THÈSE

UNIVERSITE DE PAU ET DES PAYS DE L'ADOUR
École doctorale Sciences Sociales et Humanités (481)

Présentée et soutenue le 09 juillet 2020
par Tchapo GBANDI

pour obtenir le grade de docteur
de l'Université de Pau et des Pays de l'Adour (UPPA)
Spécialité : Sciences Economiques

VILLES, CONFLITS ETHNIQUES ET ACCORDS SUR L'EAU: TROIS ESSAIS EN ECONOMIE INTERNATIONALE

MEMBRES DU JURY

RAPPORTEURS

- Julie LOCHARD — Professeur à l'Université Paris-Est Créteil (UPEC)
- Mathieu COUTTENIER — Professeur à l'Université de Lyon, ENS Lyon

EXAMINATEURS

- Marion MERCIER — Chercheur CNRS, LEDa-DIAL, Université Paris Dauphine-PSL
- Serge REY — Professeur à l'Université de Pau et des Pays de l'Adour (UPPA)
- Théophile BOUGNA — Chercheur, Banque Mondiale

DIRECTEUR

- Fabien CANDAU — Professeur à l'Université de Pau et des Pays de l'Adour (UPPA)

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR



Centre d'Analyse Théorique et de Traitement des données économiques

Center for the Analysis of Trade and economic Transitions

Thèse réalisée au

Centre d'Analyse Théorique et de Traitement des données économiques (CATT)
Center for the Analysis of Trade and Economic Transition (CATT)

Université de Pau et des Pays de l'Adour (UPPA)
Collège Sciences Sociales et Humanités (SSH)
Avenue du Doyen Poplawski
BP 1633 64016 PAU Cedex
Tél : +33 (0)5 59 40 80 61 / 80 62
E-mail : catt@univ-pau.fr
Web : https://catt.univ-pau.fr

Directeur : Fabien CANDAU
fabien.candau@univ-pau.fr

Ph.D. THESIS

UNIVERSITY OF PAU (UPPA)

Doctoral School of Social Sciences and Humanities (ED SSH-481)

Ph.D. dissertation in Economics by

Tchapo GBANDI

Publicly defended on
July, 9th 2019

CITIES, ETHNIC WARS AND WATER: THREE ESSAYS IN INTERNATIONAL ECONOMICS

Research center:
Center for the Analysis of Trade and Economic Transition (CATT)

COMMITTEE:

EVALUATORS

- Julie LOCHARD — Professor, Université Paris-Est Créteil (UPEC)
- Mathieu COUTTENIER — Professor, Université de Lyon, ENS Lyon

EXAMINERS

- Marion MERCIER — Researcher, CNRS, LEDa-DIAL, Université Paris Dauphine-PSL
- Serge REY — Professor, Université de Pau et des Pays de l'Adour (UPPA)
- Théophile BOUGNA — Researcher in Economics, World Bank Group

ADVISOR

- Fabien CANDAU — Professor, Université de Pau et des Pays de l'Adour (UPPA)

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Centre d'Analyse Théorique et de Traitement des données économiques

Center for the Analysis of Trade and economic Transitions

Remerciements

Avant tout propos, je tiens à traduire toute ma profonde gratitude à l'endroit de tous ceux et de toutes celles, qui, d'une manière ou d'une autre, ont permis l'aboutissement heureux de cette thèse. Mes remerciements s'adressent en premier lieu à Monsieur Fabien Candau, mon Directeur de thèse. Ses remarques, suggestions et critiques, sa rigueur couplée à sa bonne humeur ont été d'un apport incommensurable. Son amour à la recherche et sa combinaison parfaite entre travail et sympathie m'ont largement inspiré. Trois années de collaboration, de travail acharné sous sa direction qui me semblent déjà être plutôt trois années de plaisir vu l'environnement incitatif qu'il a instauré. Je reste convaincu que la vie c'est avant tout les bonnes rencontres ; pour faire court, merci pour tout.

