developed – the female labor being more demanded in that field of specialization. Here again, no clear correspondence emerges.

What could explain spatial differences both in terms of occupations and earnings? Could they be explained by living standards, workforce abundance, productivity differentials, quality of the labor force or levels of education? Does this reflect, on the contrary, gender discriminations? According to the rules of the market economy, individuals earn a wage according to their productivity, namely the added value a worker produces in a given amount of time. Are women less productive than men? Were women's wages set by market rules or by cultural factors?

2.2.3. Productivity versus Customs

Were women less productive than men? According to economic theory, the market is supposed to reward workers according to what they produce. The productivity of an individual is therefore very important for determining its wage (the worker output). Strength is likely to have played a role for productivity in some branches of activity (for instance the extractive industry or metallurgy), explaining partly the gender wage gap by the productivity differential between men and women. Nonetheless, other branches of activity did not require special strengths that women were not able to perform. This is even more valid with the development of steam engines. Technical change should widen female opportunities as it tends to reduce the need for human muscle power (Humphries, 1987).

Table 2-6 : Gender Wage Gap and Productivity – Similar Productivity

	Rhône	Ardèche	Moselle	Drôme
Manufacture Number	264	412	49	205
Market Value	6 173 900	14 366 600	3 402 500	8 416 000
Market Value per Worker	301,96	738,79	641,98	663,67
Male Workers	11 586	2 250	3 472	1 396
Female Workers	7 506	12 804	1 716	9 827
Children Workers	1 354	4 392	112	1 458
Occupational Gap	**0,6479**	**5,6907**	**0,4942**	**7,0394**
Male Wage	2,5	1,9	2	1,6
Female Wage	1,45	0,9	1,2	0,95
Children Wage	0,9	0,6	0,6	0,7
Wage Gap	**0,5800**	**0,4737**	**0,6000**	**0,5938**
Added Value per Worker	**5,2496**	**5,8551**	**6,5830**	**6,3134**
Watermill Number	15	406	31	220
Watermill Strength	151	1328	504	660
Steam Number	44	70	16	59
Steam Strength	267	253	211	226
Specialization	Silk/Cotton	Silk	Wool	Silk

Sources: From Statistiques Générales de la France – Statistiques Industrielles 1861

Table 2-7 : Gender Wage Gap and Productivity – Opposite Productivity

	Deux-Sèvres	Meurthe	Hautes-Alpes	Haute-Loire
Manufacture Number	79	209	61	42
Market Value	1 392 350	2 553 180	587 000	1 032 200
Market Value per Worker	872,40	332,92	358,58	965,58
Male Workers	863	1 319	1 001	142
Female Workers	404	6 152	422	846
Children Workers	329	198	214	81
Occupational Gap	**0,4681**	**4,6641**	**0,4216**	**5,9577**
Male Wage	1,9	1,9	2	2
Female Wage	0,9	0,9	1,1	0,85
Children Wage	0,6	0,6	0,6	0,7
Wage Gap	**0,4737**	**0,4737**	**0,55**	**0,4250**
Added Value per Worker	**11,3039**	**4,5130**	**4,0996**	**14,0262**
Watermill Number	32	14	66	24
Watermill Strength	194	142	220	133
Steam Number	13	5	0	1
Steam Strength	139	194	0	15
Specialization	Cotton/Wool	Cotton	Wool	Silk

Sources: From Statistiques Générales de la France – Statistiques Industrielles 1861

Tables 2-6 and 2-7 present the characteristics of textile industries in several counties in 1861. We choose to focus on the textile industry as it was the dominant industrial activity in 1861 in France. We select counties so as to have an opposition between counties in terms of the gender occupational gap allowing for a comparison between male-dominant and female-dominant textile industries. Through a parallel between extreme situations, we aim at comparing the differential productivity in order to determine whether differential productivity explain, at least partly, the gender wage gap or not.

There is an important diversity of situations among counties. The differential productivity is hard to measure as we do not know the appropriate productivity ratio. We use the value added per worker as a measure of productivity. The value added is calculated by subtracting the price of the raw material from the selling price. We then divide the value added by the total number of workers in order to obtain the productivity per worker. As we do not have data allowing us to distinguish male and female productivity, we choose to compare the productivity of counties exhibiting opposite gender occupational gaps. Thus, we assume that the productivity of workers within female-dominant textile industries is mainly that of women and the productivity of workers within male-dominant textile industry is that of men.

Table 2-6 compares first Rhône and Ardèche and then Moselle and Drôme. Rhône and Moselle are characterized by male-dominant textile industries; the gender occupational gap being low in both counties, 0.65 and 0.49 respectively. On the other hand, textile industries in Ardèche and Drôme are highly female-dominant, almost 6 women for one man in Ardèche and 7 women for one man in Drôme. When we look at the added value per worker, we note that they are very similar for both pairs of counties. Concerning Rhône and Ardèche, one possible interpretation of such similarity could find its origin in the differential of watermill strength that is significantly higher in Ardèche than in Rhône (respectively, 1328 against 151). Nonetheless, focusing on Moselle and Drôme, we see that both watermill and steam strength are similar. The correspondence in the value added per worker observed in both counties suggests that the worker output is similar, namely between the male-dominant textile industry in Moselle and the female-dominant textile industry in Drôme. As a consequence, if individuals are indeed paid according to what they produce, one might expect Moselle and Drôme to display similar female and male wages. Yet both districts exhibit low female-to-male wages. Women earn 60% of what men earn. Such differences might also be driven by the fact that men and women were not performing the exact same type of work within textile industries. Nonetheless, the systematic wage gap in favor of men despite the existence of various situations in terms of productivity makes us believe that other reasons ought to be at the origin of the wage gap.

The productivity differences cannot alone explain the gender wage gap. Table 2-7 presents the characteristics of the textile industry in counties displaying completely opposite situations. However, Deux-Sèvres and Hautes-Alpes are characterized by male-dominant textile industry while Meurthe and Haute-Loire by female-dominant textile industries. Comparing Deux-Sèvres with Meurthe, we observe that individuals' productivity is greatly larger in the first county (male-dominant) than in the second one (female-dominant), 11.3 against 4.5 – watermill and steam strengths being similar. As expected by the economic theory, male wages are much higher than those of females. However, the comparison between Hautes-Alpes and Hautes-Loire tells us a completely different story. The female-dominant textile industry of Haute-Loire is strongly more productive than the male-dominant textile industry of Hautes-Alpes (watermill and steam strength being even higher than in Haute-Loire). While we should observe a gender wage gap in favor of women, given the higher productivity of the latter, the data reveal that women where paid 42% less than men. A part of these differences could be explained by the fact that men and women do not perform the same type of jobs as suggested before. In this case, the female-to-male wage gap in female-dominant and more productive industry (such as in Haute-Loire) ought to be larger than in male-dominant and less productive industry (such as in Hautes-Alpes). But we see the opposite. Women are paid 55% what men earn in Hautes-Alpes and only 42% in Haute-Loire.

Evidence from textile industries tends not to be convincing enough to make us believe that wage differences could be explained by productivity differences. Women's wages remain too low relative to their productivity. At the national level, the gender wage gap reaches 0.506 in the textile industry – the main employer for both genders. One may doubt that women have actually been half as productive as men. It is nonetheless necessary to specify that the data account for daily ordinary wages. Therefore, a difference in hours worked between men and women may explain a part of earning differences and exaggerate the gender wage gap, as noted by Burnette (1997). Burnette argues notably that inequality in housework responsibilities would have led to a difference in average hours worked between men and women in the market.

In France, the daily working time in the textile industry is often described as having been among the longest. In his publication about the health of workers in textile industries, the Doctor Louis-René Villermé (1782-1863) qualifies the daily working time in the textile industry as being excessive. In his work, Doctor Villermé also stated about wages that:

> "*Un homme seul gagne suffisamment pour faire des épargnes ; mais c'est à peine si la femme est suffisamment rétribuée pour subsister, et si l'enfant au-dessous de 12 ans gagne sa nourriture*".

About wool industries, Colombier (2012) writes that the daily working range was around 15 hours. Following the 1848 Revolution, the government implemented an ephemeral legislation limiting daily working hours to 10 hours in Paris and 11 hours in the rest of France. The daily working wage was then fixed at a maximum of 12 hours by the Decree of September 9, 1848. This legislation was in force at the time of the completion of the Industrial Statistical Yearbook (1861-65). Thereby, although yearly average hours worked were different between genders, it seems quite reasonable to assume that in textile industries women were used to work a similar number of hours per day to men at that period of time.[26] Unfortunately, we do not yet have a sufficient number of information to bring more evidence and definitive conclusions about other industries or sectors. This will be the purpose of further research.

In addition to working conditions, circulars and a few unions start to speak against women's exploitation, asking for the increase of their wage and claiming the following principle: "equal work, equal pay" (Albert Thomas; E. Cassin, *Union des métaux*, 1916) suggesting that it was not yet the case. This followed notably the discourse of Hubertine Auclert (1879) at the *Congrès Ouvrier de Marseille* (see in Appendix) that led unions to raise the question of the situation of women within the economy/society. Devance (1976) specifies that, at least since Fourier, feminists see unanimously in woman social work based on her emancipation and denounce the discrimination imposed on women in terms of under-education and under-compensation. Another reason advanced to explain differences in wages is that male wages had to be sufficiently high so as to ensure the survival of all members of the family. This argument then would explain why men's productivity is overestimates compared to that of women (and children). Or is it on the contrary women's productivity that is underestimates – as being considered a supplementary wage? Women's biological responsibilities toward children in terms of bearing and breastfeeding are also likely to have been used as an argument justifying their lower wage. But then this argument does not hold to explain the reasons why the segregation within paid work increased in industry.

Conclusion

In the mid-19th century, women worked on the labor market but the kinds of jobs they occupied were limited in terms of number and of type. The study of the evolution of the labor force participation reveals that the female labor force increased substantially over time (in paid activities) both in its proportion and in its structure. Economic development leads to strong upheaval in the social structure of the workforce. The rural exodus drove agricultural workers to

[26] In 1832, the father of a working class family worked in average 300 days a year (for 450 Francs), the mother 200 days (for a yearly wage of 180 Francs) and children 80 days (for 65 Francs).

cities. However, the number of farms does not decline that much immediately. During the economic take-off, the working class increased substantially. After WWII, we note a profound mutation of the society. On the one hand, we observe an almost complete disappearance of farmers and a decline in the working class. On the other way, we note a sharp increase in tertiary activities.

Therefore, three main transformations of the social structure of the labor force emerged in France. We first observe a large decline in the peasantry, especially agricultural workers. Second, we note a rise followed by a decline in craftsmen and tradespeople. The decline in the peasantry, as well as craftsmen and tradespeople, occurred to the benefit of manufacturing workers, accounting for a sharp increase in their number. Finally, the last deep change is the appearance of employees and executive workers. In the mid-20th century, wage earners represented two-third of the total labor force. Their number continued to rise at an increasing pace during the second half of the century. As far as the weight of the agricultural sector declined, female labor force participation within the economy declined – at least at first. In towns, women were performing both domestic tasks and professional activities – in a distinctive way. However, in the countryside women dedicated their time often exclusively to the first task. It is from the beginning of the 1960's that this situation changed deeply. The female participation in the professional life increases and one witnesses a feminization of society. Women became more visible. In other words, the labor force tends to follow a three-stage process with first the urbanization, then the industrialization and finally the "tertiarization" – underlying a shift from the primary and secondary sectors to the tertiary sector as described previously.

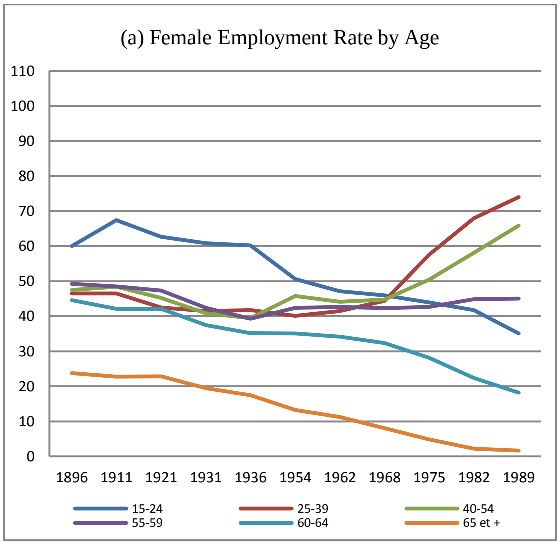
Focusing more specifically on the whole female labor force by marital status, longitudinal data reveal that the most represented category was that married women but in terms of relative proportion single women were more numerous. Women working in industry were usually young, single and were overwhelmingly concentrated in textile industries. They did not turn toward the same types of jobs. Women were less likely than men to perform skilled jobs and were also prevented from performing certain type of jobs (as well as from acquiring skills allowing them to perform other types of jobs).

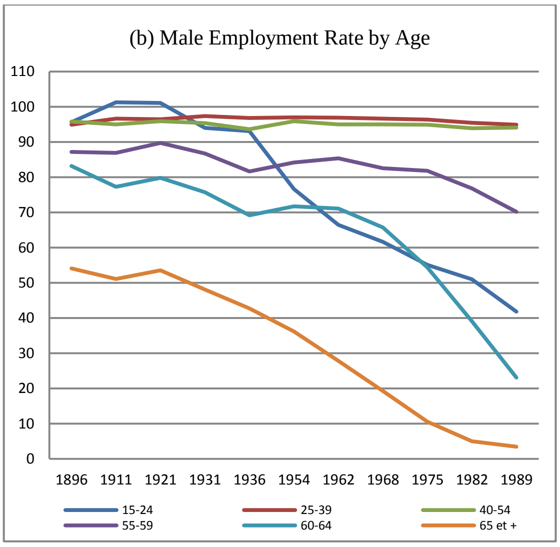
In addition, this chapter described the evolution of the gender gap in occupation and in wages. If the female-to-male gap in employment decreases over time, the experience of women at work should approach that of the male labor force. Thus, we also ought to see a decrease in wage inequality. Indeed, both gaps fell significantly over time although the decline was not continuous. Nonetheless, the completion of the closing in the gender gaps has not yet been reached. Several reasons may play a role and can explain the reduction of differences in occupations and wages – economic, social, cultural reasons. The persistence of the gap in wages may be explained by the existence of discrimination against women; in some very specific types of jobs it may also find its origin in differences in productivity resulting from the strength differential. But it may then also reflect gender differences in the skills and training of the labor force – pre-market discrimination (Burnette, 1997). Several outstanding issues still need to be addressed. A set of unanswered questions remain. Why do men and women perform different kinds of jobs? Why for the same type of jobs do men and women not earn similar payment? Why did the gender wage gap decline over time? We think that economic, social and cultural factors explain changes in women's work.

Several factors are likely to impact the productivity of an individual, among them the amount of human capital endowed in individuals. Until a relatively "recent" period, women have always had less education than men. Differences in human capital may be both a result and a cause of wage differences (Burnette, 2008). The next chapter will be dedicated to the analysis of female and male educational investments. Furthermore, we will try to clarify the possible reasons for the origin/chores of gender differences and to describe its evolutions before offering/proposing an explanation.

Appendix B

Figure B-1 : Evolution of Employment Rate by Age

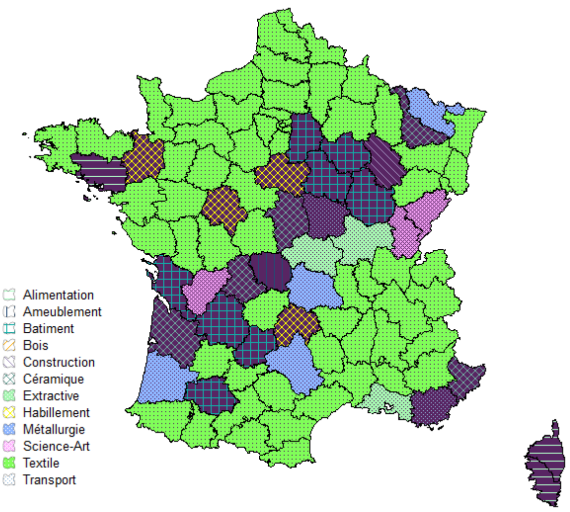




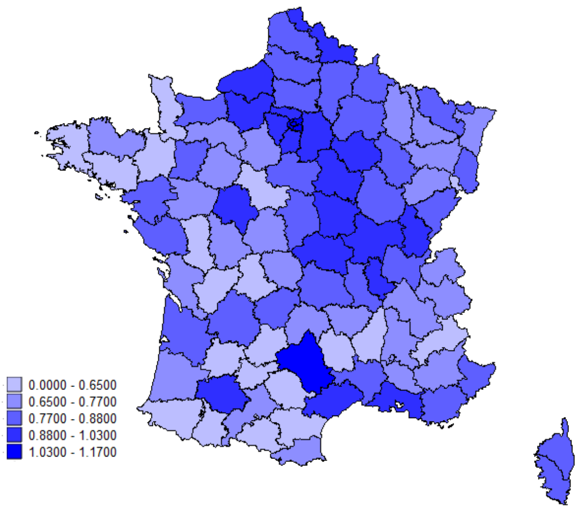
Sources: Data from Marchand and Thélot (1997)

Figure B-2 : Geographical Distribution of Top Children Occupations and Average Wages in 1961

(a) Top Children Occupations

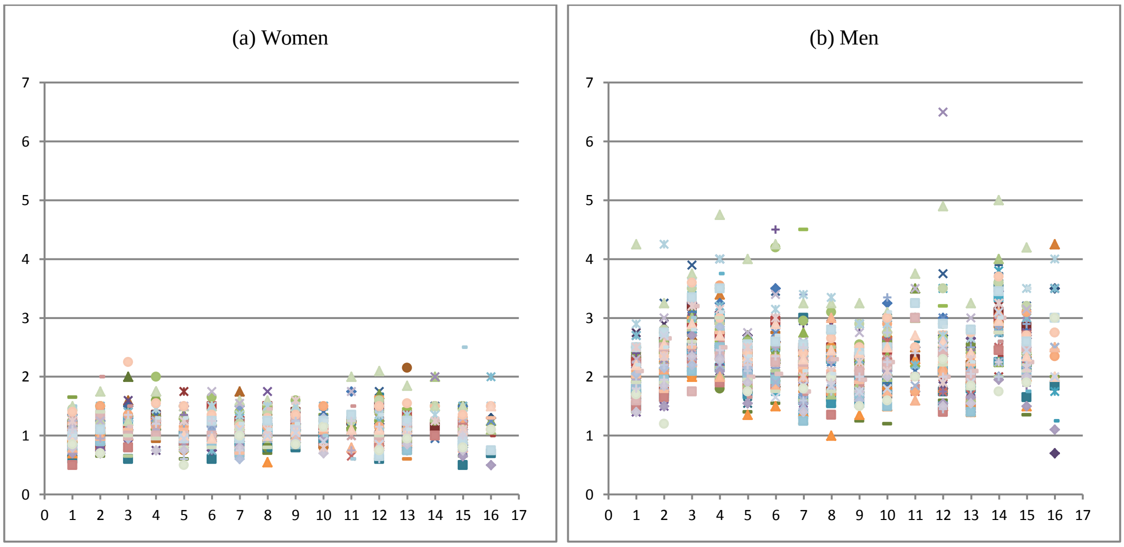


(b) Children Average Wage



Sources: Own calculations – Using data from Statistiques Générales de la France – Statistiques Industrielles 1861

Figure B-3 : Scale Distribution of Wages by Type of Industry in 1861



Sources: Data from Statistiques Générales de la France – Statistiques Industrielles 1861

Note: The vertical axis displays wages. The horizontal axis corresponds to the various types of industries: *(1)* textile, *(2)* extraction, *(3)* metallurgy, *(4)* construction, *(5)* leather, *(6)* wood, *(7)* ceramic, *(8)* chemical, *(9)* building, *(10)* lighting, *(11)* furniture, *(12)* clothing, *(13)* food, *(14)* transport, *(15)* science-art, *(16)* luxury-pleasure.

Chapter 3

Changes in Educational Investments

Content

"*When you educate a man, you educate an individual; when you educate a woman, you educate a family*." Charles Duncan McIver (1860-1906)

« *L'admission des femmes à l'égalité parfaite serait la marque la plus sûre de la civilisation, et elle doublerait les forces intellectuelles du genre humain.* » Stendhal

Introduction

The study of the ratio of female to male occupations and wages and of their respective evolutions displayed the existence of significant differences between genders, always in the disadvantage of women. Although the gender gap declined sharply over time (especially in the 1960's), the differences between men and women remain. What can explain differences in wages between genders? Why did differences in wages decline over time? Several factors may be at the origins of these differences (productivity-strength, custom-discrimination). Some have already been briefly discussed in the previous chapter. Further upstream, differences in female and male endowments in human capital may explain both differences in occupation and earning – resulting from productivity differences and allowing to justify different payments (even for tasks requiring no particular skills).

The gender gap observed on the labor market may find its source in the fewer educational opportunities offered to girls (discrimination against girls). Women were notably less literate, received less training and as a consequence had fewer skills. They were also not trained to perform certain types of jobs. In his *Traité de l'éducation des filles* (published in 1687), Fénélon assert that "Nothing is more neglected than girls' education. Custom and mothers' caprice often decide everything; it is assumed we should give to that gender little education". Surely ahead of its time, Fénélon – as well as Fleury, Mme de Lambert or Poullain de la Barre, substantially simultaneously – insists on the fact that girls should receive a thorough education that goes beyond the traditional education consisting mainly in reading, writing and counting as well as knowing, loving and serving God (Sonnet, 1995). However, these writings cater more to worldly women than ordinary women. One has to wait the mid-19th century to note institutional "progresses" in the field of women's education through the implementation of a set of laws (Duruy, Ferry or Sée) by public authorities. Nonetheless, gender differences persist both in the recognition of the need to educate girls and in the implementation of structures improving girls education both in proportion and in its content. The study of the evolution of enrollment rates notwithstanding suggests significant improvements in girls' formal (elementary) education. The evolution of girls' education followed a gradual evolution. Increasing enrollment rates have first been observed in primary education (from the early 19th century), then in secondary education (from the end of the 19th century) and later in tertiary education (from the 1960's). One key aspect at the chore of the study of the evolution of girls schooling concerns the evolution of mentalities. Did the evolution of the thinking/ideology about women lead to this first improvement in girls schooling? Or did the increase in education triggered changes in the habits?

Despite the implementation of several laws in favor of girls' education, the discourses remain in the line of patriarchal ideology suggesting that girls' knowledge should be conformed to their future role. In his *Traité de l'éducation des filles*, Fénélon (1687) stated in his arguments in favor of girls' education, that it was not enough for a woman to know how to manage her household and obey her husband without thinking that girls' education is also important and necessary for public good as they are also responsible for the value of men's education as mothers influence morals and virtues of male children who are the men of tomorrow. In the same line, one century after Fénélon, Ferry and Sée, although in favor of girls' education, expressed their opposition to the access of "classical humanities", such as Latin which was necessary to obtain the high school scientific degree. To Sée (1884), there is a "program for girls" to substitute to all abstract sciences that they [women] will never make any use; that one shall hope they will never make any use. […] It is in our interest, in the interest of the whole society that they stay at home". This "program for girls" includes notably "health" and "domestic economy", activities in the line of their future role of housewife and mother.

> "*Virgines futuras virorum matres respublica docet*" (trans. The Republic educate girls who are the mothers of men – Camille Sée)

Others such as Charles Bigot (1882) believed on the contrary that it was necessary to "give girls a solid education. The time is past when it was enough for a woman to feed and educate the children, to be able to perform household chores. A good education offers to a young girl a way to live from her work, to choose a profession" (Institut français de l'éducation).

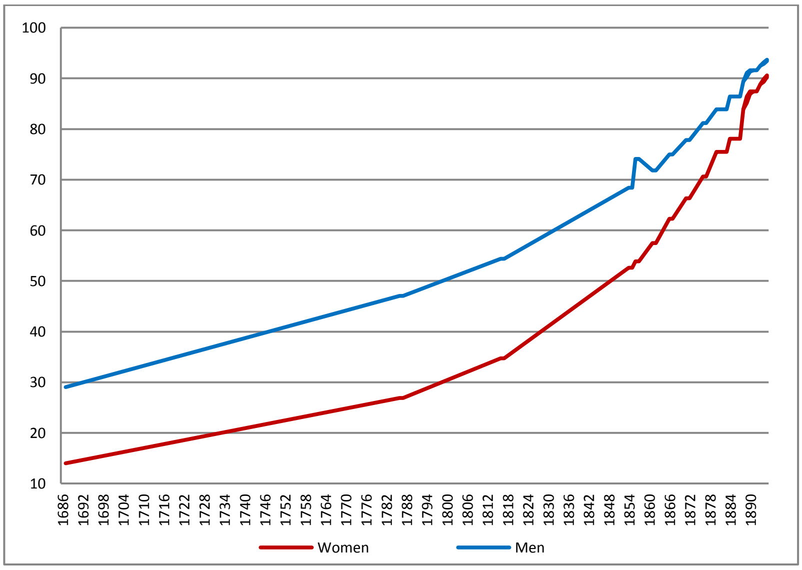
This chapter is dedicated to the study of the evolution of female endowment in human capital (Section 1). To do so, we will especially focus on the evolution of girls' enrollment rates in formal education. One of our main targets will be to understand why did men and women acquire different skills (in terms of type and proportion) although they have the same ability to do so? Educational investments are the result of decisions and incentives at various levels: institutional, family and personal (all interconnected). The study of the geographical distribution of endowment in human capital (Section 2) will help us to better apprehend regional disparities. The purpose of this chapter is notably to shed light on the evolution of gender differences observed on the labor market, Section 3 will be dedicated to the construction of a measure of the quality of the workforce from a gendered perspective.

1. General Characteristics of the Evolution of the Female Human Capital

There exists several ways to measure human capital, such as education-augmented labor input, literacy rates, educational attainment, average age at schooling, school enrollment rates or number of schools (Woessmann, 2003). Literacy rates have been one of the most extended indicators of human capital. These rates measure the ability of an individual to read and to write.

Accordingly, at the beginning of the 19th century, two-third of the labor force was illiterate. However, the only available proxy allowing the study of the evolution of literacy rates in France before the mid-19th century is the ability to sign. This measure suggests that individuals' ability to sign would reflect the capacity to carefully reproduce letters and is then a first step toward the ability to write and to read fluently.[27]

Figure 3-1: Female and Male Ability to sign



Sources: Data from Statistiques Générales de la France
Note: Missing values are interpolated by linear interpolation;

Figure 3-1 shows the evolution of the proportion of men and women able to sign their marriage contract between 1686 and 1895. This proxy for literacy rates has strongly increased over the whole period for both genders, ranged from 29.07% to 93.7% for men and from 13.97% to 90.6% for women. Male and female ability to sign their marriage contract evolved in parallel

[27] Using a factorial analysis based on French count-level data in 1866, Furet and Sachs (1974) highlight the existence of a strong correlation (0.90) linking the ability to read and to write and the "signature" proxy.

during the 18th century. The pace of growth increased during the 19th century at a higher rate for women. At the dawn of the 20th century, female literacy rates almost caught up that of males. What can explain such improvements in literacy rates over the 19th century? More specifically what can explain the improvements and the catch-up of female literacy rates?

1.1. Overview of Literacy Rates by Marital Status in 1851

1.1.1. Age-heaping and Literacy

Evidence of conventional human capital indicators by marital status (literacy, school, enrollment rates or years of schooling) is rare or inexistent for the period prior to the 20th century. No information exists by marital status, for the year 1851. Therefore, we employ a proxy approach in this sub-section allowing us to measure and compare literacy by gender and marital status: the age-heaping method.

The 1851 census does not allow us to get information about endowments in human capital of both boys and girls according to their marital status at a county level for France. We can only obtain literacy levels for married people using data on the number of spouses who were able to sign their wedding contract; or, get information on enrollment rates. We want to understand to what extent literacy rates have been affected by the status of individuals. Are higher levels of human-capital formation related to the marriage pattern (that differs between counties as seen in Chapter 1)? Do single women have higher literate abilities than married women? What about widows? We know that single women tend to be more likely living in urbanized areas. Are these women more literate? Is it a choice for these women who are more likely to work to be also more educated?

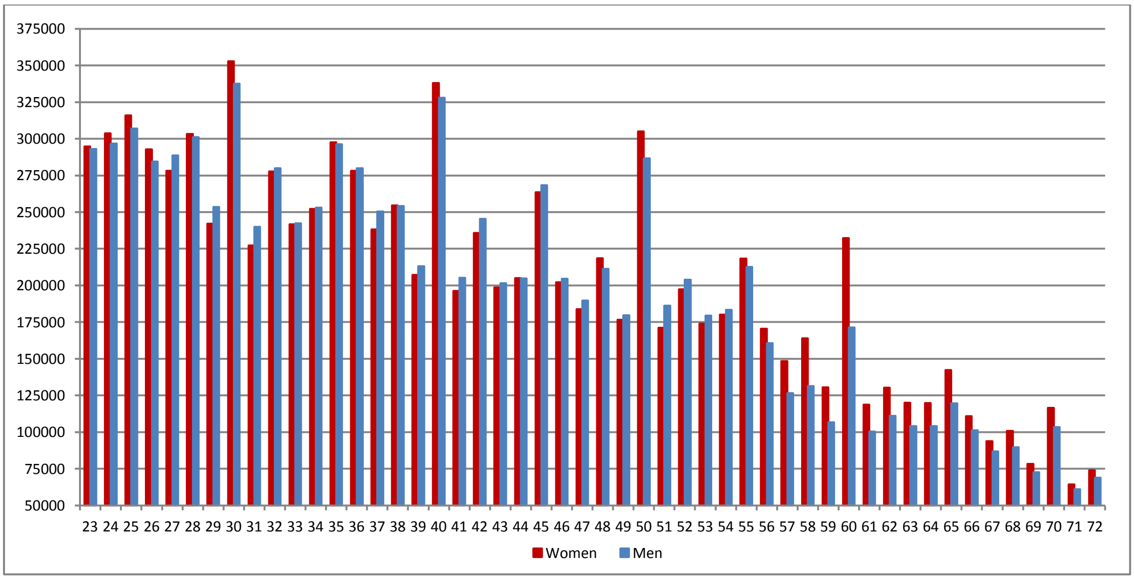
We employ the age-heaping method to chart and analyze the heterogeneity and gender-specific differences of human capital across France in the mid-19th century by marital status. We are hence able to trace basic numerical skills of populations by marital status from periods and areas for which no other human capital indicators are available. Why using age heaping? The ability of people to sign their names on marriage acts is one of the most trustworthy indicators (De Moor and Van Zanden, 2010). However, other dimensions such as numeracy can be used whenever primary data are lacking. The work done by A'Hearn, Baten, and Crayen (2009) concluded that the close relationship between the two indicators permits age heaping to be used as an alternative for estimating literacy. The age-heaping method investigates numeric skills of a population. Number of studies have recently used the method (such as A'Hearn *et al.*, 2009; De Moor and Van Zanden, 2010; Clark, 2007; O'Grada, 2006) based on the computation of the

Whipple index, invented by the American demographer George Chandler Whipple. The age-heaping method consists in looking at individuals statements about their age in census records, as a proxy for the degree to which people could count and calculate. In earlier time periods and less educated societies, it was common that individuals did not know their exact age and then had a tendency to round off their ages to a number ending with a “0” or “5”. Typically, people would erroneously declare that they are 40 years old, if they are in fact 38 or 42 years old. Human capital endowment is likely to explain this phenomenon. Baten and Crayen (2010) have demonstrated that human capital plays the most important role for age heaping. An advantage of age heaping is that it is calculated by using the data on the age distribution in the population statistics. Therefore, as we do not owe data on literacy rates by marital status, this method represents a good alternative (proxy) to measure endowments in basic human capital for single, married and widow individuals.

Data and Methodology

To analyze numeracy in French districts in the mid-19th century, we use data from census records. The database is made up of samples covering over 86 counties on the year 1851. For the age-heaping method to be employed, data on individual ages are required. Unfortunately, some countries preferred not to ask for individuals of the population their exact age but instead asked them to declare their age in certain age groups (20-25 years for example) which prevents the use of the age heaping method. This is the case for 19th century French census data with the exception of the year 1851.

Figure 3-2 : Distribution of Ages by Gender in 1851



Sources: Data from Statistiques Générales de la France

Figure 3-2 plots the distribution of ages by gender in 1851 France, using French census data. We clearly observe from the diagram high recurrences of "0" and "5". The age-heaping method allows measuring basic numeric skills of a population. The Whipple Index (WI) relates the number of age observations on "0" and "5" to the total number of observations. It is given by the subsequent equation:

$$WI = \frac{\sum_{i=5}^{14} n_{5i}}{\frac{1}{5}\sum_{i=23}^{72} n_i} \times 100 = \left[\frac{n_{25} + n_{30} + \cdots + n_{65} + n_{70}}{1/5 \times (n_{23} + n_{24} + n_{25} + \cdots + n_{72})}\right] \times 100$$

where i is the age and n the number of observations.

Values range between 100 and 50. A Whipple-Index of 100 indicates no age heaping and the maximal value 500 indicates that all individuals report an age ending on a "0" or a "5". This measure is used only for the bracket of twenty-three to seventy-two year olds, considered as the most stable population group from a demographic point of view. In order to make our results more readable, numeracy is calculated by using a transformed Whipple Index, the so-called ABCC Index. This new index was proposed by A'Hearn *et al.* (2009). It consists in a linear transformation of the Whipple Index:

$$ABCC = \left(1 - \frac{WI - 100}{400}\right) \times 100$$

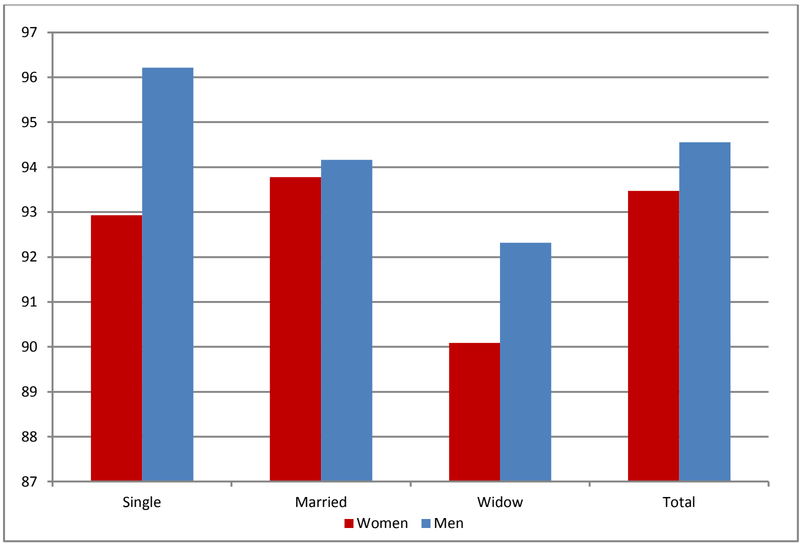
The ABCC Index has the advantage to be more comprehensive than the Whipple Index. Values are range between 0 and 100. The latter is the maximum numeracy level and 0 the lowest. Our analysis is conducted using the ABCC Index. We introduce a distinction in terms of gender in order to capture potential gender-specificities.

1.1.2. Gender Differences in Age-heaping

Figure 3-3 depicts ABCC indexes by gender and marital status in 1851. Even though it might have been expected that age-heaping would increase in age, as younger generations are more likely to be literate along with educational progress, we observe the opposite result for women.

Married women heap significantly less than unmarried women, while single men heap significantly less than married men. Marriage tends to deteriorate the age heaping of men. One possible explanation, already advanced by Földvari and Van Leeuwen (2012), is that a percentage of women adapt their age to that of their husbands, hence biasing the Whipple index. Recent research has shown that gender differences in age-heaping is rather small (De Moor and Van Zanden, '*Uit fouten kun je leren*').

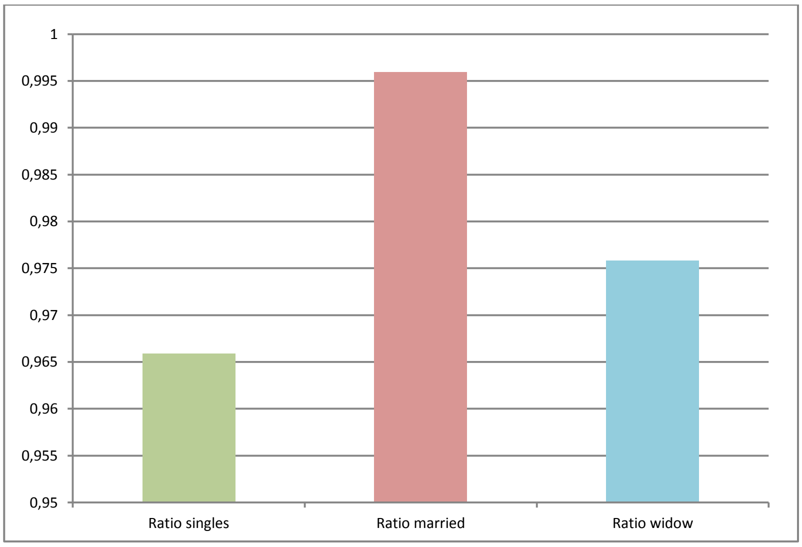
Figure 3-3 : ABCC by Gender and Marital Status in 1851



We measure gender equality in numeracy as the ratio of women and men ABCC indexes. Figure 3-4 reports female-to-male ABCC index. The higher the gender equality (the closest to one), the more women know their exact age in comparison to men (and conversely). Further from one is the ratio, higher is the gender inequality and better is the numerical discipline for men. We observe that age-heaping differences between genders are much lower for married than for non-married individuals. As advanced by Földvari and Van Leeuwen (2012), there are three main plausible explanations of lower ABCC for non-married women. First, there might be a selection effect. Men can choose to marry regarding their abilities and skills and would therefore have higher preferences for higher "quality" women to get married. Second, there might also be a learning process within marriage. Wives would learn basic skills from their husbands and then have a higher accuracy to report their age. Third, wives can adjust their age to that of their husbands, which may explain the underestimation of age-heaping of married women. As a consequence, data on single women should be more trustful to estimate real gender differences in numeracy.

If widows increased their numeracy during their marriages or were selected because of their better skills, then even after the deaths of their husbands, their numerical skills would remain superior to those of unmarried women. If, however, women adapted their age to that of their husband, one would expect that, after their husbands died, they would soon revert to rounding their ages to -5 and -0. Our results highlight that female-to-male ABCC index of widows is indeed ranged between female-to-male ABCC index of singles and married individuals, in support of both second and third explanations. The age adaptation of married women to that of their husband may have been a factor in the unexpectedly low overall level of women age-heaping. In order to calculate actual age-heaping among women reliably, it is therefore preferable to use data on non-married women.

Figure 3-4 : Gender ABCC Gap by Marital Status in 1851



By class of age

One technical requirement for the calculation of the Whipple Index is an age range of 10 successive single years. Age-heaping is likely to be overestimated if we calculate the Whipple Index over an age range such as 20-29 or 30-39. In order to mitigate this effect and to spread the final digits of 0 and 5 more evenly across the age ranges, we have calculated the Whipple Index for fixed age ranges starting with the final digit 3 and ending with the final digit 2, such as 43-52 (Crayen and Baten, 2010).

Figure 3-5 : Age-group Specific ABCC Index by Gender in 1851

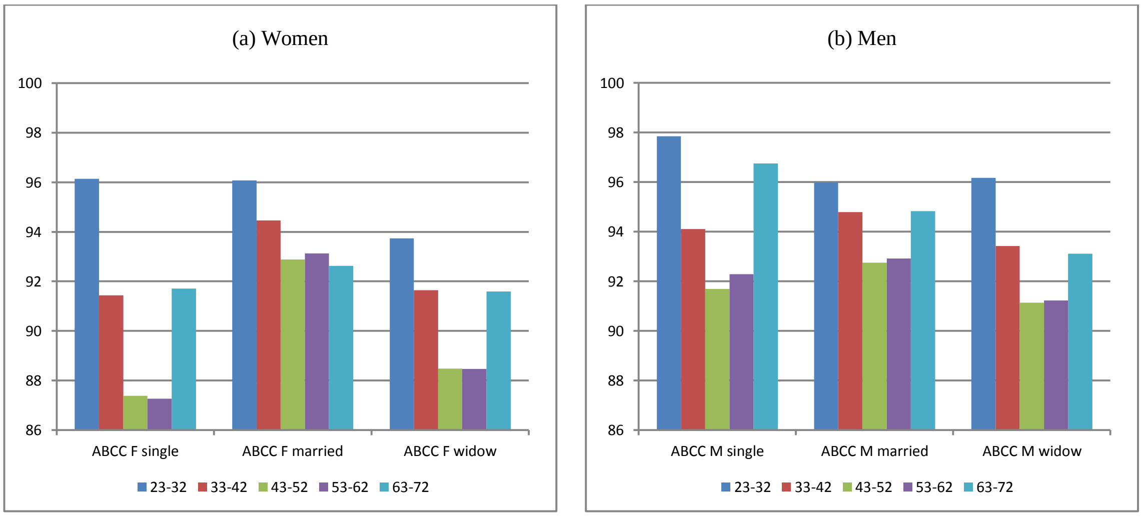
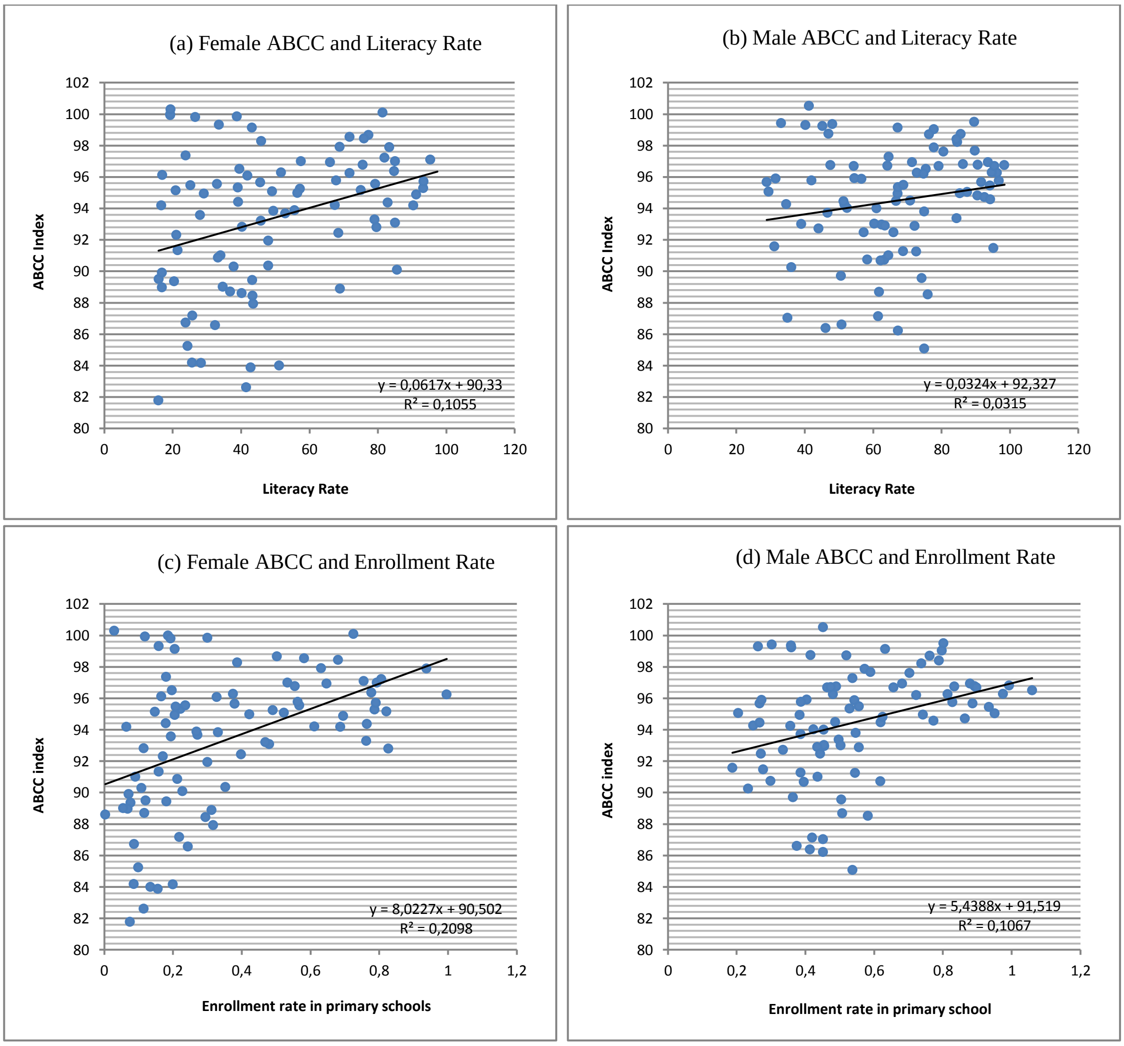


Figure 3-5 depicts age-group specific ABCC Index. We find evidence for significantly higher ABCC levels among young people (i.e. for the age-group 23-32). Three main possible reasons are advanced by Crayen and Baten (2010). The first one is that older individuals might be more likely to forget their age when they get older. Second, the society can play negatively and induce individuals of different age groups to distort their true age. Third, young people might be more aware of their exact age by passing through important stages of their social life. We may provide additional explanations of this age differential based on improvements in the educational process. We observe two additional interesting results. First, young male widows have a higher ABCC than married men. Being married may increase male numeracy (while it produces the opposite effect for women). Highly literate men may also marry more easily that less literate men. Second, we observe that young single and married women depict similar ABCC. This would suggest that the adjustment effect is not valid for younger women.

Figure 3-6 : Relationship of Age-Heaping with Literacy and Enrollment Rate by Gender in 1851



Sources: Using data from Statistiques Générales de la France

Are people who know their age really able to read and to write? To answer this question, we look at the correlation between endowment in human capital – measured by literacy rates and enrollment rates in primary school and – and our ABCC index. Figure 3-6 displays the correlation between numeracy and our two measures of human capital, literacy and enrollment rate, by gender using county-level data. We find a positive relationship between basic numeracy and our measures of human capital for both genders. However, the correlation tends to be larger when studying the case of women and when using enrollment rates as a measure of human capital rather than literacy.

As Crayen and Baten (2010), we identify primary school enrollment rates as a main determinant of age-heaping. Higher enrollment rates led to a significant decrease of the age-heaping level. This close correlation between schooling and basic numeracy is confirmed by the study of regional subsamples. Formal education is likely to be a determinant of numeracy as it can enhance numerical skills.

1.2. The Gradual Expansion of Schooling

During the 19^{th} century France (and until the mid-1950's with the work of Mincer, Schultz and the development of the concept by Becker), endowments in human capital – formal training and education – of the labor force was not yet perceived as a potential factor of competitiveness and growth. Since the 1880's, one of the main objectives of education, put forward in the literature, was to transmit culture and train future citizen but also future adults (Durkheim, 1911). Durkheim saw the function of socialization fulfilled by school (education) as the transmission of values and common norms to all individuals of the society (regardless the social class to which they belong). The progress of enrollment rates becomes more evident from the first quarter of the 19^{th} century. The development of education occurs in several steps: first, in primary education (from the mid-19^{th} century); second, in secondary education (from Sée law); and finally, in higher education (from sexual and cultural revolution). Therefore, both the 19^{th} and the 20^{th} century have shown strong improvements in educational investments. Most important, they have witnessed the feminization of educational investments.

1.2.1. Primary Education and Feminization (with Claude Diebolt)

Available statistics inform us about the situation across French counties from 1837. At that period, education was mainly devoted to boys. Throughout a quarter of century, girls erase the gap in enrollment rates almost completely. The quality and reliability of available data can obviously be questioned. However, one can certainly draw major movements in terms of timing and space witnessing real changes of school attendance and educational structures. The President of the Commission who made the 1879 report on education, Levasseur, warned on the existence of possible errors, double counting and omissions:

> "*Incorrect on many aspects when examined in detail, these statistics give, taken together, a fair idea of the great changes that have occurred, since a half-century, in our schools…*"

The major and most impressive change is certainly the sharp increase in enrollment rate of young individuals aged 5-15 on a very short period – about forty years. In 1837, 2 690 035 children were enrolled in primary schools, which represents an enrollment rate of 44%. This rate increased quickly, and reached 52% in 1850, 58% in 1856, 69% in 1867 and 74% in 1876. The evolution of girls enrollment rate was even faster, as in 1837 one in three girls was enrolled and one in two boys (36.7 and 52.3 respectively), while in 1876, almost as many girls as boys were enrolled (2.316 million and 2.4 million respectively). It is necessary to introduce here a reservation about female enrollment in 1837 because of possible under-reporting of girls enrolled in mixed schools. However, this reservation should not prevent us to take into account the evolution of enrolled individuals as being largely significant both in terms of differentiation of male-female enrollments and type of schools. Concerning the type of schools, we note a slight increase in enrollment rates in public institutions but a sharp rise of enrollment rates in public and private congregational schools (see Table 3-1).

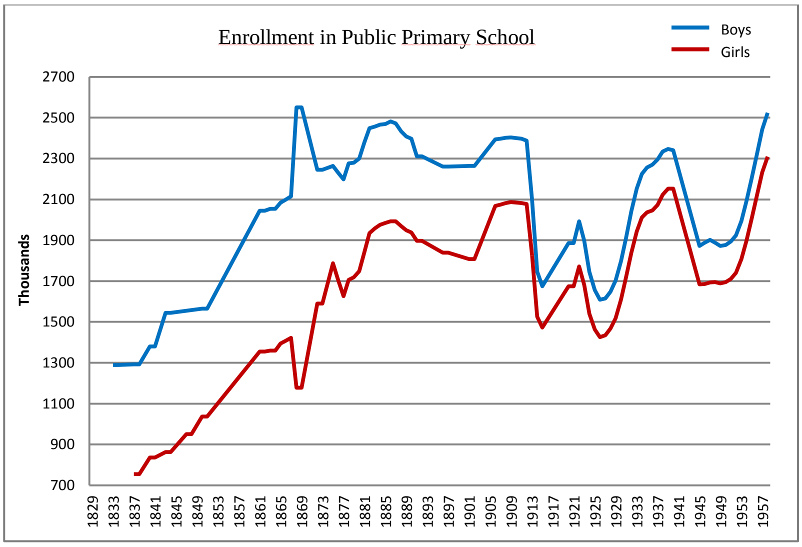
Table 3-1 : Girls Enrollment Rates by Type of Schools

Year	**Total**	**Public**	**Free***	**Congregational****
1837	36.7	67.9	32.1	
1850	47.5	67.8	32.2	44.6
1867	66.0	65.5	34.5	55.4
1876	72.3	70.2	29.8	59.9

Sources: Data from Claude Diebolt
Notes: * Free schools are private schools. They can be either secular or congregational;
** Congregational schools are religious institutions. They can be either public or private.

Figure 3-7 displays the evolution of the number of boys and girls enrollment rates in public primary schools between 1833 and 1961. The 19th century witnessed major improvements regarding primary education. Nevertheless, the real desire to apply (institutionally) measures supporting girls' education appears in the late 19th century only. Therefore, in about 40 years, girls' enrollment rates in primary education caught up those of boys, ranging from 36.7% to 72.3% (Table 3-1).

Figure 3-7 : Evolution of Enrollment in Public Primary School by Gender



Sources: Data from Claude Diebolt
Notes: Missing data are obtained by interpolation using a two period moving-average

Feminization of primary education in the law

With the French Revolution, the question of girls' education arose at a national level – as a crucial questioning concerning half of the French population. Before the Revolution, girls' education was mainly (or only in some areas) taken in charge by the Church and remained appropriated to their gender. The main objective of girls' education was to give to future mothers elementary notions of their future "duties". The 19th century has been a key century for girls' education. It is the century that witnessed the expansion of girls' education.

Several attempts have been required to implement the first measures. While during the first half of the century, measures were rather slight, the number of measures designed to promote girls education started to increase from the second half of the century.

Talleyrand was the first to introduce the question of girls' education in a draft decree during the revolutionary period. The draft decree specifies that girls could be accepted in primary schools up to age 8 (article 1). Afterwards, education will be entrusted to parents (article 2). Every district is required to offer a sufficient number of education centers for girls who could not be educated in the father's house (article 4). The teaching dispensed to pupils in public education centers might tend to prepare girls to the virtues of domestic life and to talents and skills necessary to govern a family (article 8). This draft decree is the first attempt aiming at improving girls' education. However, with an education adapted to their gender, the draft mainly prepared girls to their future role as housewives. The issue of female education is a recognized item to distinguish significantly the two "major" projects of education during the revolutionary period, that of Talleyrand and Condorcet's. Condorcet advocated a more extensive education for women. In his first report (and draft decree concerning the general organization of public education presented at the Legislative Assembly in 1792), he notably foresaw the creation of primary schools: one school (mixed) in village of 400-1500 inhabitants and two schools in towns of 1500 to 4000 inhabitants. For Condorcet, the development of education should go jointly with the establishment of the "*Déclaration des droits*". The 1793 decree resulting from Condorcet report specified that each village of 400 to 1500 inhabitants had to host a mixed primary education – raising the importance of girls' education in regards with their future role, as mothers, on offspring's education.[28]

Several personalities then expressed their support in favor of girls' education. Lepeletier claimed the increase in girls' age at school to the age of 11 in order to adjust to the rule applied for boys. Afterwards, Romme foresaw the creation of girls' schools in addition to the existence of mixed schools (directed by a female schoolteacher) and offering the same education as boys and more work appropriated to their gender such as spinning, sewing or housework. In 1794, Lakanal passed a decree instituting the principle of obligatory sexual division (article 7). Therefore, every primary school had to be split into two, with one section for girls and one for boys. Despite a few strong oppositions, notably from the *Commission des Onzes*,[29] Lakanal presented his decree requiring primary education to be divided into two sections and stipulating that girls have to learn reading, writing, counting, to learn the elements of republican moral and to be trained in various crafts.

During the First French Empire, Napoléon took care of the education of the daughters of his generals and legionaries only. Considering women as inferior, they should limit their role to the tasks in link with housework and consequently did not need education higher than elementary. Under the Bourbon Restoration, the government (after a Ministerial direction from the Minister of the Interior Decazes in 1819) realized very late the shortcomings of his policy in terms of girls public education. Deep-seated policy changes in primary education occurred under the July Monarchy with the Guizot Law in 1833. Nevertheless, this time again, changes focused on the organization of boys schools and completely overlooked the issue of girls education. We have to wait the following years to see the first progress in terms of educational programs for girls. In 1836, the royal ordinance published new rules governing girls schools – expanding part of Guizot law to girls schools. It specified that girls primary education could be dispensed at two levels: either in elementary primary schools or in upper primary schools. In addition, it is stated

[28] Condorcet is considered as a fervent supporter of human rights so as women's equality with men. He campaigned for women's suffrage and published notably on the subject: *De l'Admission des Femmes au Droit de Cité* in 1790.

[29] The *Commission des Onzes* wished to exclude girls from public education considering that girls' education had to be devoted to domestic parental care and had to go to free education institutions.

that girls not able to pay any retribution could be admitted to public schools. A new law project is presented in 1848, under the French Second Republic, by the Minister of Public Instruction Hippolyte Camot. The object of this project is to offer free and compulsory education for all children with no gender distinction. Various pedagogical aspects are discussed notably through the integration of history and geography in school curricula. Girls specific works are kept. The same year, another project proposed the construction of girls school in all towns with less than 800 inhabitants. Nevertheless, this is according to the following formulation that the Falloux Law was applied in 1850: every town with less than 800 inhabitants should have a school for girls if its resources are sufficient to do so (article 51). Article 52 added that no school could welcome children of both genders if there is either a public or a free school for girls. Limitations and shortcomings of article 51 appeared clearly. By leaving municipalities only judge to know if they have the necessary means or not to maintain a school for girls it seems very likely that the number of schools for girls in 800 inhabitants' towns remains low. The 1862 draft law of Rouland, Minister of Public Instruction, targeted on girls' schools and especially on the improvement of article 51 of the Falloux law. The Minister proposed a new law making compulsory for all municipalities higher than 500 inhabitants to maintain a local school for girls. However, we have to wait the application of the Duruy law in 1867 to note clear improvements in girls education – addressing important shortcomings of the 1850 act. Hence, article 1 specified that every of 500 inhabitants and more were required to have at least one school for girls. This project also enlarged schooling programs with the introduction of the teaching of history and geography (article 16). Finally, the 1881 law – named by the Minister of Public Instruction Jules Ferry – established free education and is followed by the 1882 law establishing as well mandatory and secular education. Therefore, primary instruction finally became compulsory for all children aged 6-13 with no gender distinction.

1.2.2. Secondary Education

French education during the 19th century was characterized by two distinct systems: the primary schools system (as seen previously) and the secondary schools system. The question of girls' secondary education appeared clearly in a Circular sent by the Minister (Duruy) to the Rectors at the end of 1867. However, the implementation of secondary lectures for girls remained scarce in the years that followed and was interrupted by the Franco-Prussian war (1871).

Similar to primary education, we need to wait the government of the Third French Republic to observe improvements of girls secondary education in terms of organization and secularization. The Member of Parliament Camille Sée promote the implementation of State schools for girls similar to secondary schools (*collège*) and high schools (*lycée*) for boys. Thereby, he presented in 1871 a draft law suggesting specifically the creation of schools dedicated to the secondary education for girls (article 1) with particular references to the principle of equality between men and women before the education. After discussions (namely regarding the secularization of girls education) and a few modifications (notably about article 3 concerning the building of schools board), the law was promulgated in December 1880. From 1884, the length of secondary education was set to last 3 years. Girls secondary education included several teaching during these 3 years – among them (see 1880 law, article 4) moral teaching, French language, reading aloud, foreign language; ancient and modern literature; geography and cosmography; national history, overview of general history; arithmetic, elements of geometry, chemistry, physics and natural history; hygiene, domestic economy; needle work, notions of customary law; drawing, music, gymnastics.

The first "*lycée de jeunes filles*" opened in 1882 in Montpellier (Lycée Georges-Clémenceau). Table 3-2 shows the evolution of the number of secondary schools since the implementation of the law and 1908. In 1886, 35 secondary schools (*collège* and *lycée*) were already created. In 1908, France recorded 67 *collèges* and 48 *lycées*. From 1886, the number of secondary schools for girls was multiplied by 3.3 while the number of students increased by 5.7. More precisely, the number of *collèges* was multiplied by 3.5 and that of *lycées* by 3. We see that the number of girls enrolled in secondary schools rose faster for *lycée* than for *collège*. Between 1890 and 1908 (dates for which we owe separate data on the number of students), the number of girls enrolled was multiplied by 4.35 and 3.37 respectively.

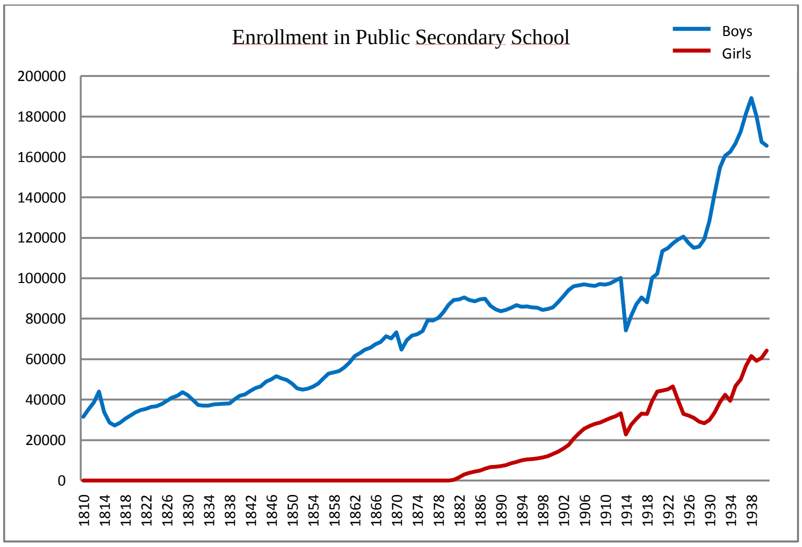
Table 3-2 : Number of *Collèges* and *Lycées*

	1881	1886	1890	1900	1908
Collège					
Number	**3**	**19**	**26**	**30**	**67**
Students	--	--	3 200	4 200	10 800
Lycée					
Number	**1**	**16**	**24**	**47**	**48**
Students	--	--	4000	9 200	17 400
Total					
Number	**4**	**35**	**50**	**77**	**115**
Students	342	4 967	7 200	13 400	28 200

Sources: Data from Institut Français de l'Éducation

Secondary education for girls developed progressively across France. Figure 3-8 shows the evolution of the number of boys and girls enrolled in secondary schools between 1810 and 1941. This is indeed from the Sée law that we graphically observe the increase in the number of girls enrolled in secondary schools. From 1881, the growth rate of female enrollment rate in secondary schools increased continuously and at a higher pace than that of boys until WWI but still far from catching up on them. The evolution of the trends suggests that the wars had a larger negative effect on girls' enrollment than on boy's enrollment. We observe a period of ten years (in the interwar period, between 1922 and 1932)) of important decline in the number of girls enrolled in secondary schools while the number of boys was almost unaffected. The curve then rises again at a higher pace (than the one observed before WWI) but be lower than that of boys this time.

Figure 3-8 : Evolution in Public Secondary School by Gender



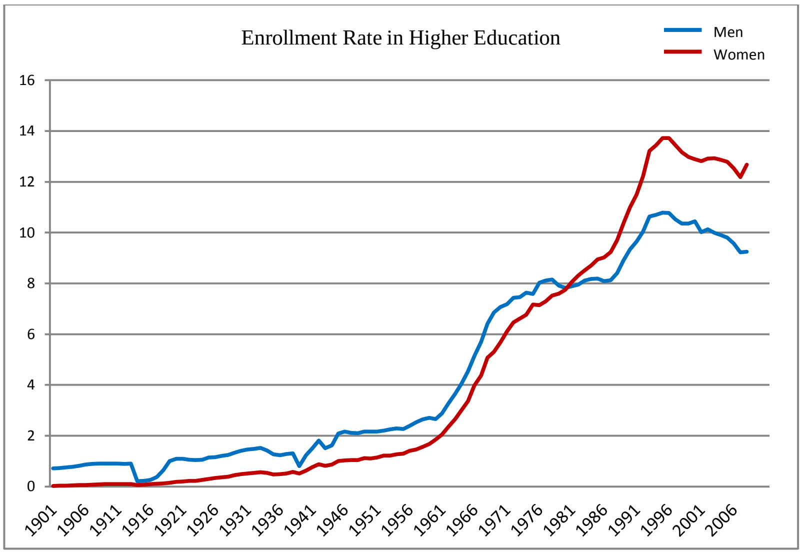
Sources: Data from Claude Diebolt

With the implementation of compulsory school until 16 years old from the end of the 1960's for children of both gendersn massive enrollment rates in high schools occurred from the end of the 1980's. The generalization of secondary school was total at the beginning of the 1990's.

1.2.3. Higher Education

There was a time when women were *de facto* excluded from higher education. Sée noted that faculties of Law, Medicine, Arts and Sciences and higher schools were well organized for men – especially in Paris – but from which women were absent. Even if Sée did not seem particularly wish women to get similar positions to men, he recognized that nothing explained such an exclusion, by law as the regulation excluding explicitly women from faculties of Arts for instance since the *Restauration* or by customs. Besides, from the moment that secondary education for girls started to develop, it became natural for some women (notably those who aspired to become secondary schools teachers) to pursue their studies. Over time, more and more women were enrolled in higher education.

Figure 3-9 : Evolution of Enrollment Rate in Higher Education by Gender



Sources: Data given by Magali Jaoul-Grammare

Figure 3-9 highlights the evolution of enrollment rates in higher education by gender during the 20th century. Female (male) enrollment rates are measured by the number of female (male) enrolled in higher education per a hundred women (men).

We observe three main phases in the gendered evolution of enrollment rates in higher education. The first phase occurred during the first mid-20th century. We observe a slight increase in both boys and girls enrollment rate. The second phase is then characterized by a strong increase in the pace of students enrolled in higher education for both genders from the beginning of the sixties, from 2% to 7% for girls and from 5% to almost 8% for boys. Finally, the curve of girls enrollment overshoots that of boys (when they both reach 8%) at the turn of the 1980's while the share of male students stabilizes, before increasing once again from the end of the eighties and reach its maximum point at the end of the 1990's at almost 14% for girls and 10.5% for boys. Both trends then experience a deceleration. The male and female college attendance rates fell significantly from the mid-nineties. Nonetheless, the number of male students never catches up back that of females. In sum, higher education is more and more accessible from the second half of the 20th century. It becomes a mass phenomenon with the democratization of the University and of the "*Grandes Écoles*" from the end of the 1980's.

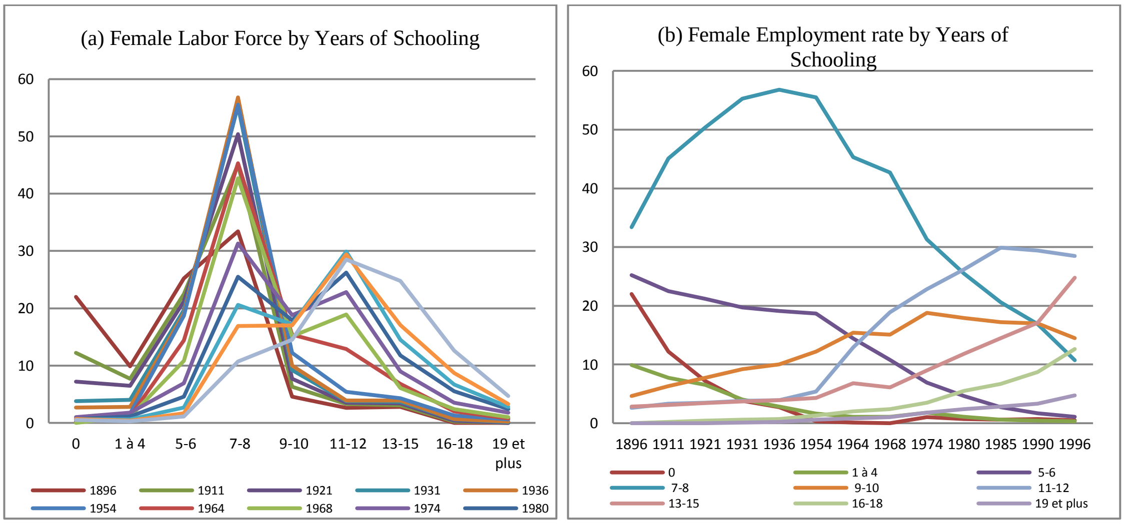
1.3. Changes in Educational Investments and Aspirations

The educational pathway of girls differs from that of boys. Girls caught up boys regarding education at several levels: in terms of enrollment rates as seen in the previous subsection but also regarding the duration of studies, the average level of diploma or again the field of specialization.

1.3.1. Years of Schooling

As seen previously, both the 19th and the 20th century witnessed a dramatic change in girls education. Progresses occurred first in primary and secondary schools. Total enrollment rate in primary school completed at the turn of the 20th century. Afterwards, improvements occurred in higher education both in terms of enrollment rates and duration of studies. Mean average years at school has then been multiplied by three: from 5 years for the 1840 cohort (stop at 11 years old) to 16 years for the 1975 cohort (stop at 22 years old) (Marchand and Thélot, 1997).

Figure 3-10 : Evolution of the Female Labor Force by Years of Schooling



Sources: Data from Marchand and Thélot (1997)

Figure 3-10 highlights the evolution of the women employment rates by years of schooling between 1896 and 1996. The structure of the labor force according to the time spent getting educated confirms that a strong change occurred over the course of the 20th century. In 1896, more than half of the female labor force did not go to school or left school fairly early. Conversely, in 1996, this share was very low while the share of women workforce who went to school for 9-10 years and more increased substantially.

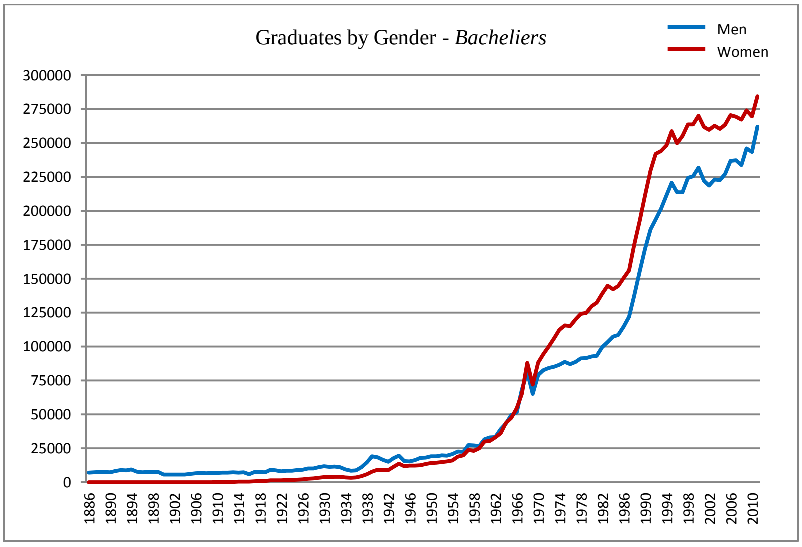
Four main female profiles are apparent according to their behavior regarding school attendance. First, we note that the share of working women who did not study or stopped early studying decreased all along the 20th century. Second, the share of working women who went to school until the legal age (13, 14 or 16 years old depending on the considered period) grew up on the considered period from one third of the active female population in 1896 to about half of the active female population from 1920 to 1975. From this time period, the share of the female workforce who went to school until the legal age decreased in favor of the two following categories: working women who spent more time getting educated than the compulsory school but with no higher long schooling such as CAP, BTS, DUT[30] – what represents half of the female working population in 2000 – and working women who got higher education (long studies).

1.3.2. Diploma

High School Diploma

Despite the will of Ferry and Sée to implement secondary education for girls, they refused to offer them the same opportunity as men to prepare and to pass the final exam. Julie-Victoire Daubié (1824-1874) was the first women to run for the Baccalaureate hitherto reserved to men. Therefore, in 1861, she became the first women to receive the *baccalauréat ès lettres*. She also graduated at the Sorbonne in 1871 and obtained the *licence ès lettres*.

Figure 3-11 : Evolution of Graduates by Gender



Sources: Compiled data from Chesnais (1975) – Cibois and Droesbeke (1988) – Magali Jaoul-Grammare

[30] CAP, BTS and DUT mean respectively *Certificat d'Aptitude Professionnelle*, *Brevet de Technicien Supérieur* and *Diplôme Universitaire de Technologie*.

Figure 3-11 shows the evolution of the number of boys and girls who take the Baccalaureate between 1896 and 2010. Therefore, a century after Julie-Victoire Daubié, we see that the number of women with a Baccalaureate still remained very low. A first increase was observed from WWI. More and more girls enrolled in secondary education took the final exam. However, it was only from 1924 – more than 40 years after the Sée law – that girls officially had the right to prepare the final exam (Bérard reform). The implementation of the reform allowed more women to prepare and pass successfully the final exam. As a consequence, the share of graduate women reaches that of men in the sixties.

The year 1968 depicts a higher number of graduates for both genders, period from which the number of girls taking the Baccalaureate exceeds that of boys. At the turn of the 1990's, the pace of the number of boys and girls taking the final exam increased substantially. In parallel to this rise, the choice of girls regarding the secondary school changed as well (contrary to that of boys that remained very stable over time). In 1984, 38% of girls enrolled in the second year of secondary education opted for a scientific specialization (*série S*), 34% for the Arts division (*série L*) and 28% for the economic and social sciences division (*série ES*).[31] Twenty years later, the share of women in Arts dropped to 25% in favor of the scientific and economic and social sciences division, 41% and 33% respectively.

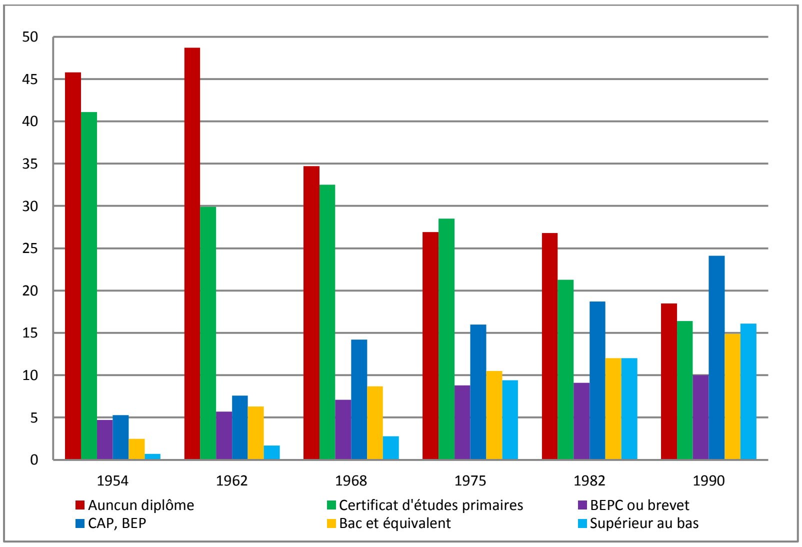
A global analysis of the structure of diploma

Between 1866 and 1882, the number of women with a degree in higher education was very low. Only 138 diploma were delivered by French universities over these sixteen years: 49 *baccalauréat ès lettres* and 32 *baccalauréat ès sciences*; 2 *licence ès lettres*, 3 *licence ès sciences*; 20 PhD in Medicine; 2 *officiat de santé* and 1 degree in Pharmacy. From the second half of the 20th century, women are more and more numerous to have a diploma. In addition, we note important changes in the structure of women's diploma over time. Therefore, the share of the female labor force with no degree declined continuously while the share of the female labor force with higher degrees rose consistently from the mid-20th century. More precisely, several aspects of female labor force participation are observed during the second half of the 20th century. Three characteristics emerge at the beginning of the period, in 1954 (Figure 3-12). First important characteristic of the female labor force participation: almost half of this population did not have any diploma. Second, we note the major role played by the "*certificat d'études primaires*". Indeed, a very large proportion (41%) of the graduated part of the female workforce had their primary school degree. Third, the data shows the lack of technical and professional training, such as the certificate of professional aptitude (CAP) and the certificate of professional

[31] In 1984, 8% of boys enrolled in second year of secondary education specialized in Arts, 26% in economics-sociology and 66% in the scientific division.

studies (BEP), of the female labor force. Therefore, we note the absence of a special training for the labor force the training of the female labor force mainly reaching the primary education level.

Figure 3-12 : Evolution of the Share of Women by Degree



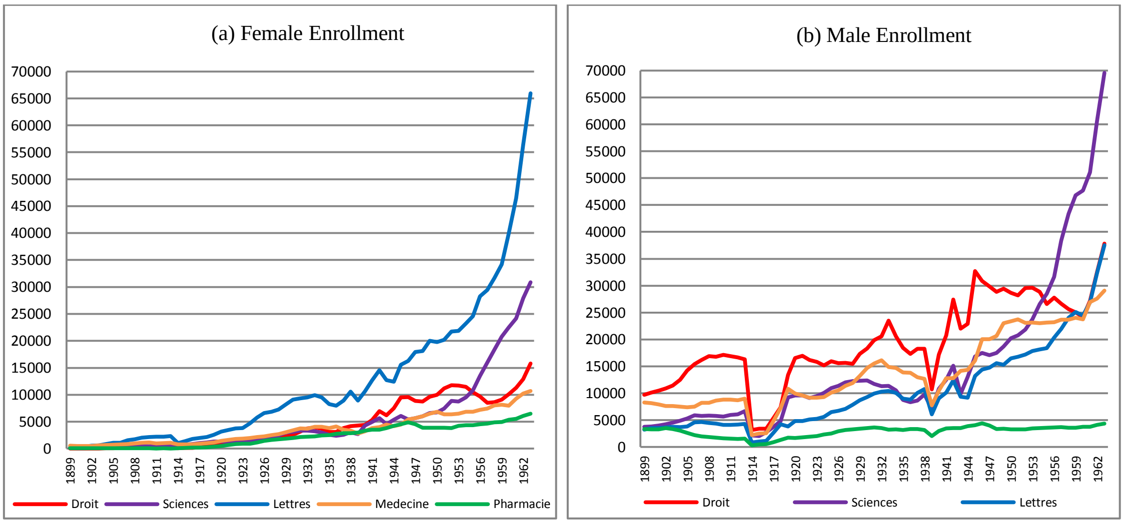
Sources: Data from Marchand and Thélot (1997)

In only forty years, the structure of the training of the female labor force changed completely. We henceforth observe a sharp decline in female labor force with no diploma or with just a primary education degree (*certificat d'études primaires*). In addition, we see that, in 1990, 24% of the female labor force had a technical-professional diploma (CAP-BEP). The share of the female labor force with a higher education degree also strongly increased. Therefore, the second half of the 20th century is characterized by a sharp increase in educational investments, especially in long-run education, in larger proportions for girls. The female labor force though became more graduated than the male labor force at the end of the century.

1.3.3. Field of Specialization

The share of girls enrolled in higher education increased as well as the duration of studies. In addition, the field of specialization in higher education changed over time. The least feminized sectors evolved toward more parity. However, the more feminized sectors such as Faculty of Arts remained always dominated by females. Men and women did not choose the same type of training and studies (industrial versus tertiary sector, scientific versus literary fields, "*Grandes Écoles*" versus university).

Figure 3-13 : Enrollment in Higher Education by Specialization



Sources: Data from Statistiques Générales de la France – Annuaire 1966

Figure 3-12 depicts the evolution of the male and female enrollment rates in higher education for five fields of specialization, namely law, science, Arts, medicine and pharmacy between 1899 and 1962. Both male and female enrollment rates increased in all fields over the considered period. More precisely we observe that at the turn of the 20th century, the number of girls enrolled in higher education was very low in all domains of specialization while that of males was already consistent. This is in Medicine that females were the most numerous at the very beginning of the period (54.7% of female students) and very quickly their number shifts toward Arts (50.8% of female students) that dominated over the rest of the period (see Table 3-3). During the academic year 1899-1900, the various universities across the country had 5 female students in Law, 528 in Medicine, 65 in Pharmacy, 120 in Sciences and 247 in Arts.[32] On the opposite, men were more numerous in Law (34.1% of male students) until the mid-fifties and in Science (39%) afterwards.

We observe that the gender gap in terms of enrollment rate in higher education changed deeply between 1899 and 1963. Since the abolition of the November 1899 law, the legal profession was no longer prohibited to women. The number of female enrolled in Law faculties sharply increased over time. Thus, the gender gap declined from 1 woman for 100 men in 1899 to 57 women for 100 men in 1963 (see Table 3-3). Similarly, the number of female in Pharmacy ranged from 1 woman for 2 men to 2 women for 1 man. A second important evolution was the drop in female-to-male enrollment rate in Science and in even stronger proportion in Medicine (from 1.89 to 0.50). Clear differences appeared between men and women regarding their choice of academic and vocational orientation. The data shows a gendered nature in the field of

[32] In 1898-1899, France had thirteen universities. Students from the *École d'Alger* are also taken into account.

specialization. The path differences between boys en girls does not seem to explain differences in terms of academic achievement but to be rather the result of choices linked to socio-cultural factors or to gender roles in society.

Table 3-3 : Share of Women and Men by Academic Discipline (in Percent)

	Academic Year 1899			Academic Year 1963		
	Women	**Men**	***Ratio***	**Women**	**Men**	***Ratio***
Law	0.5	**34.1**	*0.01*	12.1	21.2	*0.57*
Science	12.4	13.1	*0.94*	23.8	**39**	*0.61*
Arts	25.6	11.3	*2.26*	**50.8**	21	*2.42*
Medicine	**54.7**	29	*1.89*	8.2	16.3	*0.50*
Pharmacy	6.7	11.7	*0.57*	5	2.4	*2.08*

Sources: Data from Statistiques Générales de la France – Annuaire 1966

Educational attainment is a cumulative process. The past two century witnessed impressive increases in enrollment rates that diffused progressively to the whole labor force. Both 19th and 20th centuries experienced large increases in the access to schooling. The increase occurred at different levels and successively between these levels: first in primary education, then in secondary education and finally in tertiary education. If the elementary education was still sufficient for individuals to perform most of jobs during the 19th century, the situation changed deeply during the 20th century. However, illiteracy of the labor force disappeared almost completely at the dawn of WWI. Over time, the economy required higher levels of education; simple literacy and numeracy were no longer sufficient (Goldin and Katz, 2008).

The gradual improvement in access to schooling created greater equality in terms of opportunity between individuals in the broadest sense of the term and between genders. Improvements appeared more clearly from the 1960's. From that period spread the idea that education constitutes an investment with returns linked with increases in productivity. This drove to the emergence of the concept of human capital as an important factor of economic growth. It also increased the incentive to find a measure of the level of human capital that could be differentiated by gender (Section 3).

2. Regional Dynamics of Schooling

2.1. Geographical Evolution of Female Literacy Rates

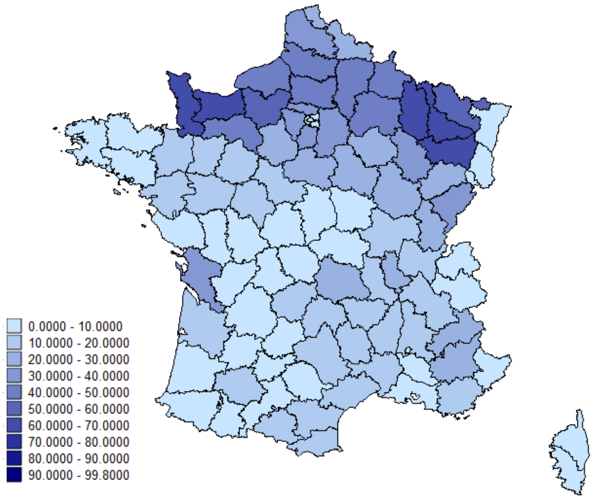
Literacy rates in the form of reading (and writing) ability are available for France only from the second half of the 19th century. Therefore, we use signature rates of conscripts and newly married couples in order to measure early literacy developments (Mitch, 1993; Reis, 2005). Marriage contracts had to be signed by both spouses. But, if one of the spouses was not able to write, marking a cross was a possible alternative. For this reason, taking the share of people who were able to sign with respect to the entire population might be employed as a proxy of literacy. Disadvantages and potential bias of the method exists. For example, we are unable to verify that the document was actually signed by the person involved and not by a substitute.

We use data from the *Statistique Générale de la France* to measure the evolution of literacy rates for France. Since the work done by Maggiolo, data on marriage signatures are available for French district for the years 1686-1690, 1786-1790 and 1812-1816; and for the second half of the 19th century (from 1854 to 1895).

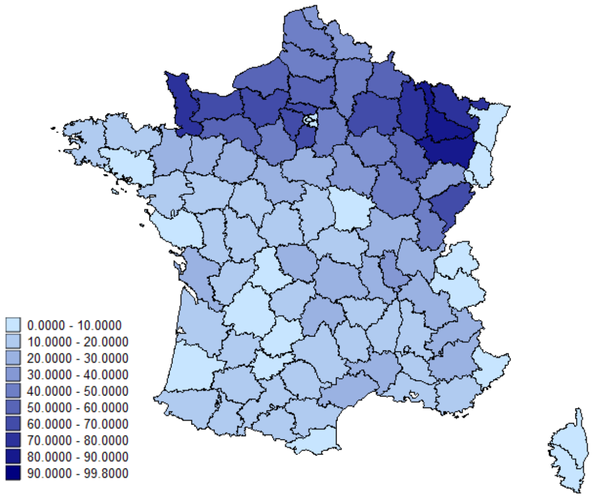
Figure 3-14 shows the geographical evolution of female literacy rates between 1786 and 1893 (and more specifically for 6 specific years: 1786, 1816, 1861-65, 1876, 1882 and 1893). Female literacy rates refer here to the number of women able to sign their marriage contract. Maps clearly reveal a France divided in two parts by a demarcation line going from Saint-Malo to Geneva line (called the *France des Lumières* by Dupin). The line splits France into two distinct zones: Northeastern France and Center-South-West France. On the Northeastern zone (left side of the line), the share of married women able to sign their marriage contract is clearly larger than the one observed in the rest of France. At the dawn of the French Revolution (Figure 3-14a), more than 40% of women leaving in the Northeast of France were able to sign their name while less than a quarter were able in the South, Center and West of France. At the national level, only 26.87% of married women were literate in 1786-90. In 1861-65, 57.5% of married women were literate. The map is still highly contrasted: 21 counties located in the North zone display female literacy rates higher than 80% (9 counties above 90% - Doubs, Manche, Haute-Marne, Meuse, Haut-Rhin or Bas-Rhin); 29 counties located in the Center-South-West France exhibit female literacy rates lower than 40% (12 counties below 30% among which Ariège, Corrèze, Côte-d'Or, Corse, Dordogne or Finistère).

Figure 3-14 : Evolution of Female Literacy Rates between 1786 and 1893

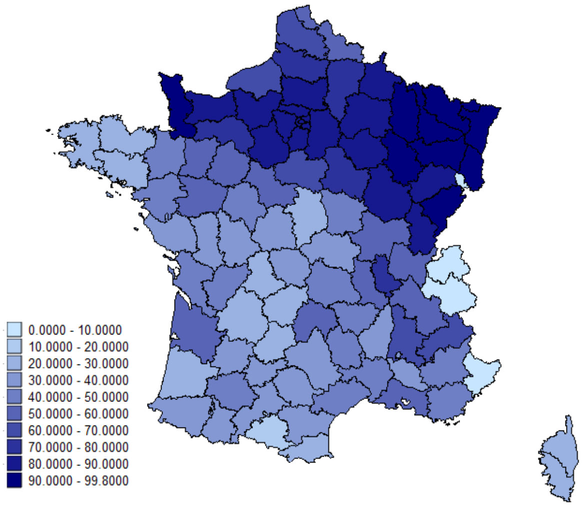
(a) Female Literacy Rate, 1786-90



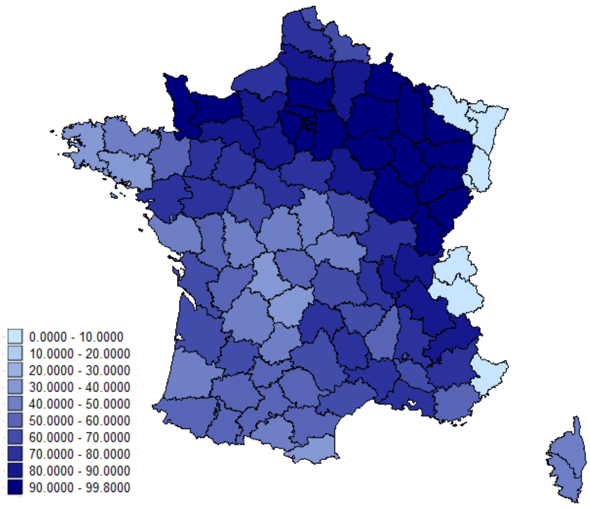
(b) Female Literacy Rate, 1816-20



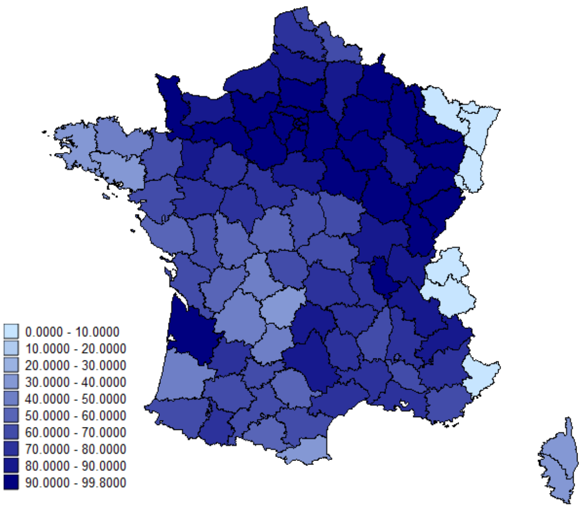
(c) Female Literacy Rate, 1861-65



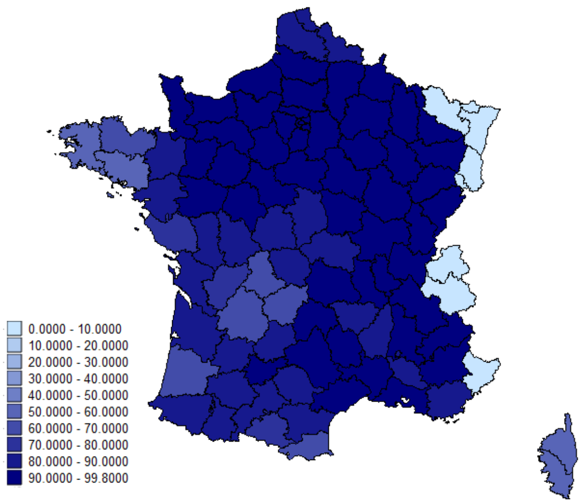
(d) Female Literacy Rate, 1876



(e) Female Literacy Rate, 1882



(f) Female Literacy Rate, 1893



Sources: Data from Maggiolo – Statistiques Générales de la France

Strong improvements are observed over the 19th century such that 90% of female spouses were able to sign their marriage contract in 1895. The implementation of laws such as Guizot or Ferry has certainly accelerated the process. However, despite the decline in women illiteracy rates over time, the demarcation line remained highly pronounced up to the last decade of the 19th century. At the turn of the 20th century, the demarcation line strongly weakened. However, counties located on the Atlantic coasts, along the Spanish border and in the centered West side of the country continued to exhibit lower female literacy rates. The geography is the same for the evolution of men literacy rates but occurred earlier in time. Women started to catch up their delay from the 2nd half of the 19th century and reached men's level at the dawn of WWI.

Several reasons and factors might explain such a peculiar development of literacy rates. In addition to educational and economic development of French districts, sociological, linguistic (in 1863 half of the population, mainly rural, was still speaking little or badly French according to Eugen Weber) or religious factors are also very likely to have played an important role. Looking at the broad geographical evolution of female literacy rates over time (Figure 3-14), improvement in literacy rates seems to have spread first from the Northeast border and then from the whole East border – strangely reminiscent of the spread in circle of Lutheran ideas around Wittenberg as put forward for Prussia (Becker and Woessmann, 2009).[33]

2.2. Distribution of Enrollment Rates in Primary Schools (with Claude Diebolt)

Despite a wish of great concordance and homogenization toward the constitution of a "*homme universel et générique*" according to the cultural ideas of the Revolution, this wish spread on a background of large regional disparities (as shown in previous chapters). Together with the French Revolution, the role of the juror priests and of the Republican teachers that afforded a transformation of both religious and schooling culture with certainly deep repercussions in individuals' life and conscious (Harten and Pitz, 1989). In this subsection, we geographically analyze enrollment rates at a county-level (*départements*) in order to highlight historical differences in school attendance by type of schools, namely public-private, secular-congregational.

[33] The Protestantism has a peculiar relationship with education. Luther insists on the obligation to know the Christian doctrine not by the oral transmission anymore but through the reading of the Bible. Therefrom, he emphasizes the importance of education and the need of a strong classical culture and requires the establishment of schools for the children of ordinary folks (being too children of the people of God).

2.2.1. The Situation of Primary education in 1837

For the year 1837, the census data on enrollment in primary schools are relatively reliable. Information has been confronted with three other available school censuses, those of 1850, 1867 and 1876. Having four detailed statistics by county allows us to draw conclusions about enrollment rates by gender and by county with minor risks, by providing major trends in terms of space and timing.

Besides general enrollment rates, we have information by type of schools (public, private, secular, congregational, boys and girls) and about teachers assigned in these institutions, by gender. In 1837, half of boys and one third of girls were enrolled in primary schools (52% and 36% respectively). This mean national gap of 16 points is obviously non-uniform across county. It depends on family habits, on economic activity, as well as on the types of institutions implemented locally. As we have seen briefly previously boys and girls went frequently in different types of schools public, private and congregational schools. In 1837, the lowest enrollment rates by county were between the interval 15-20% for boys and 5-10% for girls (Table 3-5). On the opposite, the five highest enrollment rates exceeded 90% for boys and 79% for girls. An interesting point is that this pattern concerns, for almost all, the same counties: counties located in Eastern France, except for the specific case of Hérault.

Table 3-4 : Enrollment Rates in Primary Schools in 1837

	Boys		Girls
Lowest Enrollment		Lowest Enrollment	
Finistère	15.9	*Corse*	4.9
Cher	18.7	*Haute-Vienne*	6.2
Corrèze	19.1	*Ariège*	7.6
Indre	19.1	*Corrèze*	8.1
Morbihan	19.2	*Finistère*	9.4
Highest Enrollment		Highest Enrollment	
Hérault	94.0	*Haute-Saône*	79.1
Haute-Saône	94.7	*Marne*	83.3
Marne	95.7	*Meurthe*	89.8
Meuse	98.4	*Meuse*	91.9
Haute-Marne	99.0	*Haute-Marne*	97.0

Sources: Data from Statistiques Générales de la France – Enseignement Primaire 1800-1925

Main differences observed between districts can find an explanation in differences in terms of school facilities (infrastructures). In 1837, France had a total of 52 779 schools: 29 303 public schools for boys; 5 453 public schools for girls; 9 417 free schools for boys and 8 606 free schools for girls. The disequilibrium between female and male schools is very strong, especially regarding public schools where the number of schools for boys is 5.5 times higher than that of girls. However, among the total number of male schools, half of them are identified as mixed; without strictly being able to define the reality of this co-educational schooling.

2.2.2. Evolution of Primary Education between 1837 and 1876

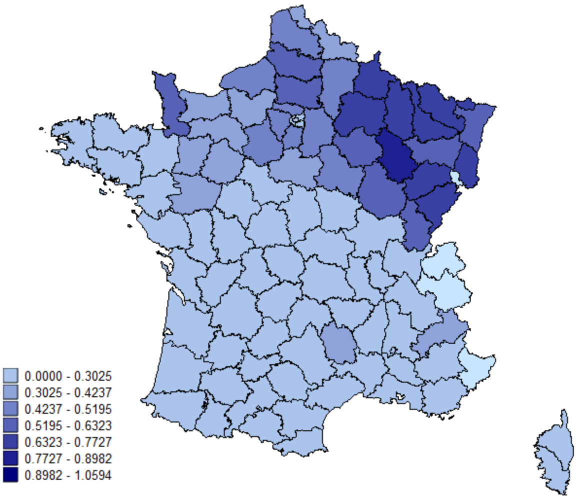
The period 1837-1867 that recorded the fastest changes, while the subsequent period – ranged from 1867 to 1877 – consolidated female schooling and showed a few transfers between types of schools. Mapping boys and girls enrollment rates (Figure 3-15) clearly shows the way increase in schooling spread across French counties from the Northeast toward the rest of France (as a spreading wave coming from Prussia). In 1867, the number of counties with girls' enrollment rates higher than 50% started to expand compared to the 1851 situation. Between 1867 and 1876, national enrollment growth rate went from 66% to 72.3%.

Figure 3-15 (a) and (b) show regional differences in girls and boys enrollment rates in 1851. We use maps representing relative quantities in geographical and administrative spaces. Maps highlight a development gap between Northern-France and Southern-France separated by the famous line Saint-Malo/Genève. Both female and male schooling in the Eastern and Northern France were already very high in 1851 while the rest of France was nearly empty. The contrast is even more evident for girls enrollment rates. As it can also be observed from Figures 3-15 (c) to (f), the increase in enrollment rates between 1867 and 1881 occurred mainly through the catch up of counties which were the latest. Counties that had the lowest enrollment rates in 1867 (e.g. in the Center and the West part of the country) exhibit the highest growth rates.

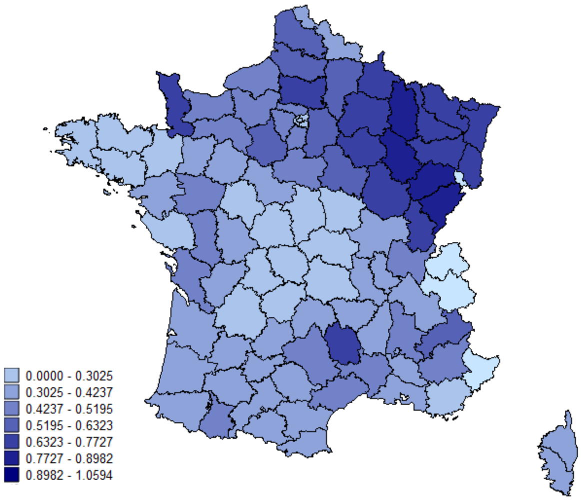
According to census data on primary school, we observe that enrollment rates varied widely in France across counties and over time. An overall analysis of the total number of girls enrolled in primary schools by county suggests relatively developed infrastructures in Northeastern counties. On the opposite, strong deficiencies appear in the Center and West part of the country. However, a more complex phenomenon concerns girls education because of their low enrollment rates in primary education and the fact that they are more likely than boys to attend free or congregational schools. Therefore, girls enrollment rates and more generally girls' education also depend on the geographical location of these types of schools. According to census data for the year 1850, congregational schools (either public or private) represented 45% of female school attendance and only 15% for males.

Figure 3-15 : Differences in Education – Educational Change

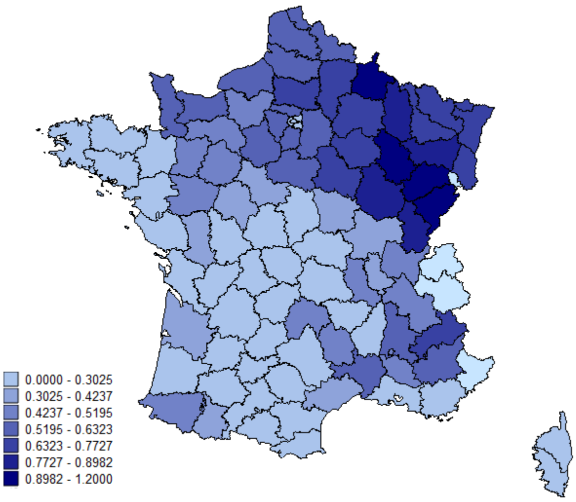
(a) Girls Enrollment Rates in Primary School, 1851



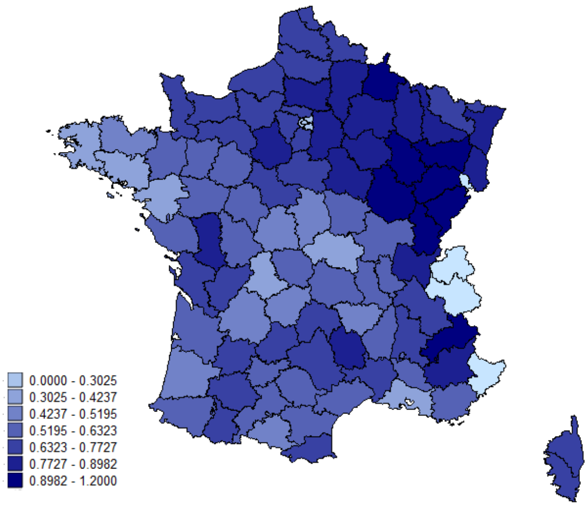
(b) Boys Enrollment Rates in Primary School, 1851



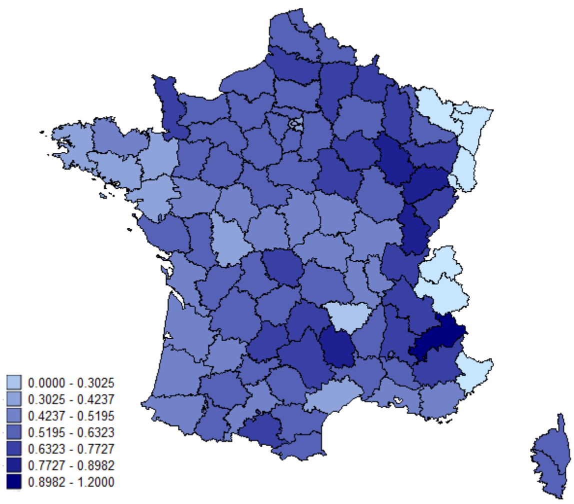
(c) Girls Enrollment Rates in Primary School, 1867



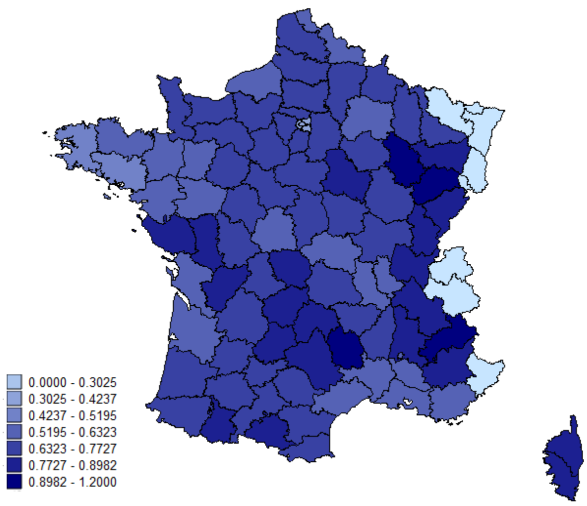
(d) Boys Enrollment Rates in Primary School, 1867



(e) Girls Enrollment Rates in Primary School, 1881



(f) Boys Enrollment Rates in Primary School, 1881



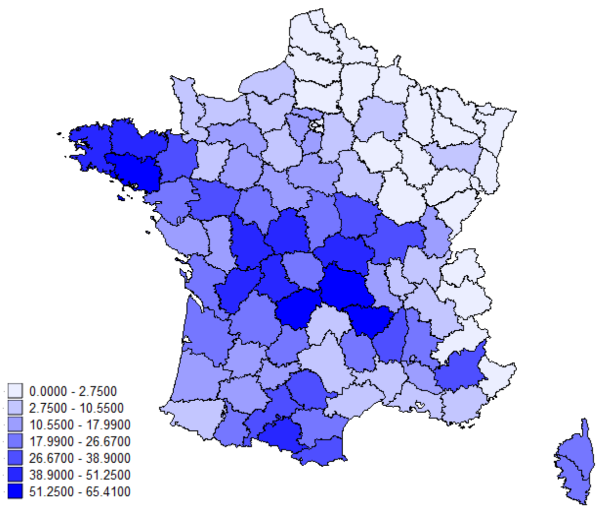
Sources: Data from Statistiques Générales de la France – Censuses

2.3. Geographical Evolution of Infrastructures

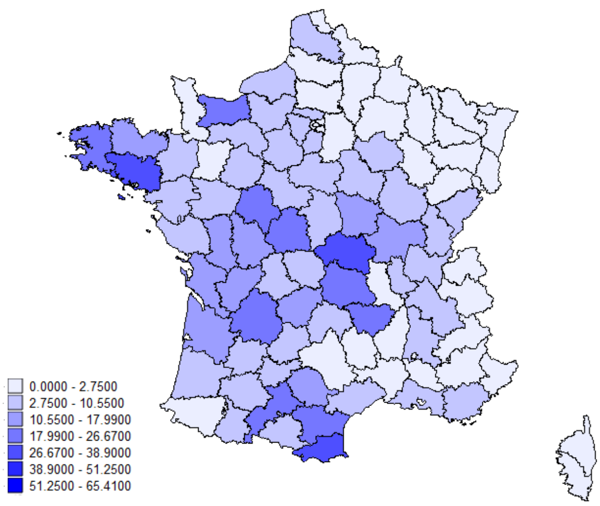
At the same time of changes in enrollment rates, we also observed increases in infrastructures, measured in terms of number of schools. The number of towns with no primary schools declined significantly during the 19th century. As expected, we note that the share of counties with the lower number of schools per municipalities were located on the left side of the line Saint-Malo/Geneva, namely in the center and Western France.

Figure 3-16 : Geographical Dynamics of Municipalities with no Schools for Girls

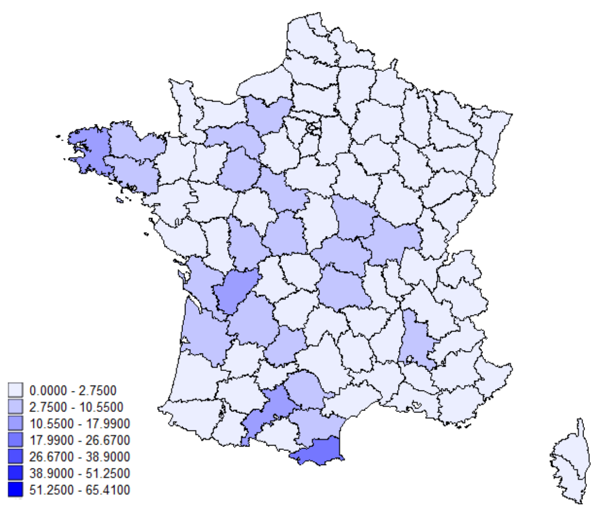
(a) Share of Municipalities with no Schools, 1837



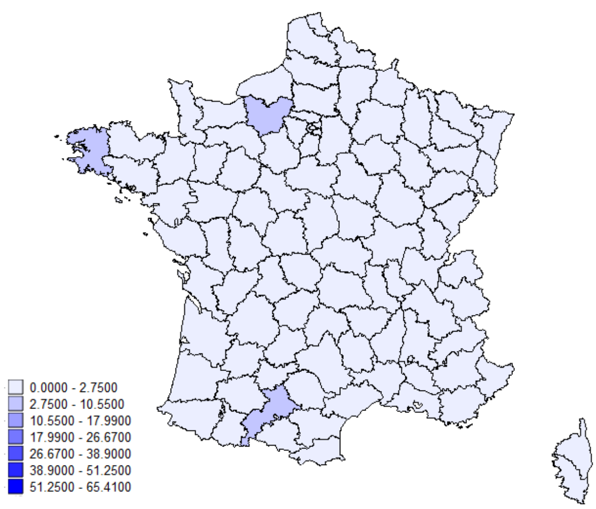
(b) Share of Municipalities with no Schools, 1850



(c) Share of Municipalities with no Schools, 1863



(d) Share of Municipalities with no Schools, 1882

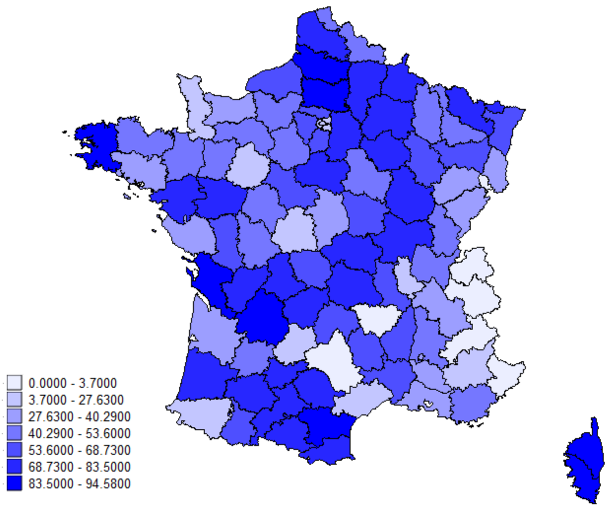


Sources: Data from Statistiques Générales de la France – Censuses

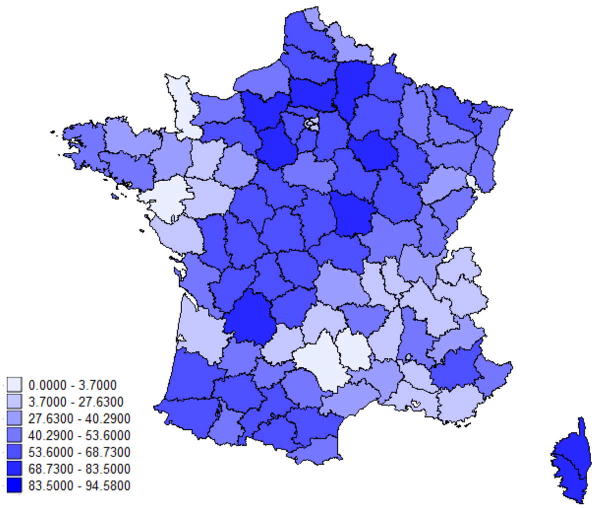
In particular, we observe in 1837 that the number of municipalities with no school was particularly high in Bretagne, Center and South border of France. In these counties, the number of municipalities with no schools exceeded 40% with a national average of 15 municipalities over a hundred with no schools. Over time, the number of municipalities with no schools declined quickly as observed in Figure 3-16 – where colors become less intense over time. In 1882, Eure, Finistère and Garonne only had a number of municipalities with no schools above 3%.