En second lieu, ma reconnaissance va à l'endroit de mon grand cousin, oncle et tuteur Ephrem, pour son parcours inspirant, ses incessants encouragements et son soutien sans relâche jusqu'à aujourd'hui ; je lui dis tout simplement "MERCI".

Je remercie particulièrement Geofroy (co-auteur) et Mamadou, que je peux appeler désormais mes frères pour leur accueil et disponibilité depuis les premiers jours de nos rencontres ; je crois qu'ils ont compris qu'ils pourront compter sur moi en toute circonstance. Qu'ils trouvent ici l'expression de ma reconnaissance. La sagesse de Carlito (Charles) et le dynamisme de Julie : merci de m'avoir permis de m'intégrer dans votre équipe, sans oublier Estelle et Marie. Je tiens à remercier tous les membres du corps professoral et tout le personnel administratif du Centre d'Analyse Théorique et de Traitement des Données Economiques (CATT) : Mme C. Haritchabalet puis Mme Cuyalaa, Mme Guenebeaud, Mme Joubert, Mme Perrin, et M. Cassagnard. J'ai naturellement une pensée spéciale à mes amis et très sympathiques collègues doctorants pour l'ambiance combien conviviale qu'ils ont su instaurer durant ces trois années d'étude. Mention spéciale Kevin E., Hervey de Paris, Lemmi, Djawé, Andrad Varella et Jean-Claude, pour leurs précieux soutiens et leurs aides, sans oublier Tiam, Leonnel, Isaine, Mamoudou, Denis, Ralph, George et Kaba.

Mes remerciements vont également à l'endroit Monsieur M. Couchoro pour son indéfectible soutien moral, ses conseils pratiques et ses expériences partagées à tous les niveaux. Un clin d'œil à Monsieur G. Afawubo, M. Agbodji, Mme Zinsou, à qui j'adresse mes remerciements les plus sincères pour leurs encouragements et conseils.

Comment pourrais-je omettre Nanou, Fatou et principalement Tanti Saly ; merci de m'avoir adopté.

Pour finir, j'aimerais rendre un hommage particulier à mes parents, ma grand-mère et mes sœurs et neveux, qui n'ont jamais douté de moi et qui m'ont toujours soutenu ; vos prières me vont droit au cœur. A Jeanne et à Diamond, je n'ai pas de mots pour signifier ma gratitude, merci, je n'ai jamais été loin.

Cities, Ethnic Wars and Water: Three essays in International Economics

Abstract

International trade is one of the key factors that have deeply reorganized the world economy. This thesis addresses three different topics in the field of international economics. It firstly brings new insights on the contribution of international trade to the geographical distribution of populations in countries and secondly, determines trade effect on ethnic conflicts. Afterwards, this document examines the reaction of world trade to international water agreements that increasingly emerged in recent decades as a tool for sustainable and socially equitable development. The contributions of this document stem not only from the originality of the topics discussed and the methodologies adopted, but it also proposes and builds more appropriate indicators that are better suited to capturing the issues under analysis.

Thus, the first chapter assesses whether international trade is relevant in explaining the development of large cities in past European colonies. We argue that trade restrictions can provide an advantage to one city, which may become the platform for exports and catastrophically attracts people. By contrast, trade liberalization, by providing market access to other cities, fosters the dispersion of economic activities and consequently a dispersion of the population. The empirical investigations have led to the conclusion that international trade does not drive the size of large cities in the former colonized countries. Only institutions drive the size of primate cities: democracy goes hand in hand with agglomeration.

The second chapter analyses the relationship between trade and insecurity in African countries. Focusing on ethnic conflicts, this part of the thesis argues that the type of trading partners determines the opportunity cost of an ethnic conflict. The international trade of ethnic groups, the regional trade and countries' internal trade may have heterogeneous effects on peace. The data analyses results support this prediction by pointing out that international ethnic trade and countries' internal trade are peace-promoting tools unlike trade between countries that share at least one ethnic group, which appears as a factor of ethnic conflicts. However, only international ethnic trade seems to reshape the national identity of countries, which in turn reduces the likelihood of ethnic conflicts.