Figure 3-17 : Geographical Dynamics of Municipalities with no Schools for Girls

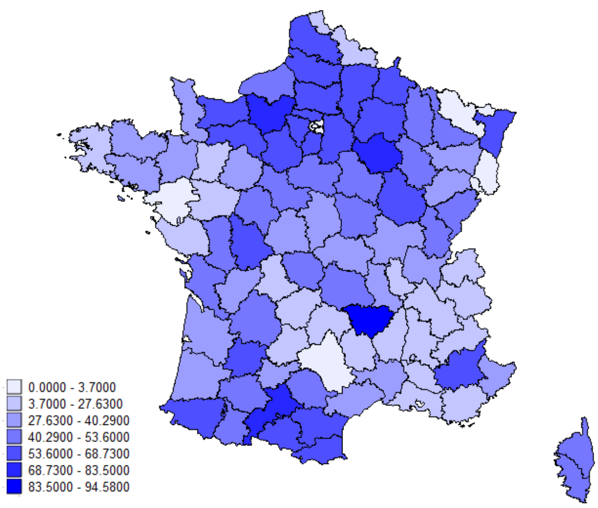
(a) Share of Municipalities with no Girls Schools, 1837



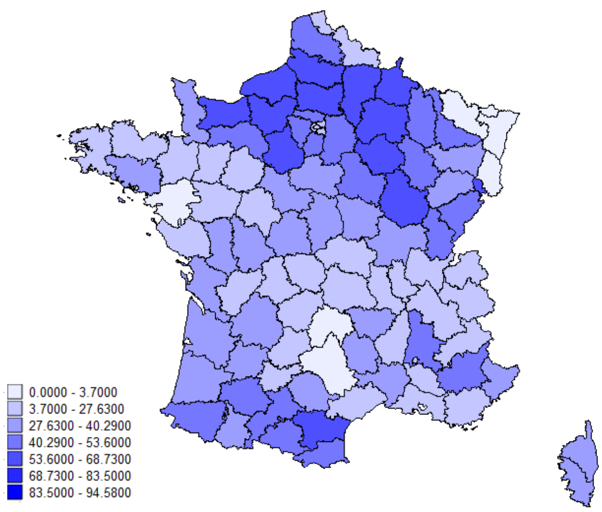
(b) Share of Municipalities with no Girls Schools, 1863



(c) Share of Municipalities with no Girls Schools, 1876



(d) Share of Municipalities with no Girls Schools, 1882



Sources: Data from Statistiques Générales de la France – Censuses

An interesting result emerges when we compare the evolution of towns with no schools to the evolution of towns without schools for girls (Figure 3-17). The geographical distribution of the share of municipalities with no schools dedicated to girls in 1837 tended to be relatively dispersed across French counties, with larger share in the North, Center and South part of the country. More than one-third of the counties displayed a share of municipalities with no schools for girls above 70% – with a national level reaching 58%. Over time, we observe an important decline in the number of municipalities with no schools for girls. Between 1837 and 1882, the national level is divided by 1.5. What could be considered as being a paradox is the evolution of the geographical distribution of the share of municipalities with no schools for girls. Counties with a higher proportion of girls enrolled in primary schools could be expected to exhibit lower share of municipalities with no schools for girls. On the contrary, the geographical dynamics of municipalities with no schools reveals the subsistence of high rates in Northeastern and Southern border counties while they decline continuously in the rest of France.

Counties with the lowest number of schools for girls also account for the highest number of co-educational schools (see Table 3-5). In that way, Oise displays one of the highest rates of municipalities with no schools for girls. Namely, in 1837, 93.7% of municipalities in Oise had no school for girls. However, co-educational schools were more numerous than in any other county accounting for 84.4% of schools. Nevertheless, this finding is not true for all counties. We observe strong differences in terms of space. Taking for instance Charente-Inférieure into consideration, 95% of municipalities in 1837 had no schools for girls and displayed no co-educational schools (this finding might be due to an error in the census). However, we can stress out the fact that there was a high number of towns with no schools – census data indicates 5 667 municipalities with no schools in 1837. Again as expected, most of these municipalities were located on the left side of a diagonal going from Saint-Malo to Geneva.

Table 3-5 : Share of Co-educational Schools in Top and Bottom Counties in 1837

Co-educational Schools in 1837 – In percent of total number of schools in the county			
Highest Rates			Lowest Rates
Oise	84.4	Bouches du Rhône	0.0
Bas-Rhin	77.4	Charente-Inférieure	0.0
Aube	77.0	Mayenne	0.9
Aisne	76.8	Var	1.6
Seine et Marne	76.3	Seine	1.7

Sources: Data from Statistiques Générales de la France – Enseignement Primaire 1800-1925

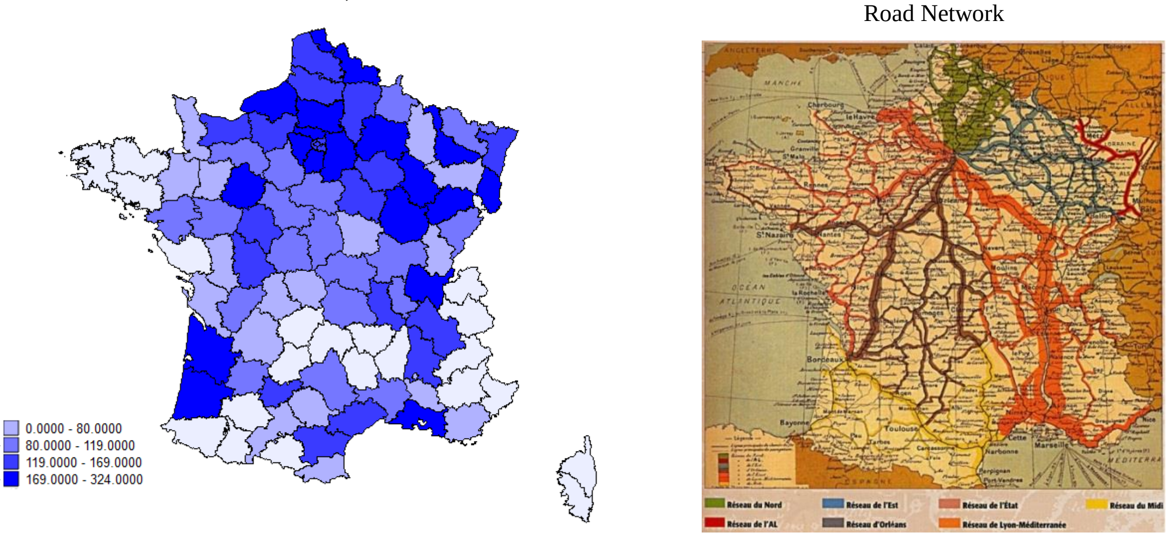
What we learn for the study is that counties more incline in having a co-educational system exhibited higher boys and girls enrollment rates (with a more similar education offered to both genders) and higher level of female-to-male enrollment rates.

The geographical distribution of literacy and enrollment rates emphasizes the existence of a pole of educational advance located in Northeastern France. The dynamical evolution of literacy and schooling over the 19th century highlights what looks like an "entry" of primary education from the Northeastern border of the country, which diffused toward the *Bassin Parisien*. The implementation of primary education in France has certainly been slowed down by Catholic hostility toward education, despite the “dechristianization” committed with the French Revolution. Closer areas from Prussia – geographical proximity to Lutheran ideas – exhibited larger enrollment rates in primary education than the rest of France. The diffusion of education is also likely to have been accelerated by the movement of ideas and individuals through the communication channels (Figure 3-18), highly-developed in that specific part of France. Another explanation emerges from regional sectorial segmentation between agriculture and industry. Enrollment rates tended to be lower in agricultural areas and high than in industrialized areas.

Figure 3-18 : Communication Channels

Railroads in km, 1854

Road Network



Sources: Data from Statistiques Générales de la France

The school system set up by the State in the 1830’s is built up on the duality of educational systems with on one side a state-funded public education and on the other side a “free” education essentially made up with Catholic schools. But in 1833, the Law Guizot only required municipalities with more than 500 inhabitants to build a school for boys – girls remaining excluded from formal education. The situation started timidly to change from the mid-19th century in primary education and spread gradually to secondary and then to tertiary education. Despite the rise in educational opportunities, girls still received proportionally less formal education than boys until relatively recently. What about the relative evolution of male and female stock of human capital over the past 200 years? How did the gender educational gap evolved over time?

3. The Gender Gap in Human Capital

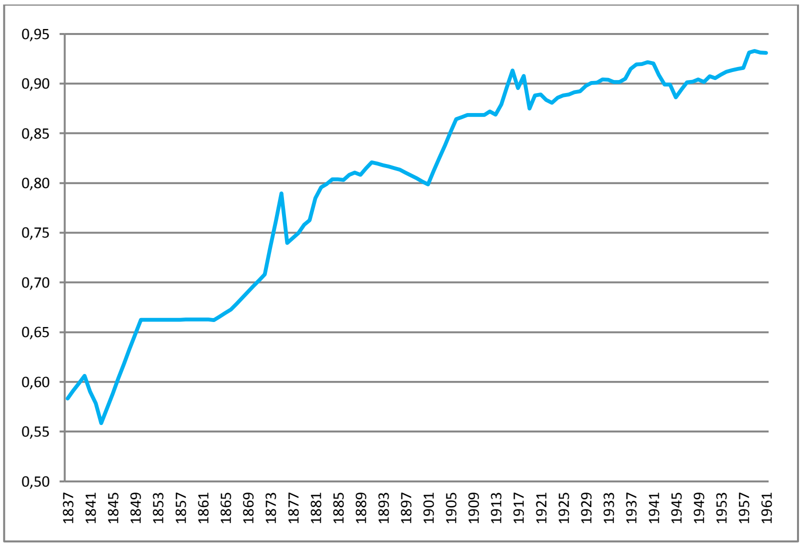
The increase in schooling for all ought to reduce differences between men and women. As more women invested in education and entered the labor market, their experience should have approached that of men over time. Therefore, we should observe a decline in the gain of specialization between men and women between home and the labor market. The gender gap should reduce over time. The study of the evolution of enrollment rates by genders (Section 1) has shown a large expansion of schooling for both genders over the past two century. We have seen that the increase occurred successively between the different levels of qualification, from primary to tertiary education through secondary education. But what about gender differences in schooling? Is there a catching up of girls over boys in parallel with the increase in numbers?

3.1. General Characteristics of the Gender Gap

3.1.1. The Gender Gap in Enrollment Rates

Primary School

Figure 3-19 : Female-to-Male Enrollment in Public Primary School



Sources: Own calculations – Using data from Claude Diebolt
Note: Missing values are interpolated using linear interpolation.

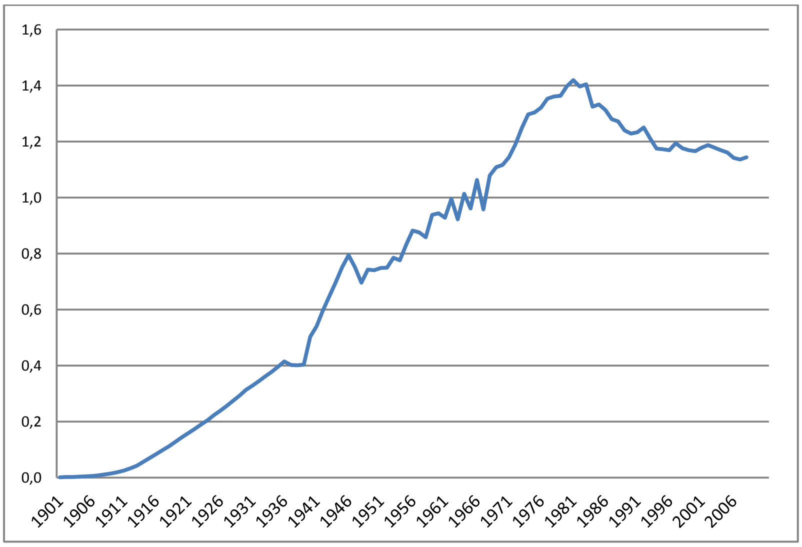
Figure 3-19 displays the evolution of the gender gap index measured as the female-to-male enrollment in public primary school between 1837 and 1961. While at the beginning of the period the gender gap index was relatively low, starting from abound 0.56, it reached 0.92 at the end of the period.[34]

The gender enrollment gap increased continuously over the whole period. The growth rate of female enrollment rate in public primary schools was more sustained than that of males. Nonetheless, the rate was not enough to fully catch up boys. The closing of the gender enrollment gap was still not complete at the beginning of the 1960's.

Diploma

In terms of high school diploma, seventy years have been necessary to observe a complete closing of the gender enrollment gap. Figure 3-20 shows the evolution of the ratio of female-to-male holder of a high school diploma in 1901-2008. The ratio started from zero in 1901 and reached one at the turn of the seventies. This catch up occurred slowly until WWI and then at an increasingly pace.

Figure 3-20 : Female-to-Male Holder of a High School Diploma



Sources: Using data from Chesnais (1975) – Cibois and Droesbeke (1988) – Magali Jaoul-Grammare

The catch up of girls holding a Baccalaureate to that of boys did not stop once perfect equality was reached. On the contrary, as seen in section 1, we note a reversal in the ratio of female-to-male high school graduates. Women became more likely than men to have a high school diploma from the end of the sixties. This trend continues today, even if a slowdown began after having reached a pick at 1.42 in 1981.

[34] The index has a range from 0, where there is perfect inequality between boys and girls, to 1where there is perfect equality between boys and girls.

3.1.2. The Gender Gap in Educational Attainment and Specialization

Years of Schooling

An important change depicted by the data is the reversal in the female-to-male training of the population. Table 3-7 presents the evolution of the average years of schooling of female and male labor force between 1896 and 1996. In addition, it shows the evolution of the female-to-male average years of schooling of the labor force. The average years of schooling increased continuously and significantly for both men and women over the whole studied period, from 5.63 years to 12.4 years and from 5.14 to 12.47 respectively. Therefrom, in the space of a century, the training of the male labor force multiplied by 2.20 and that of women by 2.43. Most importantly, we observe a reversal in the power-imbalance ratio between men and women.

Two periods emerge clearly in the female-to-male average year of schooling. At the beginning of the 20th century, the male labor force was still on average "better trained" than the female labor force. The reversal is observed in the mid-sixties. The female labor force then became on average "better trained" than the male labor force. This reversal constitutes a deep mutation of the society. Nonetheless, taking into consideration the years of schooling does not allow apprehending the relative evolution in terms of specialization.

Table 3-6 : The Gender Training Gap of the Active Population

Years	Female Years of Schooling	Male Years of Schooling	Ratio
1896	5,14	5,63	0,913
1911	6,00	6,47	0,927
1921	6,63	6,90	0,961
1931	7,15	7,38	0,969
1936	7,36	7,57	0,972
1954	7,94	8,10	0,980
1964	8,87	8,75	1,014
1968	9,18	9,21	0,997
1974	9,87	9,61	1,027
1980	10,65	10,32	1,032
1985	11,2	10,99	1,019
1990	11,64	11,40	1,021
1996	12,47	12,40	1,006

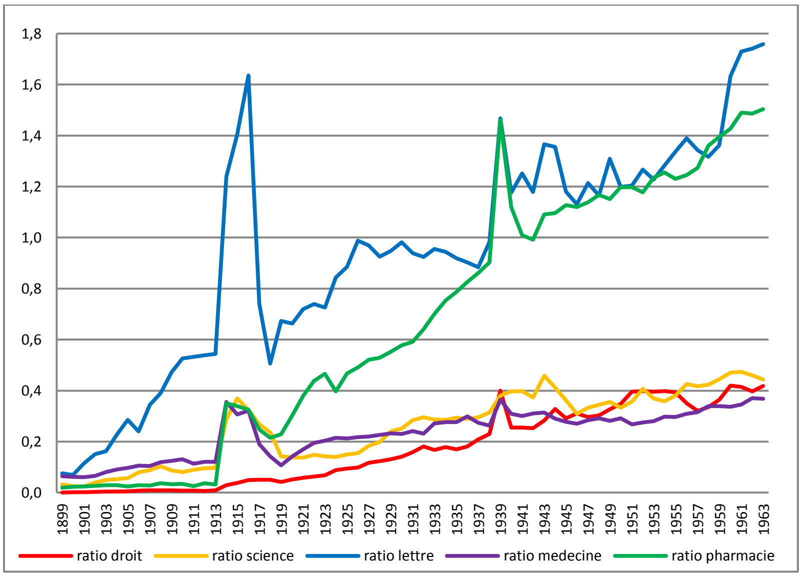
Sources: Data from Marchand and Thélot (1997)

Specialization

Focusing on higher education and more specifically on respective male and female specializations, we note that the gender gap differs significantly between disciplines. Figure 3-21 presents the ratio of female-to-male enrollment rate in higher education for five domains of specialization, namely Law, Science, Arts, Medicine and Pharmacy, between 1899 and 1963.

We observed previously that this was in Arts and Science that female enrollment rates increased the most (in higher proportion). The study of the evolution of the gender gap by domain of specialization informs us about the existence of a possible segregation that would help understanding occupational segregation and gender wage gaps. Therefrom, we note that this is both in Arts and Pharmacy that the closing of the gender gap was the quickest. Although the gender gap was close to zero in all domains of specialization at the turn of the 20th century, the ratio of female-to-male enrollment in Arts increased substantially and continuously over the whole periods – interspersed with picks during WWI and WWII. We have to wait the end of WWI to observe a similar increase in Pharmacy. Both Arts and Pharmacy experiences an equalization of boys and girls enrollment rates during WWII. Far from only being a war-related consequence, the trend continues over time and approaches 1.8 in Arts and 1.5 in Pharmacy. However, despite the increase in girls enrollment in Science, the gender gap remained very high. We were still counting 4 girls for 10 boys only in 1963. Similar trends are also observed in Medicine and Law. Girls represent today (2011-2012) 64.3% of Bachelor students in Law, 69.5% in Arts, 76.8% in Medicine, 64% in Pharmacy (51.5% in Economics and Management, 67.8% in Social Sciences) but 28% only in Fundamental and Applied Science (29.1% in Sport).

Figure 3-21 : Female-to-Male Specialization in Higher Education



Sources: Using data from Statistiques Générales de la France – Annuaire 1966

Educational attainment of the labor force during the 20th century expanded on average by 7 years. Most of the gain was attributable to the rise of high school education and to the increase in college education. What are the consequences of the rise in educational attainment for the quality of the workforce? What implications for the economy?

3.1.3. The Gender Quality of the Labor Force

As seen in previous sub-sections, the patterns of education and training changed a lot during the past two centuries. In parallel to changes in terms of lengths and specialization of educational investments, we note significant changes from a gendered point of view, notably in regards with the relative evolution of the quality of the labor force. Since the beginning of the 19th century, both the labor force participation and the average quality of the labor force increased and reinforced each other.

The training of the labor force is one of the major stakes for firms and states because of the positive role it plays on productivity. The quality of the labor force, notably driven by educational investments, was for long time recognized as one of the prime engine of growth impacting positively economic growth (theory of human capital accumulation). The quality (or productivity) of the labor force is measured by endowments in human capital. Human capital refers to the combination of knowledge, competencies, behaviors (assets, skills, attitudes) endowed in individuals. In order to better understand the evolution of the stock of human capital over the past two centuries, we use the level of knowledge, competencies, and behaviors provided by education and training (measured by the productivity of years of schooling) as a proxy to measure human capital.

Based on the same methodology as the one used by Marchand and Thélot (1997), we built a measure of the quality of the labor force by gender. The quality of the female (male) labor force is measured as a product of the productivity given to the number of years of schooling and the share of the female (male) labor force according to the years of schooling. Therefore, the quality of the labor force consists in the share of laborers according to their training (p_{it}) and their relative productivity (e_i), as given by the following equation:

$$q_i = \sum_i e_i p_{it}$$

The estimated relative productivities by years of schooling are reported in Table 3-8. Longer is the time spent by individuals at school, higher is their estimated productivity for their future job. For instance, individuals who did not go to school are supposed to have a productivity of 0.7

while individuals who left school at age 22 are supposed to have a productivity of 2.2. The methodology used to estimate the productivity consists in using a wage scale taking into account factors impacting wages. Therefore, the scales of laborers mean productivities are driven from their remuneration within the economy based on the work done by Mincer (1974) and Lévy-Garboua (1972) on wages in France (Marchand and Thélot, 1997).

Table 3-7 : Relative Productivity by Years of Schooling

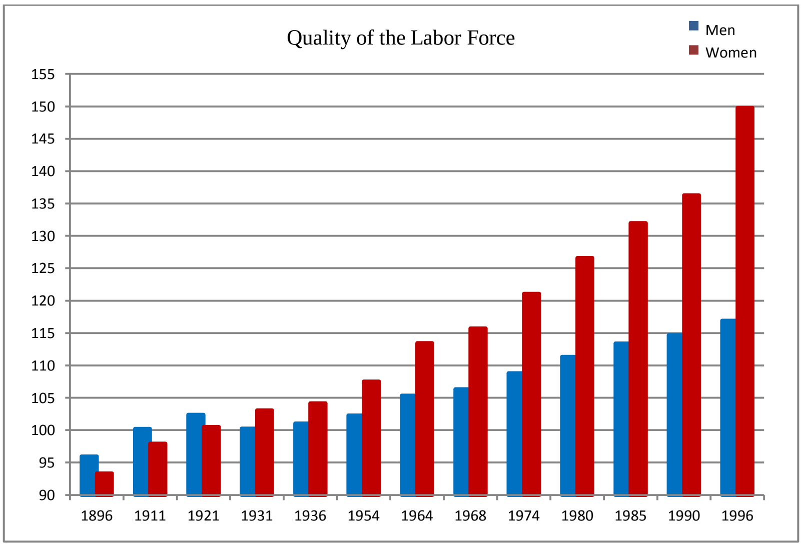
Years of Schooling	School Leaving Age	Productivity Scale
0	---	0.7
1-4	7-10	0.8
5-6	11-12	0.9
7-8	13-14	1.0
9-10	15-16	1.2
11-12	17-18	1.4
13-15	19-21	1.7
16-18	22-24	2.2
19 and +	25 and +	2.2

Sources: Data from Marchand and Thélot (1997)

Figure 3-22 displays the evolution of the quality of the labor force by gender between 1896 and 1996. The figure compares the evolution of the quality of both men and women labor force (quality in terms of years of schooling). Over the course of the 20th century, the quality of women labor force increased in stronger proportion than that of men. The quality of women and men labor force rose from 93 to 150 and from 96 to 117 respectively between 1896 and 1996. The gap in favor of women emerged during the twenties. It became highly pronounced and continuously increasing from the sixties. The average growth rate of the quality of female labor force is 2.35 and that of male labor force participation is 0.87. In a century, the quality of the female (male) labor force has been multiplied by 1.6 (1.2); 1.15 (1.06) during the first half of the 20th century and 1.39 (1.14) during the second half. These findings suggest that the strength of human capital, within French society during the 20th century, was to a major extent the result of improvements in the quality of the female labor force participation.

Evidence suggests that the main source of growth differed between 19th and 20th centuries. During the 19th century, growth tended to be mainly triggered by the increase in the labor force while during the 20th century it was mainly triggered by improvements in the quality of the labor force.

Figure 3-22 : Evolution of the Quality of the Labor Force by Gender

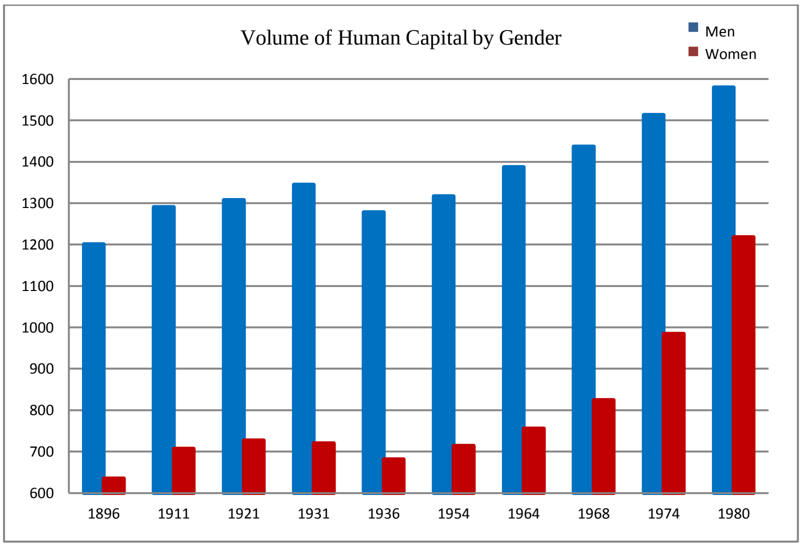


Sources: Own calculations based on data from Marchand and Thélot (1997)

The methodology used to measure the quality of the labor force can be criticized. In order to have a highly comprehension of the impact of a better trained labor force on economic growth, we consider that highly trained individuals have a higher productivity than others. However, as noted by Marchand and Thélot, even if the scale of valuation of educational investments is linked with that of productivities, there is no guarantee that it is proportional (and is in addition likely to increase over time). Integrating data on wages – assumed to reflect the marginal productivity of labor – to the measure of productivity allows for a more accurate measurement of the quality of the labor force. In market economies, wages are indeed supposed to increase with the length of educational investments. However, taking into account a gendered approach increases the number of difficulties – likely to increase the imperfection of the measure of quality. Therefore, we do not take into account the existence of wage discriminations against women.

In addition, we know that women were, and still are, more likely than men to work in lower paid jobs and incur more than men part-time work. This could also lower actual female productivity. As a consequence, the measure would not reflect correctly the quality of the female labor force – by underestimating or over-estimating it. Nonetheless, data availability makes it very difficult to build up gendered estimates of labor productivity. Thus, we chose to keep the same measurement of productivity without introducing any gender distinctions. In any case, the construction of gendered measurement of the quality of the labor force allows us to see the significant and growing role that the female labor force (through its quality) is likely to have played on economic growth during the second half of the 20th century.

Figure 3-23 : Evolution of the Stock of Human Capital by Gender between 1896 and 1980



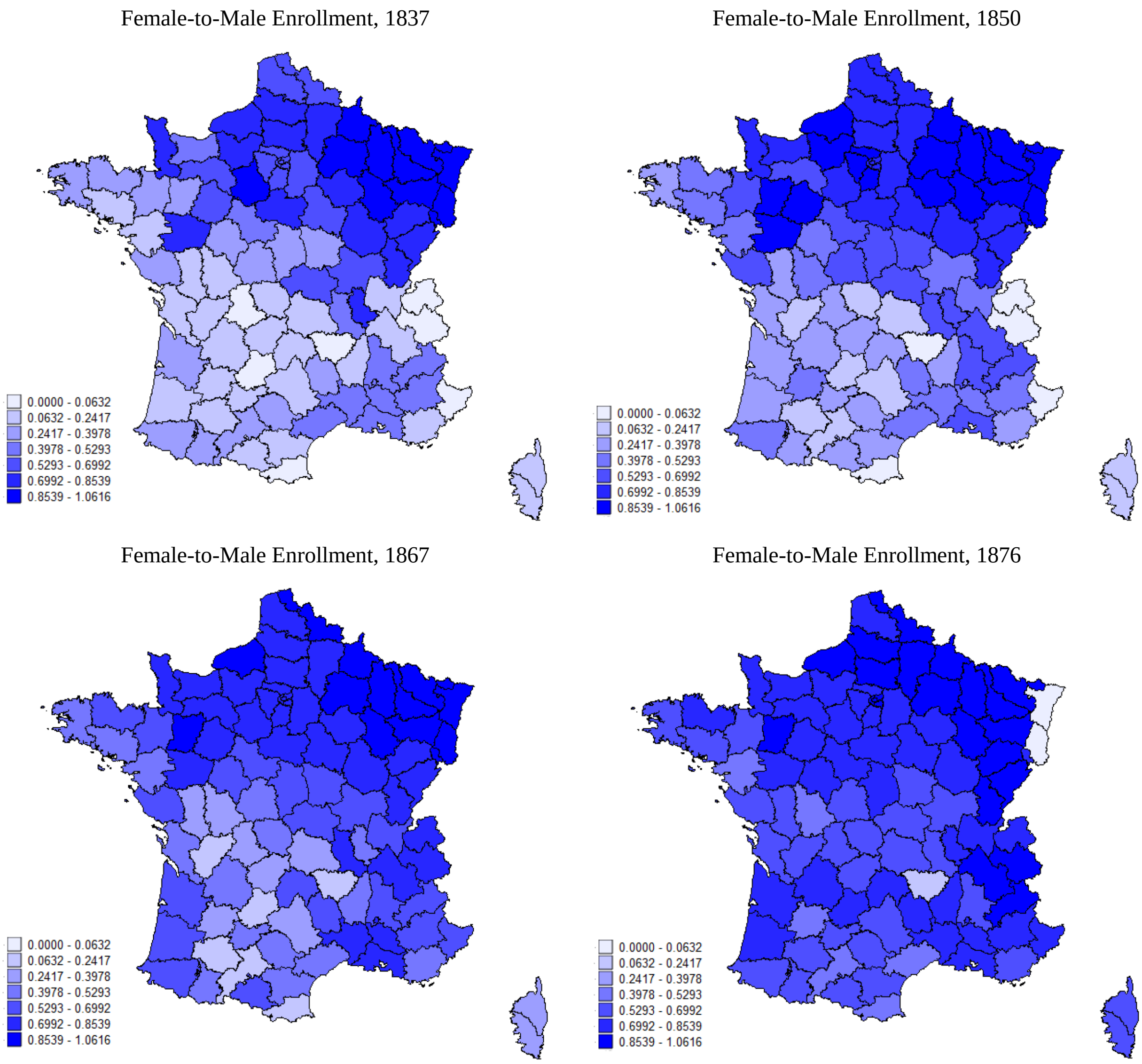
At the same time of the increase in the quality of the labor force is also the rise in the number of active individuals (as emphasized previously). The volume of female (male) human capital is calculated by multiplying the quality of the female (male) labor force by the number of active women (men). Figure 3-23 presents the evolution of the stock oh human capital by gender between 1896 and 1980. Both male and female volume of human capital increased significantly over the course of the 20th century. While the male human capital multiplied by 1.31, the female human capital almost doubled (multiplied by 1.92). The rise in human capital was not regular over the whole century. We observe a first phase of growth for both genders during the first quarter of the century. The volume of female human capital then declined, triggered by the decline in the female labor force from the 1920's. The resumption of human capital growth started after WWII at an increasing pace and in larger proportion for women.

As specified by Marchand and Thélot (1997), the sources of the sharp increase in female and male volume of human capital reversed between the 19th and the 20th century. If the rise was predominately triggered by the growing share of individuals entering the labor market during the 19th century, the major part of the growth was due to the increase in the quality of the labor force (because of its increasing training) during the 20th century (especially the second half of the century).

3.2. Regional Dynamics of the Gender Schooling Gap

From the mapping of female-to-male enrollment rate in primary schools, we note that counties where the enrollment rates are higher exhibit closer female-to-male enrollment rates. There is a weakening of male surplus in areas where average enrollment rates are the highest. On the other hand, lower is the average enrollment rate, larger is the gap between boys and girls enrollment rates.

Figure 3-24 : Evolution of the Geographical Distribution of the Gender Gap in Primary School



Sources: Own calculations – Using data from Statistiques Générales de la France

A non-expected finding is that a massive part of this Northeastern areas account for an important gap between the number of schools for girls and the number of schools for boys. This result actually hides the relative importance of co-educational schools in this region comparatively to what can be observed in the rest of the country. The presence of mixed-schools reflects a mindset focused toward more equality between girls and boys, reflecting certainly a greater equality between men and women. The Northeastern part of France was characterized by a more egalitarian educative structure of elementary education. However, the rest of the country and especially counties located on the left part of a circular axis going from the *Détroit de la Gironde* to *Marseille* showed a clear domination of boys enrollment rates to that of girls and exhibit overwhelmingly lower literacy rates.

The mapping of the evolution of the spatial distribution of the gender gap reveals similar trends to those observed in the study of the evolution of female ability to sign (Figure 3-14) and female enrollment rates in primary school (Figure 3-15). The geographical distribution suggests a spread coming from Northeast and East borders.

Conclusion

Human capital is an important factor to understand wage and occupational distribution between genders. Nonetheless, it is not sufficient to fully explain gender wage and occupational gaps. Even when they reached the same level of human capital, men and women were used not to perform the same type of jobs. If the evolution of human capital does not fully explain the persistence of gender occupational and wage gaps, it helps to understand their evolution over time.

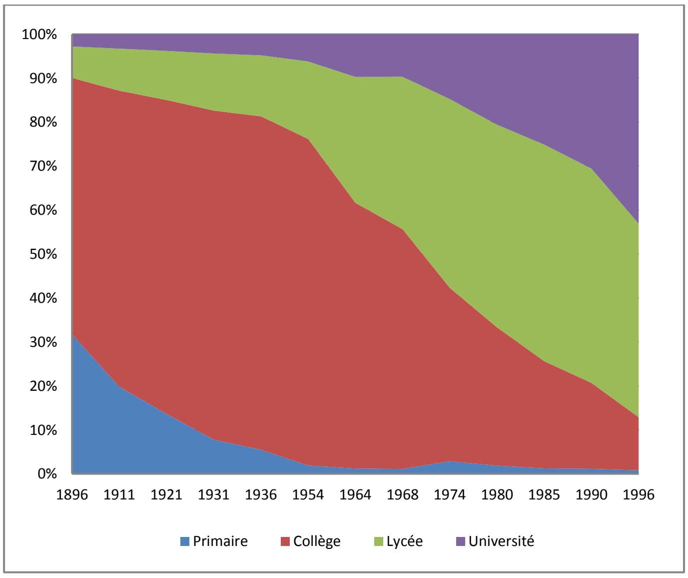
Over the 19th century, women were on average less trained than men. Women opportunities and access to education were limited and bounded. Additional education was often limited to specific knowledge related to housework and skills required for their future role within the household as mother and wife, or (to a lesser extent) for their future occupation. Hence, girls had a differentiated schooling program. For instance, in upper primary schools, girls had a lighter program in natural history, mathematics and geometry than boys; and had additionally to learn needlework (sewing, dressmaking, knitting or embroidery) and had to demonstrate practical ability and skills (see Table C-1 in Appendix). Girls became equally educated with boys from the 20th century only. Women educational investments increased substantially over the past two centuries – at an increasing pace during the second half of 20th century. The quality of the labor force increased continuously and reversed in favor of women. Together with the increase in the productivity of hours worked is the rise in human capital and in enrollment rates. The situation improved significantly over time. Within a few decades, France experienced an impressive catch up of girls enrollment rates on boys enrollment rates. The feminization of education allowed girls to fill a large part of their delay in schooling.

Why did women choose to increase their educational investment? Why did women decide at a certain point to invest in education and to become skilled workers? What is at the origin of the reversal in educational investments? What are the consequences of changes in educational aspirations? To find some piece of evidence we need to better look at gender relations and their evolutions over time.

The access to education is a first step towards equality. Together with the access to paid labor outside of the home and the recognition of women’s autonomy as civil individuals conducted to deep structural changes in gender relations. Could changes in gender ideology together with the implementation of laws promoting girls education have contributed to transform gender relations within the household and society? Could these changes explain evolutions observed on the labor market and about demographic variables?

Appendix C

Figure C-1 : Evolution of Educational Attainment of the Female Labor Force

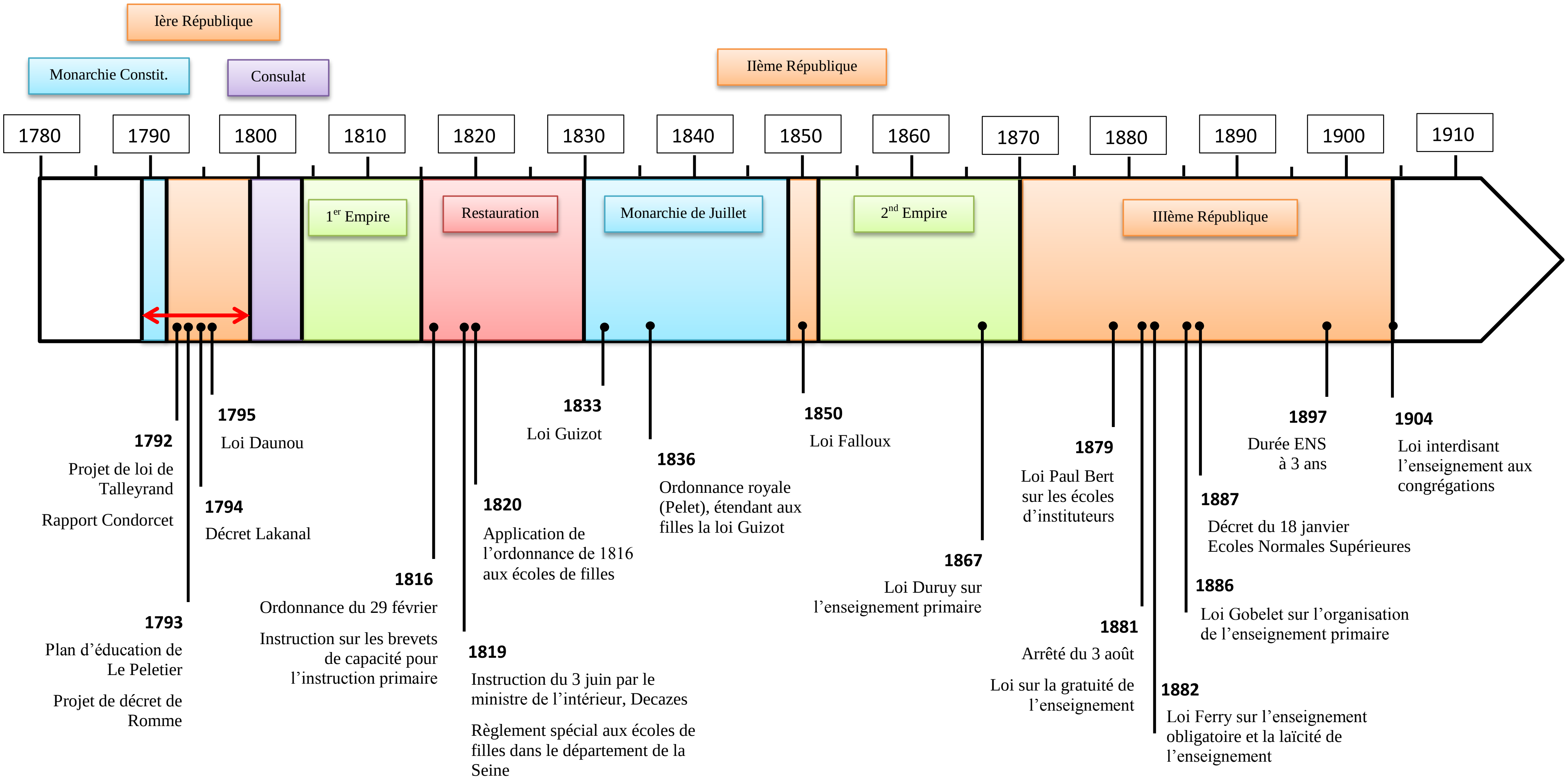


Sources: Own calculations based on data from Marchand and Thélot (1997)

Table C-1 : Manual Labor Training in Primary School by Gender

Boys		Girls	
Cours élémentaire	• Exercice manuel destinés à former la dextérité de la main • Découpage de carton-carte en formes de solides géométriques • Vannerie • Modelage	**Cours élémentaire**	• Tricot et étude du point; mailles • Point de marque sur canevas • Eléments de couture • Exercices manuel destinés à former la dextérité de la main • Petits essais de modelage
Cours moyen	• Construction d'objets de cartonnage • Petits travaux en fils de fer • Combinaisons de fil de fer et de bois • Modelage • Notions sur les outils usuels	**Cours moyen**	• Tricot et remmaillage • Marque sur canevas • Eléments de couture • Confection d'ouvrages de couture simples et faciles
Cours supérieur	• Exercices combines de dessin et de modelage • Etude des principaux outils employés au travail du bois • Exercices pratiques gradués • Etude des principaux outils employés dans le travail du fer etc.	**Cours supérieur**	• Tricot de jupons, gilets, gants • Marque sur la toile • Piqûre, froncés, boutonnière, reprise, raccommodage de vêtements • Notions de coupure et confection des vêtements les plus faciles • Notions très simples d'économie domestique et application à la cuisine, au blanchissage et à l'entretien du linge, au soin du ménage, du jardin etc.

Note: Law of July 28, 1882, about manual labor training as a compulsory discipline in the program of public primary education.



Ière République
Monarchie Constit.
Consulat
IIème République
1780
1790
1800
1810
1820
1830
1840
1850
1860
1870
1880
1890
1900
1910
1er Empire
Restauration
Monarchie de Juillet
2nd Empire
IIIème République
1792
Projet de loi de Talleyrand
Rapport Condorcet
1793
Plan d'éducation de Le Peletier
Projet de décret de Romme
1794
Décret Lakanal
1795
Loi Daunou
1816
Ordonnance du 29 février
Instruction sur les brevets de capacité pour l'instruction primaire
1819
Instruction du 3 juin par le ministre de l'intérieur, Decazes
Règlement spécial aux écoles de filles dans le département de la Seine
1820
Application de l'ordonnance de 1816 aux écoles de filles
1833
Loi Guizot
1836
Ordonnance royale (Pelet), étendant aux filles la loi Guizot
1850
Loi Falloux
1867
Loi Duruy sur l'enseignement primaire
1879
Loi Paul Bert sur les écoles d'instituteurs
1881
Arrêté du 3 août
Loi sur la gratuité de l'enseignement
1882
Loi Ferry sur l'enseignement obligatoire et la laïcité de l'enseignement
1886
Loi Gobelet sur l'organisation de l'enseignement primaire
1887
Décret du 18 janvier Ecoles Normales Supérieures
1897
Durée ENS à 3 ans
1904
Loi interdisant l'enseignement aux congrégations

Chapter 4

Changes in Gender Relations

Content

« *Dans ce siècle qui a pour loi d'achever la révolution française et de commencer la révolution humaine, l'égalité des sexes faisant partie de l'égalité des hommes, une grande femme était nécessaire.* » Victor Hugo (1802-1885) à propos de Georges Sand

« *Etant exclues de l'univers des choses sérieuses, des affaires publiques, et tout spécialement économiques, les femmes sont restées longtemps cantonnées dans l'univers domestique et dans les activités associées à la reproduction biologique et sociale de la lignée; activités (maternelles notamment) qui, même si elles sont apparemment reconnues et parfois rituellement célébrées, ne le sont que pour autant qu'elles restent subordonnées aux activités de production, seules à recevoir une véritable sanction économique et sociale, et ordonnées par rapport aux intérêts matériels et symboliques de la lignée, c'est-à-dire des hommes.* » Pierre Bourdieu (1998)

Introduction

Evidence collected in the three first chapters has brought to light profound changes experienced by the French society over the past two hundred years. Our study has highlighted deep changes both in terms of proportion and specialization in the stock of human capital. The data displayed a gradual rise in female educational attainment. The increase in enrollment rates is first observed for primary education. Secondary and tertiary educations subsequently follow the same trend. Along with such rise in school attendance, we also observe an increase in the graduation rates. The segregation in terms of specialization however persists over time. Nonetheless, the data indicate a closing in the gender gap. On average, girls' enrollment rates even overcome that of boys in the end of the 20th century. Still the quality of the female labor force tends to exceed the quality of the male labor force from the early 20th century. The study of the evolution of the labor force participation and its structure has shown important transformations in the female workforce. The female labor force participation increased substantially and the type of occupations performed by women diversified. From a dominance of the agricultural sector, the labor force moved first toward the industrial sector and then to the tertiary sector. The life cycle participation of women to the economy changed deeply as well. If during the 19th century working women were to a larger extent single, the weight of married women in the labor force increased substantially. In parallel, we note a decline in the share of younger active women in favor of women in age of childbearing. Joint with this increasing participation of women in the paid workforce, we observe a decline in gender inequality.

Despite the persistence of gender occupational segregation, the data show greater female employment opportunities and exhibit an important decline in the gender wage gap.
In parallel to educational and economic changes, we also raised issues related to a set of demographic changes. The most significant change is undoubtedly the fertility transition. The detailed study of demographic variables indicated deep changes in the marriage pattern – age at marriage, definitive celibacy and illegitimate births – in the past 200 years. In addition to the transformation of the marriage pattern, data suggest the presence of birth limitation/regulation through the increase in birth spacing and the decline of the age at last birth. The synchronicity of these transformations suggests an interconnection between all the variables related to economic, educational and demographic aspects. The common point between all these variables lies in the fact that they related to individuals' choices and behaviors. More precisely regarding labor and education, we observe – in parallel to improvements in female educational investments and in female labor force participation – a closing in the gender gap. Therefrom, instead of only focusing on individual behaviors, one might concentrate the analysis of the family unit and then on decisions taken within this unit. Indeed, all changes in terms of female-to-male ratio suggest a transformation in gender relations. In order to better understand changes that occurred at the level of the society one might first try to better understand changes that occurred at a more disaggregate level, namely in the family.

Understanding the transformation of family organization is essential to explain the deep changes in gender differences over the past two centuries. This period witnessed dramatic changes in gender relations linked to the transition from a patriarchal organization of the society to a more egalitarian one. The emergence of married women into the paid workforce has contributed to profoundly modify gender relations and has weakened the patriarchal family organization (according to which the husband belongs to the professional sphere while the wife stays at home) in favor of a more egalitarian distribution of roles within the household. The position of women evolved within the family and therefrom within the society – changes in "cultural" attitude toward gender equality. The study of changes in family organization over time and across modes of production allows getting a better understanding of the evolution of the distribution of roles between members of the household. We have seen that economic factors and market forces cannot explain alone the gendered division of labor. The sexual division of labor has been increased during the early 20th century with the expansion of manufacturing activities. There is a reinforcement of beliefs about a (biological) disadvantage for women to perform productive activities and encouraging them to return to the home.

Reproduction cannot be taken separately from economics. To understand economics one might understand demographics and the other way around. We argue that one of the key aspect to get a better comprehension of the process of development is the evolution of gender relations. Does reproduction stem from women behavior or from that of men? In order to understand the reasons why fertility transition occurred, should not we focus on gender relations and investigate gender specific roles within the household and in the society and their evolution over time? What happened in terms of changes in women status?

> "*Women have always had a reason for limiting children that men did not have, but that reason could motivate behavior on a large scale when women became self-conscious about themselves as individuals-that is, when they began to see themselves separated from their husbands and their families*" (Degler, 1980)

Demographic behavior is inseparable from the status of women in the home and in the labor market, and so as from gender roles and relations. Therefore, changes in the type of family organization and changes in gender roles have to be taken into consideration in order to better understand and explain the reasons why France experienced economic growth and why fertility transition occurred in the entire country?

This chapter aims first at describing the transformations of gender relations from the French Revolution. We know the process of women emancipation fairly well from the major set of events in the sixties-seventies – *Cultural and Sexual Revolutions*. But women's emancipation did not occur out of the blue. We argue that the process engaged a long time before the sexual and cultural revolutions, through several channels that contributed to change gender relations toward greater equality – within the household and within the economy. Along with the description of gender roles and relations over time, we aim at providing underlying mechanisms that have triggered economic and demographic transitions. This first step lays the foundation for the analysis conducted in the second part of our work (Part II). The second section of this chapter will be dedicated to the study of county-level interrelations between socioeconomic statuses, demographic and cultural variables. One key objective of the section is to construct a gender gap index that will be integrated to the analysis of the positioning of French counties according to economic, demographic, social and cultural features.

1. Family Organization and Gender Relations: The Role Played by Female Empowerment

Functions of the family

There exist three main fundamental functions that family members have to perform: *(i)* the economic function – production of goods and services within and outside the home; *(ii)* the social function – production of education and well-being, transmission of norms and values, inheritance; *(iii)* the reproduction function – renewal of generations. These functions are shared between the members of the household. The distribution of "social" tasks within family members depends on numerous external factors and relies on relations between the members of the household; that is between wife and husband. Thereby, power relations between men and women play a key role in the understanding of family organization. Female empowerment and changes in family organization cannot indeed be separated from each other.

Types of Family Organization

The gender division of labor differed greatly across time and space. There exist several possible family organizations depending on the distribution of roles within the household. The two extreme organizations are the "traditional organization" and the "modern" organization of the family. In the "traditional" organization of the family, the father is the patriarch – undisputed leader of the family. Women and children are respectively subordinated to the husband and the father who maintains a relationship of authority over all the family members. In the "modern" organization, both men and women perform paid work in the productive sphere. Women are not solely characterized by their role of wife and mother anymore.

Based on the experience of developed countries, Majnoni d'Intignano (1999) notes that family organizations correspond to distinctive historical, sociological and economic models. These models differ mainly in terms of relative compensation of the time spent performing the different tasks, in terms of participation to the tasks within the family sphere and/or within the professional sphere (market versus non-market production). One fundamental determinant of the establishment of one model or the other is the distribution of "power" between men and women.

1.1. The "Traditional" Role of Women

Systems of family organization differ along three dimensions: the female-to-male relative participation to the paid and unpaid labor, the relative remuneration of time and the sharing of power between men and women. Patriarchy is a social system in which the male is the primary authority, central figure to roles of political leadership, moral authority and control of property. Within this form of social organization, the father is the head of the family and men have authority over women and children. Patriarchy entails female subordination.

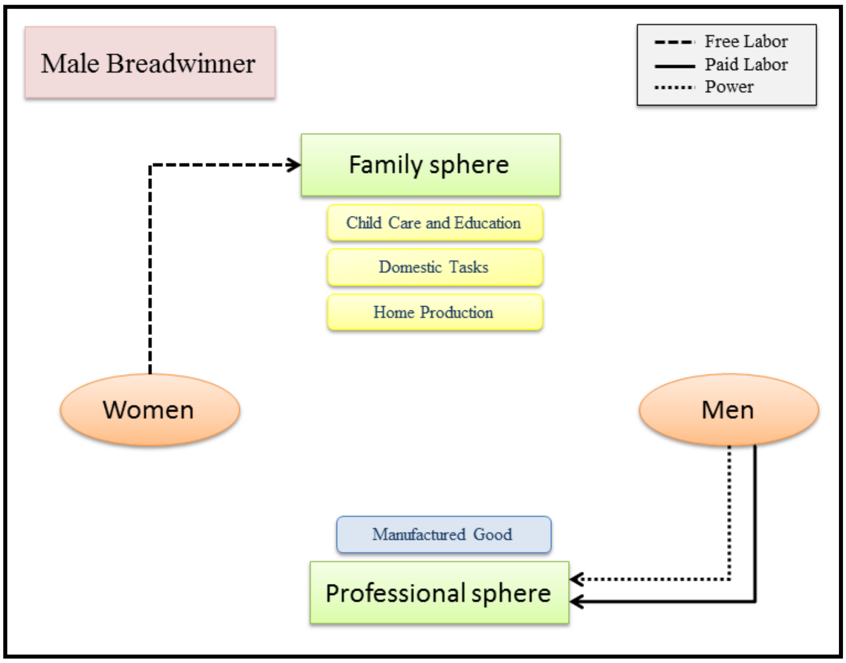
As presented above, there exist three main social tasks shared between men and women: the renewal of generations, the production of education and well-being within the family sphere and the production of market and non-market goods and services outside the family sphere. The "Traditional" organization of the family is based on the specialization of the tasks within the household. In a patriarchal organization, the marriage was most of the time characterized by the transfer of the girl from the house of the father to the house of the husband. This "traditional" organization of the family was in force both in agrarian and in industrial societies but with a more or less tight border for women between production and reproduction activities.

Agrarian Society. – In agrarian societies, property and family goods play a key role, giving great importance to the inheritance system. As seen in Chapter 1, this was in line with a pattern of late marriage and high share of definitive celibacy. Late marriage allowed the father to keep his grip on the farm longer; prolonged or permanent celibacy might in turn be explained by the socio-economic dependence of the father and allowed to limit the dispersion of land.
In that type of society, women performed different tasks and played a key role within the family economy (notably in control of sexuality and marriage). Precarious position in peasantry for women led them to remain single. The possession of some land increased marriage prospects as well as the means to raise children. The division between the public and the private sphere is not marked like in industrial societies. Women often worked (side by side with men) in the farming, craft or commercial family business although most of the time her work was not paid.

Industrial Society. – With the industrialization, we note an increasing division between the public and the family sphere and a reinforced gender division of labor between paid activities and domestic labor that increased the situation of economic dependency of women on men. The major difference between agrarian and industrial economies lies in the fact that the first one is characterized by a household mode of production (at home) while the second is characterized by a private mode of production (in the factory).

A more industrialized society is then characterized by a clearer distinction between gender roles (Figure 4-1). The man works outside the home for the economic well-being of the family while the woman takes care of the domestic sphere performing diverse tasks such as cooking, cleaning, hygiene, and taking care of children education. The role of technological progress is essential in that it allowed the transition from one mode of production to another and then contributes to remodel family organization.

Figure 4-1 : Male-Breadwinner Model



The roles remained strongly divided between genders, both in rural and urban areas; both in agriculture and in industry. Nonetheless, industrialization marked a change regarding the economic aspect of gendered organization, namely regarding the production of market and non-market goods and services. This sharp distinction between the role of wife and husband within the household arose in the early 20th century. The role of women in the workplace declined in comparison with previous periods. Women's reproductive duties occupy a significant share of their marital life. Thereby, the commonly accepted pattern was that of men specialized in paid market work and women in unpaid reproductive and maintenance work in the domestic sphere. It became then very difficult, or impossible, for women to achieve a high position in the labor market.

> "*As long as women bear a disproportionate burden in raising children, the labor market will reflect these differences.*" (Goldin, 1990)

The system of patriarchal organization of the society, dividing the work by gender and confining women inside the family in a situation of economic dependency and of subordination to men, dominated for "most" human history.[35] This pattern, based on the existence of a clear demarcation between family and labor market is the result of a division of labor between

[35] Anthropologists argue that most prehistoric hunter-gatherer societies were relatively egalitarian, and that patriarchal social structures would have developed with social and technological innovations such as agriculture and domestication.

genders which aims at combining the possibility of having a maximum number of children and income within the household.

Despite the implementation of the Civil Code, changes in gender relations took place slowly during the 19th century. The egalitarian ideal derived from the French Revolution also blew a wind of change in women's aspiration notably regarding the labor market and the access to education – as we will see in what follows. This century witnessed the increase in the "conjugal" couple and showed the first signs of the "individualization" of spouses, still not as an egalitarian couple (Segalen, 1988).

1.2. The Emergence of a New Socio-economic Role of Women

Deep changes in gender relations occurred over the past two hundred years, first timidly and then at an increasing rate. As observed in previous chapters, several of these changes emerged during the 19th century: women obtained an increasing access to education via schooling, juridical equality, sexual autonomy[36] and participation in paid labor. All these transformations are indicators suggesting the emergence of the process of women emancipation.

Ideology of Female Inferiority

A brief look at the evolution of gender ideology (since the French Revolution) can help us to understand how female status and gender relations evolved over the past two centuries. The question of gender relations and women's right emerged more clearly with the French Revolution. An air of liberty and claims for more gender equality stemmed from the Enlightenment began to be heard. Opinions were divided about the status of women and especially regarding their access to education. Important figures of the French Enlightenment such as Rousseau clearly mentioned the inferiority of women. The arguments were notably based on biological determinism which considers that men and women were naturally suitable for different social roles. Therefrom, women should devote themselves to reproduction and domestic activities.

According to Cabanis (Doctor and Philosopher), the physical weakness of women would be the result of her intellectual incapacity. In short, women would have been created to satisfy the well-being of men. Nonetheless, other authors, such as Condorcet or Laclos, spread new and revolutionary ideas requiring a proper education for women, which would release women from their dependence on men (*Des Femmes et de leur éducation*, Choderlos de Laclos, 1783). Helvétius argued that the differences in "natural" gender differences were the result of

[36] This was obtained through fertility limitation via nuptiality (celibacy, age at marriage) or via birth control (birth spacing).

differences in education. Though, he adds that education should be the same for both boys and girls – who have equal brains.

In November 1789, the Women's Petition was presented to the French National Assembly asking for women equality. The decree notably proposed the abolishment of male privilege throughout France; equal liberty, advantages, rights and honors between the sexes; or the end of clauses stating that "the wife is authorized by her husband" because there should be equality within the household; (see *Pétition des femmes du tiers-état au roi*). In 1791, Olympe de Gouges wrote the Declaration of the Rights of Women and the Female Citizen[37] in which she advocates for the emancipation of women through gender equality. The French Revolution opens the public space to women, gives them the idea that they are human beings in their own right and that they may have a place in the society outside the home. Despite the emergence of feminist movements during the French Revolution, Condorcet remains one of the rare politicians who advocated equal rights for both sexes. Most politicians (and philosophers from the Age of Enlightenment) followed Rousseau's theories and confined women to the roles of mother and spouse.

The Civil Code (Napoleonic Code), promulgated in 1804, gathers laws related to the set of rules on persons status and rights, on family rights, property law, law on obligations and statute of limitations. The Code establishing the supremacy of the man over the wife and children stopped net aspirations for more gender equality and reinforced patriarchal ideology. It ensured in particular that married women owed their husband obedience, and are forbidden from selling, giving, mortgaging or buying property.

Feminist claims rebirthed with the 1830's July Revolution (through the works of Saint-Simon and Fourier) and were directed to changing the civil status of women, especially aiming at the removal of the legal and financial subordination of the wife to her husband. Despites these claims no change was made to the Civil Code. This was with the 1848 French Revolution that some small steps are made towards higher opportunities, independence and responsibilities for women who obtain the same right as men to work. Nonetheless, as indicated by Battagliola (2000), male workers were still influenced by the thought of Proudhon – the so-called *1848 ideology* ((Devance, 1976) – proclaiming the natural inferiority of women and defended the specificity of roles during Workers Congress.[38] They advocated for a reinforcement of the doctrine of separated spheres: only men should occupy the public space while women should remain at home. Proudhon's thinking was indeed mostly shared at the time in France (Gautier, in *Peuple*, January 1849). Labor activists and male trade unions were to a major extent hostile to women's work in factories. Through the defense of the advantages attached to their work, male

[37] In French: *Déclaration des Droits de la Femme et de la Citoyenne*

[38] According to Proudhon, women are naturally inferior in terms of strength, therefore in terms of intelligence and therefore in terms of morality.

unions contributed to maintain boundaries between male and female identities (Frader, 1996). Therefore, despite feminist claims in favor of a radical change of the society toward civil equality several political groups raised an objection to the participation of women in the workplace.

One has to wait the end of the 19th century to observe real changes in gender relations. The end of the century marks a "temporary" break-point in attitudes toward women and in the male-female relationships established so far.

From the Sexual Division of Labor to the Dual-Earning Model

In France, women have had a lower legal status than men for a long time. But women's voice became increasingly heard over the course of the 19th century. The first massive women's movement called *Union des femmes pour la défense de Paris et les soins aux blessés*, was created during the 1871 Parisian Commune under the initiative of Elisabeth Dmitrieff and Nathalie Lemel. Among other things, the union asked for gender equality, divorcing right for women (which had been abolished by the Civil Code) as well as the right to secular and professional education for girls. Other great figures of the feminist movement emerged during the Commune such as Louise Michel or Eugène Varlin. Several other associations were created during the last decades of the 19th century: the *Association pour le droit des femmes* in 1870 (chaired by Victor Hugo), the *Droit des femmes* in 1876, the *Société pour l'amélioration du sort des femmes* in 1878, the *Ligue française pour le droit des femmes* in 1882 or the *Fédération française des sociétés féministes* in 1891.
Nonetheless, it was not until 1907 that married women could freely dispose of their wages. The legal incapacity of married women was abolished by the law of February 1938. Before that date, any legal act by a wife without the permission of her husband had no legal value. Thereby, although the law did not directly improve gender equality,[39] the data show the emergence of changes in gender relations toward greater equality from the mid-19th century. Labor and education are the pillars of women empowerment while political rights are at its base.

The 19th century witnessed changes in gender ideology, notably with the acknowledgement of the importance to educate girls. The Second French Empire experienced several progresses in regards with girls' education. Along with the implementation of several laws offering new educational opportunities to girls (Duruy in 1867 on primary schools, Sée in 1880 concerning secondary and higher education), we observe an increase in female educational attainment and

[39] It was in 1946 that the preamble of the Constitution states that the law guarantees women equal rights with men in all areas. In 1983, the Roudy Law lays down the general rules of professional equality between women and men by modifying the Labor and the Penal Code

the closing of the gender educational gap. Nonetheless, it is important to specify that the increase in girls' enrollment rate in primary schools started already before the establishment of the laws. Available data show that girls' schooling was already increasing so as the gender schooling gap since 1837 (date of the first census related to primary education and differentiating information by gender). Formal learning at primary level became "universal" for both genders at the turn to the 20th century. After that, improvements in gender equality in education spread to secondary education.

The rise in educational opportunities, the decline in infant mortality as well as the rise in life expectancy[40] also contributed to transform family behaviors (in terms of work, demographics or educational investments). In particular, this period witnessed an increase in women participation to the labor market, notably through the access of single women to paid jobs. At that time, the vast majority of working women were poorly educated. The access of married women, particularly those with young children, into the labor force only arose more intensively in the late 19th century, in parallel to the increase in technological progress in manufacturing. Although the employment pattern evolved toward greater equality, occupational structures remained gendered.

Such evolution in the economic role of married women reflects changes in gender roles as well as the family life cycle.[41] In parallel to the greater involvement of women to the labor is the decline in the gender wage gap. Nevertheless, gender inequalities persist. Despite a reduction in the time spent on domestic activities and better access to paid jobs, women's employment remained concentrated in sectors requiring few qualifications, in the continuity of domestic labor, and offering low wages.[42]

Another important indicator of changes in female status is the transformation of the marriage pattern. Considering changes in marriage pattern, gender relations, women's investment in human capital and participation in the labor force, it is difficult to evaluate a priori which influenced the other. Our data (Chapter 2 and 3) suggest that the decline in gender educational gap in primary education occurred prior to the decline in gender occupational gap. The data on female ability to sign (measure of literacy) show that the share of women able to sign rose at an increasingly pace even before entering in the 19th century.

Why do we simultaneously observe a decline in the gender educational gap and in the gender occupational gap over the course of the 19th century? How can we explain that individuals

[40] The former has declined and the latter risen at an increasing pace since the mid-19th century.
[41] Women increasing presence in the labor force results from a complex set of factors, among which changes in social norms or declining barriers to paid labor (Goldin, 1990).
[42] The average married women workers were less educated than the average population.

marry in larger proportions and at a younger age, while at the same time fertility declines on a continuous basis?

A Long-run Evolutionary Process

Women, especially single ones as documented above, entered the labor market mainly in textile industries. Nonetheless, more and more married women joined the paid workforce over time – as secondary earners within the household. The development of the industrial sector created a clearer division between the professional and the family sphere. With the entry of women in manufacturing activities gender inequalities in the form of employment segregation and wage gap appear more clearly. Still, the bargaining power of married women, now educated and earning their share of the household income, was improved. For example, the decision of having children is taken within the household. Nonetheless, they are still in charge of a larger number of domestic tasks as well as children's education. Thus, the rise in the time spent by women on the labor market has several effects. On the one hand, it increases the income of the household which provides the necessary resources to bear more children (income effect). On the other hand, the time spent by women on the labor market limits their availability for having and rearing children (substitution effect). As a consequence, it increases the cost of childbearing, and having an extra child would have a negative effect on the household's income. On the contrary, the possibility for households to have their children working would increase the income effect. These different effects go in opposite directions and the net impact on the opportunity cost of having children is ambiguous. Based on regional data, we observe that the marital fertility index was lower in the Northeastern part of France (Figure 1-15a), which is also the most industrialized area (Figure 1-15b), characterized by greater gender equality in schooling (Figure 3-24) and manufacturing employment (Figure 2-15). This tends to suggest that the substitution effect prevailed. This result was certainly reinforced by the progressive abolition of child labor and the implementation of compulsory education.[43] Thus, households would have been induced to modify their reproductive strategies by limiting births (either though births spacing or early stopping births).

Changes in fertility behavior reflect changing costs and benefit from having children. Links between education and fertility are important. With the access of girls to elementary education and the rise of married women into the labor force, the power imbalance between men and women is redistributed toward greater equality. The increasing cost of having children for

[43] Humphries (1991) argue in this sense. According to her, regional variation in illegitimacy allows the link with the sexual division of labor. If high illegitimacy can be taken as indicating the erosion of social control and if social control is weakened, the incidence of illegitimacy should be positively correlated with the weakness of the sexual division of labor. Humphries (1987) shows the existence of a significant negative relationship between illegitimacy and employment segregation by sex (using cross-sectional data).

women induced households to limit their number (quantity) – called the substitution effect as described above. In parallel, we observe a new strategy according to which parents heavily invest in their children; more investment in human capital). Together, they would have positively affected the increase in their children's human capital (quality) through formal education. Therefore, this process triggered a transition from quantity of children to quality of children, the so-called *child quantity-quality trade-off* (Becker, 1981).

The 19th century seems to be characterized by strong patriarchal norms. Nonetheless, it also reflects the emergence and the valuation of a more egalitarian couple, especially in proletarian settings where a second wage contributes to release parental earning constraints. We argue that education and market opportunities increased gender equality and induced changes in household structure and marriage pattern.

Early 20th Century and the Resurgence of Patriarchal Ideology

Despite the rise in household production technology which reduced women's time devoted to domestic duties in the second quarter of the 20th century, the access of American married women to paid jobs did not follow Goldin (2006).[44] On the contrary, we observe an increase in the share of housewives at the same time of the resurgence in the patriarchal ideology. As well as a reappraisal of the specialization of economic function by marital status. French data highlight a decline in the female labor force participation, more pronounced for married women, in relation with the development of manufacturing production processes and the emergence of new technologies allowing for higher labor productivity. We might have expected to see an increase in opportunities offered to the female labor force in association with such technological progress. Instead, we note a growing sexual division of labor with the development of the manufacturing sector.

The idea that motherhood and work outside the home are incompatible slowly started to rise before WWI and was diffused at an increasing pace afterwards. It then became one of the main principles of family policy (natalist policy of the 1920's). The data on female labor force participation show a sharp decline in the share of working women as well as the worsening of the gender occupational gap.

These trends seem to confirm a change in gender roles due to the rise of an ideology in favor of a separation between the family and the professional sphere (resurgence of marriage bars). Nonetheless, women's human capital continued to increase (as shown by an increase in female enrollment rates in secondary education) but the investments occurred mainly *off* the job.

[44] Phase II of the evolutionary change in the economic role of married women.

The 19th century experienced numerous socioeconomic, demographic and cultural transformations. As a guideline for all these changes is the evolution in gender relations toward greater equality. The weakening of the patriarchal family model in parallel with the changing socioeconomic role of women explains the transition from a male-breadwinner family organization to a dual-earning model. Major demographic changes have also been associated to this transition. The most striking one certainly is the second fertility transition, due to the increase in the opportunity cost of having children as explained above. The evolution of the marriage pattern mirrors a convergence in men and women's roles within the household, notably due to the integration of women into market activities. Nonetheless, despite the rise in female employment, married women remain the secondary earners in their households. Changes in marriages could thus be considered as one of the consequences of the emergence of the female emancipation movement.

One has to wait for the second half of the 20th century to note a positive impact of girl's educational investments on better employment opportunities for women. Together with women's autonomy as civil individuals, access to skilled jobs contributed to deep structural changes in gender relations. The following step towards full emancipation relates to the effectiveness of birth control.

1.3. The "Quiet Revolution"[45]

As explained by Goldin (2006), three elements are important to explain women's decisions: *(i)* the "horizon" – the perspective she has on the long-run; *(ii)* the "identity" – which affects social interactions; and *(iii)* the "decision-making" – whether decisions regarding the household are made jointly or not. With the development of the contraceptive pill (and changing attitude toward women), which impacts women's "horizon" by giving them control over their number of children, new job opportunities become available for them since they can implement new strategies notably in terms of educational investments. The increase in female educational investments raised the number of women in skilled occupations and contributed to reduce gender differences and discriminations about employment and wages.

Thanks to the pill and the legalization of abortion, women have the possibility to choose their number of children in accordance to their wishes. They can better prepare their future by investing in education and assuming higher positions in employment. Such deep change is observed from the middle of the sixties. Measures of female-to-male ratios in labor force

[45] Goldin (2006).

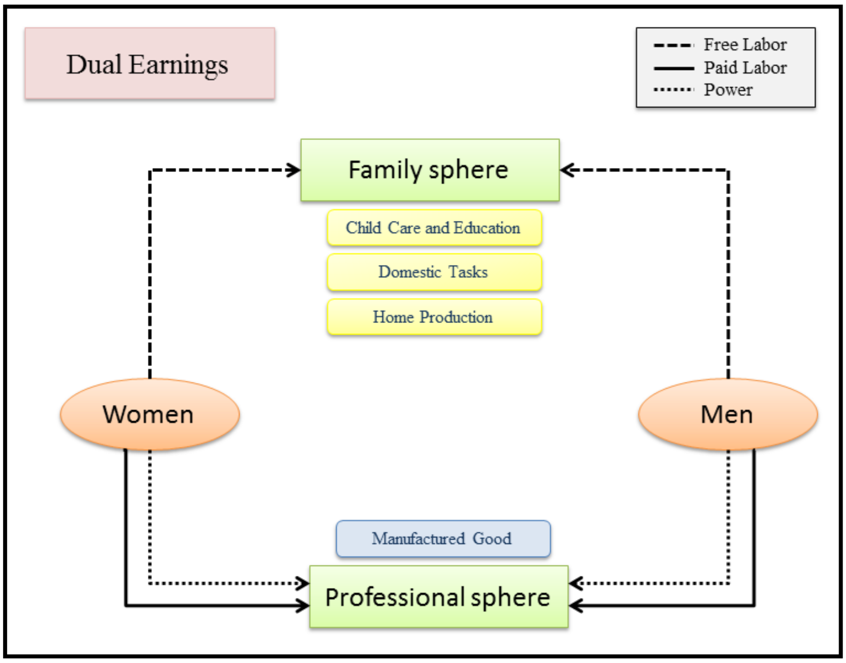
participation, earnings and educational investments in higher education, all suggest that there has been a "revolution" in the economic status of women. Violent protests in the United-States and Sweden and the quest for autonomy are at the origin of a profound societal change in Western countries. The various areas of society clamoring for change included women's rights. It challenged social norms and contributed to transform deeply the status of women in society. Part of the economic, social and cultural upheaval of the 20th century in Western countries is undoubtedly attributable to the control of procreation[46] and to the legalization of abortion.
The share of active women increased from 40% in 1968 and reached 64% in 1996, notably because of a massive entry of married women in the labor market. The gender employment gap declined substantially, so as did the gender wage gap. From 0.54 in 1968, the ratio of female-to-male workers reached 0.75 in 1990. Similarly, the ratio of female-to-male wages ranged from 0.64 in 1966 to 0.82 in 2006. Furthermore, we note similar changes in female enrollment rates in higher education. The share of female enrollment in higher education increased from 1.84 per one thousand women in 1960 to almost 14 in 1995.[47]

Reliable and easy to use, the Pill played a decisive role in the decision of millions of women to invest in long-run vocational training and to build careers without having to pay high social costs in case of unplanned pregnancies (Goldin and Katz, 2001). Indeed, in addition to financial costs of education and short run income loss, women who choose to invest in education have also to take into account social consequences of their decision. Time represents a real constraint especially for women. The time of schooling has to be managed simultaneously to that of professionalization and the project of having children (Langevin, 1984). This pattern implied that women had to elaborate strategies to reconcile professional and family roles (Commaille, 1992). If men's career is positively correlated with the fact of being married and having children, in contrast, women's career is negatively associated to it. Women have to face a trade-off: either they choose to privilege their professional career, delay childbearing and have more chances to get a stable job, either they privilege having children. The consequences of these choices are very important. In the former case, due to the decrease in fertility after thirty years old, women might lose the mere opportunity of having children. In the latter case, they most certainly will be forced to renounce to work on the labor market (Pailhé and Solaz, 2007) or keep a low-skilled, partial time. Hence, a set of demographic changes were observed. The average age at first marriage increased sharply. From age 22.5 at the end of the 1960's, it reached age 26 in the early 1980's and almost 29 years old in 2008. Furthermore, we note a drop in the crude birth rate at the turn of the 1970's. From 17 births per one thousand women in

[46] In 1956, the combined oral contraceptive pill, or birth-control pill, is developed by the doctor Gregory Pincus.
[47] However, although such a sharp rise is observed in female enrollment in higher education from the 1960's onward, it is important to specify that the gender gap in higher education began to increase earlier, from the beginning of the 20th century, so as the female-to-male holder of a high school diploma that reached 1 (perfect equality) in 1964.

1967, the crude birth rate fell to 12.7 births in 2005. This is what we called the third phase of the fertility transition.

Figure 4-2 : Dual-Earnings Model



The time constraint is a real obstacle to women's career advancements, even as of today. Invisible and artificial barriers created by behavioral and organizational prejudices prevent women from reaching the highest responsibilities in the professional sphere (BIT, 1997). Still, the above-described process of women empowerment marks the rise toward a new family organization with a modern economic role of skilled married women. Between 1975 and 2005, the female labor force increases for all age groups, except for the 12-24 because of the increase in schooling. With more accurate expectations, girls can better prepare their educational investments. At the same time (since the end of the sixties), the female average wage improves strongly, and at an increasingly rate from the eighties thanks to a better training of girls and due to the generalization of stable jobs.

In developed countries, the increase in female investments in education changes deeply the nature of available work for women. The dominant model becomes the expression of a convergence of male and female behaviors regarding their activity (Maruani, 1996). Henceforth, women do not stop anymore their professional activity on the occasion of the birth of their children. There is no more choice, neither alternation, but a plurality between family and professional spheres: this is the blossoming of the *dual-earning model* (also referred to as the gender equity model – Gibling, 1997). Each member of the household pursues a professional career, inducing a higher standard of living but fewer children.[48]

2. Regional Dynamics of the Gender Gap

Since 1997, the United Nations has promoted gender mainstreaming[49] as a globally accepted strategy for promoting gender equality. At the Millennium Summit in 2000, promoting gender equality and women's empowerment was adopted as one of eight Millennium Development Goals and as an essential component in achieving all of the other goals. Hence, in 2005 the World Economic Forum launched its first study attempting to assess the size of the gender gap by measuring the extent to which women in 58 countries have achieved equality with men. The Global Gender Gap Report 2006, the second in the series, contains a unique new methodology to create the Gender Gap Index 2006. This following subsection aims at providing a measure of the French Gender Gap at the county-level in 1851 inspired by this methodology.

2.1. The Gender Gap Index

In order to measure gender equality, we create a gender gap index for 1851 France. The French gender gap index 1851 aims at capturing the size of the gap between men and women in two critical areas: participation and opportunities and educational attainment (economic and educational criteria respectively). We chose to exclude health and political criteria. Political empowerment is not taken into account for the simple reason that there was no political power for women in mid-19th century France. Therefore, this criterion will not allow for any heterogeneity across counties (and does not require to be integrated). Health, usually measured by the sex ratio and female-to-male life expectancy, is not because even in highly gendered-unequal areas, both sex ratio and female-to-male life expectancy turn in favor of women. The index covers 86 counties. The geographical distribution and county comparisons allow identifying strengths and weaknesses of French districts in terms of gender equality. In addition, it can be a useful guide for comparison with other county-specific indicators (culture, customs) while drawing the profile of each district.

[48] Men and women always achieve unevenly domestic duties – at around 30% to 50% for men and 50% to 70% for women.

[49] Gender mainstreaming is the public policy concept of assessing the different implications for women and men of any planned policy action in all areas and levels. According to Booth and Bennett (2002), mainstreaming essentially offers a pluralistic approach that values the diversity among both women and men

2.1.1. Methodology of the Gender Gap Index

We refer here to gender equality as equal opportunities between men and women. The construction of the index aims at providing an overview about the extent to which opportunities and resources are distributed in French district among genders. In addition, based on the heterogeneity of French counties, it might help at understanding the role played by gender equality on the development process.

The Construction of the Index

The index consists in measuring gaps between men and women, with the condition that the indicators are independent from the level of development of the county. Richer counties might have, for instance, more education for all their population. Therefore, reasoning solely in terms of gaps and not in terms of levels enables us to focus strictly on gender differences, all other things being equal. The index is built out of variables related to educational attainment and economic opportunities. Table 4-1 shows all subindexes and indicators of the 1851 index. We describe below the variables used to construct the index.

Table 4-1 : Structure of the Gender Gap Index

Subindex	Variables	Sources
Economic opportunity	Ratio: female labor force in agriculture over male value	*Statistique Générale de la France*, Recensement 1851
	Ratio: female labor force in industry over male value	*Statistique Générale de la France*, Recensement 1851
	Ratio: female wage over male value for similar work	*Statistique Générale de la France*, Statistique industriel, 1861-65
Educational attainment	Ratio: female literacy rate over male value	*Statistique Générale de la France*, Enseignement primaire, 1829-1877
	Ratio: female enrollment rate in primary school over male value	*Statistique Générale de la France*, Enseignement primaire, 1829-1877
	Ratio: female enrollment rate in secondary school over male value	*Statistique Générale de la France*, Enseignement Primaire, 1829-1877

Economic opportunity. – Three variables are used to capture the gap in terms of economic opportunity: the labor force participation gap in agriculture, the labor force participation gap in industry and the wage gap (ratio of female-to-male wage in the textile industry).[50]

Educational attainment. – Three variables are also used to capture the gap in terms of educational attainment. The access to education is measured by the female-to-male enrollment rate in primary school and the female-to-male enrollment rate in secondary school. A longer-term view is used to measured counties' ability to educate males and females using the ratio of female-to-male literacy rate.

Table 4-2 : Description of Subindexes and Calculation of Weights

Economic Opportunity	Standard Deviation	Standard Deviation per 1%	Weights
Female labor force in agriculture over male value	0,1163	0,0860	0,3194
Female labor force in industry over male value	0,3386	0,0295	0,1085
Female wage over male value for similar work	0,0639	0,1566	0,5755
Educational Attainment	Standard Deviation	Standard Deviation per 1%	Weights
Female literacy rate over male value	0,1870	0,0534	0,4832
Female enrollment in primary school over male value	0,2637	0,0379	0,3428
Female enrollment in secondary school over male value	0,5194	0,0192	0,1740

Sources: Using data from Statistiques Générales de la France

Our index is constructed using a three-step process replicating the one used in the computation of the Gender Gap Index 2006, by the World Economic Forum.

Step 1: Convert to ratios. – We first convert all our data into female-to-male ratios.

Step 2: Calculate subindex scores. – As a second step, we calculate the weighted average of the variables within each subindex in order to create the subindex scores. Through this computation, we aim at giving more weight to the variable that exhibits the largest volatility (largest standard deviation). The first step is to normalize our variables by equalizing their standard deviations to determine the percentage change in terms of standard deviation to a 1% change of each variable. We then use these weights to calculate the weighted average of our variables (see Table 4-2). We therefore integrate the same relative impact on the subindex for

[50] The female-to-male wage gap does not integrate agricultural wages as we did not have access to the data at the moment of the construction of the index. A future work will aim at integrating these data. In the light of the distribution of the female-to-male wage in agriculture, the distribution of the gender gap index should remain relatively similar.

each variable so that a variable for which most counties have already reached equality would be penalized.

Step 3: Calculate final scores. – The last step in the process involves calculating final scores. All subindexes are bound between 0 and 1, 0 corresponding to perfect inequality perfect inequality and 1 to perfect equality. In order to create the overall Gender Gap Index, we bring together our two subindexes by simply taking their (un-weighted) average for each county. The final score is therefore also bound between 0 and 1, which allows for comparisons between counties.

2.1.2. Geographical distribution of the Gender Gap Index

The gender gap is evident for all counties, but clearly more pronounced in some specific parts of France. Northeastern counties occupy the highest ranks of the index, with Seine-Inférieure standing out as the most advanced over France, having closed over 80% of its gender gap. It is closely followed by Haut-Rhin, Mayenne, Eure, Bas-Rhin, Vosges, Meuse and Marne. The following Table presents the overall ranking of the Gender Gap Index among French counties in 1851 – as well as the ranking by subindexes. General trends of the Gender Gap show that the gap between women and men is relatively higher in terms of educational opportunities (0.667) than in terms of economic attainment (0.589). Nonetheless, we note that large disparities exist between counties. The difference in educational attainment subindexes between extreme counties (Mayenne and Corse) is of order 3.70. In terms of economic opportunities, the difference is "only" of order 1.85 (Drôme and Bouches-du-Rhône)

Regional Trends

Figure 4-1 presents the geographical distribution of Gender Gap Indexes in 1851 and the standard deviation measuring the dispersion between counties. The map reveals two areas, separated by an imaginary line going from Ille-et-Vilaine to Jura. In the North of that line, counties perform well. Seine-Inférieure reaches the top position, followed by Haut-Rhin, Mayenne, Eure and Bas-Rhin (all of them above 0.8). All these districts are part of the top ten when looking at economic and educational subindexes. In the South of the line, counties hold the lowest positions in the ranking. Counties such as Lot, Pyrénées-Orientales, Aude, Ariège and Corse reflect large gender disparities. At the exception of Lot which reaches a mean position in terms of the economic opportunity subindex, they are all part of the lowest subindex rankings. Only the counties close to the Eastern border distinguish themselves with regard to their performance.

County	Overall Ranking	Overall Score	Economic Ranking	Educational Ranking
Seine-Inférieure	1	0,8337	2	4
Haut-Rhin	2	0,8240	5	2
Mayenne	3	0,8196	8	1
Eure	4	0,8100	6	9
Bas-Rhin	5	0,8099	7	6
Vosges	6	0,7896	24	7
Meuse	7	0,7841	34	3
Marne	8	0,7806	10	16
Doubs	9	0,7770	9	18
Aube	10	0,7669	27	14
Sarthe	11	0,7619	17	21
Maine-et-Loire	12	0,7482	44	13
Moselle	13	0,7464	46	11
Orne	14	0,7458	11	27
Oise	15	0,7453	36	20
Seine-et-Marne	16	0,7363	56	12
Ardennes	17	0,7360	53	15
Somme	18	0,7356	33	25
Jura	19	0,7353	21	28
Aisne	20	0,7314	43	22
Seine-et-Oise	21	0,7285	72	10
Manche	22	0,7275	64	17
Côte-d’Or	23	0,7229	60	19
Rhône	24	0,7225	3	38
Pas-de-Calais	25	0,7213	14	34
Calvados	26	0,7177	51	23
Haute-Saône	27	0,7139	32	31
Haute-Marne	28	0,7115	83	5
Meurthe	29	0,7089	82	8
Seine	30	0,7071	65	24
Ille-et-Vilaine	31	0,7031	35	33
Drôme	32	0,6989	1	43
Yonne	33	0,6985	68	26
Nord	34	0,6983	38	32
Eure-et-Loir	35	0,6948	52	29
Loire	36	0,6845	66	30
Hautes-Alpes	37	0,6609	12	41
Isère	38	0,6538	29	40
Saône-et-Loire	39	0,6521	31	39
Loir-et-Cher	40	0,6508	61	36
Allier	41	0,6472	63	37
Loire	42	0,6354	76	35
Ain	43	0,6331	18	47

County	Overall Ranking	Overall Score	Economic Ranking	Educational Ranking
Indre-et-Loire	44	0,6145	47	44
Basses-Alpes	45	0,6056	40	48
Indre	46	0,6025	57	45
Morbihan	47	0,6001	58	46
Tarn	48	0,5935	75	42
Hérault	49	0,5915	13	59
Loire-Inférieure	50	0,5865	22	60
Vienne	51	0,5786	45	53
Nièvre	52	0,5779	71	50
Tarn-et-Garonne	53	0,5749	19	62
Gard	54	0,5731	49	54
Côtes-du-Nord	55	0,5730	74	49
Vendée	56	0,5718	41	57
Lozère	57	0,5714	39	58
Vaucluse	58	0,5697	16	66
Corrèze	59	0,5683	25	64
Cantal	60	0,5664	55	55
Gironde	61	0,5612	62	56
Ardèche	62	0,5561	20	69
Lot-et-Garonne	63	0,5490	42	63
Charente	64	0,5453	28	70
Finistère	65	0,5414	30	71
Cher	66	0,5364	84	51
Landes	67	0,5361	15	73
Charente-Inférieure	68	0,5353	59	61
Creuse	69	0,5345	4	78
Haute-Vienne	70	0,5249	48	68
Var	71	0,5153	69	67
Haute-Garonne	72	0,5054	78	65
Puy-de-Dôme	73	0,4950	54	74
Hautes-Pyrénées	74	0,4948	26	79
Bouches-du-Rhône	75	0,4917	86	52
Deux-Sèvres	76	0,4845	77	72
Gers	77	0,4845	23	83
Dordogne	78	0,4818	50	76
Aveyron	79	0,4792	67	75
Basses-Pyrénées	80	0,4446	79	77
Haute-Loire	81	0,4437	70	81
Lot	82	0,4392	37	85
Pyrénées-Orientales	83	0,4205	73	84
Aude	84	0,4204	80	80
Ariège	85	0,3994	85	82
Corse*	86	0,3753	81	86

* This county has one missing data out of the 6 variables in the Gender Gap Index 1851.

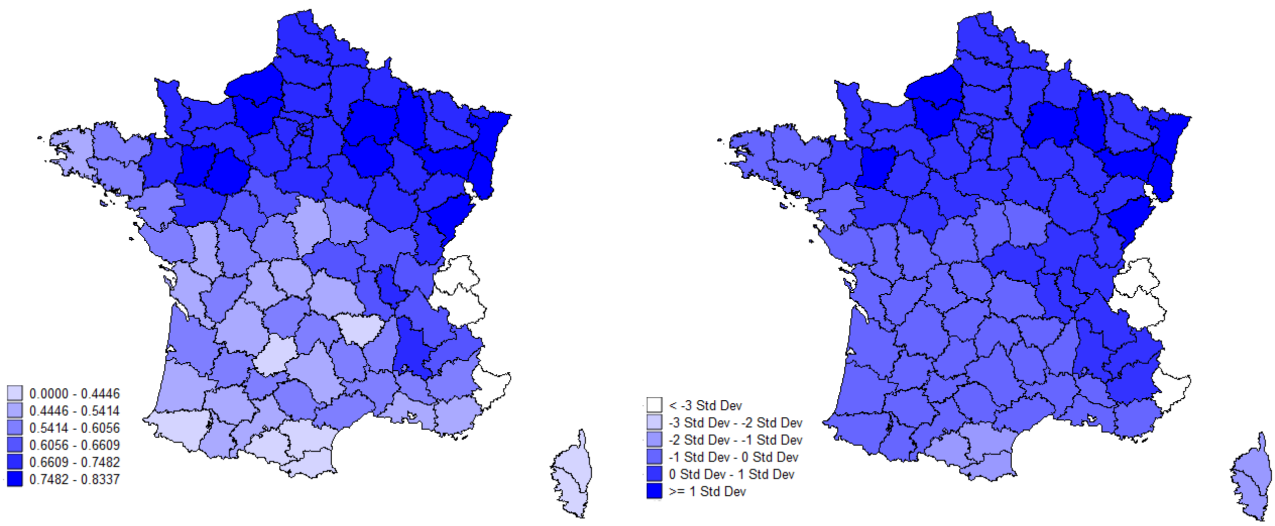
The map of standard deviations, measuring the dispersion of the variables from the average, reveals three main regional trends.[51]

Region 1. – This region (standard deviation between 1 and -1) is composed of Northern France, to the exception of Bretagne, and of counties close to the East border. A diagonal line, from Ille-et-Vilaine to Alpes-Maritimes, could be drawn to separate *Region 1* from *Region 2*. Only Nièvre, Cher and a part of Indre would then be on the wrong side of this diagonal. Counties of *Region 1* have very high ratio, especially in terms of labor force participation in agriculture and in industry (to a lesser extent for the latter). The wage gap however remains pretty large and rarely exceed 0.5. Outcomes that make real difference are both the ratio of literacy rates and the ratio of enrollment rates in primary schools, which of both are often very close from 1.

Figure 4-3 : Geographical Distribution of the Gender Gap Index in 1851

(a) Gender Gap Index

(b) Standard Deviation



Sources: Using data from Statistiques Générales de la France

Region 2. – The second region (standard deviation between -2 and -1), composed of Southwest counties have for most of them a high score in terms of female-to-male labor force participation in agriculture (at the exception of a few counties such as Gard, Bouches-du-Rhône and Tarn who struggle to reach a score between 0.5 and 0.6). Regarding the ratio of enrollment rates in primary school, the score is severely low in some counties. Ardèche, Aveyron, Creuse, Dordogne, Gers or Lot, for instance, do not even reach the score of 0.3. Consequently, the gap in literacy rates remains large for most counties of *Region 2* comparatively to those in *Region 1*.

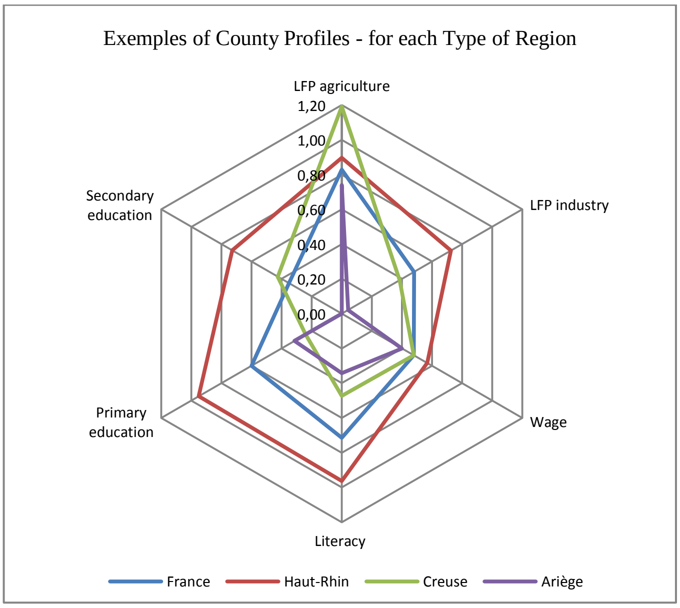
[51] The standard deviation mode for breaking data into classes in the software Qgis illustrates how values deviate from the average: low (high) deviation indicates that values are close to (far away from) the average.

Region 3. – The last region is composed of four counties with a standard deviation between -3 and -2. We find in this group of counties: Aude, Ariège, Pyrénées-Orientales and Corse at the last place. These counties are all characterized by large gaps in enrollment rates both in primary and secondary education and therefore by a large inequality in terms of literacy between males and females. Wage gap and labor force participation gap are also in average larger than in the rest of France.

County-Profile

Figure 4-4 gives us the profile of three counties, each of them belonging to one of the regions, through the plot of a radar chart. Corners of the chart allow comparing the score of counties for each ratio used to construct the index. The lowest possible score (at the center of the chart) is 0 and displays perfect gender inequality, while 1 (outer side of the chart) means perfect gender equality. Haut-Rhin represents *Region 1*, Creuse *Region 2* and Ariège *Region 3*. The blue line corresponds to the aggregate French profile computed as the average score across all 86 counties.

Figure 4-4 : Radar Chart of Three Opposite County-Profile

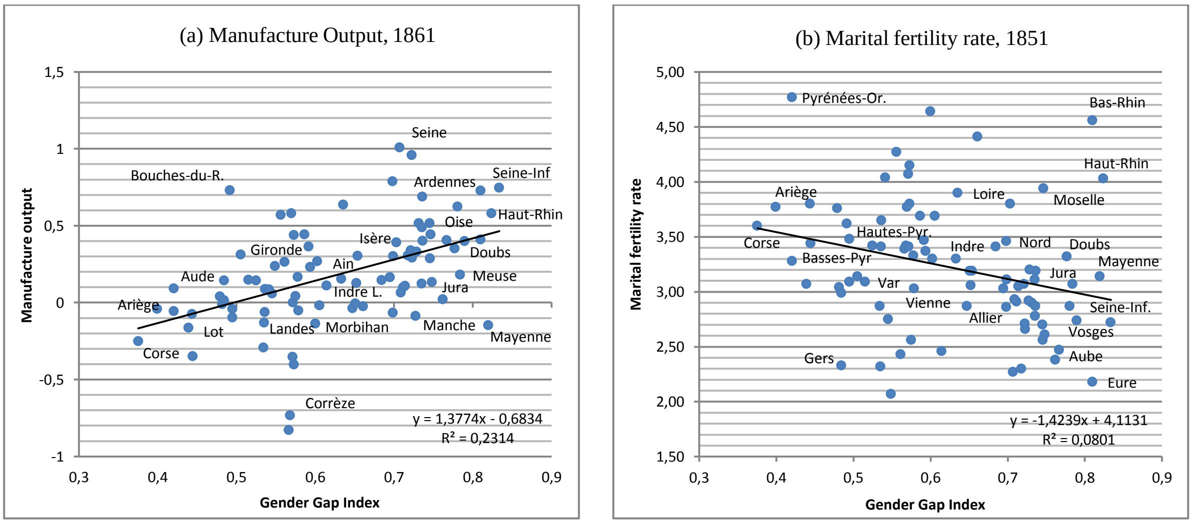


The radar chart graphically shows areas of relative strength or weakness for the three types of region. Haut-Rhin (*Region 1*) scores better than the average of French counties on all dimensions. As expected, it also scores better than Creuse (*Region 2*) and Ariège (*Region 3*) on most dimensions. There is a wide performance gap between Haut-Rhin and Ariège on almost all indicators. Only female-to-male labor force in agriculture exhibits slightly closer gaps for all types of counties, but still leading by Creuse – above one on this indicator. Haut-Rhin is really close to the perfect equality both in literacy and primary education. However, we note that the gender gap remains fairly large in the manufacturing sector, both in terms if labor force and wages.

2.1.3. Links with Economic Performance and Demographic Profile

Figure 4-3 relates the Gender Gap Index with economics, measured by the output in the manufacture sector in 1861, and demographics, measured by marital fertility rate in 1851. Both graphs show the correlation of these variables with gender equality. In the case of output, the correlation is positive (Figure 4-5a). Counties with a higher gender gap index also depict a higher manufacture output. In the case of demographics, the correlation is negative, such that counties with a higher gender gap index tend to exhibit lower fertility rates. We observe a few outliers not in line with such negative relation between fertility rates and the gender gap index. For example, counties closer from the Northeastern border such as Haut-Rhin, Bas-Rhin or Moselle exhibit both large fertility rates and large gender equality.

Figure 4-5 : Scatter Plot of the Links between GGI and Economic-Demographic Profiles



Sources: Using data from Statistiques Générales de la France

Still, correlation does not mean causality. We will address causality through the use of theoretical modeling and empirical analysis in the second part of our work.

Our aim with the construction of the Gender Gap Index is to provide a comprehensive dataset – easily comparable with other variables (economic, demographic or cultural) notably through the use of mapping. The index reveals which counties have first divided more equitably their resources between genders and given higher opportunities to women. Counties of the Northeastern diagonal part of France are the best performers, with Seine-Inférieure being at the top position followed by Haut-Rhin and Mayenne. The index scores plotted against economic performance highlight a correlation. This result suggests that women's emancipation is positively associated to the development process of a region. The channel linking a reduction of the gender gap to economic development can be the improvements in terms of education and training, leading to higher productivity of the female labor force.

2.2. Gender Gap and Socioeconomic Status. The Positioning of French Counties

This subsection aims at providing a global synthesis of gender-related issues as described all along the thesis with the help of detailed county-level information based on mid-19th century data. To this purpose, a factor analysis is conducted in order to summarize the information contained in our first three chapters as well as integrate the spatial characteristics of the relationships between socio-economic, demographic and educational indicators.

2.2.1. Methodology

The purpose of this analysis is to determine the main characteristics of French counties by proceeding to groupings on the basis of 74 variables (9 nominal variables and 65 numeric variables) without ex-ante bias in terms of groupings. The Principal Component Analysis (PCA) will represent the position of the French departments along two dimensions (the factors) using the 74 dimensions, reducing to only two axes (or dimension). PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. In other words, it allows us to extract from a set of variables those few orthogonal linear combinations of the variables that capture the common information most successfully.[52] The purpose of this method is not to explain correlations but to synthetize the information contained in our variables.[53]

The French counties will then be grouped into different classes or categories according to their positioning using a hierarchical cluster analysis. These groupings will be done by maximizing the intra-class homogeneity and inter-class heterogeneity. In other words, departments of the same class have very similar characteristics that allow grouping them together. These characteristics are sufficiently divisive to determine other classes characterized by average values over this set of very different variables.

[52] Intuitively the first principal component of a set of variables is the linear index of all the variables that captures the largest amount of information that is common to all of the variables (Filmer and Pritchett, 2001).
[53] For more descriptions of principal components, see Lindeman, Merenda, and Gold (1980).

Important characteristics need to be kept in mind while interpreting and using the results of the PCA and hierarchical cluster analyses. Careful attention should be paid to the interpretation of the axes. The representation in two dimensions actually conceals *n*-dimensions (74 in our case). All groups and analyses are compared to the average. A central position, at the intersection of the two axes, means that the county has an average behavior in relation to other counties on these two axes. A hierarchical cluster analysis proceeds to groupings independently of the use that will be made from the results.

2.2.2. Variables and sources

The vast majority of the variables have been built using data from the *Statistique Générale de la France*. These variables are available for 86 counties. Three additional counties are part of our sample (Alpes-Maritimes, Savoie and Haute-Savoie) however all data are not available for them. These 89 departments constitute our "individuals" in the PCA.[54] Since the 19th century, some of the French departments have evolved over time (some changed their name, other merged or split), and if a similar analysis were to be conducted on a more recent period, it would require to take these changes into account.

The 74 variables used in our analysis consist mainly of socio-economic indicators:

- Demographics (fertility, life expectancy, age at marriage…);
- Educational (number of schools, literacy rate...);
- Economic development (urbanization, industrialization, employment, production, wages, means of communications);
- Cultural (religion, family structure, gender gap index...);
- Geographic (North-South, East-West Centre ...).

The identifiers, names and descriptions of our variables are given in Table 4-3. Most data (otherwise stated) concern the year 1851. We use here a larger number of economic indicators. They include characteristics on numerous aspects: sectors (agriculture, industry), urbanization, industrialization, wealth but also employment, wages, specialization (by gender) that also reflect the social position of individuals.

[54] Because of missing data for Alpes-Maritimes (belonging to the Kingdom of Piedmont-Sardinia from 1814 to 1860), Savoie and Haute Savoie, the positioning of these three counties have to be interpreted with caution.

Table 4-3 : Description of the Variables

Identifier	Name of the Variable	Description of the Variable
Demographics		
CW_RATIO	Child women ratio	Number of children aged 0-5 per women of childbearing age (15-45)
MF_RATE	Marital fertility rate	Number of new born per married women in age of childbearing (15-45)
CB_RATE	Crude birth rate	Number of birth over total population
IMF_IG	Index of marital fertility	From Princeton European fertility project
MW_SHARE	Share married women	Number of married women per women in age of being married
AGE_H_55	Male median age at marriage	Men average age at marriage in 1855
AGE_F_55	Female median age at marriage	Women average age at marriage in 1855
Age at marriage <25	Female who married below 25	Number of women who married young (< 30 years old) over total number of married women in age 15-30
Age at marriage <30	Female who married below 30	Number of women who married young (< 25 years old) over total number of married women in age 15-24
ill_urb_birth	Illegitimate urban birth	Number of illegitimate births over total number of births in urban areas
ill_rur_birth	Illegitimate rural birth	Number of illegitimate births over total number of births in rural areas
Def_celib	Rate of definitive celibacy	Share of women who are still single after age 50
young_celib	Rate of young celibacy	Share of women aged 35 and less who are single
LEXP_0	Life expectancy at birth	Life expectancy at age 0
INF_MORT	Infant mortality	Mortality at age 0
CHILD_MORT	Child mortality	Mortality at age 5
Education		
SCHOOL_H	Schools for boys	Number of public primary schools for boys per number of boys aged 6-14
SCHOOL_F	Schools for girls	Number of public primary schools for girls per number of girls aged 6-14
no_school_50	Towns with no schools	Towns with no schools of all types
no_school_F_63	Towns with no schools for girls	Towns with no schools dedicated to girls in 1863
PP_ENROL_H	Boys enrollment rate in primary schools	Number of boys enrolled in public primary schools divided per number of boys aged 6-14
PP_ENROL_F	Girls enrollment rate in primary schools	Number of girls enrolled in public primary schools divided per number of girls aged 6-14
LIT_F_6165	Female literacy rate 1861-66	Number of women able to read and to write
LIT_H_6165	Male literacy rate 1861-66	Number of men able to read and to write
859 ILETRE	Share of illiterate	Number of individuals who were not able to sign their marriage contract in 1859
Economic		
VILLE_2000	Towns	towns populated with more than 2000 inhabitants
DEN	Density	Number of people per km²
URB_RESID	Urban resident	Number of people living in towns of more than 2000 inhabitant per total population
RUR_RESID	Rural resident	Number of people living in towns of less than 2000 inhabitant per total population

URB	Urbanisation	Number of towns of more than 2000 inhabitant per km²
RUR	Ruralisation	Number of towns of less than 2000 inhabitant per km²
urb_pop_H	Share of male urban population	Number of men living in urban areas over total male population
urb_pop_F	Share of female urban population	Number of women living in urban areas over total male population
rur_pop_H	Share of male rural population	Number of men living in rural areas over total male population
rur_pop_F	Share of female rural population	Number of women living in rural areas over total male population
pop_agglo	Agglomerated population	From Statistique Générale (towns populated of min 2000 inhabitants)
TEM_H_MIGR	Temporary male migration	Number of migration of people in working age
railroad_54	Railroads	Lengths of railroads in km in 1854
routes_1854	Roads	Length of secondary roads/surface in 1854 per 1000km
voie_com_54		Length communication by land and water (in km) 1854
FARMLAB_F	Female labor force in agriculture	Number of women employed in agriculture over total number of women aged 15-60
INDUSLAB_F	Female labor force in industry	Number of women employed in industry over total number of women aged 15-60
FARMLAB_H	Male labor force in agriculture	Number of men employed in agriculture over total number of women aged 15-60
INDUSLAB_H	Male labor force in industry	Number of men employed in industry over total number of women aged 15-60
agriculteurs	Agricultural workers	Number of individuals working in agriculture per 10000
indus_gr	Big industry workers	Number of individuals working in big industries per 10000
indus_peti	Small industry workers	Number of individuals working in small industries per 10000
pof_lib	Professional workers	Number of individuals working in liberal professions per 10000
domestique	Domestic workers	Number of individuals working in domestic activities per 10000
prof_diver	Various workers	Number of individuals working in diverse labor per 10000
workers_H	Share male workers	Number of male workers over total male population
workers_F	Share female workers	Number of female workers over total female population
workers_C	Ratio female to male workers	Number of female workers over number of male workers
wage_H	Average male wage 1861	Average of male worker wages in different industries proportionally to the weight of male in each industry for each department
wage_F	Average female wage 1861	Average of female worker wages in different industries proportionally to the weight of female in each industry for each department
wage_C	Average children wage 1861	Average of children worker wages in different industries proportionally to the weight of children in each industry for each department
PROTO_61	Level of proto industrialization	Number of steam engine per capita (in thousands) in 1861
MANOUTP_61	Manufacture output	Manufacture output per capita in 1861
nbr_indus	Industry per 1000 inhabitants	Manufacture of all types per 1000 inhabitants in 1861
wealth_ind	Wealth per industry	Output per number of industry in 1861
LAND_35	Available arable land	Acreage of arable land per km² in 1835
INEG_AGRI2	Landownership inequality	Share of landowners
Dernier exode rural	Last rural exodus	Date of the census from which the labor force in agriculture goes below 50% of the total labor force (from Lebras et

		Todd)
wageHagr	Male wage in agriculture	Daily Male wages in agriculture in 1852
wageFagr	Female wage in agriculture	Daily Female wages in agriculture in 1852
spé_indH	Male specialization in industry	Male industrial specialization (branch of activity in which men are more numerous)
spe_indusF	Female specialization in industry	Female industrial specialization (branch of activity in which women are more numerous)
topindwagH	Industry with top male wage	Branch of activity in which men wages are higher
topindwagF	Industry with top female wage	Branch of activity in which women wages are higher
Socio-Cultural		
catholic	Catholics	Number of Catholics per total 100 people
protestants	Protestants	Number of Protestants per total 100 people
WITT_DIST	Distance to Wittenberg	Distance from Wittenberg to the Capital of the department
DIST_GEN_V	Distance to Geneva	Distance from Geneva to the Capital of the department
Dialect	French dialects	County speaking in majority Oil, Oc, Franco-provençal, etc. languages
Structure familiale	Family structure	Diverse types of family structure – depending on the type of family organization; more or less solidary
GGI	Gender gap index	Built up using data about gaps on enrollment rates in primary education, secondary education, wage, labor force in agriculture, in industry
Geographic		
LAT	Latitude	
LONG	Longitude	
N/S	Nord or South	
E/O/C	East or West	

2.2.3. Factor Analysis

We have 89 departments (our individuals) and 74 variables. A Principal Component Analysis has been conducted in order to explore the structure of our data, using the software Spad 7.0. The method allows us to synthetize the information by reducing our important number of variables to a small number of factorial axes. The three first axes represent 50% of the data variance.

Positioning of the variables on the factorial axes

On axis 1. – The first axis is marked:

- In negative by the following variables:
  The number of farmers per one thousand inhabitants, female and male labor force in agriculture, illiteracy rates, distance to Wittenberg, marital fertility rate, inequality in agriculture (land), the number of towns with no schools;

- In positive by the following variables: manufacture output, number of small industries per one thousand inhabitants, female literacy rates (1861-65), male wage in industry, proto-industrialization, male and female workers, gender gap index, railroad, male literacy rates (1861-65), share of urban individuals, enrollment in public primary schools;

Axis 1 tends to reflect a fairly well marked opposition in terms of **productive structure**. Therefore, we have a contrast between departments very rural, led by a strong agricultural production, versus departments more mechanized and oriented toward industrial production. Axis 1 also shows a clear distinction between poorly educated individuals (with little access to education and relatively high fertility rates), rarely owner of their land versus a more urban population, more educated especially a more educated female population. This first axis has a relatively good “explicativity” rate – about 24%.

On axis 2. – The second axis is marked:

- In negative by the following variables:
  The share of urban resident, agglomerate population, density, level of urbanization, crude birth rate, the number of industry per one thousand inhabitant, children mortality, infant mortality, workers, the share of individuals working in domestic activities;
- In positive by the following variables:
  The share of rural resident, the number of schools for boys, boys’ enrollment rate in public primary school, girls’ enrollment rate in public primary school, life expectancy at age 0, rural areas, the number of towns with no school for girls, literacy rates 1861-65;

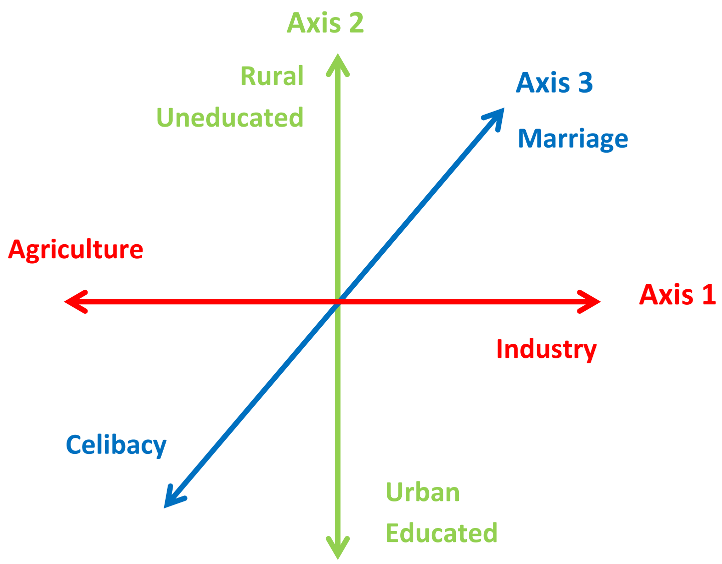
Axis 2 tends to reflect the demographic structure of the population. On the one hand, we find counties largely marked by urban population, with high population density, high employment rates and relatively low children and infant mortality rate – lower than the average of other departments. On the other side (positive part of axis 2), we find departments with a population more rural, poorly educated (men and women together). This second axis has an “explicativity” rate at around 14%.