In the last chapter of the thesis, we discuss the growing concern about the international management of shared water resources. As water constitutes an important input in the production of goods, it seems necessary to assess the effectiveness of international water agreements with regards to trade after several decades of implementation. One can argue that these agreements are just "cheap talk", or rather pragmatic attempts to meet the sustainable development objectives to take actions for better water management. Conversely, these agreements, by allowing a better allocation of water resources between countries, can also stimulate production (especially agricultural production) and ultimately trade. Thus, this chapter firstly sheds light on the climate change indicators that are the main drivers of the increasing implementation of shared water resources' agreements. Secondly, it examines whether these agreements affect international trade before proposing their overall effects on countries. In general, the study reveals that water agreements, motivated in particular by high temperature signals, represent a cost to free trade in Europe, Asia and the Americas, except in Africa. Therefore, it seems that these water agreements have substantial environmental protection contents that restrict trade.

Résumé

Le commerce international est l'un des éléments majeurs qui a restructuré profondément la vie des nations et de l'économie mondiale. Cette thèse aborde trois sujets différents dans le domaine du commerce international. Elle apporte en premier lieu, de nouveaux développements sur la contribution du commerce international à la répartition géographique des populations au sein des nations et détermine en second lieu son influence sur les conflits ethniques. Ensuite, elle analyse la réaction des échanges mondiaux aux accords internationaux sur l'eau qui s'érigent ces dernières années comme un outil important du développement durable et socialement équitable. Les contributions de ce document, tiennent non seulement de l'originalité des questions traitées et des méthodes utilisées, tout en proposant et en exploitant des mesures mieux indiquées pour capter les faits analysés.

Dans le premier chapitre, nous analysons si le commerce international a eu un rôle dans le développement des grandes villes des anciens pays colonisés. D'un point de vue théorique, un accès difficile au marché mondial de biens pourrait amener la principale ville à devenir la plateforme des exportations, attirant ainsi les populations. Dans le cas contraire, il y aura une meilleure répartition de l'activité économique dans le pays, et par conséquent moins d'incitation des populations à s'agglomérer dans la capitale. Notre analyse montre que le commerce international semble ne pas affecter la taille des grandes villes dans les anciens pays colonisés. Les institutions restent par contre déterminantes pour expliquer la taille des villes : la démocratie est source de concentration des populations dans les grands centres urbains des pays en développement.

Le second chapitre examine la relation entre le commerce et l'insécurité dans les pays africains. En nous concentrant sur les conflits ethniques, cette partie met en avant le fait que le type de partenaires à l'échange déterminerait le coût d'opportunité à un conflit ethnique. Les résultats obtenus valident cette intuition en démontrant que les échanges internationaux des ethnies, le commerce régional et le commerce interne d'un pays ont des effets hétérogènes sur la promotion de la paix. Ainsi, il ressort que le commerce international des ethnies et le commerce interne des pays ont des effets pacificateurs contrairement au commerce entre pays qui partagent au moins un groupe ethnique. Cependant, seul le commerciale international des ethnies semble remodeler l'identité nationale qui à son tour réduit la probabilité de conflits ethniques.