On axis 3. – This third axis is marked:

- In negative by the following variables:
  Female and male average age at marriage, index of marital fertility, boys’ enrollment rate in public primary schools, the share of definitive celibacy;

- In positive by the following variables:
  The share of women who married young below age 25 and 30, the share of married women, illiteracy rate, life expectancy at age 0, temporary male migration;

Axis 3 tends to reflect the marital structure of the population and reflect the method of birth restriction employed by the population. On one side, we find departments largely marked by a population exhibiting age at marriage larger than the average. On the other side are departments where the share of individuals married below 25 and 30 are lower than the average (higher rate of definitive celibacy, lower index of marital fertility). This third axis has an “explicativity” rate at around 11%.



The three main dimensions have been determined using Cattell criteria. For methodological reasons and for the sake of better presentation, we will only retain the first two axes in the rest of our analysis. Among the variables at our disposal, nine have not been used to determine our two main axes, but were simply projected on them. They are used as “illustrative” variables.[55] Thereby, they are projected on the first two axes (see Appendix).

[55] The nominal variables are the cardinal directions: North-South and East-West; the dialects: Oïl, Oc, Franco-provençal and others; the family structure; the last rural exodus, the industrial specialization for men and women, the top industrial wage for men and women.

2.2.4. The Positioning of French Counties in mid-19th Century

Hierarchical Cluster Analysis – The 6 classes

The PCA is followed by a Hierarchical Cluster Analysis (HCA) allowing us to group counties with similar socio-economic characteristics. HCA is a method of clustering analysis that seeks to build a hierarchy of clusters based on a number of descriptors satisfying intra-classes homogeneity criteria and inter-classes heterogeneity criteria. From a set of *n* individuals, the clustering method aims to spread these individuals in a number of classes. The hierarchical clustering is called upward as it starts from a situation where all individuals are alone in a class and are then gathered in classes increasingly large. This work is done by successive iteration in which inter-class inertia decreases with each aggregation.

The Ward method (1963) is applied to Euclidian distances of our individuals (districts) represented by their coordinates on the three first factorial axes. The more homogeneous the class is, the lower is the inertia.[56] Ward's method is an algorithm that allows combining two classes of a partition for a more aggregate score. It consists in aggregating the scores (in each iteration) so as to obtain a minimum gain of intra-class inertia and a minimum loss of inter-class inertia. The algorithm used in our analysis is that of the Spad 7.0 software.[57]

Table 4-4 : Ascendant Hierarchical Clustering

	Inertia Decomposition		
	Inertia	**Counties**	**Distances**
Inter-classes	28,28860		
Intra-class			
Class 1 / 6	7,16713	**21**	20,98910
Class 2 / 6	5,97168	**33**	6,40904
Class 3 / 6	2,91875	**8**	32,38540
Classe 4 / 6	2,75967	**11**	34,86310
Class 5 / 6	4,08842	**15**	31,64520
Classe 6 / 6	0,00000	**1**	813,79900
Total	51,19430		

[56] Following Huygens criteria, the total inertia of a partition is constant and equal to the sum of inter and intro-classes inertia.
[57] For more explanations and a comparison of existing software see Chavent, Kuentz *et al.*, 2007.

Quotient (I. inter / I. totale)	0,55257

The choice of a distribution in 6 classes is guided by the intra-class and inter-class homogeneity criteria (Table 4-4). We describe the components of each class below.[58]

Class 1: Rural, remote and « less developed » counties

Counties within this class found counties are rather oriented toward agricultural activities – activities in which women are more represented than the average of other counties. Nonetheless, the class is marked by a gender gap index strongly below the general average. These departments also present an age at marriage of both men and women and a share of definitive celibacy higher than the average. Despite these patterns, the marital fertility rate is a lot larger than the average of all counties, so as the crude birth rate which remains above the average. In addition, these departments are also marked by relatively higher mortality rates of both children and infants. We note that children's wages are lower than in other departments. Moreover, these departments have less reliable transportation/means of communication and display low manufacture output. Therefore, Class 1 groups less developed counties, dominantly agrarian and located in remote areas. They are characterized by low gender equality, high fertility despite a control of nuptiality and low living standard.

The 21 counties of this class are: *Basses-Alpes, Hautes-Alpes, Ardèche, Ariège, Aveyron, Cantal, Corrèze, Corse, Côtes-du-Nord, Drôme, Finistère, Ille-et-Vilaine, Isère, Haute-Loire, Loire-Inférieure, Lozère, Mayenne, Morbihan, Basses-Pyrénées, Hautes-Pyrénées, Pyrénées-Orientales;*

These districts are located on the left part of the dial and mainly concentrated on the negative side of axis 2 (red color).

Class 2: Rural and uneducated counties

This is the largest class in terms of number of departments. The 33 departments of this class present high share of illiterates among married individuals, a lack of educational infrastructures and are predominantly agrarian. The industrial production is low in these districts, as are both male and female employment rates in the industry. Contrary to Class 1 counties, a large share of the population married young and the share of definitive celibacy is below the national average, although marital fertility remains a little bit below the national average. Similarly to Class 1, the gender gap index is low. Hence, Class 2 groups counties located in rural areas. The population is poorly educated compared to the average of other classes so are living standards. Fertility

[58] See Appendix D-1 for more details on the characteristics of each class.

rates are in the national average. Individuals marry young but tend to exercise some control of fertility within marriage.

We find in this class the following 33 counties: *Ain, Allier, Alpes-Maritimes, Aude, Charente, Charente-Inférieure, Cher, Creuse, Dordogne, Haute-Garonne, Gers, Gironde, Indre, Indre-et-Loire, Landes, Loir-et-Cher, Loiret, Lot, Lot-et-Garonne, Maine-et-Loire, Nièvre, Orne, Puy-de-Dôme, Saône-et-Loire, Sarthe, Savoie, Haute-Savoie, Deux-Sèvres, Tarn, Tarn-et-Garonne, Vendée, Vienne, Haute-Vienne ;*

These counties are located in the center of the dial - at the corner of both axes with a gravity center somewhat pulled towards the upper-right part of the dial (blue color).

Class 3: Industrial and rich counties

The departments that compose this class clearly display a concentration of population in urban areas. These departments are industrial with a rural and agrarian population below the national. The average wage of men and children within these departments is high – it may be pulled by a larger proportion of professional as well as by a stronger industrial production. In addition, we note that this class is characterized by educational infrastructures for boys below the national average. Finally, these departments present high fertility rates. Class 3 groups rich and industrial counties. They present large gender inequalities in regards with education and wages and high fertility rates.

The 8 counties of the class are: *Bouches-du-Rhône, Gard, Hérault, Loire, Nord, Rhône, Var, Vaucluse;*

These districts are located in the lower part the dial – more on the positive side of axis 1 (green color).

Class 4: "Protestants" areas, highly educated counties

This class – which consists of 11 departments – is very interesting with regard to its members' positioning. Indeed their educational indicators are the most divisive: their enrollment and literacy rates as well as educational structures are larger than in any other districts for both genders. It is also noteworthy that religion appears clivant for these departments – closely located from Wittenberg and characterized by the largest share of Protestants among the population. Men and women in these departments married on average later than in other departments. Furthermore, the departments of this class show a relatively rich industrial production, but outside urban areas. The class is also marked by a gender gap index fairly larger than in other counties. Class 4 is then composed of counties characterized by highly educated population of both genders. These counties are mainly rural and present high living standards. Gender equality is high and average fertility rates are close to the national average (26.25 against 26.95, respectively).

This class is composed of the following 11 departments: *Doubs, Jura, Manche, Haute-Marne, Meuse, Moselle, Bas-Rhin, Haut-Rhin, Haute-Saône, Vosges, Meurthe;*

These districts are located in the right (and mainly upper) part of the dial (yellow color)

Class 5: Gendered egalitarian counties using birth control

Departments of this class are characterized by a high availability of arable land – they are mostly rural. The female population of these departments is highly educated despite a low number of schools dedicated for girls. Female education and literacy is a strongly divisive indicator. Similarly, the gender gap index is clearly larger than the national average. Female average wages are larger than in any other department. Men and children's wages are also higher but to a lesser extent those of women. These departments have a dynamic industry as revealed by high employment rates in industrial activities but remain also largely rural. Finally, the counties of this class present low fertility rates (24.86) within marriage although women marry younger than the national average. Class 5 differs mainly from Class 4 in regards with fertility. While counties of Class 5 limit fertility within marriage, Counties of Class 4, more religious, tend to "regulate" fertility via nuptiality.

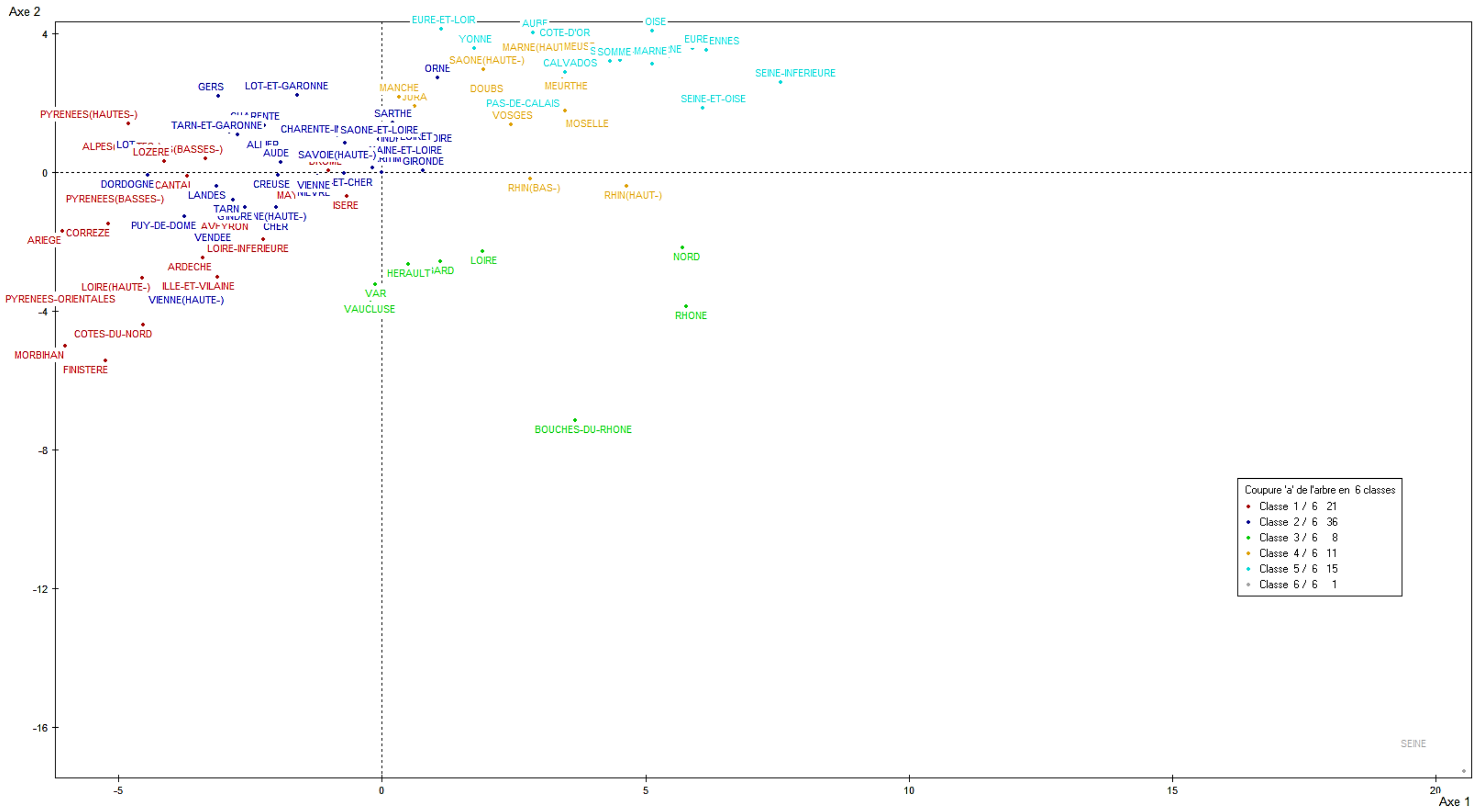
The 15 districts that compose this class are: *Aisne, Ardennes, Aube, Calvados, Côte-du-Nord, Eure, Eure-et-Loir, Marne, Oise, Pas-de-Calais, Seine-Inférieure, Seine-et-Marne, Seine-et-Oise, Somme, Yonne;*

These counties are located in the upper-right part of the dial (turquoise color).

Class 6: The peculiar case of Seine

Seine is different from all other departments. The population density is 29 times larger than the national average. Seine is more industrialized than any other county and manufacture output is five times that of the national average. The level of gender equality is close to the average. However, this level hides the fact that education and literacy rates are very low for both genders. Total fertility is very high although marital fertility is lower than the national average. Individuals marry late; the share of definitive celibacy is high and the share of illegitimate births is twice that of the national average.
Seine is located in the bottom right part of the dial (grey color).

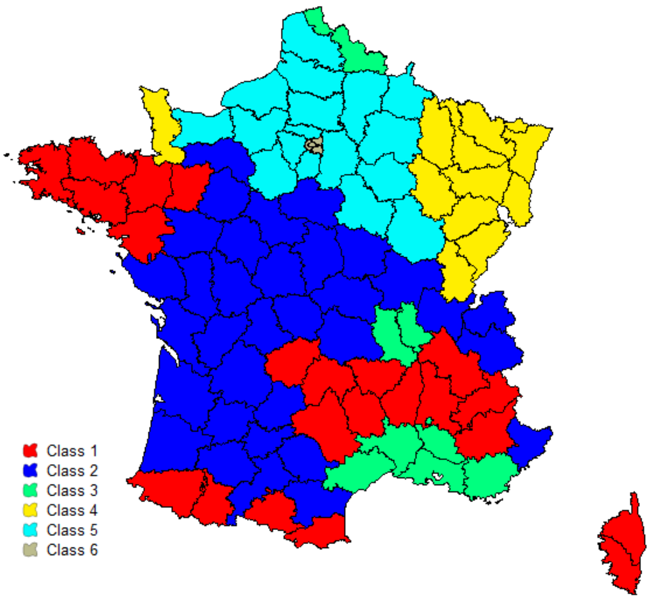
Position of the classes of counties on the first two factorial axes:



Typology of French Counties

Figure 4-6 presents the geographical distribution of the six clusters representing the different levels of socio-economic development in the mid-19th century. The clusters divide the French territory in such a way that we can distinguish fairly clearly the different zones fairly clearly.

Figure 4-6 : Clusters of French Counties



The methods used to analyze our data allowed us to identify the main socio-economic characteristics and then to identify the positioning of the French counties with different degrees of development. Indeed, France appears to be a mixed country in terms of socio-economic development. Still, we note that counties within a same class present similar characteristics in terms of sectorial specialization, fertility level and educational investments. Counties of Class 5 (turquoise) and Class 4 (yellow) located in the Northeastern part of France have a dynamic industry. They also both pay great attention to education. However, Protestant religion (practice or influence) seems to matter more for counties of Class 4 which also tend to favor a control of nuptiality as shown by late age of marriage. Counties of Class 4 are concentrated at the Prussian border which may suggest an influence coming from this Protestant country. On the opposite, counties of Class 5 differ in that they seem to strongly control births within marriage: their inhabitants marry young but have a low fertility. Women work sensitively more and earn more.

Counties of Class 3 (green) are also highly urbanized and industrialized. But unlike counties of Class 4 and 5, they do not seem to stress advancements in education. In addition, in Classes 1 to 3, fertility rates are higher than the national average. Contrary to Class 3, Classes 1 and 2 are strongly agrarian. Furthermore, education is low for both genders so as gender equality. One important difference between these two classes lies in their respective demographic indicators.

While counties of Class 1 seem to control nuptiality (but not births), counties of Class 2 marry young but have a slightly low fertility within marriage. Nonetheless, counties of Class 2 have an average fertility in the average of all other counties.

The study of the positioning of nominal variables, our illustrative variables, shows that Class 1 is positively marked by imperfect stem-family and by late rural exodus (1968). Class 2 is also marked by late rural exodus (1954) as well as by intermediary Atlantic zone and extended family. Class 3 however is positively characterized by patrilocal nuclear family. Class 5 and Class 4 are both marked positively by (very) early rural exodus (1851 and 1891 respectively). In addition, Class 5 is strongly marked by egalitarian nuclear family, so as Class 4 but to a lesser extent (Appendix D-2). Although these variables have not been integrated to the analysis allowing the creation of the axes, their positioning confirms the findings of Chapter 1. Hence, on the one hand, more developed counties have undergone an early rural exodus and families were of nuclear type; on the other hand, less developed counties remained dominantly agrarian until fairly recently and were characterized by extended-family type.

Gender Gap Index and Typology of French Counties

The gender gap index was strongly clivant for the construction of our various classes. While Classes 1 and 2 show large female-to-male differences in terms of educational and economic opportunities, Class 4 and 5 are ranking high in the index.

Figure 4-7 : Gender Gap Index by Class

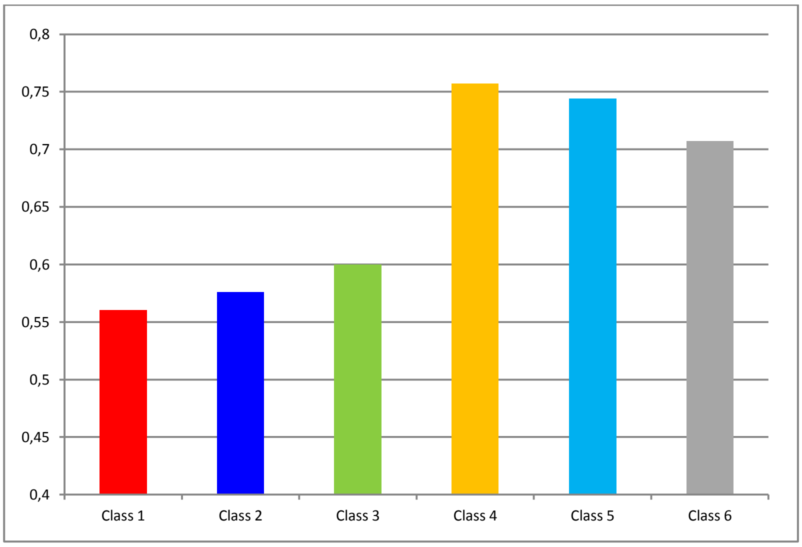


Figure 4-7 presents a histogram of the average gender gap index for each class obtained from the HCA procedure. Counties of Classes 1 and 2, characterized by a predominant agricultural sector, large fertility rates, low educational attainment and low literacy rates for both genders both display a low gender gap index. Similarly, Class 3 exhibits a gender gap index below the average. Contrary to Classes 1 and 2, Class 3 is characterized by a predominant industrial sector but similar to them, Class 3 is characterized by a relatively high average fertility but low education rates.

On the other hand, Classes 4 and 5 display high valued of the gender gap index. They are both characterized by high literacy rates and educational attainment for both genders and a predominance of the industrial sector. Average fertility rates are lower than in the rest of the country for both classes – lower for Class 5 than for Class 4 – but marriage patterns differ strongly between them. Counties of Class 5 seem to control birth within marriage while counties of Class 4 control via nuptiality.

Finally, Class 6 – Seine – is a peculiar case. Seine is far ahead the most industrialized counties in France. From Figure 4-5, we also note that the level of gender equality is relatively high (although lower than that observed for Classes 4 and 5). However, the high level of gender equality in fact hides levels of educational infrastructure and enrollment rates amongst the lowest of France for both genders. In addition to relatively low education rates and a powerful industry, Seine is characterized by high infant mortality and high fertility rates. Looking more deeply into marriage patterns, we note that the share of young single women is very large, so is definitive celibacy; women and men marry late and the index of marital fertility is fairly low. However, the share of illegitimate births is the largest of France.

The analysis of socio-economic and demographic profiles of French counties contributes to shed new light on regional characteristics in terms of economic development, education and fertility. Our data, about mid-19th century France, have shown that regional diversities were large. Such heterogeneity has enabled us to group counties according to the proximity of their profiles. It is interesting to note that the most apparent separating dimensions are those of industry versus agriculture, rural and uneducated versus urban and educated, and late versus early marriage. The typology leads to very different profiles of French regions. This factor analysis allows differentiating French counties using characteristics rarely taken into account to study the diversity of local development. Therefrom, we note the existence of two extreme types of profile. On one side, we find counties characterized by a dynamic industry, gender equality, high education, low adult and infant mortality and low fertility rates (Class 5 and to a lesser extent Class 4). On the opposite side, we find counties of Class 1 (and to a lesser extent Class 2) characterized by an agrarian economy, gender inequality, a poorly educated population, high adult and infant mortality rates and high fertility rates (Class 1 and to a lesser extent Class 2).

The study of economic, educational and demographic variables over the long-run (Chapters 1 to 3) tells us that the French economy has moved from agriculture toward industry, from a small share of the population able to read and to write to a vast majority able to do so and from high to low fertility rates. In parallel, we have seen that the economy has moved from pronounced gender inequality to fairly high gender equality. All these long-run transformations suggest that the first extreme profile (of Class 5) is more modern in terms of economic, educational and demographic indicators. Counties belonging to more traditional profiles will also evolve towards such a modern pattern, but later in time.

Conclusion

In this chapter, we have emphasized the importance of considering family as a unit of analysis aiming at providing a better comprehension of social relationships and economic decision-making. Looking at family patterns is indeed necessary to get a better understanding of the development process that occurred in France over the past two centuries. Hence, changes in gender relations and family organization are crucial to the development process and more specifically the transition from stagnation to sustained growth. Our claim is that the transition from stagnation to sustained growth occurred in parallel to a transition from a patriarchal organization of society to a more gendered-egalitarian organization.

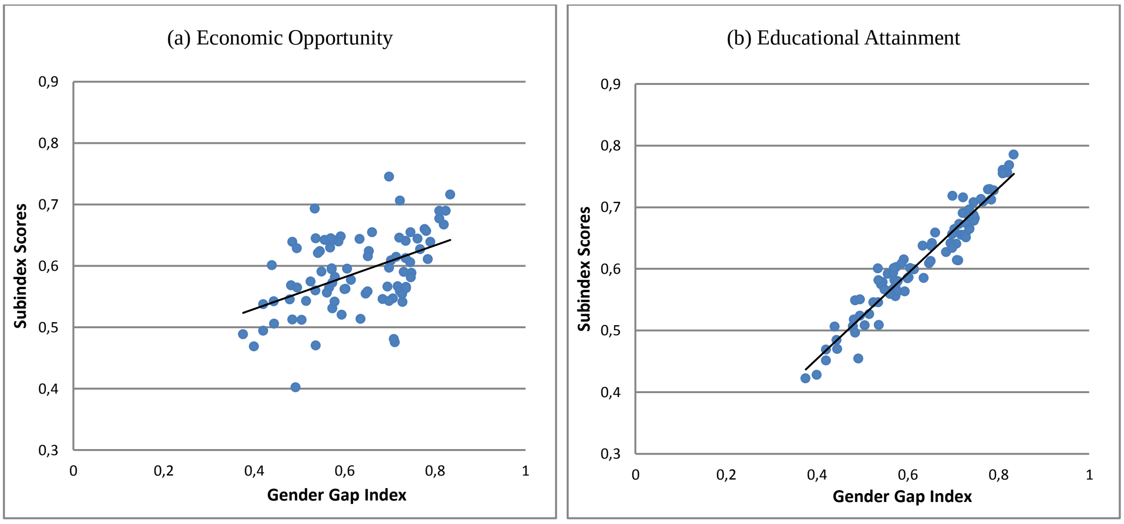
According to Goode (1963), urban growth and industrialization would lead to a simplification of family structures, and ultimately see the diffusion of nuclear families. Urbanization and industrialization together with the increase in education contributed to change the status and the role of women, within the family and economic spheres. Those changes led to a decline in fertility. Our study of the evolution of family organization at the national level affords a distinction between three major periods. During most of the 19th century, the French society was dominantly agrarian and the family was the unit of production. The second half of the 19th century witnessed the emergence of the industrial sector which continuously rose until the 1920-30's. With the transition from an agricultural to an industrial society, most of the production was then realized outside the home. Finally, the second half of the 20th century saw the emergence of the post-modern society. Such pattern is characterized by a greater ease for women in balancing the professional and the family sphere through a more efficient control of births. Within each of these three periods, we observe persistent regional disparities in the background of the national evolution. It is more specifically during the second period (second half of the 19th century) that differences may have been the most significant as it marks the transition between two "extreme" situations. As confirmed in our analysis conducted for the year 1851 (Section 2), several types of family organizations were coexisting at that same time.

The role played by socio-economic factors in the development differences between regions is clear, although cultural specificities embedded in the regions’ history (language, religion or inheritance systems) are also likely to explain the timing of the transition across regions.

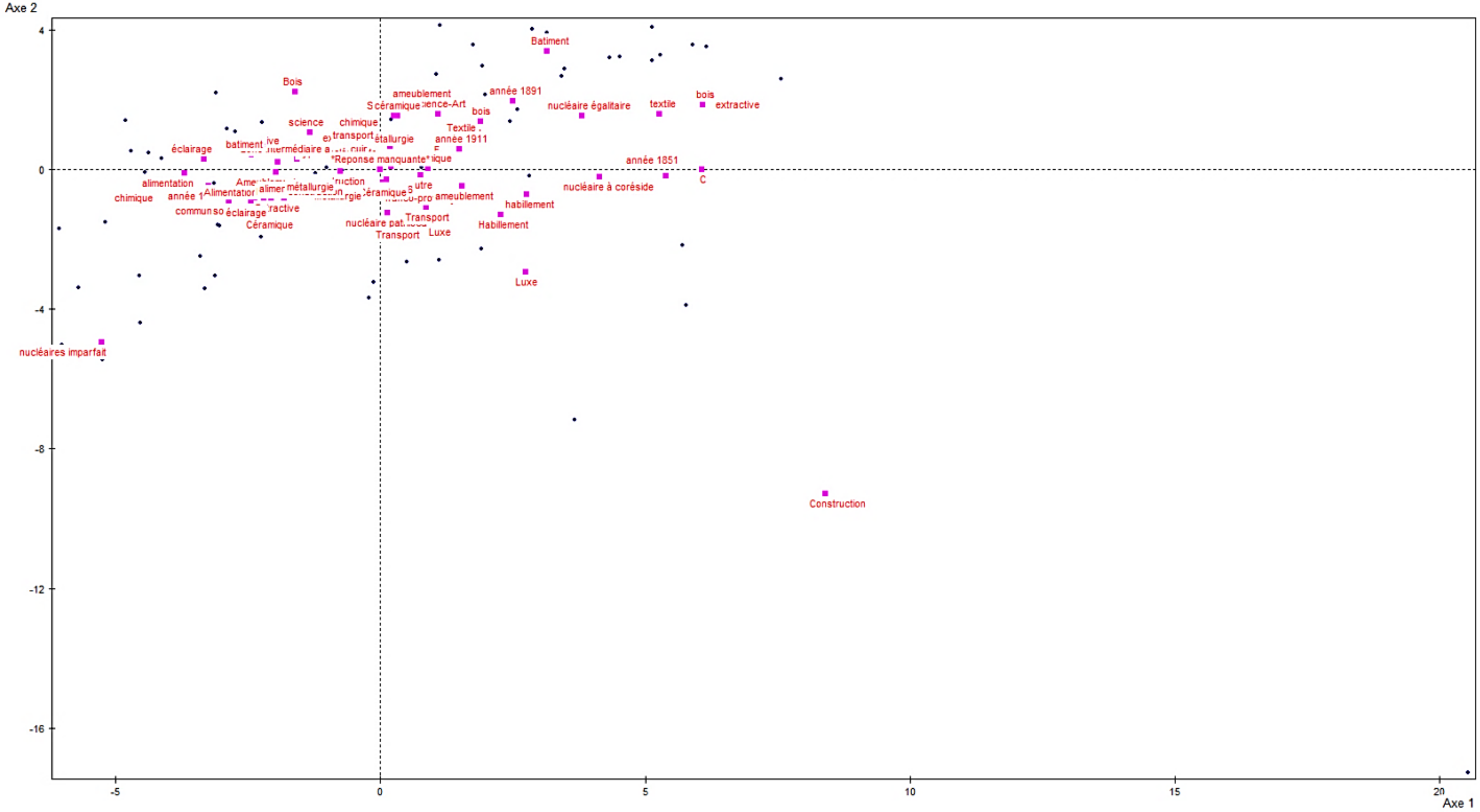
Changes observed over the development process seem to be linked with the evolution of gender relations toward greater equality. The agrarian economic system allowed women to better combine their domestic duties and labor in the fields. The number of children was then maximized. With the development of industries it became more difficult for women to combine both types of work. Two profiles emerged from industrialized areas. On the one hand, we find very urbanized and industrialized areas with large gender inequalities. In these areas we observe a thicker sexual division of labor and fertility remains large. Effort is put on education but specifically on boys’ education. On the other hand we find industrialized, but still rural, areas putting significant effort on education for both genders. The gender gap index is larger, women tend to be more integrated on the labor market and fertility rates are lower.

Appendix D

Figure D-1 : Subindex Scores in Relation to Gender Gap Index Scores



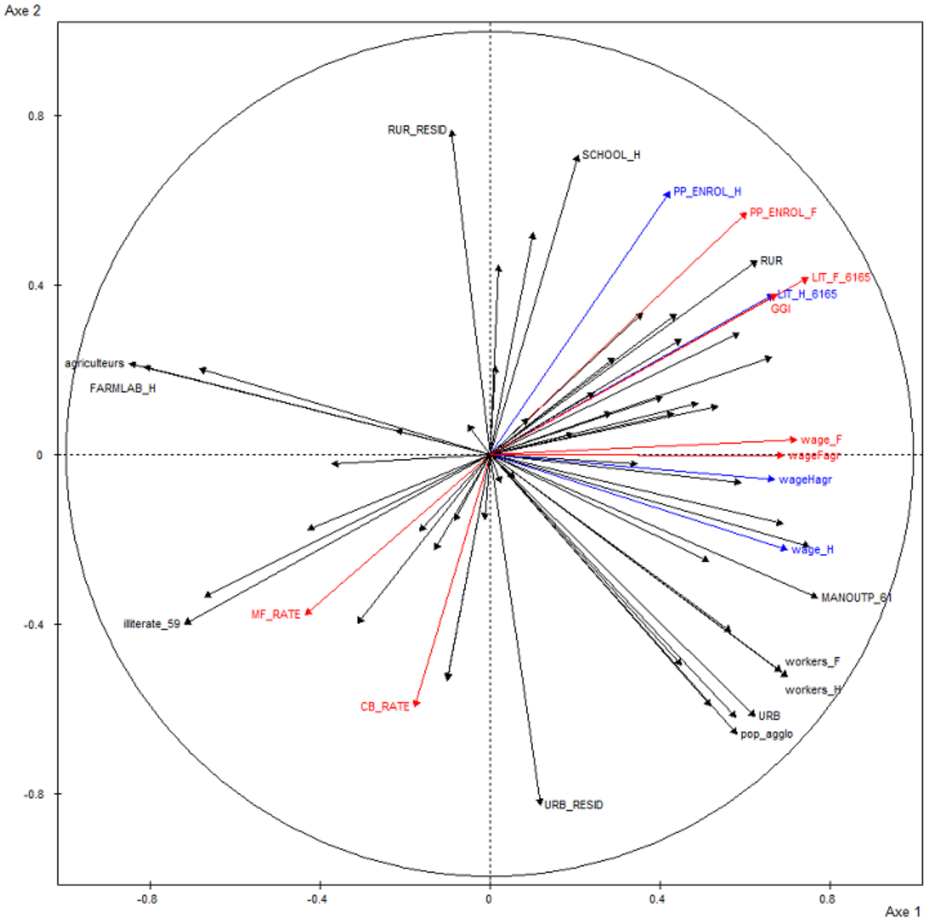
Position of the nominal variables on the first two factorial axes:



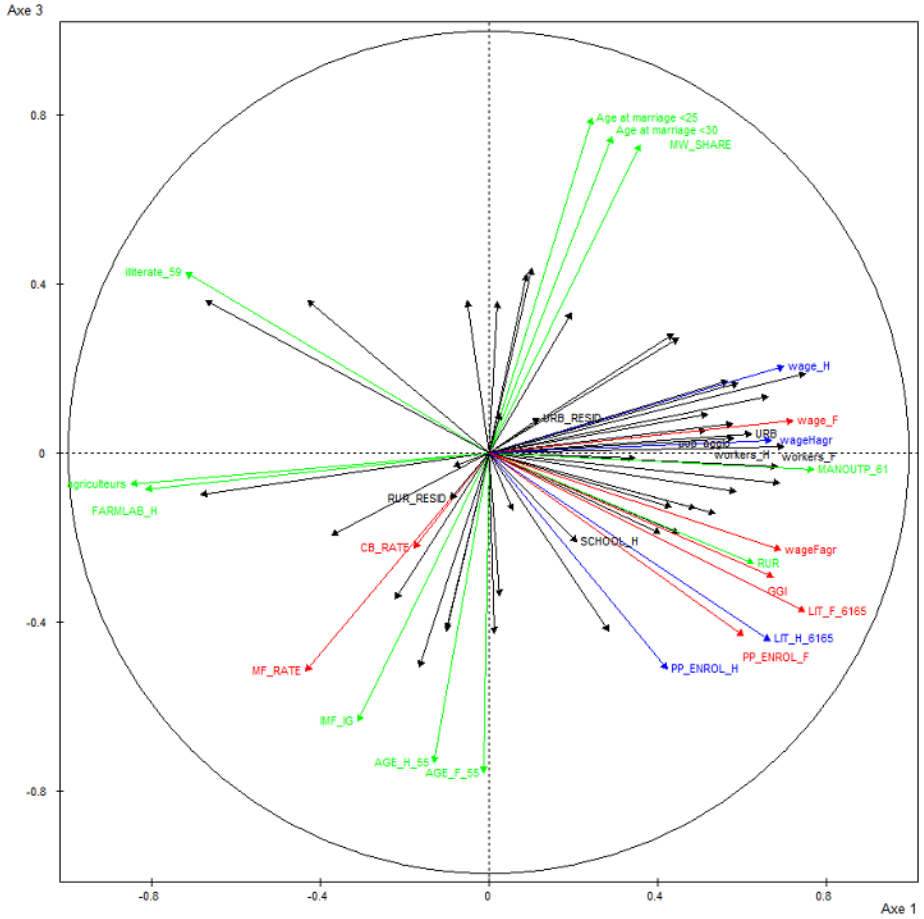
Notes: We find here a marked opposition between the departments of Southern France (negative part of axis 1) and of Northern France (positive part of axis 1) as well as between Eastern and Western counties (on axis 2). Axis 1 also marks a sharp contrast between the departments which have experienced a late rural exodus (negative part) and others having experienced an early exodus (positive part). Similarly, these oppositions are found regarding *Oc* language (negative part) and *Oïl* language (positive part). Instead, distinctive family structures are well spread over the four quadrants (see details below).

Projection of the variables on the axes:

Axis 1 and 2



Axis 1 and 3



Appendix D.1 – Characteristics of the classes by continuous variables

Divisive variables in positive for the class are colored in blue while divisive variables in negative are colored in orange. In other words, divisive variables reflect that counties in a class have on average values above (or below) the variable x by comparison to the average of departments of the other classes.

Class 1 :

Caractérisation par les variables continues

De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 1 / 6 Poids = 21,00 Effectif = 21

Histogramme des : Valeurs-test

Variables caractéristiques	Valeurs-test	Probabilités	Moyenne dans la modalité	Moyenne générale	Ecart-type dans la modalité	Ecart-type général
MF_RATE	5,21	0,0000	3,79	3,21	0,45	0,57
IMF_IG	4,81	0,0000	0,59	0,49	0,07	0,10
FARMLAB_H	4,30	0,0000	0,87	0,73	0,11	0,17
agriculteurs	4,26	0,0000	7140,09	6073,70	849,21	1311,68
AGE_H_55	4,18	0,0000	31,68	30,51	1,09	1,46
Def_celib	4,10	0,0000	15,40	12,11	5,36	4,20
FARMLAB_F	3,73	0,0000	0,74	0,61	0,14	0,17
WITT_DIST	3,66	0,0001	1116,57	969,90	129,74	209,53
CHILD_MORT	3,55	0,0001	0,04	0,03	0,01	0,01
INF_MORT	3,54	0,0001	0,35	0,30	0,07	0,07
AGE_F_55	3,44	0,0002	26,98	26,08	1,07	1,37
illiterate_59	3,10	0,0009	52,42	39,91	13,22	21,09
CB_RATE	2,56	0,0050	28,70	26,95	2,61	3,57
INEG_AGRI2	2,49	0,0062	0,44	0,36	0,22	0,17
routes_1854	-2,02	0,0212	0,70	0,92	0,33	0,57
PP_ENROL_H	-2,11	0,0174	0,45	0,54	0,14	0,21
indus_gr	-2,13	0,0165	224,28	462,40	223,56	585,79
no_school_F_63	-2,25	0,0121	36,64	45,21	20,95	19,82
domestique	-2,26	0,0118	13785,70	18694,20	5735,21	11375,20
ill_rur_birth	-2,37	0,0088	3,00	3,84	1,27	1,86
MANOUTP_61	-2,44	0,0072	1,15	1,97	0,90	1,74
pof_lib	-2,45	0,0070	8483,33	10601,00	4123,41	4524,67
voie_com_54	-2,46	0,0068	9,83	12,29	3,16	5,22
wealth_ind	-2,51	0,0060	153,65	250,99	110,90	202,14
wageHagr	-2,52	0,0057	1,27	1,41	0,28	0,28
LIT_H_6165	-2,62	0,0043	62,10	70,95	15,09	17,68
TEM_H_MIGR	-2,73	0,0030	1,02	5,12	9,48	7,84
PROTO_61	-2,75	0,0029	0,08	0,21	0,09	0,24
wage_C	-2,93	0,0016	0,70	0,78	0,13	0,13
GGI	-3,11	0,0009	0,56	0,62	0,10	0,11
LAT	-3,15	0,0007	45,20	46,47	1,93	2,10
PP_ENROL_F	-3,22	0,0006	0,20	0,35	0,13	0,25
wage_H	-3,42	0,0003	2,01	2,26	0,26	0,37
LEXP_0	-3,51	0,0002	34,70	38,79	5,49	6,07
LIT_F_6165	-3,56	0,0001	39,46	55,44	14,07	23,47
RUR	-3,68	0,0001	0,44	0,66	0,18	0,30
wage_F	-3,92	0,0000	0,93	1,07	0,15	0,19
LAND_35	-3,99	0,0000	0,36	0,48	0,13	0,15
Age at marriage <25	-4,11	0,0000	0,12	0,17	0,04	0,06
indus_peti	-4,40	0,0000	1416,33	2010,74	421,57	706,58
Age at marriage <30	-4,40	0,0000	0,26	0,32	0,06	0,07
railroad_54	-4,84	0,0000	31,20	104,23	48,74	76,69
MW_SHARE	-5,43	0,0000	0,33	0,38	0,03	0,04

Class 2 :

Caractérisation par les variables continues

De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 2 / 6 Poids = 36,00 Effectif = 36

Histogramme des : Valeurs-test

Variables caractéristiques	Valeurs-test	Probabilités	Moyenne dans la modalité	Moyenne générale	Ecart-type dans la modalité	Ecart-type général
illiterate_59	4,65	0,0000	54,47	39,91	11,62	21,09
no_school_50	3,83	0,0000	12,60	7,90	7,81	8,27
Age at marriage <25	3,36	0,0003	0,20	0,17	0,04	0,06
WITT_DIST	3,31	0,0004	1072,83	969,90	141,78	209,53
LEXP_0	3,26	0,0005	41,73	38,79	5,65	6,07
Age at marriage <30	3,06	0,0010	0,36	0,32	0,04	0,07
MW_SHARE	2,98	0,0014	0,40	0,38	0,02	0,04
agriculteurs	2,22	0,0129	6506,50	6073,70	673,06	1311,68
FARMLAB_H	2,12	0,0167	0,79	0,73	0,09	0,17
FARMLAB_F	2,00	0,0223	0,66	0,61	0,13	0,17
pop_agglo	-2,01	0,0221	18,48	22,30	5,76	12,82
INDUSLAB_H	-2,02	0,0212	0,03	0,05	0,02	0,08
indus_gr	-2,18	0,0142	272,33	462,40	199,89	585,79
workers_F	-2,24	0,0124	0,00	0,02	0,00	0,05
pof_lib	-2,26	0,0117	9081,67	10601,00	2524,02	4524,67
wealth_ind	-2,30	0,0105	186,27	250,99	126,32	202,14
wageHagr	-2,44	0,0071	1,31	1,41	0,17	0,28
RUR	-2,93	0,0016	0,52	0,66	0,14	0,30
SCHOOL_H	-2,95	0,0015	0,96	1,21	0,29	0,58
Def_celib	-3,02	0,0012	10,22	12,11	2,46	4,20
MF_RATE	-3,06	0,0010	2,95	3,21	0,40	0,57
PROTO_61	-3,07	0,0010	0,11	0,21	0,10	0,24
GGI	-3,09	0,0009	0,57	0,62	0,08	0,11
CHILD_MORT	-3,14	0,0008	0,03	0,03	0,01	0,01
INF_MORT	-3,18	0,0007	0,26	0,30	0,06	0,07
LONG	-3,22	0,0006	1,25	2,51	1,59	2,64
MANOUTP_61	-3,24	0,0005	1,16	1,97	0,47	1,74
wageFagr	-3,32	0,0004	0,80	0,89	0,12	0,18
IMF_IG	-3,40	0,0003	0,44	0,49	0,07	0,10
AGE_H_55	-3,50	0,0002	29,74	30,51	0,95	1,46
AGE_F_55	-3,88	0,0000	25,29	26,08	0,99	1,37
PP_ENROL_F	-4,10	0,0000	0,20	0,35	0,11	0,25
LIT_F_6165	-4,13	0,0000	41,05	55,44	12,75	23,47
PP_ENROL_H	-4,17	0,0000	0,41	0,54	0,10	0,21
LIT_H_6165	-4,72	0,0000	58,58	70,95	10,82	17,68

Class 3 :

Caractérisation par les variables continues

De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 3 / 6 Poids = 8,00 Effectif = 8

Histogramme des : Valeurs-test

Variables caractéristiques	Valeurs-test	Probabilités	Moyenne dans la modalité	Moyenne générale	Ecart-type dans la modalité	Ecart-type général
pop_agglo	5,47	0,0000	46,06	22,30	7,59	12,82
URB_RESID	4,47	0,0000	0,55	0,32	0,11	0,15
PROTO_61	4,13	0,0000	0,55	0,21	0,38	0,24
MANOUTP_61	4,08	0,0000	4,39	1,97	2,29	1,74
wage_H	3,41	0,0003	2,70	2,26	0,30	0,37
wealth_ind	3,07	0,0010	461,87	250,99	309,37	202,14
TEM_H_MIGR	3,03	0,0011	13,20	5,12	10,65	7,84
wageHagr	2,53	0,0056	1,65	1,41	0,22	0,28
CB_RATE	2,38	0,0084	29,84	26,95	2,52	3,57
LONG	2,38	0,0086	4,64	2,51	0,94	2,64
indus_peti	2,36	0,0089	2576,87	2010,74	537,88	706,58
pof_lib	2,36	0,0091	14218,80	10601,00	6156,83	4524,67
wage_C	2,09	0,0180	0,87	0,78	0,07	0,13
LAT	-2,05	0,0198	45,00	46,47	2,28	2,10
LAND_35	-2,06	0,0194	0,37	0,48	0,15	0,15
ill_urb_birth	-2,38	0,0085	8,28	12,07	3,66	4,68
SCHOOL_H	-2,50	0,0062	0,72	1,21	0,35	0,58
ill_rur_birth	-2,63	0,0042	2,17	3,84	1,56	1,86
agriculteurs	-2,92	0,0017	4773,13	6073,70	1133,75	1311,68
FARMLAB_H	-3,00	0,0013	0,56	0,73	0,13	0,17
FARMLAB_F	-3,13	0,0008	0,42	0,61	0,12	0,17
no_school_F_63	-3,20	0,0006	23,69	45,21	7,90	19,82
RUR_RESID	-3,95	0,0000	0,42	0,66	0,15	0,17

Class 4 :

Caractérisation par les variables continues

De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 4 / 6 Poids = 11,00 Effectif = 11

Histogramme des : Valeurs-test

Variables caractéristiques	Valeurs-test	Probabilités	Moyenne dans la modalité	Moyenne générale	Ecart-type dans la modalité	Ecart-type général
PP_ENROL_F	6,09	0,0000	0,80	0,35	0,08	0,25
PP_ENROL_H	6,01	0,0000	0,90	0,54	0,08	0,21
LIT_F_6165	5,52	0,0000	92,19	55,44	4,20	23,47
LIT_H_6165	5,14	0,0000	96,71	70,95	1,78	17,68
RUR	4,39	0,0000	1,04	0,66	0,11	0,30
AGE_F_55	4,38	0,0000	27,78	26,08	0,65	1,37
LONG	4,03	0,0000	5,52	2,51	2,22	2,64
GGI	3,97	0,0000	0,75	0,62	0,03	0,11
SCHOOL_F	3,89	0,0000	0,33	0,15	0,35	0,16
AGE_H_55	3,86	0,0000	32,11	30,51	0,82	1,46
SCHOOL_H	3,31	0,0004	1,76	1,21	0,45	0,58
ill_rur_birth	3,16	0,0007	5,51	3,84	1,89	1,86
LAT	2,84	0,0022	48,16	46,47	0,75	2,10
protestants	2,18	0,0144	5,42	2,18	9,00	5,22
wealth_ind	2,18	0,0145	376,20	250,99	262,96	202,14
pof_lib	2,17	0,0148	13386,40	10601,00	3996,74	4524,67
URB_RESID	-2,01	0,0220	0,23	0,32	0,07	0,15
MW_SHARE	-2,30	0,0106	0,35	0,38	0,03	0,04
no_school_50	-2,55	0,0053	1,92	7,90	1,58	8,27
catholic	-2,57	0,0050	93,62	97,65	9,96	5,51
TEM_H_MIGR	-2,58	0,0049	-0,60	5,12	2,90	7,84
Age at marriage <30	-3,15	0,0008	0,25	0,32	0,05	0,07
Age at marriage <25	-3,64	0,0001	0,10	0,17	0,03	0,06
WITT_DIST	-5,20	0,0000	661,00	969,90	134,10	209,53
illiterate_59	-5,59	0,0000	6,45	39,91	2,94	21,09

Class 5 :

Caractérisation par les variables continues

De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 5 / 6 Poids = 15,00 Effectif = 15

Histogramme des : Valeurs-test

Variables caractéristiques	Valeurs-test	Probabilités	Moyenne dans la modalité	Moyenne générale	Ecart-type dans la modalité	Ecart-type général
RUR	4,88	0,0000	1,01	0,66	0,24	0,30
LAND_35	4,77	0,0000	0,65	0,48	0,06	0,15
LAT	4,65	0,0000	48,78	46,47	0,91	2,10
PP_ENROL_F	4,45	0,0000	0,62	0,35	0,10	0,25
LIT_F_6165	4,40	0,0000	79,86	55,44	7,39	23,47
no_school_F_63	4,36	0,0000	65,71	45,21	7,63	19,82
SCHOOL_H	4,32	0,0000	1,81	1,21	0,35	0,58
GGI	4,28	0,0000	0,74	0,62	0,03	0,11
MW_SHARE	4,04	0,0000	0,43	0,38	0,03	0,04
wage_F	4,01	0,0000	1,26	1,07	0,12	0,19
railroad_54	3,76	0,0000	172,20	104,23	58,46	76,69
LIT_H_6165	3,74	0,0000	86,59	70,95	5,49	17,68
Age at marriage <30	3,68	0,0001	0,39	0,32	0,06	0,07
PP_ENROL_H	3,57	0,0001	0,72	0,54	0,11	0,21
indus_gr	3,48	0,0002	944,66	462,40	1010,25	585,79
INDUSLAB_H	3,44	0,0002	0,12	0,05	0,15	0,08
ill_rur_birth	3,40	0,0003	5,34	3,84	1,46	1,86
Age at marriage <25	3,26	0,0005	0,22	0,17	0,05	0,06
wage_C	3,22	0,0006	0,88	0,78	0,09	0,13
INDUSLAB_F	3,04	0,0011	0,08	0,03	0,13	0,06
LEXP_0	2,89	0,0018	42,94	38,79	2,30	6,07
wageHagr	2,83	0,0023	1,60	1,41	0,20	0,28
wageFagr	2,76	0,0028	1,01	0,89	0,14	0,18
wage_H	2,74	0,0030	2,50	2,26	0,27	0,37
RUR_RESID	2,66	0,0038	0,77	0,66	0,16	0,17
PROTO_61	2,55	0,0053	0,36	0,21	0,20	0,24
MANOUTP_61	2,53	0,0055	3,01	1,97	1,36	1,74
TEM_H_MIGR	2,36	0,0092	9,49	5,12	4,20	7,84
indus_peti	2,24	0,0122	2385,80	2010,74	499,44	706,58
FARMLAB_F	-2,57	0,0050	0,50	0,61	0,11	0,17
AGE_F_55	-2,60	0,0045	25,23	26,08	1,06	1,37
URB_RESID	-2,75	0,0029	0,22	0,32	0,06	0,15
FARMLAB_H	-2,78	0,0026	0,62	0,73	0,11	0,17
INF_MORT	-2,93	0,0016	0,24	0,30	0,02	0,07
CHILD_MORT	-2,94	0,0016	0,03	0,03	0,00	0,01
INEG_AGRI2	-2,95	0,0015	0,23	0,36	0,12	0,17
agriculteurs	-3,03	0,0011	5133,47	6073,70	879,65	1311,68
CB_RATE	-3,08	0,0010	24,34	26,95	2,65	3,57
MF_RATE	-3,17	0,0007	2,78	3,21	0,28	0,57
IMF_IG	-3,41	0,0003	0,40	0,49	0,05	0,10
WITT_DIST	-3,71	0,0001	786,40	969,90	85,65	209,53
AGE_H_55	-3,90	0,0000	29,15	30,51	0,99	1,46
illiterate_59	-4,14	0,0000	19,29	39,91	6,92	21,09

Appendix D.2 – Features of the classes by nominal illustrative variables

Class 1:

Caractérisation par les modalités des variables nominales
De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 1 / 6 Effectif = 21 Pourcentage = 22,83
Histogramme des : Valeurs-test

Libellés des variables	Modalités caractéristiques	Valeurs-test	% de la modalité dans la classe	% de la modalité dans l'échantillon	% de la classe dans la modalité	Probabilités	Poids
Structure familiale	souche imparfait	3,00	38,09	14,13	61,53	0,0013	13,00
N/S	S	2,57	71,42	44,56	36,58	0,0049	41,00
Dernier exode rural	année 1968	2,44	42,85	20,65	47,36	0,0072	19,00
Structure familiale	nucléaires imparfait	2,30	14,28	3,26	100,00	0,0105	3,00
N/S	N	-2,11	28,57	51,08	12,76	0,0171	47,00
Dernier exode rural	année 1851	-2,32	0,00	17,39	0,00	0,0101	16,00
Dialect	oïl	-2,38	14,28	38,04	8,57	0,0085	35,00
Structure familiale	nucléaire égalitaire	-3,42	0,00	28,26	0,00	0,0003	26,00

Class 2 :

Caractérisation par les modalités des variables nominales
De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 2 / 6 Effectif = 36 Pourcentage = 39,13
Histogramme des : Valeurs-test

Libellés des variables	Modalités caractéristiques	Valeurs-test	% de la modalité dans la classe	% de la modalité dans l'échantillon	% de la classe dans la modalité	Probabilités	Poids
E/O/C	O	3,66	69,44	44,56	60,97	0,0001	41,00
Dernier exode rural	année 1954	3,23	50,00	29,34	66,66	0,0005	27,00
Structure familiale	zone intermédiaire a	2,77	16,66	6,52	100,00	0,0027	6,00
Structure familiale	communautaires	2,55	19,44	8,69	87,50	0,0053	8,00
spé_indH	Textile	-1,98	22,22	35,86	24,24	0,0234	33,00
N/S	N	-2,09	36,11	51,08	27,65	0,0180	47,00
Dernier exode rural	année 1851	-2,20	5,55	17,39	12,50	0,0135	16,00
Structure familiale	nucléaire égalitaire	-2,26	13,88	28,26	19,23	0,0116	26,00
Dialect	autre	-3,05	2,77	18,47	5,88	0,0011	17,00
spe_indusF	Textile	-3,27	47,22	68,47	26,98	0,0005	63,00
E/O/C	E	-3,59	19,44	43,47	17,50	0,0001	40,00

Class 3 :

Caractérisation par les modalités des variables nominales
De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 3 / 6 Effectif = 8 Pourcentage = 8,70
Histogramme des : Valeurs-test

Libellés des variables	Modalités caractéristiques	Valeurs-test	% de la modalité dans la classe	% de la modalité dans l'échantillon	% de la classe dans la modalité	Probabilités	Poids
E/O/C	E	3,14	100,00	43,47	20,00	0,0008	40,00
Structure familiale	nucléaire patrilocal	2,63	50,00	10,86	40,00	0,0041	10,00
topindwagF	Luxe	2,47	25,00	2,17	100,00	0,0066	2,00
N/S	S	2,21	87,50	44,56	17,07	0,0133	41,00
Dialect	oïl	-2,10	0,00	38,04	0,00	0,0177	35,00
E/O/C	O	-2,46	0,00	44,56	0,00	0,0068	41,00

Class 4 :

Caractérisation par les modalités des variables nominales
De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 4 / 6 Effectif = 11 Pourcentage = 11,96
Histogramme des : Valeurs-test

Libellés des variables	Modalités caractéristiques	Valeurs-test	% de la modalité dans la classe	% de la modalité dans l'échantillon	% de la classe dans la modalité	Probabilités	Poids
N/S	N	3,41	100,00	51,08	23,40	0,0003	47,00
Dernier exode rural	année 1891	3,32	45,45	8,69	62,50	0,0004	8,00
E/O/C	E	3,13	90,90	43,47	25,00	0,0008	40,00
Structure familiale	nucléaire égalitaire	2,31	63,63	28,26	26,92	0,0102	26,00
Dernier exode rural	année 1954	-2,12	0,00	29,34	0,00	0,0166	27,00
E/O/C	O	-2,30	9,09	44,56	2,43	0,0106	41,00
Dialect	oc	-2,34	0,00	32,60	0,00	0,0094	30,00
N/S	S	-3,12	0,00	44,56	0,00	0,0008	41,00

Class 5 :

Caractérisation par les modalités des variables nominales
De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 5 / 6 Effectif = 15 Pourcentage = 16,30
Histogramme des : Valeurs-test

Libellés des variables	Modalités caractéristiques	Valeurs-test	% de la modalité dans la classe	% de la modalité dans l'échantillon	% de la classe dans la modalité	Probabilités	Poids
Structure familiale	nucléaire égalitaire	4,34	80,00	28,26	46,15	0,0000	26,00
N/S	N	4,23	100,00	51,08	31,91	0,0000	47,00
E/O/C	C	3,59	40,00	8,69	75,00	0,0001	8,00
Dernier exode rural	année 1851	2,67	46,66	17,39	43,75	0,0037	16,00
spé_indH	Textile	2,38	66,66	35,86	30,30	0,0086	33,00
Dialect	oïl	2,17	66,66	38,04	28,57	0,0146	35,00
Dernier exode rural	année 1968	-2,01	0,00	20,65	0,00	0,0221	19,00
E/O/C	O	-2,46	13,33	44,56	4,87	0,0068	41,00
Dialect	oc	-2,98	0,00	32,60	0,00	0,0014	30,00
N/S	S	-3,89	0,00	44,56	0,00	0,0000	41,00

Class 6 :

Caractérisation par les modalités des variables nominales
De la classe : Coupure 'a' de l'arbre en 6 classes - Classe 6 / 6 Effectif = 1 Pourcentage = 1,09
Histogramme des : Valeurs-test

Libellés des variables	Modalités caractéristiques	Valeurs-test	% de la modalité dans la classe	% de la modalité dans l'échantillon	% de la classe dans la modalité	Probabilités	Poids
spé_indH	Construction	2,01	100,00	2,17	50,00	0,0217	2,00
spé_indH	Transport	-2,01	0,00	2,17	0,00	0,0217	2,00
topindwagF	Luxe	-2,01	0,00	2,17	0,00	0,0217	2,00
spé_indH	Céramique	-2,01	0,00	2,17	0,00	0,0217	2,00
topindwagF	textile	-2,01	0,00	2,17	0,00	0,0217	2,00
spé_indH	Batiment	-2,01	0,00	2,17	0,00	0,0217	2,00
Structure familiale	nucléaire à coréside	-2,01	0,00	2,17	0,00	0,0217	2,00

Part II

The Analysis of the Relationship between Gender Equality and Economic Growth

The inquiry conducted in the first part of the dissertation based on French data produces a complex story of national and regional variation. It suggests the existence of interconnected relations between the process of historical emancipation of women, demographic transition and economic development. The second part of the dissertations is analytical.

The literature review on theories of economic growth in **Chapter 5** highlights the need for a Unified Growth Theory that could capture in a single framework the main characteristics of the process of development. In addition, it emphasizes the lack for gender considerations in growth theory. Rare are growth models that differentiate the role of men and women in their analysis, considering rather the effect of household decisions on fertility. This leads us to tackle the issue of the development process by a renewed gendered approach. The main concern of the study is precisely to show to what extent and through what mechanisms gender equality affects decisions taken by the members of the household and acts on long run economic developments.

Hence, **Chapter 6** contributes to the literature on unified growth theory by bringing to light new determinants of the development process that would have triggered the transition from a long period of stagnation to a regime of sustained growth (***second step of the cliometric analysis***). We develop a unified cliometric growth model that captures the interplay between fertility, technology and income per capita in the transition from stagnation to sustained growth. In particular, we consider a two-sex overlapping-generations framework with two types of human capital and integrating gendered aspects. The key state variables for individuals' decisions are the technological environment and the power-imbalance ratio between sexes. A rapid change in technological environment increases the return to skilled education and increases both boys' education and fertility through an income effect. Higher gender equality, triggered by the acceleration of the pace of technological progress, increases girls' education and consequently the opportunity cost of having children what reduces the total number of children. Furthermore, maternal endowment in human capital is recognized as being primordial in the educative development of children. Therefore, the rise in women's educational investments impacts positively children's endowment in human capital in turn. Ultimately, higher gender equality changes the trade-off from "quantity of children" toward "quality of children". The average level of fertility hence depends on the skill composition of the population. The different elements of our model lead to a positive feedback loop. At the dynamic level, the increase in gender equality together with the rise in technological progress creates higher opportunities for women to invest in skilled human capital. The negative correlation linking maternal investments in human capital and fertility encourages families to have fewer children but better educated ones. Human capital being a factor with increasing returns to scale, the reallocation of resources toward this factor sets the economy on a growing path dependency. More precisely, the theory suggests that female empowerment has been at the origin of the demographic transition and engaged the take-off that allowed economies to move from the post-Malthusian regime to Modern economic growth. In line with empirical evidence, the theory characterizes the conditions under which the process of human capital accumulation initiated. Changes in the shares of population acquiring skilled human capital have substantial effects on fertility patterns and affect individuals' living conditions. The dynamical system of the economy generates the transition from a state characterized by low technology, low equality between men and women and high fertility to a state characterized by large technological progress, high gender equality and low fertility rates.

The key ingredient of the model allowing the transition of economies from one state to the other one is the "quantity-quality" trade-off. **Chapter 7** is devoted to the empirical analysis of the relationship between education (quality) and fertility (quantity) (***third stage of the cliometric analysis***). More specifically, the model assumes the increase in women's education to be at the origins of the demographic transition (and the process of human capital accumulation). Using econometric tools and based on 19th century French county-level data, we test the impact of the rise in female (and male) education on the variation in fertility. Our results confirm the importance of the role played by girls and women education on the process of demographic transition for France.

Chapter 5

The Theoretical Foundations of the Process of Development

Content

Introduction

During the past two centuries, Western world witnessed dramatic economic, demographic and cultural upheavals. This period marked a turning point in historical economic and demographic trends. Despite some variations in terms of timing and speed of changes (Galor, 2012), Western countries experienced similar patterns of economic and demographic transition. Before the Industrial Revolution, all societies were characterized by a very long period of stagnation in per capita income with high fertility rates and the dominance of physical capital over human capital (Clark, 2005). Since this fateful period, Western countries observed a complete reversal with high and sustained income per capita, low fertility (Becker *et al.*, 2012, Klemp, 2012). Human capital became an important source of income.

The major challenge of this chapter is to present the theoretical approaches attached to the understanding of the process of development. Empirical regularities raise numerous questions about the potential interactions linking demographic developments and the economic transition, and about the role they have played in the transition from the stagnation to sustained growth. What are the underlying behavioral forces behind this demographic transition? What are the endogenous interactions between population and production? What account for the unprecedented rise in income per capita? Why has the transition to a state of sustained economic growth occurred together with the demographic transition?

This chapter lays the theoretical foundations of our analysis that aims at providing a better understanding of the long-run relationship between gender equality and economic growth. This chapter is organized as follows. We first provide an overview of the three fundamental regimes that have characterized the process of development over the course of human history on the basis of the seminal work of Galor and Weil (2000).[59] We then explore existing theories offering explanations of the different stages of the process of development. In particular, we briefly examine the predictions and underlying mechanisms of the traditional theories of economic growth and development, and the theories of demographic transitions. Next, we show the relevance of the Unified Growth Theory to explain and capture the underlying mechanisms of the development process. Finally, we highlight the relevance of using this theory to study the long-run relationship between gender equality and economic growth.

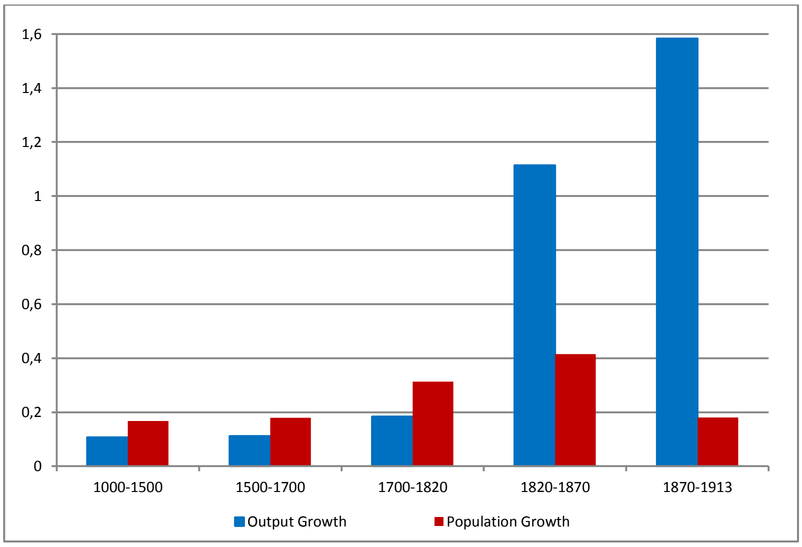
[59] The seminal work of Galor and Weil was quickly followed by new contributions *f*or example, Jones (2001), Lucas (2002), Hansen and Prescott (2002), Galor and Moav (2002), Doepke (2004), Galor (2005), Cervellati and Sunde (2005), Strulik and Weisdorf (2008), etc.

1. The Stylized Facts of the Development Process

1.1. Evolution of Output and Population Growth in France

The first part of our work has highlighted the importance of focusing on demographic behaviors to get a better comprehension of the process of development that occurred in Western countries over the past two hundred years.

Figure 5-1 : GDP per Capita and Population Growth Rates in France



Source: Data from Maddison (2008)

Figure 5-1 presents a broad picture of the joint evolution of output growth and population growth in France over six periods between 1000 and 1913. The first two periods, 1000-1500 and 1500-1700, are highly similar with a population growth rate slightly larger than the output growth rate (respectively around 0.11% and 0.17%). Both average annual growth rates start to increase slowly over the period 1700-1820 (respectively 0.18% and 0.31%). The wealth generated was absorbed by the rise in population growth. This positive relationship between income and population continues over the period 1820-1870 but becomes progressively narrower.

The period 1820-1870 experiences a sharp rise in economic growth. The take-off in growth rates of GDP per capita in France was associated with a rise in population growth as observed in all regions of the world (Galor, 2011). However, the population growth remains relatively contained in comparison to output increase. More precisely, the average growth rate in GDP per capita in France between 1820 and 1870 rose to an annual growth rate of 1.11% (from 0.18% during 1700-1820) while the average population growth rate increased to 0.41% (from 0.31%

during 1700-1820). Comparing France with the rest of Western Europe, we note that population growth was significantly larger in Western Europe than in France, with an average annual growth rate of 0.7% over the same period. The last period, 1870-1913, is marked by an unprecedented reversal in the relationship between population and output growth. For the first time, the rate of population growth decreases as the growth rate of per capita GDP continues to rise. The rate of GDP per capita then grows by 1.58% per year while population growth rate decline to a yearly average of 0.18%. Ultimately, most regions like France experienced this demographic transition in parallel to the continuous increase in GDP per capita.

1.2. The Three Phases of the Development Process

Several important features stand out from the Maddison's data (Maddison, 2008). Human history can be divided into three fundamental regimes: the Malthusian Epoch, the Post-Malthusian Regime and the Modern Growth Regime.

1.2.1. Stagnation – Malthusian Era

Maddison's data indicate that the average level of world per capita income fluctuated around \$450 per year over the period 1-1000 and around \$670 per year then until the end of the 18th century. The monotonic increase in income per capita during the Malthusian era was associated with such a uniform evolution of the average population growth rate in the world (0.01% per year in the first millennium; 0.1% per year in the years 1000-1500; 0.27% per year over the period 1500-1820), keeping living standards fairly stable. The stagnation has characterized human history for thousands of years. At that stage, population growth was positively affected by the level of income per capita. The monotonic increase in income per capita during the Malthusian era was associated with such a uniform evolution of the average population growth rate in the world while it did not result in variations in the standard of living (Galor, 2011). The absence of significant changes in the level of technology trapped the income per capita around a subsistence level and population size remained relatively stable.

1.2.2. Take-off – Post-Malthusian Phase

At the beginning of the 19th century, Western countries experienced a take-off from Malthusian stagnation. This shift took place with the increase in the pace of technological progress in association with the process of industrialization, presumably stimulated by the accumulation of human capital.[60] Based on Maddison's data, we note that the world average growth rate of output per capita increased from 0.05% per year for the period 1500-1820 to 0.54% per year during the period 1820-1870, and reached 1.3% per year in the years 1870-1913. Similarly, the average rate of population growth in the world increased from 0.27% per year in the period 1500-1820 to 0.4% per year in the years 1820-1870, and to 0.8% per year in the interval 1870-1913. Hence, we note that this period is still marked by a positive relation between income and population growth. The acceleration of technological progress resulted in a significant increase in the growth rate of output per capita, generating an unprecedented increase in population growth. The timing of the take-off differs across regions. In less developed countries,[61] the take-off occurred progressively with a one-century delay, from the beginning of the 20th century. The decline in population growth marked the end of the so-called Post-Malthusian Regime by the end of the 19th century in Western countries, and by the second half of the century in less developed regions.

1.2.3. Sustained Growth – Modern Growth Regime

The acceleration of technological progress in the second phase of industrialization, its interaction with the human capital accumulation and the reversal in the relation between income per capita and population growth signed the transition toward a state of sustained economic growth. The entrance in the Modern Growth Regime, associated with the phenomenon of demographic transition, has led to a great divergence in income per capita in the past two centuries in Western countries (Galor, 2011).

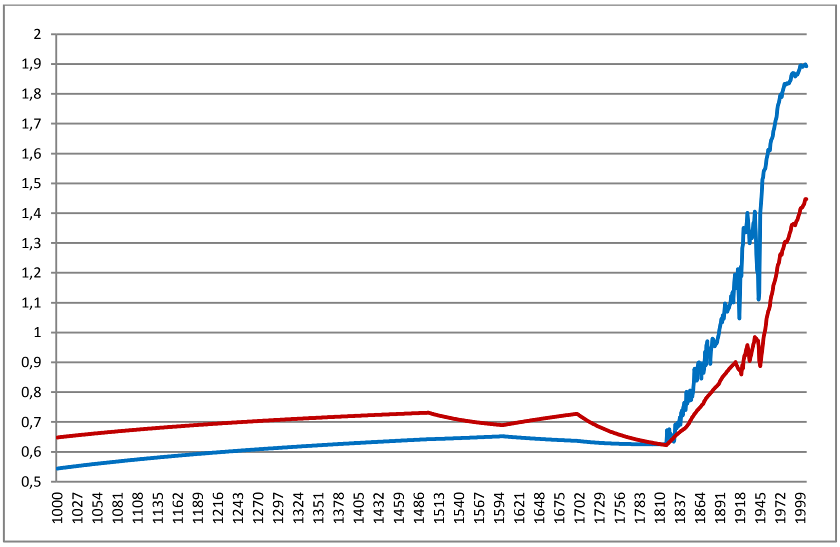
According to Maddison's data, the reversal in the rate of population growth occurred by the end of the 19th century and the beginning of the 20th century for particular regions of the world (Western Europe, Western Offshoots and Eastern Europe). From an average of 0.77% per year in the period 1870-1913 in Western Europe, the population growth rate decreased to an average of 0.42% per year in the years 1913-1950, while it continued to grow in other parts of the world. At the same time, the world average growth rate of GDP per capita kept on increasing, reaching an average of 2.92% per year on the period 1950-1973.

Although, the phenomenon of demographic transition initiated by the late 19th century in most Western countries, as countries developed along the process of industrialization, French data indicate that the process started nearly a century earlier in France, as described in Chapter 1. Figure 5-2 makes a comparison between the ratios of output and population growth in France and Western Europe over the period 1000-2008. After a rather stable evolution of the output-to-

[60] The demand for education increased from the end of the period.
[61] By less developed countries, we mean Latin America, Asia and Africa.

population growth rates, i.e. about 0.6 in France and 0.7 in Western Europe for centuries, the ratio experiences a brutal and sudden rise. Both France and Western Europe witness this unprecedented increase at the same time, namely by the first decade of the 19th century.

Figure 5-2 : Ratio of Output and Population Growth Rates in France and Western Europe, 1000-2008



Source: Data from Maddison (2008)
Note: The blue and red lines correspond to the ratio of France and Western Europe respectively.

However, while the ratio of population and output growth rates reached one in France in 1891,[62] Western Europe reached this fateful ratio in 1953 only. The growth rate of GDP per capita relative to population growth has been much faster and intense in France than in the rest of Western Europe. Two main issues emerge from these findings. Why did population and output growth reverse at the same time in France and in other Western European countries? Why was the rise in the ratio between output and population growth so much faster in France than in the rest of Western Europe?

1.3. Main Challenges

As described previously, the development process raises a number of questions and puzzles. This exacerbates the interest of researchers specialized in the field of growth and development. Unprecedented upheavals occurred during this process. The demographic transition, the transition from stagnation to growth and the phenomenon of great divergence in income per capita took place with different timings across regions of the world. Many mysteries persist. Contemporary growth theorists such as economic historians need to improve the understanding of the development process: the driving forces and underlying determinants that led to the

[62] An output-to-population growth rates ratio equal to 1 means that both output and population evolved at the exact same rate of growth.

escape from the Malthusian trap and allowed the transition to sustained growth. The main questions addressed (Galor 2005, 2011) are the following ones:

- What can explain the centuries of stagnation that characterized most of human history?
- What are the driving forces that account for the sudden increase in growth rates of GDP per capita and the persistent stagnation in others?
- What conducted to the Industrial Revolution? Why did this phenomenon occur first in Great Britain?
- What factors can account for the relationship between population and output growth? Why has the positive link between income and population growth reversed its course in some economies but not in others?
- What are the main forces that initiated the process of demographic transition?
- What has caused the Great Divergence in income per capita across regions of the world over the last two centuries?
- Would the transition have been possible without the demographic transition?

In other words, what are the underlying behavioral and technological structures that could simultaneously account for these distinct phases of development? Additionally, what are their implications for the contemporary growth process of developed and under-developed countries?

2. Toward a Unified Theory of Growth

The fundamental challenge faced by social scientists is to provide reliable answers to these questions using the contributions of economists, historians as well as sociologists. The issue for growth theorists is to develop a unified theory of growth that would account for the main features of the three distinct phases that have characterized the process of development. This is what has been first undertaken by Galor and Weil (1999, 2000) with the development of the Unified Growth Theory.[63] This theory aims at giving a better understanding of the driving forces that have triggered the escape of the Malthusian trap and allowed the transition to a state of sustained growth.

[63] The term was coined first by Galor (2005).

2.1. Theoretical Background

2.1.1. Traditional Theories of Economic Growth

Malthusian Theory

The world economic history has been dominated by the Malthusian stagnation. For a long time, theories which aim at explaining the development and economic growth found their inspiration in Malthusian and Neoclassical conceptions. In his *Essay on the Principle of Population* (1798), Malthus defends a "pessimistic" vision of the impact of population growth on the long run economic development, coherent with the world economic history prior to the Industrial Revolution. Malthus thinking can be summarized by the two following postulates: *(i)* population growth is bounded by the means of subsistence; *(ii)* population increases with livelihoods in a geometric progression while production of food grows in arithmetic progression. The theory developed by Malthus matches pretty well with the empirical evidence on the relation between income and population dynamics prior to the Industrial Revolution. According to this theory, the effect of population growth would be counterbalanced by the expansion of resources, reflecting the fluctuations of the income per capita around a subsistence level. Malthus argues that two types of barriers contribute to reduce the size of the population at the subsistence level: the "positive checks" and the "preventive checks". The "positive checks" raise the death rates through hungers, diseases or wars. The "preventive checks" affect births rates through birth control, abortion, late age at marriage or celibacy.

Without changes in the level of technology and resources, both the population size and the income per capita would remain stable. However, periods of technological progress and expansion of resources would lead to an increase in population growth, triggering ultimately a decline in income per capita. Despite the capacity of the Malthusian theory to capture the characteristics of the epoch of stagnation, its predictions appear inconsistent with the features of the post-demographic transition era and the modern growth regime. At the end of the 19th century, liberal economists such as Leroy-Beaulieu (1913) found that the theory was contradicted by the facts. Hence, it became clear that the movement of population was slowing down and output growth was accelerating. As a consequence, doctrines evolved. From that was born the idea that population growth would obey to different rules from that of economics. Boserup (1965, 1981) argued notably that the demographic pressure would lead to a reorganization of agricultural production. According to Boserup, the size of the population drives changes in the operating modes, and not the subsistence level. Technological progress may then allow the subsistence level of production to consistently exceed population growth.

From Exogenous to Endogenous Growth Theory

Contrary to the Malthusian theory that has investigated the relation between population and production prior to the demographic transition, neoclassical growth models focused largely on the growth process during the Modern Growth phase. Far from being limited to agricultural productivity, population growth is affected by complex socioeconomic-cultural phenomena related to the enrichment of society, culture, choices of social organization that triggered families to limit their number of children (as seen in Part I). Growth models gradually started to integrate these aspects, although timidly.

In opposition to Malthus' approach, exogenous growth models, such as the Solow model (1956), deal with demographic growth as an exogenous variable and assume demographic behaviors to be independent of wages, incomes and prices. Without technological progress, the income per capita converges toward a stable steady-state independently of the size of the population. The model is based on the assumption that the factors of production separately have diminishing returns. However, returns to scale are assumed to be constant. Factors of production are assumed to be used effectively by all countries. In an economy with more capital, the productivity of labor increases. As a consequence of diminishing returns to factors of production, economies will reach a point where any increase in production factors does not generate an increase in output per capita. In other words, for Solow, economic growth results from an "exogenous" technical progress. For most Classic economists (such as Malthus and Solow) no growth could be sustained.

In parallel to the evolution of growth models, a branch of theoretical economic literature analyzed household decisions (consumption, savings or labor supply). The lack of consideration of family behavior and its impacts in economics[64] led to the creation of a new stream of research: the "New Home Economics". The New Home Economics extends the domain of microeconomic analysis to a wide range of behaviors and human interaction, such as demographic behavior, investments in human capital and intergenerational transfers. The (static) modeling of household production and time allocation was notably used to explain the sexual division of labor and the market behavior of household members. Among the first publications were Becker (1960) on fertility, Mincer (1962) on women's labor supply, and Becker (1965) on the allocation of time. Key assumptions of this stream are that institutions and cultures influence decisions in the home (Folbre, 1994) and that these decisions are made by families as a unit. Manser and Brown (1980) have introduced household (two-sex) bargaining

[64] However, coming back to the origin of the notion "economics", its etymology is derived from the Greek "*oîkos*" (house, dwelling) and "*nómos*" (law, custom) that refers to the art of properly administrate its home.

models taking into account the separate interests of individual household members. Their framework was then developed by authors such as Chiappori (1992) or Lundberg and Pollak (1993). A decade after the creation of the New Home Economics, Nerlove (1970), Razin and Ben-Zion (1975) or Srinivasan (1988) linked demographic behaviors to macroeconomic evolutions in order to analyze their implications on the general equilibrium.[65]

In the extension of the Solow model, endogenous growth models have been developed in the 1980's to address the issue of the origin of technological progress – to make it endogenous. The first endogenous growth model was published by Romer (1986) and was then developed by Lucas (1988), Romer (1990) and Barro (1990). Endogenous theorists identified four key factors of growth: returns to scale, research and innovation (Romer, 1990; Grossmann and Helpman, 1991; Aghion and Howitt, 1992), knowledge and human capital (Lucas, 1988), and State intervention (Barro, 1990).

Inspired by the New Home Economics literature and by endogenous growth models, growth models with explicit microeconomic foundations of family have progressively been developed (Barro and Becker, 1990; Becker, Murphy and Tamura, 1990; Ehrlich and Lui, 1991; Galor and Weil, 1996; Dahan and Tsiddon, 1998; Iyigun, 2000). Growth theorists exploring mechanisms by which fertility and growth are related focused for a vast majority on the modern era (Barro and Becker, 1989; Barro and Sala-i-Martin, 1995; Becker *et al.*, 1990; Moav, 2005; Tamura, 1994, 1996). The so-called endogenous growth theory taking into account family behavior (as a single decision-maker) is able to explain the empirical regularities that characterized the growth process of developed countries over the last hundred years.

2.1.2. Theories of Demographic Transition

The demographic transition is identified as having played a key role in the process of development. From a theoretical point of view different factors have been put forward to explain the process of demographic transition. Becker (1960) argued notably that the rise in per capita income had an effect on both households' income and opportunity cost of raising children. However, this explanation does not seem sufficient to fully explain empirical regularities described previously. Why did demographic transitions occur simultaneously across countries that significantly differ in income per capita? Why did France experience its demographic transition prior to other countries?

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[65] Within the framework of neoclassical growth model with endogenous fertility, the authors attempt to determine the optimal population growth rate.

The gradual rise in the demand for human capital along the process of industrialization has been seen by some researchers as a prime force leading to the onset of the demographic transition, specifically during the second phase of the Industrial Revolution. Taking family as a single decision-maker, Becker's models manage to generate the demographic transition but do not differentiate between the behaviors of males and females. Becker *et al.* (1990) model the relationship between human capital, fertility and economic growth. In this "one sex" model with altruistic parents, higher productivity leads to higher wages and favors human capital accumulation, which in turn raises the opportunity cost of children. This feature highlights the existence of two locally stable steady-states: a Malthusian steady-state with many children and little human capital and a steady-state with few children and high human capital (same result in Tamura, 1994). In the interpretation of the model, they consider changes in female labor force as implicit. Galor and Weil (1999, 2000) developed the idea that the acceleration in the rate of technological progress would gradually increase the demand for human capital, inducing parents to invest in the quality of their offspring rather than in the quantity. The existence of a negative correlation between education and fertility has been demonstrated by Becker, Cinnirella and Woessmann (2011) with county-level evidence for Prussia in 1816. Ultimately, the process of human capital accumulation would induce a reduction in fertility rates as far as the growth rate of technological progress increase.

The decline in the gender gap is also considered as a reinforcing mechanism impacting fertility rates. Galor and Weil (1996) investigate the relationship between fertility, gender gap in wages and economic growth by assuming explicitly that men and women have different abilities and do different kinds of work. The authors postulate that technological progress and capital accumulation positively impact the relative wages of women along the process of industrialization, what increases the opportunity cost of raising children and ultimately leads to a reduction in fertility. Hence, economic growth would contribute to close the gender gap in earnings what would lower fertility and reinforce economic growth. In a dynamic model with endogenous fertility, Iyigun and Walsh (2007) investigate how the evolution of the spousal bargaining power within the couples' decision-making problem may trigger the decline in fertility.[66] Doepke and Tertilt (2007) study the opposite direction of causation. Based on a model with quantity-quality trade-off on children, they investigate what economic forces may be at the origin of the progressive rise in women's rights throughout the process of industrialization. For Falcao and Soares (2008), it is the demographic transition that increases female labor supply and decreases the female-to-male wage gap. The authors show that gains in adult longevity increase the returns to human capital and reduce fertility. The subsequent

[66] In this paper, the authors do not focus on economic development and leave aside the question of how changes in gender heterogeneity may affect long-run growth.

decline in demand for household production (initially women specialization) increases the fraction of time spent by women on the labor market and reduces the gender earning gap. De La Croix and Vander Donckt (2010) employ the notion of intra-household bargaining power (called "welfare weight") and analyze how its variations may affect demographic and economic outcomes.

The progress of neoclassical growth models with endogenous fertility provides plausible explanations of the modern experience of economic growth in developed economies. Nonetheless, they do not provide a global understanding of the development process as a whole and mysteries persist about some of the most fundamental features of the process of development. They capture neither the recent negative relationship between population growth and income per capita, nor the positive effect of income per capita on population growth and the economic factors that triggered the demographic transition. This left the door opened to a new generation of growth theorists (Galor and Weil, 2000; Jones, 2001; Galor and Moav, 2002; Hansen and Prescott, 2002; Doepke, 2004; Strulik and Weisdorf, 2008) to face the challenge of developing a theory consistent with the entire process of development.

2.2. Unified Growth Theory

Unified Growth Theories are endogenous growth theories consistent with the whole process of development – accounting for empirical evidence that have characterized the growth process over longer time horizons in developed and less developed economies.

2.2.1. Building Blocks of the Theory

Advanced first by Galor and Weil (1999, 2000) and developed by Galor (2005, 2010), Unified Growth Theory intends to capture in a single framework the main characteristics of the transition from the Malthusian era to the modern era, as well as the associated phenomenon of Great Divergence and Demographic Transition.

Unified Growth Theory integrates the main features of the Malthusian economy within a context where the size of population and technology are linked. First, the increase in technological progress and the capital accumulation counterbalance the negative effect of population growth on income per capita highlighted by the Malthusian theory. As proposed by Galor and Weil (2000):

> *"…during the Malthusian epoch, the dynamical system would have to be characterized by a stable Malthusian steady-state equilibrium, but ultimately due to the evolution of latent state variables in this epoch, the Malthusian steady-state equilibrium would vanish endogenously leaving the arena to the gravitational forces of the emerging Modern Growth Regime."*

Galor and Weil (1999, 2000) develop the idea that the acceleration in the rate of technological progress gradually increases the demand for human capital, inducing parents to invest in the quality of their offspring rather than in the quantity. Ultimately, the process of human capital accumulation induces a reduction in fertility rates as far as the growth rate of technological progress increases, what leads to a demographic transition, and sustained growth. The model therefore generates a transition from the Malthusian stagnation to the Modern growth regime. Later on, models incorporating new mechanisms emerge. Galor and Moav (2002) and Lagerlöf (2003) share similar intuitions, by suggesting the existence of innate/inherited preferences in terms of children quality. Based on a unitary approach of the family, Lagerlöf (2003) explains how high-quality preferences may have spread over time and generate higher prosperity and lower fertility – considering changes in gender discrimination in education exogenous. In Cervellati and Sunde (2005), the authors introduce complementary mechanisms/channels based on the relations linking life expectancy, human capital and technological progress. In a simple model, Strulik and Weisdorf (2008) provide a unified theory that captures the interplay between technological progress, mortality, fertility and economic growth. Using a two-sector framework with agriculture and industry, the authors demonstrate how fertility responds differently to productivity and income growth between both sectors. Agricultural productivity and income growth make food, goods, and therefore children, relatively less expensive while industrial productivity and income growth, on the other hand, makes food goods, and therefore children, relatively more expensive. Common to all these models (and to our model) is the central role played by the quantity-quality substitution in the phase transition. Empirically, the existence of a negative correlation between education and fertility has notably been demonstrated by Becker, Cinnirella and Woessmann (2011) with county-level evidence for Prussia in 1816 (and will be investigated for France in Chapter 7).

Unified Growth Theory generates the endogenous driving forces allowing the economy to experience a demographic transition and which ultimately lead to a take-off from the era of stagnation towards a state of sustained economic growth. As highlighted in Section1, Western countries experienced similar patterns of economic and demographic transition. This theory that seems to be consistent with empirical regularities is based on the interaction between four key elements: the building aspects of the Malthusian theory, the engines of technological progress, the origin of human capital accumulation and the triggering forces of the demographic transition. The theory suggests that the acceleration in the pace of technological progress increased the importance of human capital. The rise in the demand for human capital and its impact on the accumulation of human capital led to a decline in fertility and to a rise in living standards.

However, one paradox persists. The French-English paradox (Chesnais, 1992) raises a central question: why demographic development came so late in England and so early in France while economic development was early in England and comparatively late in France. One underlying aspect of the development process may be missing.

2.2.2. Toward a Greater Integration of Gender in UGT

The trends upheaval, highlighted in Part I, strongly question the likely interaction between the rise in gender equality, decline in fertility, increase in human capital and the onset of sustained economic growth. Women related issues have become central to the field of labor economics[67] and economic history (Goldin, 2006). Empirical literature on the link between gender equality and economic development is rather abundant (Schultz, 1995; Dollar and Gatti, 1999; Klasen, 2002; Knowles, Lorgelly and Owen, 2002, among many others). However, the contributions remain rare in the field of economic growth. Few growth models explicitly take into consideration the role played by gender on economic development. Galor and Weil (1996) – based on the assumptions of different gender abilities, Lagerlöf (2003) – taking gender differences as exogenous variables, or more recently De La Croix and Vander Donckt (2010) – focusing especially on the pathways by which improvement in gender equality may affect fertility, are among the few growth theorists having integrated gender differentiation in their model.

On the one hand, non-unified theories of economic growth having integrating gender remain scarce. Galor and Weil (1996) – addressing the issue of the relationship between fertility, gender gap in wages and economic growth with an intertemporal dimension – have engaged a first step toward a better integration of gender in growth theory. Nevertheless, the model focuses on the modern era of economic growth and does not aim at providing a global framework of analysis for the evolution of economies over the entire course of human history. On the other hand, unified theories of growth aim at capturing in a single analytical framework the main characteristics of the process of development but no model has yet tried to consider

[67] Notably with the pioneered work of Jacob Mincer (1962) that contributed to the development of economic analysis in the understanding of household sphere.

endogenous gender equality. Lagerlöf (2003) sets up a model capturing gender stereotypes in which increasing gender equality can account for the important changes in growth rates of income per capita and population, in a unitary approach of the family. However, as De La Croix and Vander Donckt (2010) note, the model does not capture the notion of gender decisional empowerment.

We emphasize the need for more integration of gender within the framework of Unified Growth Theory. The integration of gender may provide new key mechanisms and answers to the transition from Malthusian stagnation to Modern Growth. We have the conviction that the understanding of the global variation in economic development would remain incomplete without integrating and analyzing the variations in gender relations.

Conclusion

The unified theory of growth is developed as an alternative theory of exogenous and endogenous model that can capture the main characteristics of the process of development in a single framework. The Unified Growth Theory sheds light on the driving forces that would enable countries in a state of Malthusian stagnation to take-off towards a state of sustained economic growth. In the Malthusian Regime, the economy remains trapped around a substantial level of output. During the Post-Malthusian Regime, the pace of technological progress accelerated, under the effect of the increase in the population size, and allowed economies to generate a take-off. In the Modern Growth Regime, the output per capita increases along with the rate of population growth and human-capital accumulation (Galor and Weil, 2000). Rapid technological progress, resulting from human capital accumulation, triggers a demographic transition with a constant decrease in fertility rates. The theory of unified growth suggests that the transition from stagnation to sustained growth is an “inevitable by-product” (Galor, 2011) of the process of development.

Other central determinants of the development process have been left out from the first attempts of modeling a unified theory of growth. This left the door open to social scientists and growth theorists to bring to light and explore additional mechanisms of the transition from stagnation to sustained growth. This is the issue were deal with in Chapter 6, through the construction of a unified theory of economic and demographic transitions with gender considerations.

Appendix E

The development process is a complex phenomenon. In order to have a more global view of the full span of human economic history, we chose to imagine what would represent the time span of 4Ma BC-2010 AD in terms of 24 hours-day, inspired by the Snowdown "soccer field of history" (Snowdown, 2008).

Figure E-1(a) illustrates the time span of human history in 24 hours. If humans appeared at 0h00 and if 24 hours have elapsed… Humans are born 3 to 5 million years ago (depending on whether we consider Australopithecus as being Humans or only the type Homo) but let's bring back this period to 24 hours. At the beginning, at 0h00, Humans evolved in an economy of predation, divided into groups of hunters-gatherers, fishers, pickers (using available natural resources without having the control over them). At approximately 21 h 48 min 29 sec, on our one-day scale, the domestication of fire by Homo erectus marks a turning point in the Prehistory (around 450 000 BC).

Figure E-1 : Time Span of Human Economic History in 24 Hours

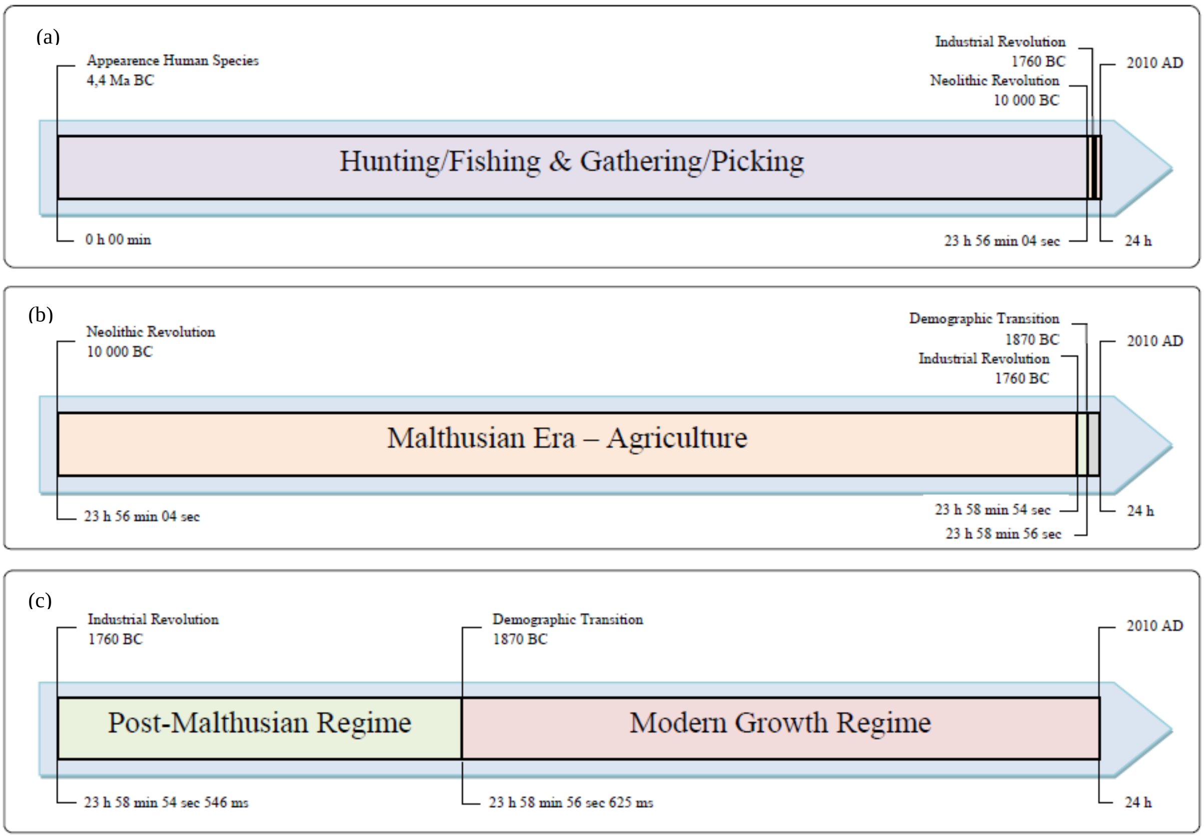


Figure E-1(b) shows that during the last hour of the day of history (10,000BC-2010 AD), the Malthusian Growth Regime dominated human history until the onset of the Industrial Revolution. At about 23 h 56 min 04 sec, the Neolithic Revolution initiates the transition from hunting and gathering towards agriculture and sedentary lifestyle. The livelihood of the population is insured by the production. Then everything accelerates. Figure E-1(c) represents the final 01 min 05 sec 454 ms that has witnessed the demographic transition and the emergence of the modern growth regime. It was 23 h 58 min 54 sec 546 ms when the Industrial Revolution marked the transition from a predominantly agricultural and artisanal society towards a commercial and industrial society (lagged in time and space depending on the considered countries); at 23 h 58 min 56 sec 625 ms, onset of the Demographic Transition with a rise by two or three of the European population.

Chapter 6

Gender Equality and Economic Growth: A Unified Growth Model

Content

Introduction

The relationship between gender equality and long-run economic growth has received little attention from theorists so far. Understanding gender roles is difficult in that it requires a global understanding of family organization and its interaction with the marketplace. The empirical regularities described in the first part of the dissertation have raised the importance of the role played by changes in gender roles in the economic development of societies. Insights from economics suggest the role of women to be a strategic variable in economic development, through its effects on demographic behavior as well as on human-capital formation in the next generation.

This chapter contributes to this literature on unified growth theory by bringing to light new determinants of the economic transition process. Our model incorporates novel and additional mechanisms consistent with observed stylized facts, emphasizing the importance of the role played by women in the development process. Rare are growth models that differentiate the role of men and women in their analysis, considering rather the effect of household decisions on fertility. We choose here to tackle the issue of the development process by a renewed gender approach. The main concern of the study is precisely to show to what extent and through what mechanisms gender equality affects decisions taken by members of the household and acts on long run economic development. We examine mechanisms that are likely to have played an important role in the sequence of events leading to the transition from high birth and death rates to low birth and death rates as countries developed from a pre-industrial to an industrialized economic system.

We develop a unified cliometric growth model that captures the interplay between fertility, technology and income per capita in the transition from stagnation to sustained growth. The theory suggests that female empowerment has been at the origin of the demographic transition and engaged the take-off to Modern economic growth. In line with empirical evidence, the theory characterizes the conditions under which the process of human capital accumulation initiated. Changes in the shares of population acquiring skilled human capital have substantial effects on fertility patterns and affect individuals' living conditions. In particular, we consider a two-sex overlapping-generations framework with two types of human capital and integrating aspects of gender equality. Households' members receive utility from their own consumption and from the potential lifetime income of their children. Therefrom, they decide about the amount of time to invest in the education process and the number of children they want to raise. We consider all childrearing completely done by women. The key state variables for individuals' decisions are the technological environment and the power-imbalance ratio between genders. A rapid change in technological environment increases the return to skilled education and increases both boys' education and fertility, through the income effect. Higher gender equality (triggered by the acceleration of the pace of technological progress) increases girls' education and reduces the total number of children, through the substitution effect. Furthermore, given the assumption that all childrearing is done by women, maternal endowment in human capital is recognized as being primordial in the educative development of children. Ultimately, higher gender equality changes the trade-off from quantity of children toward quality of children. The average level of fertility therefore depends on the skill composition of the population. The different elements of our model lead to a positive feedback loop. At the dynamical level, the increase in gender equality and the rise in technological progress create higher opportunities for women to invest in skilled human capital. The negative correlation linking maternal investments in human capital and fertility encourages families to have fewer children but who are better educated. Dynamically, it affects the incentive for individuals to acquire skilled human capital. Human capital being a factor with increasing returns to scale, the reallocation of resources toward this factor sets the economy on a growing path dependency.

The chapter is divided into two sections. Firstly, we present the basic structure of the model (Section 1). Secondly, we investigate the dynamical evolution of the economy (Section 2).

1. Basic Structure of the Model

We consider an overlapping-generations model in which the activity extends over infinite continuous time, denoted by $T \in \mathbb{R}^+$. The economy is made up of a discrete number of overlapping generations. In every period, the economy produces a single homogenous good, using efficiency units of labor.

Each generation is populated by two types of individuals: males (m) and females (f).[68] Each males and females are endowed with one unit of time that they split up between market work, education, having and rearing children. In the first period of life, individuals only consume a fraction of parental time endowment. We assume that the time cost of childbearing is greater for women, so that $\tau^f \equiv \tau > \tau^m = 0$ (as in Iyigun and Walsh, 2007), with τ the cost of rearing one child.[69] In the second period of life, agents match (randomly) into couples with someone of the opposite sex belonging to the same generation. All adult-members of the households make

[68] Males and females have the same abilities and preferences (contrary to Galor and Weil, 1996) but differ in terms of time cost of childbearing.
[69] A recent study of the *Observatoire des inégalités* (using the Insee "*Emploi du temps 2009-2010*" survey) shows that women still spend twice more time than men taking care and rearing children.

decisions regarding their own education, work and fertility. [70] Each household is therefore composed of several individuals: a man and a woman, with different preferences; and their children. Men and women of generation t face a deterministic level of gender equality θ_t.

1.1. Production

1.1.1. Production of Final Output

The production occurs according to a constant-return-to-scale technology that is subject to endogenous technological progress. The unique consumption good (output) is produced using two factors of production: skilled labor (L^s)[71] and unskilled labor (L^u). The aggregate production function at time t, Y_t, is given by the following CES production function:

$$Y_t = A_t Y(L^u, L^s) = A_t\left[(1-\alpha_t)L_t^{u\rho} + \alpha_t L_t^{s\rho}\right]^{\frac{1}{\rho}}, \tag{1.1}$$

where $\alpha_t \in (0,1)$ is the relative productivity share, $A > 0$ represents the endogenously determined technological level at time t (total factor productivity) and $\rho \in (0,1)$. All factors of production are assumed to earn their marginal products. The returns from each type of labor at time t, respectively unskilled labor, w_t^u, and skilled labor, w_t^s, are:

$$w_t^u = \frac{\partial Y_t}{\partial L_t^u} = A_t(1-\alpha_t)L_t^{u\rho-1}\left[\alpha_t L_t^{s\rho} + (1-\alpha_t)L_t^{u\rho}\right]^{(1-\rho)}/_{\rho}, \tag{1.2}$$

$$w_t^s = \frac{\partial Y_t}{\partial L_t^s} = A_t(\alpha_t)L_t^{s\rho-1}\left[\alpha_t L_t^{s\rho} + (1-\alpha_t)L_t^{u\rho}\right]^{1-\rho}/_{\rho}, \tag{1.3}$$

1.1.2. The Production of Human Capital

Human capital can be defined as the stock of (accumulated) knowledge, skills, competencies, attributes embodied in people that improves their ability to perform labor so as to produce economic value. The benefit from embodying additional knowledge in a person may depend positively on the knowledge he or she already has (Becker, Murphy and Tamura, 1990). In order to earn an income y_t^i that is used for consumption, individuals have to acquire human capital and supplied this human capital to the labor market. The acquisition of human capital requires time. We model the production of human capital as the outcome of an education

[70] Contray to most papers with quantity-quality trade-off, in which education is a decision taken by parents (see for example Galor and Moav, 2002 or Lagerlöf, 2003), we consider that educational investments are those of individuals themselves (as in Cervellati and Sunde, 2005).
[71] Skilled labor constitutes adult workers who have invested a fraction of time in schooling when young.

process involving decisions of parental (maternal) investments in education and decisions of individuals themselves in their own education.

At birth, every individual is endowed with a certain amount of incorporated form of "cultural capital", $h_{t-1} \in [0,1]$. This "cultural capital" is characterized by a set of intellectual qualifications resulting from family environment, and more specifically from parental endowment in human capital. This type of capital is transmitted via the time spent between parent and child. Human capital can be accumulated over time through the education process, which is the institutionalized form of human capital. The effect of parental human capital is reflected by the higher productivity of the amount of time spent by children in their education. The amount of human capital acquired throughout the education process hence depends on the parental endowment in human capital. The larger the human capital embodied in parents (h_{t-1}^i) is, the larger the effectiveness of the education process is, and the larger the resulting impact on human capital (h_t^i) becomes. We assume that the time cost of childbearing is greater for women so that $\tau^f \equiv \tau > \tau^m = 0$, with τ the cost of rearing one child. Therefore, the human capital of each child depends on the incorporated form of human capital of his mother, e.g. of maternal endowment in human capital, rather than the human capital of his father.

We denote e_t^i the amount of time invested by an individual in his own education of either type of human capital, $i = u, s$, unskilled or skilled.[72] The education process differs between these two types of human capital with respect to the time intensity of the education process. There exists a fix cost $\underline{e}$ (in terms of time units) that agents need to pay when acquiring human capital.[73] The acquisition of skilled human capital involves a larger fix cost of education than the acquisition of unskilled human capital, $\underline{e}^s > \underline{e}^u$. As a consequence, the number of year spent working is also lower for a skilled individual. We assume that cultural capital – maternal endowment in human capital – is more important when acquiring advanced skills. For simplicity, we assume that $h_{t-1}^{f,s} = \hbar$ and $h_{t-1}^{f,u} = 1$.

The human capital production function can be written as follows:

(1.4) $$h_t^i = \beta^i\left(e_t^i - \underline{e}^i\right)\left[h_{t-1}^{f,i}\right],$$

with $\forall e \geq \underline{e}^i$; $i = u, s$ and β, the productivity of a unit of education.

[72] Galor and Moav (2002) already introduced two types of individuals: a quality type, *a*, and a quantity type, *b*, of adult individuals, as a determinant of offspring's quality.
[73] Such as in Cervellati and Sunde (2007).

An individual that have received an inherited human capital of type i and acquired human capital by investing e_t^i amount of time in education of type i can earn the lifetime income $y_t^i(\hbar)$, such that :

(1.5) $$y_t^i \equiv y_t^i(\hbar, e_t^i) = w_t h_t^i(\hbar, e_t^i)[1 - e_t^i],$$

The lifetime income results from supplying human capital on the labor market – itself function of maternal human capital. A World Development Report already emphasized in 1993 the importance of women's income on children welfare. The report highlights a stronger effect of the income of mothers on the welfare of children than does an increase in the husbands' income. The concept of human capital (quality) in addition to abilities, competencies or knowledge embodied in individuals also includes health. Educational investment is a source of labor productivity that positively impact wages. Through this channel, it is very likely that women education also have a stronger effect on children's health than do men education (see Currie and Moretti, 2003).

1.1.3. Technological Progress

The technology evolves endogenously. Technological progress is assumed to raise the value of education in the production of human capital.[74] According to Lucas (1988) and Romer (1990), the process of human capital accumulation is a key engine of growth. It occurs through the acquisition of education and training which increases the skills and the productivity of the labor force (and promotes the adoption of new ideas and technologies). This implies for the technological progress to be biased toward high-skill intensive production and to depend on the stock of human capital available in the economy. The arrival of new technologies involves larger factor productivity.

(1.6) $$g_t = \frac{A_t - A_{t-1}}{A_{t-1}} = F(\Lambda_{t-1}, A_{t-1}),$$

The more individuals of a generation invest in skilled education, the more effective is the accumulation of skilled human capital for future generations.

[74] Technological progress reduces the adaptability of existing human capital for the new technological environment. Education lessens the adverse effect of technological progress.

1.2. Individuals

The members of generation t live for two periods: childhood and adulthood. In the first period of life, individuals are children. They consume a fraction of parental time endowment. We assume that individuals make no decisions during childhood but they receive parental education. In the second period of life (adulthood), individuals make decisions about their own education and fertility (time invested in having and rearing children). The remaining period of time is spent on the labor market (either as skilled or unskilled worker). As already stated previously, agents of both genders are assumed to be identical except in their time constraint, so that women only endorse the time cost of childbearing. In the model, women decide endogenously what portion of their lifetime to devote to child rearing. Through their strategies of life, females choose the optimal mixture of quantity and quality of children;[75] and allocate the rest of their time working on the labor market and consuming their wage. The number of efficient units of labor is hence determined by individuals depending on their level of human capital, and number of children.

1.2.1. Preferences and Budget Constraint

Multi-person Dimension Household. – We assume that all individuals get married in the second period of life. The utility function captures the two-sex dimension of the household. Individuals care about their own consumption and about the potential lifetime income of their children.[76] Household preferences are represented by the following *weighted* utility function, which is monotonically increasing, concave and satisfies the standard boundary conditions insuring interior solutions,

$$U\left(c_t^m, c_t^f, y_{t+1} n_t^i\right) = (1-\theta_t) ln c_t^m + \theta_t ln c_t^f + \gamma ln\left(y_{t+1}^i n_t^i\right), \tag{1.7}$$

where c_t^f and c_t^m represent the female (wife) and of the male (husband) consumptions respectively, n_t^i is the total number of children of the couple, y_{t+1}^i denotes the lifetime income of children,[77] $\gamma \in (0,1)$ measures the value attached to the number of offspring relative to the labor-force participation and θ_t represents the female bargaining power within the household decision process.

The bargaining power of the wife in the household decision process is endogenous and assumed to be a function of the stock of human capital of the spouses. It indicates how the level of

[75] We will talk here about fertility as quantity and human capital as quality.
[76] The utility function reflects the trade-off between the resources devoted to own consumption and to raise children.
[77] This generates a link between generations (altruistic preferences).

human capital affects the bargaining power of the female in the decision process. This parameter can be interpreted as a measure of gender equality within the household and is given by:

$$\theta_t = \frac{w_t^f h_t^f}{w_t^f h_t^f + w_t^m h_t^m} \equiv \varphi(h_t^f, h_t^m), \tag{1.8}$$

with h_t^f and h_t^m, the female and male endowments in human capital respectively. $\theta_t \in (0,1)$, $\theta_t = 0$ implies that the decision-making power rests with the husband within the household and $\theta_t = 1$ that the power rests with the wife. Perfect equality between the spouses is reflected by $\theta_t = 1/2$.

Budget Constraint. – Individuals consume according to the time spent on the market. For women, investing in own education and raising children represent a cost in terms of time – time that is not available for market work. Let $\tau n_t^i + e_t^{f,i}$ be the time cost for a female member of generation t raising a child, getting a level of education e_t^i of type i. Thereby, the time spent by women on the labor market is what remains after investing in education and raising children. Men only face a cost of time in terms of education. The time spent by men on the labor market is what remains after getting educated. Let $e_t^{m,i}$ be the time cost for a man of generation t to get the level of education e_t^i of type i. The potential income of men and women is allocated to the consumption, respectively c_t^m and c_t^f. Wife and husband jointly face the following budget constraint – integrating their respective time constraints:

$$c_t^m + c_t^f \leq \left(1 - \tau n_t^i - e_t^{f,i}\right) w_t^{f,i} h_t^{f,i}(\cdot) + \left(1 - e_t^{m,i}\right) w_t^{m,i} h_t^{m,i}(\cdot), \tag{1.9}$$

Similarly to Becker (1960), Barro and Becker (1989), Galor and Weil (2000) and Cervellati and Sunde (2007), our model integrates quantity-quality considerations. The members of the household choose the number of children and their quality, on the basis of the total amount of time they devote raising children and working on the labor market. However, unlike existing models, the trade-off relies here on females' decisions making in the face of the trade-off between fertility and own investment in education.