Le dernier chapitre se concentre sur la fulgurante augmentation des coopérations internationales concernant la gestion des bassins d'eau communs. L'eau étant un élément essentiel des processus de production des biens, il conviendrait de savoir, après plusieurs décennies d'implémentation, l'impact de ces accords sur le commerce. En effet, trois hypothèses concurrentes peuvent être émises. Il se pourrait que ces accords ne soient que des discours politiques sans conséquences réelles n'impactant pas le commerce. Il est aussi possible que ces accords se matérialisent par des tentatives pragmatiques visant à respecter les objectifs de développement durable et dans ce cas, il est probable que ces accords ont un effet négatif sur le commerce. A l'inverse, ces accords permettant une meilleure allocation des ressources en eau entre pays, peut aussi stimuler la production (notamment agricole) et *in fine* les échanges commerciaux. En général, les résultats révèlent que les accords sur l'eau, motivés en particulier par les hausses de température, représentent un coût au libre-échange en Europe, en Asie et en Amérique (mais pas en Afrique), il semble donc que ces accords sur l'eau ont un contenu de protection environnementale important qui limitent les échanges commerciaux.

Contents

Remerciements ..... **i**
Abstract ..... **iii**
Résumé ..... **iv**
Contents ..... **v**
List of figures ..... **viii**
List of tables ..... **ix**
General introduction **1**
Trade and Institutions in Explaining Urban Giants: summary 10
Beyond the Income Effect of Trade Integration on Ethnic Wars: summary 13
Climate Change, Water Treaties and International Trade: summary 16
I. Chapter 1 - Trade and Institutions: Explaining Urban Giants **21**
Introduction 21
I.1 Hypothesis, data and preliminary results 25
I.1.1 Empirical Strategies 25
I.1.2 Data 29
I.1.3 First results 34
I.2 IV Strategy 36
I.2.1 Two steps SLS identification strategy with a zero-stage 37
I.2.2 Results of the Zero-Stage 39
I.2.3 Results of the first stage 40
I.2.4 Results, second stage 41
I.2.5 Non parametric estimation: matching estimator approach 43
I.2.6 Discussions 45
I.3 Conclusion 46
I.4 Appendices 47
I.4.1 Appendix A: Light nights and urban primacy 47
I.4.2 Appendix B: Outdegree Indicator of Network 48
I.4.3 Appendix C: Theoretical foundation of the market access 50

I.4.4 Appendix D: Alternative measures of democracy in the zero stage regressions 51
I.4.5 Appendix E: Deepening the analysis 53
II. Chapter 2 - Beyond the Income Effect of Trade Integration on Ethnic Wars ... 56
Introduction 56
II.1 1 Empirical strategy 60
II.1.1 A brief review of the literature 60
II.1.2 International, regional and internal trade at the ethnic group level 62
II.1.3 Estimation 67
II.2 1 Results about the effects of trade on conflicts 69
II.2.1 Trade and conflicts without income effect 69
II.3 Inference from a two-step strategy 73
II.3.1 Empirical strategy 73
II.3.2 Results 77
Conclusion 81
II.4 Appendices 82
II.4.1 Appendix A: First resuts 82
II.4.2 Appendix B: First-stage IV estimates, explaining ethnic groups' international trade 84
II.4.3 Appendix C: First-stage IV estimates, explaining regional trade 85
II.4.4 Appendix D: Robustness check analyses of the impact of Regional trade with imports 86
II.4.5 Appendix E: First-stage IV estimates, explaining countries' local trade 88
II.4.6 Appendix F: First-stage IV estimates 89
III. Chapter 3 - Climate Change, Water Treaties and International Trade 91
III.1 Introduction 91
III.1 About water treaties 95
III.2 Estimating Elasticity 101
III.3 The Structural Gravity Equation 101
III.4 Data and estimators 103
III.5 Baseline results 105
III.6 Heterogeneity analysis 106
III.7 Water treaties versus Regional Trade Agreements on Water 109
III.8 General Equilibrium Analysis 111

III.8.1 Methodology and data 112
III.8.2 Results 115
III.9 Conclusion 118
III.10 Appendices 120
III.10.1 Appendix A: Climate reasons of water agreements, unilateral estimation approach 120
III.10.2 Appendix B: Reverse causality test 122
III.10.3 Appendix C: Sensitivity of results to changes in trade elasticities 123
General conclusion 125
References 129