1.2.2. The Household Choice Problem

Optimization Problem. – The members of a household of generation t have to choose the type of human capital they want to acquire via educational investments, the number of offspring and their respective consumption. In period t, the household solves the following optimization program:

(1.10) $$\{e_t^{fi*}, e_t^{mi*}, n_t^{i*}, c_t^{f*}, c_t^{m*}\} = \text{argmax}\, U_t(c_t^{f*}, c_t^{m*}, y_{t+1}^i n_t^i)$$

subject to:

$$c_t^m + c_t^f \leq (1 - \tau n_t^i - e_t^{f,i}) w_t^{f,i} h_t^{f,i} + (1 - e_t^{m,i}) w_t^{m,i} h_t^{m,i},$$

(1.4) and (1.5) for $i = u, s$

We derive the optimal choices. We obtain the following set of first order conditions with respect to the spousal consumption levels, optimal fertility and optimal investment in education, conditional to the acquisition of a particular type of human capital, i, given by:

(1.11) $$c_t^m = (1 - \theta_t)\left[(1 - \tau n_t^i - e_t^{f,i}) w_t^{f,i} h_t^{f,i} + (1 - e_t^{m,i}) w_t^{m,i} h_t^{m,i}\right],$$

(1.12) $$c_t^f = \theta_t\left[(1 - \tau n_t^i - e_t^{f,i}) w_t^{f,i} h_t^{f,i} + (1 - e_t^{m,i}) w_t^{m,i} h_t^{m,i}\right],$$

(1.13) $$e_t^{m,i} = \frac{1+\underline{e}^i}{2},$$

(1.14) $$e_t^{f,i} = \frac{1+\underline{e}^i - \tau n_t^i}{2},$$

(1.15) $$n_t^i = \frac{\gamma}{(1-\theta_t)} \frac{c_t^m}{\tau w_t^{f,i} h_t^{f,i}},$$

The first order conditions show that the level of consumption of the husband and the wife are proportional. Everything else being equal, the trade-off between the acquisitions of own human capital and fertility faced by women implies that the optimal number of children is decreasing with the time invested by women in education. Thereby, having more children decreases the time invested by women in their education. In addition, a higher fix cost of education for the acquisition of skilled human capital requires a larger time investment in education.

Optimal Solutions. – The household optimal choices of c^f, c^m, n, e^f, e^m, conditional to the type human capital acquired, is obtained solving the system of equation. Hence we establish that levels of consumption of the husband and the wife are proportional and function of the bargaining power distribution within the household.

(1.16) $$c_t^{m*} = \frac{(1-\theta_t)(1-\underline{e}^i)}{(2+\gamma)} (w_t^{f,i} h_t^{f,i} + w_t^{m,i} h_t^{m,i}),$$

(1.17) $$c_t^{f*} = \frac{\theta_t(1-\underline{e}^i)}{(2+\gamma)} (w_t^{f,i} h_t^{f,i} + w_t^{m,i} h_t^{m,i}),$$

The female optimal consumption is increasing with the female marital bargaining power. On the contrary, the male optimal consumption is decreasing with the female bargaining power. Each spouse contributes to a fraction of the household labor earning according to the value of the parameter θ_t. In other words, the distribution of the consumption between spouses is function of the level of gender equality within the household.

At the extreme case $\theta_t = 0$, for instance, the husband contributes fully to the household labor earnings; There is a strong gender gap between spouses. In the opposite case, since $\theta_t = 1/2$ – there is perfect gender equality, both spouses contribute fairly to the household labor earnings.
Educational optimal choices for both member of the household are given by the following equations:

(1.18) $$e_t^{m*} = \frac{1+\underline{e}^i}{2},$$

(1.19) $$e_t^{f*} = \frac{\left(1+\underline{e}^i\right)}{2} - \frac{\gamma(1-\underline{e}^i)}{2\theta_t(2+\gamma)} = e_t^{m*} - \frac{\gamma(1-\underline{e}^i)}{2\theta_t(2+\gamma)},$$

Male optimal level of education is function of the fix cost of education. A higher cost of education in terms of time units requires a larger amount of time invested in education. The optimal level of female education displays a similar positive impact of the educational cost on the amount of time invested in education. Furthermore, as female optimal education is increasing with the female marital bargaining power, stronger is the power of the wife within the household, higher is the time she invests in her education.

The household optimal fertility is given by:

(1.20) $$n_t^{i*} = \frac{\gamma(1-\underline{e}^i)}{\tau(2+\gamma)} \frac{\left(w_t^{f,i}h_t^{f,i} + w_t^{m,i}h_t^{m,i}\right)}{w_t^{f,i}h_t^{f,i}} \equiv \frac{\gamma(1-\underline{e}^i)}{\theta_t \tau(2+\gamma)},$$

The investigation of the optimal choice of fertility raises the central role played by the wife within the household decision-making. The optimal fertility is decreasing with the female marital bargaining power. Lower is the bargaining power (*male-breadwinner model*) of the wife within the household; higher is the number of offspring. Conversely, higher is the gender equality (*dual-earning model*); lower is the optimal number of children. Additionally, we note from the equation (1.20) the existence of a negative relationship between quantity and quality of children. The fix cost of education impacts negatively the optimal number of children.

1.2.3. Choice of Human Capital and Fertility

We consider two types of human capital: the skilled and the unskilled human capital. The choice between each type of human capital depends partly on the level of wages, but also on returns from education and technology. The approach used in what follows shares similarities with Galor and Moav (2002) and Cervellati and Sunde (2007). Substituting $e_t^{m,s*}$ and $e_t^{m,u*}$; as well as $e_t^{f,s*}$ and $e_t^{f,u*}$ in the expression of production function of human capital, we obtain the respective male and female levels of human capital:

(1.21) $$h_t^{m,i*}(\hbar) = \beta^i \frac{(1-\underline{e}^i)}{2} h_{t-1}^{f,i},$$

(1.22) $$h_t^{f,i*}(\hbar) = \beta^i \frac{(1-\underline{e}^i)}{2} \left(1 - \frac{\gamma}{\theta(2+\gamma)}\right) h_{t-1}^{f,i},$$

For any males and females endowed with maternal human capital, $\hbar$, there exists unique levels of education, $e_t^{m,i*}$ and $e_t^{f,i*}$, and level of fertility, n_t^{i*}, maximizing their utility, conditional to the type of human capital acquired. Individuals with higher maternal human capital have a comparative advantage in acquiring skilled human capital. Therefore, the number of individuals endowed with the skilled type of human capital increases in $\hbar$. On the contrary, unskilled human capital does not depend on maternal human capital. There exist a unique threshold of parental human capital, $\hat{\hbar}_t$, such that individuals are indifferent between acquiring skilled or unskilled type of human capital (equalizes their utility).

(1.23) $$\hat{\hbar}_t = \beta \frac{w_t^u}{w_t^s} \left(\frac{1-\underline{e}^u}{1-\underline{e}^s}\right)^{2+\gamma},$$

For a given distribution of maternal human capital, $d(\hbar)$,[78] the threshold $\hat{\hbar}$ determines the fraction of individuals acquiring skilled human capital. This threshold is a monotonically increasing function of the relative wage between unskilled and skilled human capital, (w_t^u/w_t^s). (*Proof* – See Appendix F.1)

(1.24) $$(1-\Lambda_t) = \int_0^{\hat{\hbar}} d(\hbar)d\hbar = \hat{\hbar} \text{ and } \Lambda_t = \int_{\hat{\hbar}}^1 d(\hbar)d\hbar = (1-\hat{\hbar}),$$

Thereby, all agents with $\hbar > \hat{\hbar}$ acquire skilled human capital (a fraction Λ_t of the population) while all agents with $\hbar < \hat{\hbar}$ acquire unskilled human capital (a fraction $1-\Lambda_t$ of the population). Higher is the skilled wage, lower is the relative wage and bigger is the fraction of

[78] $d(\hbar)$ denotes the distribution of "cultural capital" within a given generation of new individuals.

people acquiring skilled human capital. For any level of maternal human capital there is a unique optimal level of education and level of fertility which maximize the utility function. According to equation (1.29) and (1.30), the acquisition of skilled rather than unskilled human capital induces individuals to spend more time on education ($e_t^{s*} > e_t^{u*}$) and to have a lower number of children ($n_t^{s*} < n_t^{u*}$). The difference of fertility obtained, conditionally to the type of education, is one of the most (if not the most) fundamental ingredient in the model.

The maternal human capital is conditional to the choices of education and fertility that depend on *cultural* and technological environment. One of the key determinants of educational investments is the rate of technological progress. Through this channel, the rate of technological change affects gender roles by increasing female marital bargaining power – what drives to higher equality between men and women.
Choices of human capital type and optimal fertility are function of the time spent by individuals in education. The acquisition of skilled rather than unskilled human capital induces individuals to spend more time on skilled education and to have fewer children. Conversely, individuals investing in unskilled education have more children. Differential fertility emerges since the acquisition of skilled human capital induces girls to substitute utility from the number of children to utility from consumption. Ultimately, these mechanisms drive to a fertility transition.

The threshold of parental human capital, making an individual indifferent between acquiring skilled or unskilled human capital, $\hat{h}_t$, is decreasing in gender equality, θ. It induces a larger share of the population to optimally acquire formal education, Λ_t. Any change in the fraction of individuals acquiring skilled and unskilled human capital, i.e. the skill composition of the population, Λ_t, impacts the average fertility of the population. For any $\{A_t, \theta_t, g_t\}$, the average fertility is given by the following equation:

(1.25) $$n_t^{i*} = (1-\Lambda_t)n_t^u + \Lambda_t n_t^s \equiv \frac{\gamma}{(2+\gamma)} \frac{\left(1-\underline{e}^u(1-\Lambda_t)-\Lambda_t \underline{e}^s\right)}{\tau\theta_t},$$

with $\frac{\partial n_t^*}{\partial \theta_t} < 0.$

Gender equality is a key determinant of average fertility. The fertility rate is negatively correlated with the level of gender equality within the population. Improvements in θ induce more people to acquire education (especially girls). Henceforth, improvements in gender equality induce a generalized decline in fertility. An economy with lower gender equality is characterized by lower fertility rate. Gender equality in the form of female marital bargaining power affects fertility by inducing a change in the female optimal choice of education time and in the type of education. Finally, an increase in female human capital is associated with reduction of the number of children and an increase in their quality. Associated together, the different effects of technological progress and gender equality can account for the demographic and the economic transition, such that fertility decreases, education expands and growth reaches a sustained level.

1.3. Distribution of Labor Types

The aggregate levels of each type of human capital are given by:

$$L_t^u = H_t^u(\hat{\hbar}) = N_t \int_0^{\hat{\hbar}} h_t^u(\hat{\hbar}) d(\hbar) d\hbar, \tag{1.26}$$

$$L_t^s = H_t^s(\hat{\hbar}) = N_t \int_{\hat{\hbar}}^1 h_t^s(\hat{\hbar}) d(\hbar) d\hbar, \tag{1.27}$$

There exists a unique threshold of “cultural capital” (derived from maternal endowment in human capital) that splits the population between individuals acquiring skilled and unskilled human capital. From (1.2) and (1.3), we determine the unskilled-to-skilled wage rates on competitive markets.

$$\frac{w_t^u}{w_t^s} = \frac{1-\alpha_t}{\alpha_t} \left(\frac{L_t^u}{L_t^s}\right)^{\rho-1}, \tag{1.28}$$

The wage ratio depends on the ratio of the aggregate level of unskilled and skilled human capital. (*Proof* – See Appendix F.2)

2. The Dynamic Evolution of the Economy

2.1. Dynamic Evolution of the Key Variables

The evolution of the economy is characterized by demographic and economic transitions. In particular, the development of the economy is characterized by the evolution of educated people, technological level and gender equality. The global dynamics of the economy is described by the trajectory of gender equality θ_t, the share of the population acquiring skilled human capital Λ_t and the total factor productivity. We can study the dynamic development of the economic by analyzing the evolution of the key state variables over generations. The evolution of the economy is fully described by a sequence $\{\Lambda_t, \theta_t, \alpha_t\}_{t=0}^{\infty}$, resulting from the evolution of the three-dimensional nonlinear first-order system.

2.1.1. The Fraction of Skilled Individuals

The equilibrium fraction of the population acquiring human capital is monotonically increasing in θ_t. The higher the gender equality, the more people invest in the acquisition of skilled human capital. Intuitively, for low levels of gender equality the fraction of skilled individuals is small. There is no accumulation of human capital and the returns from investing in skilled education do not worth the effort. Very large improvements in gender equality are necessary to make individual invest in skilled education and then to allow for human capital accumulation. The equilibrium fraction of the population acquiring human capital also depends on the technological environment – is increasing in the relative productivity of skilled human capital intensive sector, α_t. The labor market condition equilibrium is given by:

(2.1) $$\Lambda_t = \boldsymbol{\Lambda}(\theta_t, \alpha_t),$$

which is an increasing and S-shaped function of θ_t.

2.1.2. Dynamic Evolution of Gender Equality

Based on historical evidence, we suggest that gender equality is function of the stock of skilled human capital of spouses (measuring human capital on the bargaining power distribution), such that gender equality increases with individuals human capital. In particular, gender equality is linked with the distribution of knowledge embodied in individuals in the previous generation, $t-1$ (function of the average stock of female skilled human capital), through the time invested in skilled education (e_{t-1}^{s}). The dynamic evolution of gender equality can be expressed as:

(2.2) $$\theta_t = \boldsymbol{\Theta}(\theta_{t-1}, \Lambda_{t-1}),$$

This expression involves that gender equality is increasing with the share of individuals (within the parental generation) acquiring skilled human capital.

2.1.3. Process of Technological Process

The process of technological change depends on the stock of skilled human capital (biased toward skill-intensive sector of production). The available stock of human capital in a generation t makes human capital more profitable to acquire for future generations. The dynamic evolution of technological progress is given by:

(2.3) $$g_t = \boldsymbol{G}(\Lambda_{t-1}, A_{t-1}),$$

which implies that the productivity A_t increases with the aggregate level of skilled human capital of a generation using the previous technology available in the economy. This level of technology is then function of the fraction of skilled people in the parent generation, as well as the level of productivity achieved in $t-1$.

2.2. The Dynamical System

In order to characterize the dynamic development of the economy, we study the trajectory of three key variables over generations. The path of the economy is entirely described by the sequence $\{\Lambda_t, \theta_t, \alpha_t\}_{t=0}^{\infty}$, according to the evolution of the nonlinear first-order dynamic system of equations:

$$(2.4) \qquad \begin{cases} \Lambda_t = \boldsymbol{\Lambda}(\theta_t, \alpha_t) \\ \theta_t = \boldsymbol{\Theta}(\theta_{t-1}, \Lambda_{t-1}) \\ g_t = \boldsymbol{G}(\Lambda_{t-1}, \alpha_{t-1}) \end{cases},$$

The dynamic path of Λ, θ and α describes the joint evolution of the share of individual acquiring skilled education, gender equality and the relative productivity share (of each type of labor), given initial conditions Λ_0, θ_0 and α_0. The dynamic path does not depend on population size (no scale effect). We focus on the sub-system of equations, conditional on the value of the productivity share, α_t, in order to illustrate the development dynamics. It results from the labor market equilibrium and the intergenerational externality on gender equality:

$$(2.5) \qquad \begin{cases} \Lambda_t = \boldsymbol{\Lambda}(\theta_t, \alpha_t) \\ \theta_t = \boldsymbol{\Theta}(\theta_{t-1}, \Lambda_{t-1}) \end{cases},$$

The system delivers the dynamics of human capital formation and gender equality for a given relative productivity share $\alpha > 0$. Any steady-state of the sub-system of equation is characterized by the intersection of $\boldsymbol{\Lambda}$ and $\boldsymbol{\Theta}$.

Given the non-linearity of $\boldsymbol{\Lambda}$ (S-shape trajectory), the dynamic sub-system is characterized by three different configurations that exhibit from one to three steady-state equilibriums. There are two stable and one unstable steady-state. The low steady state equilibrium is characterized by low gender equality and a small share of population acquiring skilled human capital. On the opposite, the high steady-state equilibrium is characterized by high gender equality and a relatively large fraction of population acquiring skilled human capital.

Figure 6-1 : The Conditional Dynamic System

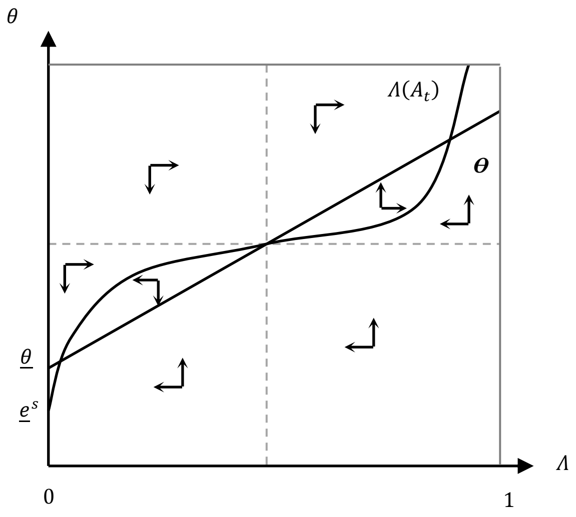


Figure 6-1 illustrates the system under the existence of three steady-state equilibriums. The state of the value of the productivity affects the relative returns from skilled human capital. A higher productivity, A, increases the returns to skilled human capital and the associated equilibrium fraction of individuals, Λ.

2.3. The Global Dynamics of Development

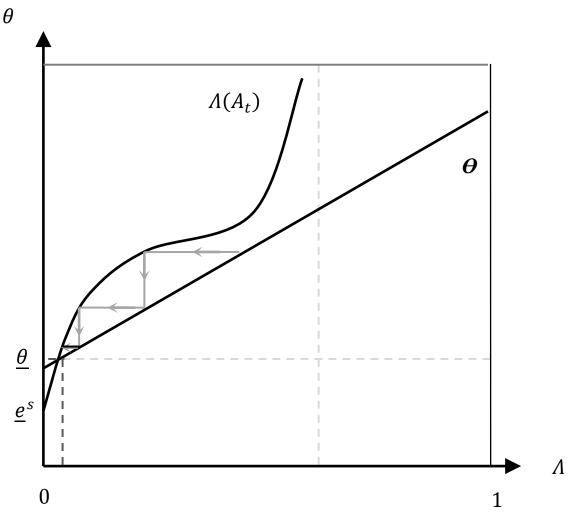
The evolution of the economy has to account for the evolution of all state variables. We focus here on the entire path of development: from stagnation to sustained growth. Then, how can economies move from the Malthusian trap of stagnation (with high fertility) to an era of sustained growth (with low fertility)? We emphasize the existence of three main stages of development: the early stage of development ("*Non-developed economy*"), the transitory stage – toward the development ("*Transitory economy*") and the final stage of development ("*Developed economy*").

2.3.1. Non-Developed Economy

Non-developed economies are characterized by low gender equality $\underline{\theta}$ (close to its minimum) and low value of productivity A_0 (initial level). According to these conditions, investing in skilled human capital is costly for a large majority of the population. Thereby, the fraction of individuals acquiring skilled human capital Λ is very low. The corresponding average fertility reflects those of individuals acquiring unskilled human capital (high fertility).

Graphically (Figure 6-2), every intersection of the locus Θ and $\boldsymbol{\Lambda}$ represents an equilibrium. With initial low level of gender equality and low changes in technological progress, the dynamic system exhibits a unique globally stable steady-state equilibrium.

Figure 6-2 : The Early Stage of the Development Process



In a non-developed economy, gender equality and technological progress are close to their minimum, $\theta_0 \simeq \underline{\theta}$ and $A_0 \simeq 0$. The conditional system exhibits a unique steady state with few individuals acquiring skilled human capital h^s, $\Lambda_0 \simeq 0$, and with large fertility rates.

(2.6) $$n \simeq \frac{\gamma}{\underline{\theta}(2+\gamma)} \frac{(1-e^u)}{\tau},$$

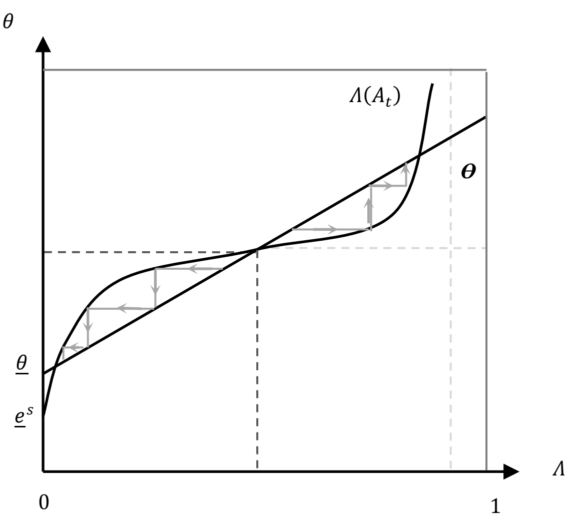
At this stage of development, the economy is characterized by an extended phase with low living standards, low gender equality and large fertility.

2.3.2. Transitory Economy

As emphasized previously, Western countries experienced both an economic and a demographic transition. This transition account for a switchover from an environment characterized by low income per capita, low investments in education and high fertility to economy characterized by high living standards, a high share of the population investing in education and low number of children per women. Endogenous skill biased technological change leads to a monotonic increase in the importance of skilled human capital for production (by reinforcing the adoption of new ideas and technologies). Therefore, as generations pass, productivity growth makes investing in skilled education more profitable. However, as long as a critical level of gender equality is not reached, the process of human capital accumulation cannot start.

Graphically (Figure 6-3), productivity growth increases the convex part of the curve $\boldsymbol{\Lambda}$. The dynamic equilibrium moves along Θ triggering improvements in gender equality. Fertility remains high since the fraction of skilled individual is low. $\boldsymbol{\Lambda}$ slowly shifts downwards and after sufficiently many generations $\boldsymbol{\Lambda}$ exhibits three intersections with Θ, which are multiple equilibria: two locally stable steady-states and an interior unstable steady-state. In the absence of large shocks, the economy remains at the low steady-state equilibrium.

Figure 6-3 : The Transitory Stage of the Process of Development



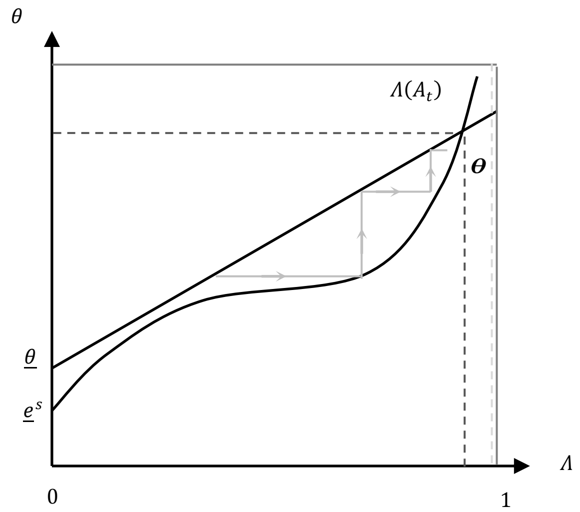
During this stage of development, the economy experiences increases in θ_t, Λ_t, income per capita (y_t) and technological level A_t. At this transitory stage of development, the economy is characterized by improvements in living standards, low gender equality and large fertility.

2.3.3. Developed Economy

In contrast to early stages of development, mature stages of development are characterized by advanced technology and high living standard. Gender equality is high, close to its maximum $\overline{\theta}$. Given these characteristics, investing in skilled human capital is much cheaper than in less advanced economy. As a consequence, the very large majority of the population acquires skilled human capital. Thereby, the fraction of individuals acquiring skilled human capital Λ is very high. The corresponding average fertility reflects those of individuals acquiring unskilled human capital (low fertility).

In other words, the reach of a specific threshold in gender empowerment engages the process of human capital accumulation. Due to larger educational investments (in terms of time units), the female opportunity cost of having children increases and average fertility declines. Accordingly, households have fewer children but each of them is endowed with a higher quality of parental human capital – what *de facto* increases the ability of children to succeed in education and allow them to become in turn skilled individuals. From generations to generations, the fraction of skilled individuals increases and generates a positive feedback loop, impacting positively the rate of technological progress and the value of productivity. Ultimately, the economy experiences both a demographic and economic transition driven by improvements in gender equality.

Figure 6-4 : The Late Stage of the Process of Development



Graphically (Figure 6-4), as $\boldsymbol{\Theta}$ and $\boldsymbol{\Lambda}$ shift downwards, the dynamic equilibrium exhibits a unique globally stable steady-state (a single intersection between the two curves). Once gender equality growth to a high level, $\overline{\theta}$, a substantially large fraction of the population decide to acquire skilled human capital. Therefore, it triggers a period of rapid development (transition in living conditions) and the economy converges to the globally stable steady-state.

In a developed economy, with $A_0 \simeq 1$, the conditional system exhibits a unique steady state where almost all the population acquire skilled human capital, $\Lambda \simeq 1$; gender equality is high $\theta \simeq \overline{\theta}$ and fertility rates are low,

(2.7) $$n \simeq \frac{\gamma}{\overline{\theta}(2+\gamma)} \frac{(1-e^S)}{\tau},$$

At this mature stage of development, the economy is characterized by an extended phase with high living standards, high gender equality and low fertility.

Proposition – The economy is characterized by the three main following phases:

(i) Along phase of stagnation with low female bargaining power $\theta_0 \cong \underline{\theta}$, few individuals acquiring human capital h^s, $\Lambda_0 \cong 0$ and large fertility rates;

(ii) A rapid transition inducing a strong increase in female bargaining power (θ_t), in the share of the population acquiring skilled human capital (Λ_t), in income per capita (y_t) and technological progress (A_t);

(iii) A phase of sustained growth in technology and income with high female bargaining power $\theta_\infty \cong \bar{\theta}$, almost all population acquiring skilled human capital h^s, $\Lambda_\infty \cong 1$ and low fertility rates.

(See Appendix F.3)

Conclusion

The development process is characterized by the evolution of economies from an era of stagnation to the demographic transition and the Modern Growth through the post-Malthusian Regime (such as in Galor and Moav, 2002). Our model provides a new approach, complementary to existing unified models, notably those of Galor, with new mechanisms and new answers on how economies managed to escape the Malthusian trap to reach a state of sustained growth and to experience a demographic transition. In our model, the prime driving forces in this transition emerge from gender empowerment, as depicted by the phase diagrams (Figure 6-2 to 6-4).

More specifically, we develop a unified cliometric growth model that encompasses the interplay between income, gender equality and fertility. Our model suggests that gender empowerment is a crutial factor of both demographic and economic transition. In particular, the theory points out that the acceleration of skill-biased technological progress generates a positive externality on the level of gender equality. Both wages and gender equality are key variables in the education decision process of individuals. More specifically, higher gender equality reinforces individuals' incentives to acquire skilled human capital. In turn, female choices in terms of time and quality of educational investments increase their endowment in human capital and impact positively the fraction of the subsequent generation of individuals acquiring skilled education. In other words, improvements in technological progress, gender equality and skilled human capital reinforce each other. Ultimately, the presence of a sufficiently high fraction of skilled individuals in the population yields to sustained economic growth.

In the early stage of development, the low rate of technological progress does not provide any incentive to invest in skilled education. Therefore, the fraction of skilled individuals is low and the economy remains trapped in the Malthusian steady-state equilibrium, with low education, low living standard and low gender equality. Technological progress is assumed to increase monotonically from generation to generation. Thereby, as technological progress grows, we observe a qualitative change, and the subsequent income effect triggers (temporarily) higher fertility rates. After sufficiently many generations, increases in the returns from investments in skilled education (productivity growth) – driven by the rise in technological progress – makes investing in skilled education more profitable so that gender equality improves. The dynamical system of skilled human capital and gender equality is therefore characterized by multiple steady-state equilibriums. Since gender equality becomes high enough, a substantially larger fraction of individuals acquires skilled human capital what triggers rapid developments and reinforces gender equality. Due to larger educational investments (in terms of time units), female opportunity cost of having children increases and average fertility declines: the demographic transition occurs along with the process of human capital accumulation. Ultimately, in later stage of development, gender equality and the fraction of skilled individuals converge towards their maximum. Thereby, the economy is characterized by the Modern Growth steady-state equilibrium, where living standards are high, gender equality is high and fertility is low.

Appendix F

Appendix F.1 – *Proof*

The indirect utility receives from investing in both types of human capital is given by:

$$U\left(c_t^m, c_t^f, y_{t+1} n_t^i\right) = (1-\theta_t) lnc_t^{m*} + \theta_t lnc_t^{f*} + \gamma ln\left(y_{t+1}^i n_t^{i*}\right)$$

Substituting for c_t^{m*}, c_t^{f*} and n_t^{i*}, we obtain the following indirect utility function.

$$(1-\theta_t)\ln\left[\frac{(1-\theta_t)\left(1-\underline{e}^i\right)}{(2+\gamma)}(w_t^{f,i}h_t^{f,i} + w_t^{m,i}h_t^{m,i})\right] + \theta_t ln\left[\frac{\theta_t\left(1-\underline{e}^i\right)}{(2+\gamma)}(w_t^{f,i}h_t^{f,i} + w_t^{m,i}h_t^{m,i})\right]$$
$$+ \gamma ln\left(y_{t+1}^i \frac{\gamma(1-\underline{e}^i)}{\theta_t\tau(2+\gamma)}\right)$$

What is equivalent to what follows:

$$\left[\frac{(1-\theta_t)\left(1-\underline{e}^i\right)}{(2+\gamma)}(w_t^{f,i}h_t^{f,i} + w_t^{m,i}h_t^{m,i})\right]^{(1-\theta_t)} \left[\frac{\theta_t\left(1-\underline{e}^i\right)}{(2+\gamma)}(w_t^{f,i}h_t^{f,i} + w_t^{m,i}h_t^{m,i})\right]^{\theta_t} \left(y_{t+1}\frac{\gamma(1-\underline{e}^i)}{\theta_t\tau(2+\gamma)}\right)^{\gamma}$$

We compare the indirect utility function of a unskilled and a skilled individual.

$$\left[\frac{(1-\theta_t)\left(1-\underline{e}^u\right)}{(2+\gamma)}(w_t^{f,u}h_t^{f,u} + w_t^{m,u}h_t^{m,u})\right]^{(1-\theta_t)} \left[\frac{\theta_t\left(1-\underline{e}^u\right)}{(2+\gamma)}(w_t^{f,u}h_t^{f,u} + w_t^{m,u}h_t^{m,u})\right]^{\theta_t} \left(\frac{\gamma(1-\underline{e}^u)}{\theta_t\tau(2+\gamma)}\right)^{\gamma}$$
$$\equiv \left[\frac{(1-\theta_t)\left(1-\underline{e}^s\right)}{(2+\gamma)}(w_t^{f,s}h_t^{f,s} + w_t^{m,s}h_t^{m,s})\right]^{(1-\theta_t)} \left[\frac{\theta_t\left(1-\underline{e}^s\right)}{(2+\gamma)}(w_t^{f,s}h_t^{f,s} + w_t^{m,s}h_t^{m,s})\right]^{\theta_t} \left(\frac{\gamma(1-\underline{e}^s)}{\theta_t\tau(2+\gamma)}\right)^{\gamma}$$

$$\Leftrightarrow \left[\frac{\left(1-\underline{e}^u\right)}{(2+\gamma)}(w_t^{f,u}h_t^{f,u} + w_t^{m,u}h_t^{m,u})\right]^{(1-\theta_t)} \left[\frac{\left(1-\underline{e}^u\right)}{(2+\gamma)}(w_t^{f,u}h_t^{f,u} + w_t^{m,u}h_t^{m,u})\right]^{\theta_t} \left(\frac{\gamma(1-\underline{e}^u)}{\theta_t\tau(2+\gamma)}\right)^{\gamma}$$
$$\equiv \left[\frac{\left(1-\underline{e}^s\right)}{(2+\gamma)}(w_t^{f,s}h_t^{f,s} + w_t^{m,s}h_t^{m,s})\right]^{(1-\theta_t)} \left[\frac{\left(1-\underline{e}^s\right)}{(2+\gamma)}(w_t^{f,s}h_t^{f,s} + w_t^{m,s}h_t^{m,s})\right]^{\theta_t} \left(\frac{\gamma(1-\underline{e}^s)}{\theta_t\tau(2+\gamma)}\right)^{\gamma}$$

$$\Leftrightarrow \left[\left(1-\underline{e}^u\right)(w_t^{f,u}h_t^{f,u} + w_t^{m,u}h_t^{m,u})\right]^{(1-\theta_t)} \left[\left(1-\underline{e}^u\right)(w_t^{f,u}h_t^{f,u} + w_t^{m,u}h_t^{m,u})\right]^{\theta_t}\left((1-\underline{e}^u)\right)^{\gamma}$$
$$\equiv \left[\left(1-\underline{e}^s\right)(w_t^{f,s}h_t^{f,s} + w_t^{m,s}h_t^{m,s})\right]^{(1-\theta_t)} \left[\left(1-\underline{e}^s\right)(w_t^{f,s}h_t^{f,s} + w_t^{m,s}h_t^{m,s})\right]^{\theta_t}\left((1-\underline{e}^s)\right)^{\gamma}$$

$$\Leftrightarrow \left[\left(1-\underline{e}^u\right)w_t^u(h_t^{f,u} + h_t^{m,u})\right] \ \left(1-\underline{e}^u\right)^{\gamma} \equiv \left[\left(1-\underline{e}^s\right)w_t^s(h_t^{f,s} + h_t^{m,s})\right] \ \left(1-\underline{e}^s\right)^{\gamma}$$

$$\Leftrightarrow \left[(1-\underline{e}^u) w_t^u \beta^u \left(\frac{1-\underline{e}^u}{2}\left(2-\frac{\gamma}{\theta(2+\gamma)}\right)\right)\right] \ (1-\underline{e}^u)^\gamma$$

$$\equiv \ \left[(1-\underline{e}^s) w_t^s \beta^s \left(\frac{1-\underline{e}^S}{2}\left(2-\frac{\gamma}{\theta(2+\gamma)}\right)\hbar\right)\right] \ (1-\underline{e}^s)^\gamma$$

$$\Leftrightarrow \ \left[(1-\underline{e}^u) w_t^u \beta^u (1-\underline{e}^u)\right] \ (1-\underline{e}^u)^\gamma \equiv \left[(1-\underline{e}^s) w_t^s \beta^s (1-\underline{e}^S)\hbar\right] \ (1-\underline{e}^s)^\gamma$$

$$\Leftrightarrow \left[w_t^u \beta^u (1-\underline{e}^u)^2\right] \ (1-\underline{e}^u)^\gamma \equiv \ \left[w_t^s \beta^s (1-\underline{e}^s)^2 \hbar\right] \ (1-\underline{e}^s)^\gamma$$

$$\Leftrightarrow w_t^u \beta^u \ (1-\underline{e}^u)^{2+\gamma} \equiv \ w_t^s \beta^s \, \hbar (1-\underline{e}^s)^{2+\gamma}$$

$$\Leftrightarrow \ \hbar \ = \frac{w_t^u \beta^u}{w_t^s \beta^s}\left(\frac{1-\underline{e}^u}{1-\underline{e}^s}\right)^{2+\gamma} \ \Leftrightarrow \ \hat{\hbar} \ = \frac{w_t^u \beta^u}{w_t^s \beta^s}\left(\frac{1-\underline{e}^u}{1-\underline{e}^s}\right)^{2+\gamma}$$

Appendix F.2 – *Proposition*

Equilibrium average human capital of both types and each gender for generation t. Taking the distribution as being uniform, we obtain:

$$\begin{cases} h_t^{m,u*}(\hbar) = \beta^u \frac{(1-\underline{e}^u)}{2} h_{t-1}^{f,u} \\ h_t^{m,s*}(\hbar) = \beta^s \frac{(1-\underline{e}^s)}{2} h_{t-1}^{f,s} \end{cases} \Leftrightarrow \begin{cases} h_t^{m,u*}(\hbar) = \beta^u \frac{(1-\underline{e}^u)}{2} \hbar \\ h_t^{m,s*}(\hbar) = \beta^s \frac{(1-\underline{e}^s)}{2} \frac{(1-\hbar^2)}{2} \end{cases}$$

$$\begin{cases} h_t^{f,u*}(\hbar) = \beta^u \frac{(1-\underline{e}^u)}{2}\left(1-\frac{\gamma}{\theta(2+\gamma)}\right) h_{t-1}^{f,u} \\ h_t^{f,s*}(\hbar) = \beta^s \frac{(1-\underline{e}^s)}{2}\left(1-\frac{\gamma}{\theta(2+\gamma)}\right) h_{t-1}^{f,s} \end{cases} \Leftrightarrow \begin{cases} h_t^{f,u*}(\hbar) = \beta^u \frac{(1-\underline{e}^u)}{2}\left(1-\frac{\gamma}{\theta(2+\gamma)}\right) \hbar \\ h_t^{f,s*}(\hbar) = \beta^s \frac{(1-\underline{e}^s)}{2}\left(1-\frac{\gamma}{\theta(2+\gamma)}\right) \frac{(1-\hbar^2)}{2} \end{cases}$$

$$h_t^u(\hbar) = h_t^{f,u}(\hbar) + h_t^{m,u}(\hbar) = \beta^u \frac{(1-\underline{e}^u)}{2}\left(1-\frac{\gamma}{\theta(2+\gamma)}\right)\hbar + \ \beta^u \frac{(1-\underline{e}^u)}{2}\hbar$$

$$\Leftrightarrow h_t^u(\hbar) = \beta^u \frac{(1-\underline{e}^u)}{2}\hbar\left[2-\frac{\gamma}{\theta(2+\gamma)}\right]$$

$$h_t^s(\hbar) = h_t^{f,u}(\hbar) + h_t^{m,u}(\hbar) = \beta^s \frac{(1-\underline{e}^s)}{2}\left(1-\frac{\gamma}{\theta(2+\gamma)}\right)\frac{(1-\hbar^2)}{2} + \beta^s \frac{(1-\underline{e}^s)}{2}\frac{(1-\hbar^2)}{2}$$

$$\Leftrightarrow h_t^s(\hbar) = \beta^s \frac{(1-\underline{e}^s)(1-\hbar^2)}{2}\left[2-\frac{\gamma}{\theta(2+\gamma)}\right]$$

The wage ratio is given by:

$$\frac{w_t^{uS}}{w_t^s} = \frac{1-\alpha_t}{\alpha_t}\left(\frac{L_t^u(\hat{\hbar}_t)}{L_t^s(\hat{\hbar}_t)}\right)^{\rho-1} \quad \Leftrightarrow \quad \frac{w_t^{uS}}{w_t^s} = \frac{1-\alpha_t}{\alpha_t}\left(\beta \frac{(1-\underline{e}^u)}{(1-\underline{e}^s)}\frac{(1-\hbar^2)}{2\hbar}\right)^{\rho-1}$$

We substitute h_t^u and h_t^s and the wage ratio into condition (1.23): $\hat{\hbar} = \frac{w_t^u \beta^u}{w_t^s \beta^s}\left(\frac{1-\underline{e}^u}{1-\underline{e}^s}\right)^{2+\gamma}$

$$\left(\frac{(1-\hbar^2)^{1-\rho}}{\hbar^{2-\rho}}\right)^{2+\gamma}\left[\left(\frac{1-\alpha_t}{\alpha_t}\right)^{2+\gamma}\left(\frac{1}{2}\right)^{(1-\rho)/(2+\gamma)}\beta^{\rho(2+\gamma)}\right]\left(\frac{1-\underline{e}^u}{1-\underline{e}^s}\right)^{1+\rho/(2+\gamma)} = 1$$

Appendix F.3 – *Proposition*

For any level of gender equality θ, the equilibrium $\hbar$ is an implicit function of α. By implicit differentiation of (2.1), $\partial\hat{\hbar}/\partial\alpha < 0$. It implies that the equilibrium share of skilled agents in increasing in α ($\partial\Lambda/\partial\alpha > 0$) for any θ. Graphically, an increase in α moves the locus Λ upwards.

In addition, from (2.1),

- if $\alpha = 0$, then $\hat{\hbar} = 0$ and $\Lambda = 0$ for all θ (while $\overline{\Lambda}(0) \simeq 0$; $\forall\theta \in (\underline{e}^s, \infty)$ what implies that only a very small fraction of the population acquires skilled human capital irrespective of θ). For $\alpha \simeq 0$, Θ and Λ cross only once for $\Lambda = 0$ and $\theta = \underline{\theta}$. The average fertility is therefore given by n^u, as implied by (3.15) evaluated at $\underline{\theta}$ what implies (31).
- if $\alpha = 1$, from (29), $\hat{\hbar} = 1$ and $\Lambda = 1$ (while $\overline{\Lambda}(1) \simeq 1$). From (2.2), this implies that $\theta = \overline{\theta} \in (\underline{e}^s, \infty)$. The average fertility is therefore given by n^s, as implied by (1.15).

Taking into consideration the three different stage of development:

- *Early stage of development:*
  With A_0 sufficiently low such that $x_0 \simeq 0$, and $\Lambda_0 \simeq 0$, $\theta = \underline{\theta}$, from (1), (1.26) and (1.27), the level of income per capita is, arbitrarily low, so that from fertility given in (2.6).

  ⇨ Conditional system (2.5) characterized by a unique steady-state.

- *Transitory stage of development:*
  For any θ, $\partial\Lambda/\partial\alpha > 0$. It implies that a monotonic counter-clockwise shift in the locus $\boldsymbol{\Lambda}$ making the locus steeper and a monotonic increase of $\boldsymbol{\Lambda}$ for any making the locus flatter. Similarly for any ¸ an increase in θ leads to a clockwise shift in the locus Θ. This implies, in particular, that since the functions (2.1) and (2.2) are continuous it is always possible to identify a combination (α, θ) such that the two loci are tangent.

⇨ (2.5) characterized by one stable and one unstable steady state.

- *Later stage of development:*

  With A_∞ sufficiently high such that $x_\infty \simeq 1$, and $\Lambda_\infty \simeq 1$, $\theta = \overline{\theta}$, from (1.25), it implies fertility characterized in (2.7).

  ⇨ Conditional system (2.5) characterized by a unique steady-state.

Chapter 7

Quantity-Quality Trade-off: Evidence from 19th Century France

Content

Introduction

First advanced by Galor and Weil (1999, 2000), unified theories of growth model the transition from Malthusian stagnation to modern economic growth in a single framework.[79] Common to most unified models, the rise in the rate of technological progress (through the emergence of new technologies) during the process of industrialization increased the demand for human capital and induced parents to invest more in the education of their offspring. Investing in education increases the opportunity cost of having children and implies the trade-off for parents between number and education of children. This is the so-called child quantity-quality (Q-Q) trade-off.[80] According to the literature, this process ultimately triggered the demographic transition. The demographic transition itself has been shown by the unified growth theory to play a central role for the transition from stagnation to modern growth.

Despite a renewed interest in recent years, empirical evidence of the existence of a parental trade-off between the quantity and the quality of children is still scarce and controversial. The question of whether this correlation is causal remains open. Besides, as pointed out by Becker, Cinnirella and Woessmann (2010, 2012), most existing evidence supporting the Q-Q trade-off is based on modern data.

This chapter fits into the literature on the interaction between investment in education and fertility from an historical prospective. We empirically investigate whether a child quantity-quality trade-off existed in France in the 19th century. Using a census-based dataset of 86 French counties built from the *Statistique Générale de la France* for the year 1851, we examine the causal link between education and fertility during the French demographic transition.[81] France is an iconic case, particularly interesting to study. While France was the most populated European country at the dawn of the nineteenth century, it was also the first clear case of fertility decline in Europe. The French demographic transition can be clearly divided in two clear phases. Before 1851, fertility transition is a rural phenomenon, rapid in its infancy and driven by prosperous departments (Van de Walle, 1986). After 1851, the process slows down and fertility even increases slightly for almost half departments. During the last quarter century, France experiences a resurgence of its demographic transition at the same time of the beginning process in most European countries. In the 19th century France was also a precursor in the light of

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79 The seminal work of Galor and Weil was quickly followed by new contributions; for example, Jones (2001), Lucas (2002), Hansen and Prescott (2002), Galor and Moav (2002), Doepke (2004), Galor (2005), Strulik and Weisdorf (2008).

80 Becker (1960) was the first to introduce the distinction between child quantity and child quality, followed by Becker and Lewis (1973) and Willis (1973).

81 Literature on the timing of the onset of the demographic transition in France is still controversial: 1776 according to Cummins, 1800 according to the European Fertility Project and if we respect Chesnais criteria (decline of CBR of at least 20%) we can date that France entered the demographic transition not before 1829.

primary education. In 1792, Condorcet already proposed a reform for secular, compulsory and free schooling. Since 1833, the Guizot law has required municipalities with more than 500 residents to fund a primary school and a teacher. An even more fundamental progress is the repeal of the Ferry laws establishing free (1881), secular and compulsory (1882) primary school.[82]

This work is the first attempt to test the existence of a child Q-Q trade-off using French data.
Our empirical analysis focuses on the reverse causality between education and fertility choice. We start by showing the existence of the Q-Q trade-off in 1851 in France using ordinary least squares regressions. Then, we estimate both direction of the causality. Our results show evidence of a significant trade-off between quantity and quality of children in 1851 France. Conversely, we address the issue of long-run impact of education on fertility from a gendered approach. Our results suggest that the fertility transition in France was more pronounced in counties with higher educational enrollment for girls in 1851. Our findings on the negative relationship between female education and fertility in the nineteenth century are consistent with unified growth models as developed in Chapter 6. The trade-off between the quantity and quality of children depends on the level of mother's education which determines her bargaining power within the household.

This chapter is structured as follows. First, we place our contribution within the existing literature. Then, we provide a description of our dataset. Next, we explain and discuss our empirical strategy. We then run the analysis and present our results. Finally, we summarize and conclude.

1. Related Literature

Since the seminal work of Galor and Weil (1999, 2000) and Galor and Moav (2002), the role of human capital has been largely recognized as crucial in the movement toward developed economies. In most unified growth models, the child quantity-quality trade-off is considered as a key mechanism allowing economies to switch from a positive correlation linking income and population size during the Malthusian stagnation a negative one. Within the epoch, the acquisition of formal education and literacy was limited to rich individuals, who represented a very small fraction of the population. Conversely, most people lacked elementary education and displayed large fertility.

[82] These laws are seen as a consequence of the 1870 war against Prussia – German soldiers being judged better educated than the French one.

The emergence of new technologies during the process of industrialization increases the need for skilled workers and accordingly increased the demand for education. This process in turn triggered a shift from high fertility to greater education of children which led to the demographic transition. The quantity-quality trade-off implies that the optimal number of children is decreasing with the time invested in each of them (Cervelatti and Sunde, 2005).

Empirical evidence on the Q-Q trade-off is neither clear-cut nor extended. Two types of studies have emerged: the studies investigating the effect of fertility on education and the studies investigating the effect of education on fertility. Most of these studies are based on modern data. This is the case of the work done by Rosenzweig and Wolpin (1980), Cáceres-Delpiano (2006), Black *et al.* (2005), Zhang and Zhu (2008) or Angrist *et al.* (2010) for more contemporaneous studies. Analyses based on past data have however been recently addressed. Hence, Becker, Cinnirella and Woessmann (2010, 2012) have investigated the relation using Prussian data while Klemp and Weisdorf (2011) studied the English case and Fernihough (2011) the Irish one.

Some authors have chosen to investigate the effect of fertility on education. The first study investigating the fertility effect on education is Rosenzweig and Wolpin (1980). Using an IV strategy with modern data, they found evidence supporting the existence of a Q-Q trade-off among Indian households. Hanushek (1992) finds a distinct trade-off between quantity and quality of children, using individual level data within 1971 and 1975 in Iowa. Considering the allocation of time to children, he finds that achievement falls systematically with increased family size. Using multiple births Black *et al.* (2005) and Angrist *et al.* (2010) corroborate this effect from fertility to education. Several studies have investigated this relationship using Chinese data and have found contradictory results. Estimating the effect of family size on school attainment using multiple births and variation in China's one-child policy, Qian (2009) find a positive effect of the increase in family size on the child enrollment rate. Conversely, Rosenzweig and Zhang (2009) show that having extra-child decreases significantly endowment in human capital of all children in the family. Based on individual level data from 15 Anglican parishes within the period 1700-1830, Klemp and Weisdorf (2011) examine the existence of the child Q-Q trade-off for historical England. Using time interval from marriage to first birth (number of siblings who survive to age five) as a measure of exogenous variation in family size, they find a negative causal effect of family size on individual literacy. Using a sample of individual level data from 1911 Census of Ireland, Fernihough (2011) investigates the impact of sibship size on school enrollment in Belfast and Dublin. He finds strong evidence of a negative impact of extra sibling on school enrollment. He also finds that the Q-Q mechanism is stronger in more industrialized areas.

Other authors have however chosen to analyze the opposite direction of causation, from education to fertility. This is the case of Breierova and Duflo (2004). From micro data in 1970s Indonesia, the authors estimate the effect of education on fertility and child mortality. On the one hand, they show that parental education has a strong causal effect on the reduction of child mortality. They also find that female education seems to matter more on female age at marriage and on early fertility than male education does. Similarly, Osili and Long (2004) estimate the exogenous effect of female education on fertility (by age 25) in 1970's Nigeria. They conclude that the establishment of an educational program increased female schooling and decreased fertility. Bleakley and Lange (2009) show the consistency of the Q-Q trade-off and unified growth theory in the case of Southern USA. They argue that the eradication of hookworm disease reduced the cost of child quality increased education and decreased fertility.

Only Becker, Cinnirella and Woessmann (2010) investigated both direction of causality. Based on aggregated regional data for 19th century Prussia, they find evidence of a causal relation between education and fertility, consistent with the Q-Q trade-off.

2. A County-Level Database for France

We consider both the short-run and the long-run nexus between education and fertility. First we investigate the two directions of causality between child quantity and child quality in 1851 in France. Second, we study the long-run impact of the accumulation of human capital on the demographic transition during the 19th century. Our incentive is to check whether parental investment in education has an effect on the ability of their children to succeed in education (process driving to the accumulation of human capital). To do so, we use regional data collected from diverse publications of the *Service de la Statistique Générale de la France*. Our dataset covers information about aggregated individual-level behavior for 86 French counties (*départements*).[83] At the dawn of the 19th century, France was the largest European country with about 29.4 million inhabitants. The French Statistical Office publishes data from 1800. Nevertheless, it is from 1851 that published data rank population by age, gender, marital status and other essential information to study the evolution of fertility behavior and habits regarding education.

The major part of the dataset is constructed from General Censuses, Statistics of Primary Education, Population Movement and Industrial Statistics conducted in 1851 (1850 for Education, 1861 for Industrial Statistics). The rest of the data stems from diverse sources. A part

[83] 1851 France consists of current metropolitan French *départements* except Alpes-Maritimes, Savoie and Haute-Savoie.

of fertility data was available from the Princeton European Fertility Project (Coale and Watkins, 1986), while data on migration and life expectancy at birth come from Bonneuil (1997). A combined use of the various Censuses allows us to construct a dataset with detailed information on fertility, mortality, literacy rates, enrollment rates in primary schools for both boys and girls, employment in industry and agriculture by gender, level of urbanization and stage of industrialization.[84] In addition, we use data from French Censuses for the years 1821, 1835, 1861, 1881 and 1911 to get more demographic and socio-economic information necessary to carry out our analysis.

We use two measures of fertility: the child-women ratio, defined as the number of children aged 0-5 per women of childbearing age, and the crude birth rate.[85] We also use two measures of education for both boys and girls: the enrollment rates in public primary school in 1850, defined as the number of children attending school divided by the number of children aged 6-14, and the enrolment rate in secondary school, defined as the number of children attending secondary school divided by the number of children aged 14-18.

Table 7-1 reports descriptive statistics of the variable used in our analysis. In 1816, the literacy rate was about 51% for males and 30% for females on average. In 1851, 54.5% of boys aged 6-14 were enrolled in public primary school, while the enrolment rate in public primary school for girls was 36%. There is a strong heterogeneity in education across counties. Enrollment rates go from about 19% to 105% for boys and from 0.3% to 99% for girls.[86] These variations can be explained by several factors: the diffusion of the official French language, the difference in attitudes toward education between Catholics and Protestants (Becker and Woessmann, 2009), the wave of spreading ideas coming from Prussia and the insufficiency of educational resources deployed in rural areas in terms of teachers and financial spending.

[84] To our knowledge, these data have not yet been used for micro-econometric analysis.
[85] As specify by Becker *et al*. (2010), children aged 0-5 allows to capture surviving children (according to Galor 2005b).
[86] Enrollment rates above 100% are due to the possibility that children below 6 years old and above 14 years old might have been enrolled in public primary schools. In 1851, 44.4% of boys aged 5-15 were enrolled in public primary school, while the enrolment rate in public primary school for girls was 30%. Yet, there is a strong heterogeneity in education across counties. It goes from a minimum of about 15.5% to a maximum of 86.1%[86] for boys and from 0.3% to 81% for girls.

Table 7-1 : Summary Statistics

	Mean	Std. Dev.	Min	Max
Crude birth rate	26.95	3.597	18.717	34.275
School enrollment rate	0.454	0.229	0.13 3	1.029
Boys enrollment rate	0.544	0.211	0.188	1.059
Girls enrollment rate	0.356	0.259	0.003	0.997
Share in industry	0.029	0.047	0	0.370
Share in agriculture	0.426	0.106	0.031	0.655
Female in industry	0.036	0.070	0	0.552
Female in agriculture	0.615	0.179	0.037	1.054
Male in industry	0.057	0.081	0	0.636
Male in agriculture	0.737	0.171	0.046	1.135
Urbanization	0.059	0.083	0.007	0.736
Population density (km²)	1.011	3.166	0.219	29.907
Life expectancy at age 0	38.792	6.115	25.8	50.8
Marital fertility rate	0.497	0.109	0.298	0.747
Share Protestants (1861)	2.258	5.332	0.003	31.298
Male workers (1861)	0.048	0.037	0.006	0.160
Female workers (1861)	0.027	0.056	0.001	0.497
Share married women	0.389	0.048	0.303	0.479
Crude birth rate (1881)	0.024	0.004	0.017	0.035
Crude birth rate (1881-1911)	-0.245	0.092	-0.405	-0.002
Marital fertility rate (1881)	0.473	0.130	0.266	0.819
Marital fertility rate (1881-1911)	-0.290	0.091	-0.476	0
Boys enrollment (1851-67)	0.600	0.342	-0.076	1.624
Girls enrollment (1851-67)	1.067	1.962	0.017	17.485
Male literacy (1856-66)	0.113	0.092	-0.093	0.358
Female literacy (1856-66)	0.271	0.213	-0.085	0.956

Note: Detailed description of variables is provided in appendix

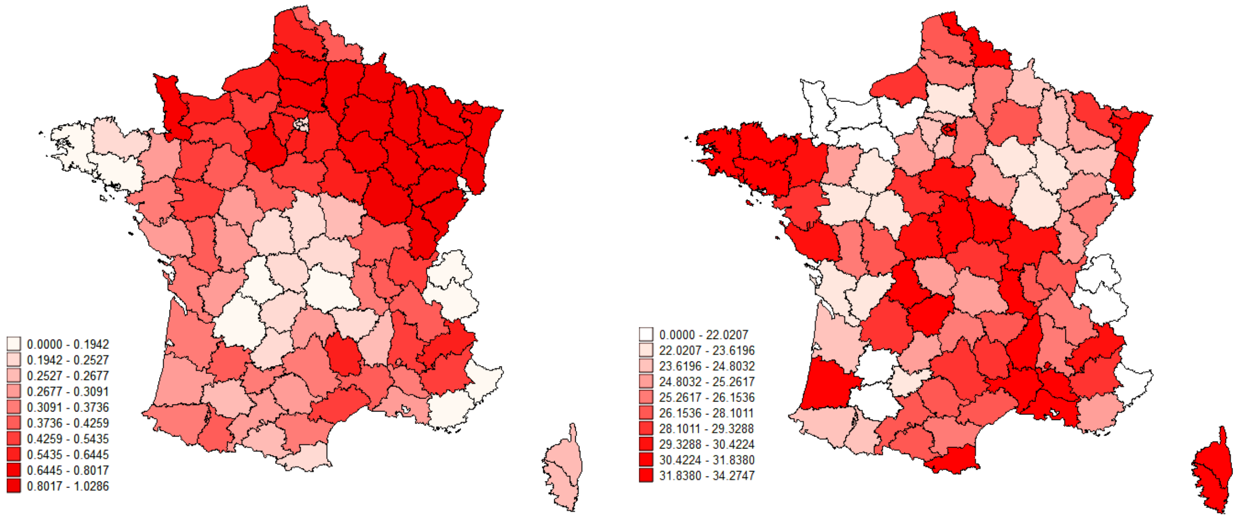
3. Evidence on the Relation between Fertility and Education in 1851

3.1. Empirical Model

We investigate the short-run relationship between investment in human capital and fertility. The geographical distribution of enrollment rates and the crude birth rate in 1851 are presented in Figure 7-1. Similarly to Prussia (Becker, Cinnirella and Woessmann, 2010), the most industrialized area in France (Northeast) shows higher enrollment rates. The remainder of France which is more agricultural and rural displays higher levels of fertility.

Figure 7-1 : Geographical Distribution of Primary School Enrollment and Fertility

(a) Enrollment rate, 1851 (b) Crude birth rate, 1851



Sources: Using data from Statistiques Générales de la France – Census 1851

Following the work done by Becker, Cinnirella and Woessmann (2010), we differentiate between the two directions of causality: from education to fertility and from fertility to education. We estimate the following empirical models separately (Wooldridge, 2002):

$$fertility_i = \alpha_1 \,.\, education_i + \boldsymbol{X}_{i1}\, \delta_1 + e_{i1} \qquad (7\text{-}1)$$

$$education_i = \alpha_2 \,.\, fertility_i + \boldsymbol{X}_{i2} \delta_2 + e_{i2} \qquad (7\text{-}2)$$

where $fertility_i$ and $education_i$ refer for fertility and education for each county i. Coefficients α_1 and α_2 are our parameters of interest. $\boldsymbol{X}_1$ and $\boldsymbol{X}_2$ are vectors of control variables.

We estimate equation (7-1) and (7-2) using ordinary least squares (OLS). Our incentive is to investigate to what extent the current level of boys and girls education are correlated with the current level of parental fertility. This work is the first attempt to test the existence of a child Q-Q trade-off using French data.

We keep in mind that we suspect a bi-causal relationship between fertility and education. Estimating a causal relationship may consequently be biased by some potential endogeneity of each of our variables of interest. But our motivation is not to measure the exact causation but to have preliminary results on the fertility-education nexus.[87]

To control for the main determinants of fertility and education The covariates used in the regression analysis are: *(i)* a proxy for the level of industrialization specified as the share of people employed in manufacturing, *(ii)* the share of people making their living of agriculture by gender, *(iii)* the share of urban residents,[88] *(iv)* population density, *(v)* the share of married women, *(vi)* the infant mortality rate, *(vii)* the share of Protestants, *(viii)* the life expectancy at age 0, *(ix)* the share of workers in 1861 by gender.

3.2. Results

From Education to Fertility. – Table 7-2 reports OLS estimates of equation (7-1) where the dependent variable is the crude birth rate. The results show that the coefficient for education is significant at the 0.1% and negative for both genders. Column 1 reports the results without any control variables. Columns 2 to 4 display the results of equation (7-1) adding different set of control variables. Whatever the specification of equation (7-1), the coefficient of education remains significant and negative for boys as for girls.

Turning to control variables, we observe that counties with a larger share of employment in manufacturing, fertility rates are higher, whereas in more densely populated counties, fertility tends to be lower. Contrary to what has been found by Becker *et al.* (2010) for Prussia, fertility is positively affected by the share of Protestants and negatively associated with life expectancy at age 0. Our results seem to confirm the existence of a negative effect of child quality on the child quantity.

From Fertility to Education. – Table 7-3 reports OLS estimates of the education equation (7-2). The school enrollment is the dependent variable and the crude birth rate is our variable of interest. Columns 1 display estimation results without any control variables. Columns 2 to 6 report estimation results adding different set of control variables. Table 7-3a and 7-3b report the estimates where boys and girls' enrollment rates are each in turn function of the crude birth rate. Regardless the regression, the coefficient of fertility is significant and negative at least at the 1% level.

[87] The central challenge in estimating the causal relation between education and fertility decisions is that unobserved characteristics affecting schooling choices are potentially correlated with unobserved factors influencing the decision to have children (and conversely). In addition, the presence of error in available measures of schooling can also introduce a bias towards zero. Given, the presence of error in available measures of schooling can also introduce a bias towards zero and possible problems of endogeneity and omitted variables, our results do not tend have necessarily a causal interpretation.

[88] The share of urban residents is defined as the share of people living in towns populated with more than 2000 inhabitants.

The share of both male and female in industry are positively associated with the boys and girls enrollment rates while the share of individuals living from agriculture is negatively associated with education. In counties with a higher share of Protestants, the propensity to invest in education tends to be higher. Unexpectedly, counties where longevity is higher, enrollment rates are lower. Our results seem to confirm the existence of a negative effect of child quantity on child quality.

The OLS estimates confirm the existence of a negative and significant relationship between fertility and education during the demographic transition in 1851 in France. Hence, counties in which the increase in education has been more important account for larger changes in fertility, and conversely. These results are coherent with the interpretation of the unified growth theory (Galor, 2005b; Galor and Moav, 2002). Yet, the decisions about quality and quantity of children being taken simultaneously, the analysis does not allow us to conclude about the causality between education and fertility.

Table 7-2a : The Association between Boys Education and Fertility

Dependent variable	Crude birth rate			
	(1)	(2)	(3)	(4)
Boys enrollment rate	-6.153***	-6.178***	-7.221***	-6.650***
	(1.476)	(1.680)	(1.564)	(1.143)
Male in agriculture		3.192	1.655	-0.163
		(2.964)	(2.904)	(2.253)
Male in industry		3.997*	4.402	4.606*
		(2.860)	(2.677)	(2.297)
Urbanization		0.097*	0.059	0.071*
		(0.040)	(0.031)	(0.030)
Population density		-1.763**	-1.265**	-1.500***
		(0.552)	(0.429)	(0.399)
Share protestants			0.187***	0.161***
			(0.043)	(0.043)
Life expectancy at age 0				-0.315***
				(0.042)
Constant	30.299***	26.458***	28.206***	41.551***
	(0.920)	(3.234)	(3.110)	(2.856)
N	86	86	86	86
R^2	0.131	0.193	0.259	0.521
F	17.389	24.641	25.370	25.723

OLS regressions. Dependent variable: crude birth rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Crude birth rate is defined as the number of birth (in 1000 s) over the total population. Boys enrollment rate is the share of boys aged 6-14 enrolled in public primary schools.
Source: County-level data from the French Census 1851.

Table 7-2b : The Association between Girls Education and Fertility

Dependent variable	Crude birth rate			
	(1)	(2)	(3)	(4)
Girls enrollment rate	-4.320**	-4.962***	-5.292***	-5.087***
	(1.298)	(1.268)	(1.170)	(0.974)
Female in agriculture		1.065	0.438	-2.049
		(2.684)	(2.589)	(2.044)
Female in industry		3.414	3.696	3.033
		(3.637)	(3.307)	(4.527)
Urbanization		0.092*	0.066*	0.078*
		(0.038)	(0.030)	(0.030)
Population density		0.037	0.047	-0.149***
		(0.053)	(0.052)	(0.052)
Share protestants			0.157***	0.132**
			(0.042)	(0.048)
Life expectancy at age 0				-0.329***
				(0.044)
Constant	28.505***	26.762***	27.224***	41.568***
	(0.625)	(2.298)	(2.176)	(2.599)
N	86	86	86	86
R^2	0.096	0.164	0.213	0.495
F	11.072	26.369	24.730	22.427

OLS regressions. Dependent variable: crude birth rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Crude birth rate is defined as the number of birth (in 1000 s) over the total population. Girls enrollment rate is the share of girls aged 6-14 enrolled in public primary schools.
Source: County-level data from the French Census 1851.

Table 7-3a : The Association between Fertility and Boys Education

Dependent variable	Boys enrollment rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Crude birth rate	-0.021***	-0.020**	-0.023***	-0.025***	-0.034***	-0.033***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)
Male in industry		0.219	0.271	0.256	0.312	0.000
		(0.200)	(0.185)	(0.182)	(0.178)	(0.185)
Male in agriculture		-0.322*	-0.203	-0.263	-0.278	-0.197
		(0.160)	(0.165)	(0.170)	(0.167)	(0.163)
Urbanization		-0.563**	2.573	1.081	1.812	1.143
		(0.203)	(1.798)	(1.401)	(1.567)	(1.588)
Population density			-0.072	-0.038	-0.058	-0.046
			(0.040)	(0.030)	(0.035)	(0.035)
Share protestants				0.010**	0.011**	0.010*
				(0.004)	(0.004)	(0.004)
Life expectancy					-0.009*	-0.009*
					(0.005)	(0.004)
Male workers (1861)						1.559*
						(0.723)
Constant	1.116***	1.312***	1.288***	1.376***	1.990***	1.866***
	(0.163)	(0.199)	(0.201)	(0.201)	(0.364)	(0.342)
N	86	86	86	86	86	86
R^2	0.131	0.203	0.242	0.298	0.343	0.381
F	12.900	6.487	18.920	16.851	13.070	11.803

OLS regressions. Dependent variable: boys enrollment rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$".
Source: County-level data from the French Census 1851

Table 7-3b : The Association between Fertility and Girls Education

Dependent variable	Girls enrollment rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Crude birth rate	-0.022**	-0.021**	-0.025***	-0.026***	-0.038***	-0.036***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)	(0.009)
Female in industry		0.698**	0.711***	0.697***	0.700**	0.543
		(0.233)	(0.202)	(0.199)	(0.235)	(0.282)
Female in agriculture		-0.399*	-0.313	-0.332*	-0.394*	-0.385*
		(0.156)	(0.162)	(0.166)	(0.160)	(0.158)
Urbanization		-0.313	3.318	2.458	3.242	2.939
		(0.215)	(2.059)	(1.729)	(1.859)	(1.848)
Population density			-0.085	-0.065	-0.088*	-0.103*
			(0.046)	(0.039)	(0.042)	(0.042)
Share protestants				0.007	0.007	0.006
				(0.005)	(0.005)	(0.006)
Life expectancy					-0.012*	-0.011
					(0.006)	(0.006)
Female workers (1861)						1.343
						(1.373)
Constant	0.961***	1.167***	1.186***	1.229***	2.020***	1.936***
	(0.196)	(0.207)	(0.197)	(0.198)	(0.439)	(0.455)
N	86	86	86	86	86	86
R^2	0.096	0.221	0.259	0.275	0.321	0.329
F	10.183	8.891	12.847	11.585	8.579	7.584

OLS regressions. Dependent variable: girls enrollment rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$".
Source: County-level data from the French Census 1851

4. Long-run Effect of Endowment in Human Capital on Fertility Transition

From the study of the short-run relationship between education and fertility our results show that the correlation goes in both directions of causation. This suggests the existence of a child quantity-quality trade-off in France during the French demographic transition. However, these results may mask a more complex underlying relationship. Our hypothesis is that women endowments in human capital affect their own choices of fertility, and subsequently that of future generations. The second objective of this study is to determine if the endowments in human capital in time t have effects on the level of fertility in the subsequent period, $t + 1$.

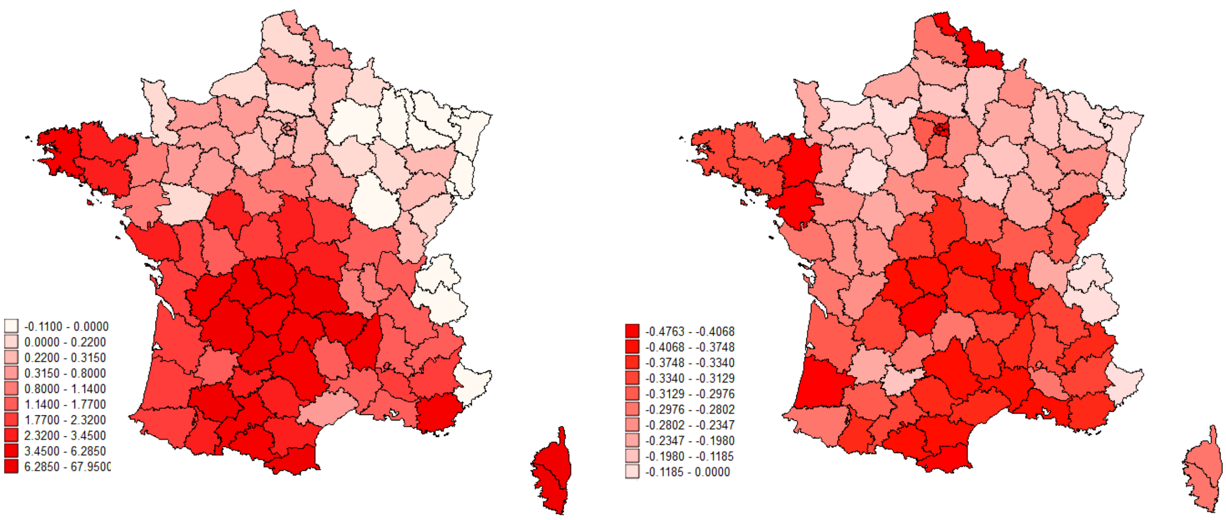
4.1. Empirical Model

We now turn to the long-run effect of investment in human capital on fertility. We empirically test the effect of investments in human capital between 1856 and 1866 on variations in fertility between 1881 and 1911 across French counties. The motivation of such choice of data is to account for the effect of education on several generations of individuals.

Figure 7-2 : Geographical Distribution of Percentage Changes in Girls Education and Fertility

(a) Change in Girls Enrollment, 1850-67

(b) Change in Marital Fertility, 1881-1911



Sources: Using data from Statistiques Générales de la France – Census 1851

Figure 7-2 gives us an insight on the geographical distribution of changes in girls enrollment rates between 1850 and 1867 and the subsequent changes in marital fertility rate over the period 1881-1911. Contrary to the agricultural and rural areas, the most industrialized area of France (Northeast) display lower variations in girls enrollment rates over the period studied. Comparatively, we see that counties experiencing stronger improvement in girls' education over the period 1851-1867 tend also to experience a steeper fertility decline in marital fertility rate over the period 1881-1911.

We use equation (7-3) to test the hypothesis that increasing investment in education might have played a significant role in the fertility transition:

(7-3) $$\Delta fertility_{\ i,1881-1911} = \alpha\ \Delta education_{i,1856-66} + \boldsymbol{X}_i\,\delta + e_i$$

where the percentage change in the crude birth rate between 1881 and 1911 is the dependent variable and the percentage change in literacy rates between 1856 and 1866 is our variable of interest. $\boldsymbol{X}$ is the vector of control variables (see Appendix… for description of variables).

We estimate equation (7-3) using ordinary least squares (OLS). We use various specifications to study how male and female endowments in human capital affect their future fertility including all or some of the following covariates: *(i)* a proxy for the level of industrialization specified as the share of people employed in manufacturing by gender, *(ii)* the share of people making their living of agriculture by gender, *(iii)* the urbanization, *(iv)* the population density, *(v)* the share of Protestants, *(vi)* the life expectancy at age 0, *(vii)* the crude birth rate in 1851, *(viii)* the crude birth rate in 1881.

4.2. Results

Table 7-4 reports the estimation results on the hypothesis that increased educational investments have played a significant role in the changes in fertility. Columns 1 to 4 present various specifications of equation (7-3) for both boys (7-4a) and girls (7-4b). Hence, we control for socio-economic factors adding successively control variables for employment opportunities and urbanization (column 1), religion (column 2), life expectancy (column 3) and crude birth rate in 1881 (column 4).[89]

We find very interesting results from a gendered perspective. The results show that the coefficients of the change of literacy rates are negative but only significant for women. The significance of the coefficients of female literacy is always above 99.9%. This result seems to support our hypothesis. It suggests that the more women are educated today, the fewer children they have tomorrow.

Fertility decline is positively associated with female literacy rates. Table 7-4b shows particularly strong results for all specifications. Consistent with the results of the previous

[89] In order to test the robustness of our results, we add the initial level of birth rate in 1881.

section, the transition is higher in counties where the share of Protestants is the largest (see Table 7-4).[90] However, contrary to what found by Galloway *et al.* (1998) and Becker *et al.* (2010), our coefficients do not indicate that the fertility transition was stronger in urbanized area. On the opposite, coefficients indicate that the fertility transition is stronger in areas where individuals are more oriented toward agriculture.[91] In the complete specification reported in column 4 (Table 7-4b), we observe that an increase in the variation of the female literacy rate by 10% is likely to decrease the variation of the birth rate by 1.5 percentage point. In terms of explanatory power, the variation in crude birth rate across counties is explained at 64% by the richest model.

Our results indicate that female education has a more robust and significant impact on fertility than male education, which is consistent with the intuition of the unified growth model of Diebolt and Perrin (2013) reported in Chapter 6. According to this model, female empowerment as well as technological progress increased returns to education for girls because of complementarities between technological changes and human capital. As a consequence, girls could invest more in their own education but had to limit the number of offspring. Indeed, girls endowed with a higher amount of human capital tend to limit their fertility due to a larger opportunity cost of having higher than girls endowed with lower amount of human capital.

[90] Namely in Haut-Rhin and Bas-Rhin.
[91] Note that agricultural areas are also those where education levels were historically the lowest and where fertility was the most important (in comparison with industrialized areas).

Table 7-4a : Long-run Effect of Changes in Male Human Capital on Fertility Transition

Dependent variable	Crude birth rate (% change 1881-1911)			
	(1)	(2)	(3)	(4)
Male literacy (% change 1856-66)	-0.123 (0.083)	-0.162 (0.083)	-0.152 (0.084)	-0.119 (0.084)
Crude birth rate	-0.014*** (0.003)	-0.013*** (0.002)	-0.014*** (0.003)	-0.019*** (0.004)
Male in industry	0.070 (0.075)	0.070 (0.080)	0.076 (0.081)	0.029 (0.095)
Male in agriculture	-0.187** (0.067)	-0.170* (0.067)	-0.171* (0.069)	-0.186** (0.065)
Urbanization	-1.013 (0.636)	-0.873 (0.615)	-0.805 (0.586)	-0.763 (0.605)
Population density	0.017 (0.014)	0.014 (0.013)	0.012 (0.012)	0.011 (0.013)
Share protestants		-0.003** (0.001)	-0.003** (0.001)	-0.004* (0.002)
Life expectancy at age 0			-0.001 (0.002)	-0.000 (0.002)
Crude birth rate (1881)				6.279 (3.961)
Constant	0.294*** (0.065)	0.273*** (0.065)	0.321* (0.129)	0.286* (0.130)
N	83	83	83	83
R²	0.517	0.541	0.542	0.564
F	28.583	26.007	23.288	20.878

OLS regressions. Dependent variable: % change crude birth rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Male literacy rate is number of male able to read and to write over total number of males. *Source:* County-level data from French censuses

Table 7-4b : Long-run Effect of Changes in Female Human Capital on Fertility Transition

Dependent variable	Crude birth rate (% change 1881-1911)			
	(1)	(2)	(3)	(4)
Female literacy (% change 1856-66)	-0.158*** (0.033)	-0.156*** (0.033)	-0.155*** (0.036)	-0.148*** (0.037)
Crude birth rate	-0.013*** (0.002)	-0.013*** (0.002)	-0.013*** (0.003)	-0.017*** (0.003)
Female in indutry	-0.003 (0.124)	0.005 (0.125)	0.006 (0.129)	-0.027 (0.133)
Female in agriculture	-0.144** (0.045)	-0.141** (0.045)	-0.142** (0.048)	-0.146** (0.047)
Urbanization	-0.925 (0.526)	-0.798 (0.500)	-0.783 (0.494)	-0.729 (0.528)
Population density	0.016 (0.012)	0.013 (0.011)	0.012 (0.011)	0.011 (0.012)
Share protestants		-0.003*** (0.001)	-0.003** (0.001)	-0.004** (0.001)
Life expectancy at age 0			-0.000 (0.001)	0.000 (0.001)
Crude birth rate (1881)				5.327 (3.284)
Constant	0.249*** (0.057)	0.241*** (0.057)	0.255* (0.121)	0.218 (0.121)
N	83	83	83	83
R²	0.606	0.628	0.628	0.644
F	44.057	43.032	37.989	34.719

OLS regressions. Dependent variable: % change crude birth rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Female literacy rate is number of male able to read and to write over total number of females. *Source:* County-level data from French censuses

Conclusion

This chapter documents the existence of quantity-quality trade-off for France during the 19th century. The objective of this chapter in twofold: investigating both directions of causation of the relationship between education and fertility during the French demographic transition and studying the long-term effect of endowment in human capital on future fertility. We contribute to the literature of unified growth theory by shedding light on these two types on relationships from a gendered renewed approach.

Using an original county-level dataset of 86 county observations built up from the *Statistique Générale de la France*, we find evidence of the existence of the child Q-Q trade-off during the French demographic transition in the 19th century which corroborates unified growth predictions. This relationship may hide a more complex relationship that is the relationship between education of women at a given moment and their future fertility as predicted by Diebolt and Perrin (2013) whose findings are presented in chapter 6. Hence, we have tested this hypothesis on 19th century French data. In line with Diebolt and Perrin (2013), our results suggest that females with a higher level of human capital have stronger preferences for a lower number of children. In particular, we find the existence of a negative and significant effect of variations in female literacy rates (1856-66) on fertility transition between 1881 and 1911. Counties with higher improvements in female literacy display stronger fertility decline in France at the turn of the 19th century.

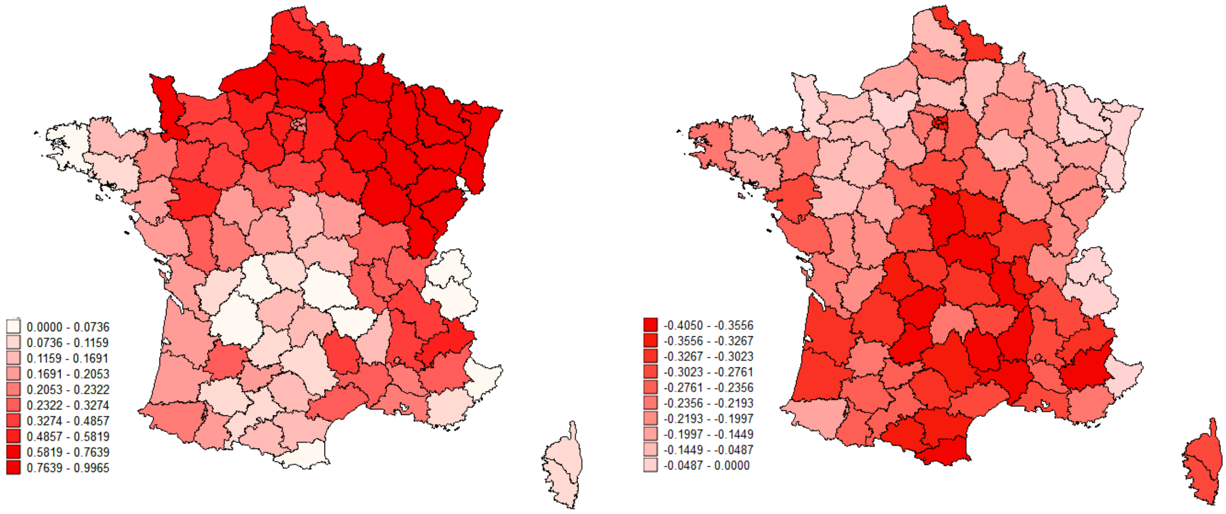
From our empirical investigation, we find that the Q-Q trade-off was possibility driven by women endowment in human capital of previous generation. By extension, as demographic transition is considered necessary condition to allow economies to move from stagnation to sustained growth, female human capital is likely to be a key ingredient for economic transition. Indeed, female empowerment increases returns to education for girls because of complementarities between technological changes and human capital. Girls invest more in their own education and limit their fertility because of a greater opportunity cost of having children. As a consequence, girls with higher endowments in human capital have fewer children what ultimately leads to the fertility transition.

The role of further research needs to extend this case study to wider panel data investigation to confirm the intuition that female may be an important factor of economic growth.

Appendix G

Figure G-1 : Geographical Distribution of Girls Enrollment Rate and Variation in Fertility

(a) Girls enrollment rate, 1851 | (b) Change in Crude birth rate, 1881-1911



Sources: Using data from Statistique Générale de la France – Censuses

Table G-1a – Long-run Effect of Boys Education on Fertility Transition

Dependent variable	Crude birth rate 1880-1911 (% change)			
	(1)	(2)	(3)	(4)
Boys enrollment	0.061	0.076	0.072	0.060
	(0.041)	(0.039)	(0.045)	(0.043)
Crude birth rate	-0.014***	-0.013***	-0.014***	-0.019***
	(0.003)	(0.003)	(0.003)	(0.004)
Male in industry	0.067	0.067	0.072	0.023
	(0.075)	(0.079)	(0.082)	(0.096)
Male in agriculture	-0.173*	-0.154*	-0.155*	-0.173*
	(0.066)	(0.066)	(0.069)	(0.066)
Urbanization	-0.900	-0.726	-0.676	-0.668
	(0.591)	(0.574)	(0.540)	(0.581)
Population density	0.016	0.012	0.011	0.010
	(0.013)	(0.012)	(0.011)	(0.013)
Share protestants		-0.003**	-0.003**	-0.004*
		(0.001)	(0.001)	(0.002)
Life expectancy at age 0			-0.001	0.000
			(0.002)	(0.002)
Crude birth rate (1881)				6.482
				(3.858)
Constant	0.224*	0.185*	0.232	0.205
	(0.092)	(0.090)	(0.175)	(0.170)
N	83	83	83	83
R^2	0.519	0.541	0.542	0.566
F	27.037	25.408	22.778	21.703

OLS regressions. Dependent variable: % change crude birth rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Crude birth rate is defined as the number of birth (in 1000 s) over the total population. Boys enrollment rate is the share of boys aged 6-14 enrolled in public primary schools. *Source:* County-level data from the French Census 1851.

Table G-1b – Long-run Effect of Girls Education on the Fertility Transition

Dependent variable	Crude birth rate 1880-1911 (% change)			
	(1)	(2)	(3)	(4)
Girls enrollment	0.119***	0.121***	0.120***	0.116***
	(0.028)	(0.028)	(0.033)	(0.031)
Crude birh rate	-0.012***	-0.012***	-0.012***	-0.017***
	(0.002)	(0.002)	(0.003)	(0.003)
Female in industry	0.020	0.026	0.027	-0.012
	(0.109)	(0.110)	(0.114)	(0.118)
Female in agriculture	-0.116*	-0.111*	-0.112*	-0.118*
	(0.046)	(0.046)	(0.050)	(0.049)
Urbanization	-0.749	-0.612	-0.601	-0.553
	(0.530)	(0.497)	(0.486)	(0.535)
Population density	0.014	0.011	0.011	0.010
	(0.012)	(0.011)	(0.011)	(0.012)
Share protestants		-0.004**	-0.004**	-0.004**
		(0.001)	(0.001)	(0.001)
Life expectancy at age 0			-0.000	0.000
			(0.002)	(0.002)
Crude birth rate (1881)				6.076
				(3.621)
Constant	0.123	0.110	0.122	0.081
	(0.073)	(0.072)	(0.145)	(0.139)
N	83	83	83	83
R^2	0.570	0.598	0.598	0.620
F	27.668	27.562	24.206	24.018

OLS regressions. Dependent variable: % change crude birth rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Crude birth rate is defined as the number of birth (in 1000 s) over the total population. Girls enrollment rate is the share of girls aged 6-14 enrolled in public primary schools. *Source:* County-level data from the French Census 1851.

Table G-2a – Long-run Effect of Boys Education on Fertility Transition. Robustness Checks

Dependent variable	Marital fertility rate (% change)			
	(1)	(2)	(3)	(4)
Boys enrollment	0.077*	0.083*	0.097*	0.105*
	(0.038)	(0.038)	(0.043)	(0.044)
Crude birth rate	-0.015***	-0.015***	-0.012**	-0.011**
	(0.003)	(0.003)	(0.004)	(0.004)
Male in industry	0.053	0.053	0.038	0.054
	(0.080)	(0.083)	(0.085)	(0.087)
Male in agriculture	-0.071	-0.063	-0.059	-0.044
	(0.057)	(0.058)	(0.057)	(0.062)
Urbanization	-0.935	-0.869	-1.018	-1.106*
	(0.592)	(0.620)	(0.603)	(0.544)
Population density	0.018	0.017	0.021	0.022
	(0.013)	(0.013)	(0.013)	(0.012)
Share protestants		-0.001	-0.001	-0.001
		(0.001)	(0.001)	(0.001)
Life expectancy at age 0			0.002	0.001
			(0.002)	(0.002)
Marital fertility (1881)				-0.104
				(0.078)
Constant	0.123	0.109	-0.029	-0.022
	(0.096)	(0.099)	(0.183)	(0.184)
N	83	83	83	83
R^2	0.546	0.549	0.558	0.569
F	34.069	29.434	28.446	30.291

OLS regressions. Dependent variable: % change marital fertility rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Boys enrollment rate is the share of boys aged 6-14 enrolled in public primary schools. *Source:* County-level data from the European Princeton Fertility Project.

Table G-2b – Long-run Effect of Girls Education on Fertility Transition. Robustness Checks

Dependent variable	Marital fertility rate (% change)			
	(1)	(2)	(3)	(4)
Girls enrollment	0.110***	0.111***	0.126***	0.127***
	(0.029)	(0.029)	(0.030)	(0.031)
Crude birth rate	-0.014***	-0.014***	-0.011***	-0.010**
	(0.002)	(0.002)	(0.003)	(0.003)
Female in industry	0.009	0.011	-0.001	0.006
	(0.096)	(0.097)	(0.084)	(0.090)
Female in agriculture	-0.069	-0.067	-0.052	-0.046
	(0.046)	(0.046)	(0.048)	(0.050)
Urbanization	-1.010	-0.968	-1.115	-1.215*
	(0.535)	(0.554)	(0.561)	(0.500)
Population density	0.020	0.019	0.023	0.025*
	(0.012)	(0.012)	(0.013)	(0.011)
Share protestants		-0.001	-0.001	-0.001
		(0.001)	(0.001)	(0.001)
Lif expectancy at age 0			0.002	0.002
			(0.001)	(0.002)
Marital fertility (1881)				-0.086
				(0.069)
Constant	0.089	0.085	-0.083	-0.064
	(0.074)	(0.074)	(0.145)	(0.151)
N	83	83	83	83
R^2	0.605	0.608	0.620	0.628
F	36.805	31.068	30.829	30.741

OLS regressions. Dependent variable: % change marital fertility rate. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Girls enrollment rate is the share of boys aged 6-14 enrolled in public primary schools. *Source:* County-level data from the European Princeton Fertility Project.

County-level Data for France in the 19th Century

The data used in this chapter are mainly extracted from books published by the *Statistique Générale de la France* (SGF) on population, demographic and public education censuses, between 1800 and 1925. Almost all data are available for 86 counties.

1821 Census

- **Crude birth rate.** Number of birth over total population (per one thousand inhabitants).

1851 Census

- **Crude birth rate.** Number of birth over total population (per one thousand inhabitants).
- **School enrollment rate.** Number of children enrolled in public primary schools over the total number of children aged 6-14.
- **Girls (Boys) enrollment rate.** Number of girls (boys) enrolled in public primary schools over the total number of girls (boys) aged 6-14.
- **Share in industry.** Number of individuals employed in manufacturing over total population. Manufacturing refers to all types of industry: textile, metal sector and other factories (food, wood, construction…).
- **Female (Male) in industry.** Number of women (men) employed in manufacturing over total number of women (men) aged 15-60. Manufacturing refers to all types of industry: textile, metal sector and other factories (food, wood, construction…).
- **Share in agriculture.** Number of individuals employed in agriculture over total population. Agriculture refers to all positions within agricultural sector: owners, farmers, sharecroppers and others.
- **Female (Male) in agriculture.** Number of women (men) employed in agriculture over total number of women (men) aged 15-60. Agriculture refers to all positions within agricultural sector: owners, farmers, sharecroppers and others.
- **Urbanization.** Number of towns populated with more than 2000 inhabitant (per km²).
- **Population density.** Number of people per km².
- **Life expectancy at age 0.** Updated C7 tables published in Bonneuil (1997). Calculation of life expectancy by calculating the area under the survival function.
- **Marital fertility rate.** Index of marital fertility from Princeton European Fertility Project. I_g index compares the observed number of marital births to the number of marital births expected if the standard fertility rates applied.
- **Share married women.** Number of married women per women in age of being married (15 years old and above). Number of married women refers to the sum of married women at each age (from 15 years to 100 years and above).
- **Distance to Wittenberg.** Distance from the Prefecture of the *département* to Wittenberg (own computations).
- **Dummy for *Oïl* and *Franco-provençal* dialects.** Geographical dummy variable for the provinces with the highest share of *Oïl* and *Franco-provençal* dialects.
- **Share married women.** Number of married women per women in age of being married (15 years old and above). Number of married women refers to the sum of married women at each age (from 15 years to 100 years and above).
- **Sex-imbalance ratio.** Number of female individuals over number of male individuals.

1861 Census

- **Share Protestants.** Number of Protestants over total people within the different religions (per a hundred people). Protestants refers to all types of Protestants: Lutherans, Calvinists and other Protestant sects. Religions refer to all types of Protestants, Catholics, Israelite and other non-Christian cults.
- **Female (Male) workers.** Number of female (male) workers in textile industries over total female (male) population.

1881 Census

- **Crude birth rate.** Number of birth over total population.

Percentage Changes

- **Crude birth rate (1881-1911) - % change.** Percentage variation of the number of birth over total population in 1881 compared to 1911.
- **Marital fertility rate (1881-1911) - % change.** Percentage variation of index of marital fertility in 1881 compared to 1911, from Princeton European fertility project
- **Girls (boys) enrollment rate (1851-67) - % change.** Percentage variation of the girls (boys) enrollment rate between 1851 and 1867.
- **Female (Male) literacy rate (1856-66) - % change.** Percentage variation of the female (male) literacy rate between 1856 and 1866. The literacy rate consists in number of individuals able to read and to write over total population.

General Conclusion

Differences between men and women have certainly existed throughout history and are still a feature of many contemporary social arrangements. The issue we have addressed in this dissertation is whether gender equality serves to foster economic development. We do believe that history offers insights for the understanding of the current relationship.

Objectives of the Thesis

This work has assessed the long-run relationship between gender equality and economic growth using a cliometric analysis. It confirms the existence of a significant impact of gender equality on economic development. Our reflection provides a new track on the specification of this relationship. It puts into perspective the impact of female empowerment on demographic and economic transitions. It therefore appears that the particular organization of the society, and more precisely the distribution of roles within households, is an influential aspect of the contribution of gender equality to economic growth. The socially constructed roles, behaviors, activities and attributes that a given society considers appropriate for men and women has evolved significantly in the Western world over the past two hundred years. Changes in gender roles have affected the economic performance of Western countries and demographic behavior in a number of ways. The participation of women in economic life, the educational investments of girls and their increasing empowerment in these areas, was essential to strengthen their rights. It enabled women to have control over their lives and influence within the society. Improving women status led to larger investments in the education of their children as well as in their health and well-being. Educating girls and women has been a key and necessary condition for sustainable development.

Contributions and Results of the Thesis

The main contributions and results of our work are of several orders.

First – Data Collection. One major contribution of our work is the construction of a large dataset gathering longitudinal and cross-sectional data. The construction of this large dataset required a huge amount of time collecting data from various sources. Most data come from the *Statistique Générale de la France*. Other data have been mainly collected from books and articles. County-level census data on population, statistics of primary education and industrial statistics contain treasures of information but are challenging because of several changes in the administrative boundaries. These data had first to be carefully organized and various demographic, socio-economic and educational variables have then been constructed. The collection of this dataset enabled us to reconstruct accurately a set of facts and events about France from the late 18th century. The use of this original dataset grouping time series and county-level data enables to offer a better understanding of economic, social, demographic, cultural and geographical variables in connection with the process of development.

Second – Improve the Understanding of the French Development Process. An important objective of our dissertation was to improve our understanding of the French process of development ("*verstehen*", Diebolt and Demeulemeester, 2012). Economic growth is just one aspect of the process of development. Numerous changes have occurred at the same time as the unprecedented rise in income per capita observed in France by the early 19th century. The take-off was associated with significant transformations of demographic behavior, labor force participation, educational investments and gender relations. These various aspects, underlying the transition from stagnation to sustained economic growth, are studied in Chapter 1 to Chapter 4 using longitudinal and cross-sectional data. The study of longitudinal data puts into perspective several important findings.

Important transformations have affected the marriage pattern in France in the course of the demographic transition. We distinguish three main stages in the evolution of marriage practices since the 18th century. Prior to the French Revolution, marriage practices were characterized by the classical features of the European Marriage Pattern: a large share of definitive celibacy, marriage at a late age and low frequency of illegitimate fertility. We observe a reversal after the French Revolution. The share of definitive celibacy falls sharply, the median age at marriage engages into an impressive downward path and illegitimate births rise substantially. Finally, an important increase in the median age at marriage to a larger extent for women occurred from the 1960-70's while the number of births outside marriage exploded as well as the share of single individuals. Despite the change in marriage pattern, fertility declined continuously from the end of the 18th century. The decline in fertility reflects a change in habits with regards to fertility regulation. During a large part of the 18th century, individuals have authentically acted in a Malthusian way accepting more and more late marriage and a larger proportion of definitive celibacy in parallel to the fall in infant mortality in order to maintain a sustainable number of offspring. This explains why a decline in fertility was not observed before the French

Revolution. The decline in the median age at marriage and the decline in the proportion of celibacy together with the decline in fertility can be explained by the adoption of contraceptive behaviors within marriage.

The study of the transformation of the female labor force participation and life cycle at work together with the investigation of the evolution of girls' educational investments helps to understand the reasons of the diffusion of birth limitation within marriage. The involvement of women in paid activities increased substantially over time while its structure transformed. The 19th century is characterized by a large decline in the peasantry, as well as craftsmen and tradespeople, in favor of manufacturing workers. From the early 20th century, the share of manufacturing workers declined, in turn, to the benefit of employees and executive workers. In the mid-20th century, wage earners represented two-third of the total labor force and their number continued to rise at an increasing pace during the second half of the century. At the same time, the share of married women and of women in childbearing age in the labor force increased significantly from the mid-19th century, and at an increasingly pace from the 1960's onwards, despite a temporary decline during the first half of the 20th century. On the contrary, the share of women aged 15-24 experienced an important decline. Simultaneously to these transformations, the gender gap in occupation and earnings reduced sharply, although differences persisted. These differences do not seem to be fully explained by economic factors. The investigation of the evolution of educational investments revealed strong differences between boys and girls. Over the 19th century, women were on average less trained than men. Women opportunities and access to education were limited and bounded. Significant changed are, however, observed. Women educational investments increased substantially over the past two centuries, from primary education to secondary education and from secondary education to tertiary education. Women became more and more trained. Within a few decades, France experienced an impressive catch-up of girls' enrollment rates over that of boys. The feminization of education allowed girls to fill a large part of their delay in schooling. Hence, the quality of the labor force increased continuously and reversed in favor of women by the early 20th century.

Therefore, longitudinal data indicate that gender inequalities reduced significantly as the educational investments of girls and the participation of women in economic life increased. Along these transformations, individuals adapted their behaviors regarding marriage and birth control. Hence women got more educated, they were more numerous to integrate the labor market but at the same time they married younger and had less children. All these elements together reveal the empowerment of women and suggest a significant change in women status along the process of development. In addition, the study of cross-sectional data sketches an interesting picture of the geography of economic activities, educational investments, demographic behavior and gender relations. The analysis of socio-economic and demographic profiles of French counties contributes to shed new light on the specific regional characteristics. Two opposite profiles emerged. On the one hand, we find agrarian counties characterized by a poorly educated population, important gender inequalities, high mortality and high fertility rates. On the other hand, we find industrialized, but still rural, areas putting significant effort on education for both genders. Gender equality is larger, women tend to be more integrated on the labor market and fertility rates are lower. Areas combining both industrialization and large urbanization are however characterized by large gender inequalities. The sexual division of labor remains significant. Effort is made on education but specifically on boys' education and fertility remains large.

Third – Recognition of the Need of Adopting a Gender perspective. What stands out from the study of the French process of development is the existence of an intricate long-run relationship between economic development, demographic transition and gender relations. The literature review on the theoretical foundations of the process of development has shown the lack of consideration of gender perspective in explaining the development process (Chapter 5). Evidence of interconnections between changes in gender relations and the process of development together with the lighting on the lack of related literature raised the need for more gender considerations in economic history. Especially, it puts into perspective the need for a greater integration of gender into unified growth models.

Fourth – Additional and Novel Mechanisms in a Unified Growth Model. The study of the French process of development emphasized evidence of an intricate relationship between gender equality and economic development however it does not explain underlying mechanisms and does not afford to determine whether gender equality spur economic development or whether economic development foster gender equality. This is what the theory helps us to determine, by a renewed gendered approach. The use of modeling aims at explaining, "*erklären*" (Diebolt and Demeulemeester, 2012), the process of development and at identifying the underlying mechanisms of the economic development.
Chapter 6 sheds light on the importance of the role played by female empowerment (changes in gender relations) on the development process. We argue that gender empowerment have been necessary to allow economies to move from stagnation to sustained growth. Our intuition is that the transition from a "Patriarchal" organization of the society (male-breadwinner model), characterized by a sexual division of labor with a desire for households to maximize both their income and the number of children, toward a "Modern" organization of the society (dual-earnings model), characterized by a better distribution of duties within the household, where

both men and women work on the labor market, is at the heart of both the process of human capital accumulation and the demographic transition that occurred during the process of development in Western countries. More specifically, we develop a unified cliometric growth model that encompasses the interplay between income, gender equality and fertility. Our model suggests that gender empowerment is a crucial factor of both demographic and economic transition. In particular, the theory points out that the acceleration of skill-biased technological progress generates a positive externality on the level of gender equality. Both wages and gender equality are key variables in the education decision process of individuals. More specifically, higher gender equality reinforces individuals' incentives to acquire skilled human capital. In turn, female choices in terms of time and quality of educational investments increase their endowment in human capital and impact positively the fraction of the subsequent generation of individuals acquiring skilled education. In other words, improvements in technological progress, gender equality and skilled human capital reinforce each other. Ultimately, the presence of a sufficiently high fraction of skilled individuals in the population yields to sustained economic growth.

In the early stage of development, the low rate of technological progress does not provide any incentive to invest in skilled education. Therefore, the fraction of skilled individuals is low and the economy remains trapped in Malthusian steady-state equilibrium, with low education, low living standard and low gender equality. Technological progress is assumed to increase monotonically from generation to generation. Thereby, as technological progress grows, we observe a qualitative change, and the subsequent income effect triggers (temporarily) higher fertility rates. After sufficiently many generations, increases in the returns from investments in skilled education (productivity growth) – driven by the rise in technological progress – makes investing in skilled education more profitable so that gender equality improves. The dynamic system of skilled human capital and gender equality is therefore characterized by multiple steady-state equilibriums. Since gender equality becomes high enough, a substantially larger fraction of individuals acquires skilled human capital what triggers rapid developments and reinforces gender equality. Due to larger educational investments (in terms of time units), female opportunity cost of having children increases and average fertility declines: the demographic transition occurs along with the process of human capital accumulation. Ultimately, in later stages of development, gender equality and the fraction of skilled individuals converge towards their maximum. Thereby, the economy is characterized by Modern Growth steady-state equilibrium, where living standards are high, gender equality is high and fertility is low.

Fifth – Key Role of Women Human Capital on Fertility Transition. The trade-off between the women endowment in human capital and their number of children is the crucial ingredient of the unified growth model developed in Chapter 6. According to the model, greater opportunities for women to invest in education increases the opportunity cost of having children and implies for women to face a trade-off between education and fertility. This process ultimately leads to a fertility transition. In Chapter 7, we have tested the hypothesis that women endowment in human capital is negatively correlated with their fertility. Using a dataset of 86 county-level observations in the 19th century, we have compared the effect of changes in men's human capital on changes in fertility with the effect of changes in women's human capital on changes in fertility. In accordance with the theory, we find the existence of a significant and negative effect of women endowment in human capital on fertility during the demographic transition.

Sixth – Use of an Original Method. To assess the long-run relationship between gender equality and economic growth, we have used a well-adapted method to our questioning: the cliometric analysis. The first step consisted in accurately reconstruct a set of facts and events from various documentary sources. The second step aimed at identifying the causes and consequences of the findings of the first stage of the analysis. Economic theory was then mobilized to model and transform a complex system into a simpler set of information in order to better understand the mechanisms underlying the stylized facts. The last step used econometric tools to check the relevance of the theory by comparing it to past data. Through this three-stage process, we have put into perspective evidence of interplay between gender equality and economic development. In particular, we have shown that gender equality was necessary to allow economies to move from Malthusian Stagnation to Modern Economic Growth. More generally our research had the ambition to be an original illustration of the main achievement of cliometric research in the recent years, i.e. to slowly but surely establish a solid set of economic analyses of historical evolution by means of measurement and theory. This dissertation aimed at bringing together theoretical growth models and economic history. Following Diebolt (2012), we believe that understanding more deeply the historical working and path dependence of the socio-economic processes may enable to interpret current economic issues. The past-dependency may then be a guide for the analysis and the implementation of economic policies.

Future Work – Research Agenda

While this dissertation tries to bring answers to our research question regarding the role played by gender equality on long-run economic development, there is room for future research in order to improve our knowledge of this long-term relationship. Three different aspects are worth mentioning.

1. Econometric aspects

Our results could be verified and extended by various empirical methods.

- Improving the empirical validation of our results by using the method of instrumental variable IV.
- Extending the current work to a panel data analysis. This econometric approach will allow us to gain higher accuracy in our estimates and to better understand the role played by women on the child quantity-quality trade-off during 19th century France.
- Testing different relations associated with human capital accumulation, namely the effect of parental education on children education by gender.
- Investigating the causality of the relationship between gender equality and economic growth.

2. Theoretical aspects

Up to now, studies having explored economic and demographic transitions have been relying on neoclassical conception which is highly stylized and based on the rationality of homogenous individuals. Despite its limitations, the neoclassical framework of rational-choice behavior remains a "powerful and useful tool" (Echevarria and Moe, 2000). Nonetheless, another type of modeling approach may be exploited in order to address some of the major issues raised by the neoclassical framework, such as the multi-agent simulation. The use of this type of modeling allows us to abandon most of the main stringent assumptions of standard formalization and to account for heterogeneity among agents. The models simulate the simultaneous operations and interactions of multiple agents, in an attempt to recreate and predict the appearance of complex phenomena. It may then provide an explicit micro-foundation of the dynamics of economic growth within an evolutionary framework. In addition, it allows the integration of the role of institutions – that is essential to create a suitable environment to potential economic growth and demographic transition.

3. Empirical aspects

- It would be interesting to investigate the long term evolution of the level of gender equality. Generalization of the construction of our gender gap index to cover several periods will allow us to study quantitatively this evolution over time and to compare it with the evolution of other demographic and economic variables.

- A comparative study of the French case with other developed countries on the evolution of the level of gender equality would be of interest to examine whether France was indeed more gendered equalitarian than other Western countries. We could test if France was relatively more advanced than other countries in terms of female labor force participation or endowments in human capital.

- Constructing statistical estimates of the performance of France to work out on more reliable estimates of GDP per capita along the line of recent works such as Broadberry *et al.* (2011) for England and Britain over the period 1270-1870; Clark (2010) for England for the period 1200-1870; Van Zanden and Van Leeuwen (2012) for Holland over the period 1347-1807; Malanima (2011) for central and Northern Italy for the period 1300-1913; Pfister (2011) for Germany over the period 1500-1850 and Nuvolari and Ricci (2013) for England over the period 1250-1850.

- Wages are one of the key variables in the economy but they are still a poorly known variable, especially in the long run. There is currently no pertinent macroeconomic appraisal of wages and payroll costs in a gender perspective for France. So far, the work of Simiand (1932) is the only one in this direction which looked at wages over a long period. He suggested that the long-term development of wages moved in the same direction as the price trend and put forward the hypothesis of an inverse real wages cycle. This hypothesis is significant and efforts should have been made to settle possible doubts. However, in the past eighty years, French research has devoted little attention to it. Hence, the purpose of this research is to fill this gap by proposing new statistic measures to shed light on the successive stages in long-run changes of French wages and payroll costs in a gender perspective.

- Previous research has shown that historical legacies can have long-term impacts that continue to be felt to this day (Nunn, 2009). However, the family as a historical micro-institution has received little attention in this respect. Family, the main vehicle of socialization and the transmission of values, deserves attention as a crucial determinant of development both in socio-economic and political terms. For instance, Greif and Tabellini (2010) and Greif (2006) claim that differences in the family structure help explain the diverging economic development between regions. Likewise, De Moor and Van Zanden (2010) link the European Marriage Pattern with development in medieval and early modern Europe. This link between family and development recently received more support from empirical studies. Duranton *et al.* (2009) provide evidence on the role of regional variation in Europe in terms of family structures and various development outcomes (e.g., GDP per capita, educational achievement, fertility). Alesina and Giuliano (2010) show that family ties are a strong predictor of female labor force participation whereas Galasso and Profeta (2010) provide evidence on the link between family structures and the pension systems of the societies. Overall, family plays a role in the transmission of norms, beliefs, and values which matter for economic, political and social outcomes. Another strand of literature, the famous "quantity–quality tradeoff" argument, highlights the link between household structure (in particular the number of children) and human capital formation (Diebolt and Perrin, 2013). However, more research is required to understand the mechanisms through which family have a persistent impact on various development outcomes. To start with, there is a scarcity of data to capture the global variation in the family structures, especially from a historical perspective. Furthermore, more investigation is needed into the channels through which the family has a persistent effect on current development outcomes. Doing so would contribute to our understanding of diverging patterns of global development. More particularly, our future research intends to focus on the following questions. How do societies differ from one another in terms of how families have historically been formed? To what extent does the variation in the family structures explain the regional differences in political, economic, and social development? To what extent the way families organized in the past has a persistent effect on current development outcomes? Does the effect of family change over time?

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Gender Equality and Economic Growth in the Long-Run.
A Cliometric Analysis

Abstract. – This thesis studies the long-run relationship between gender equality and economic growth. In particular, it aims at understanding and explaining the mechanisms and determinants underpinning the development process which allowed economies to move out of a long period of stagnation into a state of sustainable economic growth. The scientific objective is to check the validity of the central hypothesis that improving equality between men and women is a key ingredient of the demographic transition and of the process of socio-economic development. Quantitative and empirical analysis of this relationship is based on a renewed cliometric approach. Hence we aim at producing a quantitative projection of social sciences in the past, structured by economic theory, mathematical modeling, and informed by statistical and econometric methods. The projected innovation is to build a bridge between the theoretical models of growth and economic history. This new line of research between pure empiricism and abstract theory allows to interpret economic issues taking into account the past and in so doing, to understand more deeply the economic and social historical processes.

Keywords: Cliometrics • Economic Growth • Demographic Transition • Human Capital• Gender

Égalité hommes-femmes et croissance économique de long terme.
Une analyse cliométrique

Résumé. – Cette thèse étudie la relation de long terme entre égalité hommes-femmes et croissance économique. Plus particulièrement, elle vise à comprendre et à expliquer les mécanismes et les déterminants sous-jacents au processus de développement qui a permis aux économies de sortir d’une longue période de stagnation à un état de croissance économique durable. L’objectif scientifique est de vérifier la validité de l’hypothèse centrale que l’amélioration de l’égalité entre hommes et femmes est un ingrédient clef de la transition démographique et du processus de développement socio- économique. L’analyse quantitative et empirique de cette relation est basée sur une approche cliométrique renouvelée. Ainsi, nous visons à produire une projection quantitative des sciences sociales dans le passé, structurée par la théorie économique, la modélisation mathématique, et informée par les méthodes statistiques et économétriques. L’innovation projetée est de construire un pont entre les modèles théoriques de la croissance et l’histoire économique. Cette nouvelle ligne de recherche entre empirisme pur et théorie abstraite permet d’interpréter les questions économiques en tenant compte du passé et, ce faisant, de comprendre plus profondément les processus historiques économiques et sociaux.

Mots clefs: Cliométrie • Croissance économique • Transition démographique • Capital humain • Genre