List of figures

Figure 1 : World exports trend 1
Figure 2 : Cumulative function of water agreements 10
Figure 3: Urbanization Primacy in 2010 and Density in 1500 23
Figure 4: World Trade Network in 1900 48
Figure 5: Crops production imagery: cotton and cassava 64
Figure 6: Mineral resources location in Africa at the Ethnic/country level 66
Figure 7: Water Treaties Contents 97
Figure 8: The Impact of No Water Treaties on Trade (GETI) 117

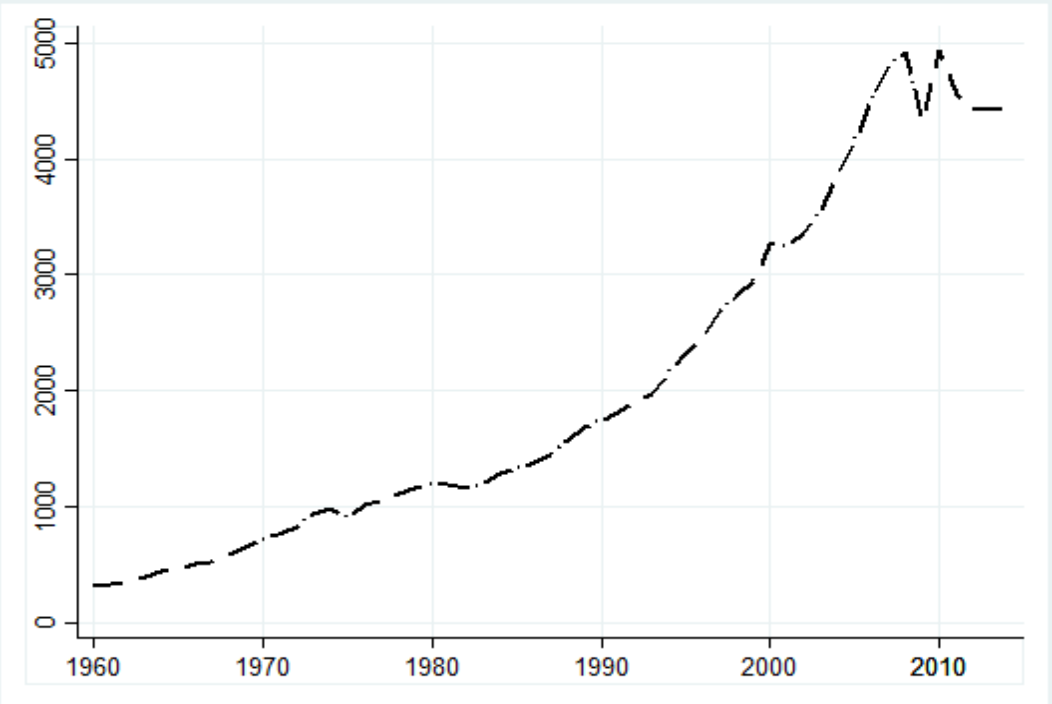
List of tables

Table I-1: Urban Reversal 36
Table I-2: Democracy (ANRR index), zero stage 39
Table I-3: Market Access, zero stage 40
Table I-4: Democracy and Trade, First stage 41
Table I-5: Trade, Institutions and Urban Primacy 43
Table I-6: Average effect of democracy on log urban primacy 44
Table I-7: Effect of the constructed light night gap on urban primacy 47
Table I-8: Democracy (Polity 2 score), zero stage 51
Table I-9: Democracy (PR, CL), zero stage 52
Table I-10: First and Second Nature of Urban Giants 54
Table II-1: International Trade effect on ethnic wars onset 70
Table II-2: International Trade effect on ethnic wars onset 73
Table II-3: First stage regression 78
Table II-4: Second stage regression: Country fixed effects regression 80
Table II-5: Results from naïve regressions 83
Table II-6: IV first stage regressions: explaining ethnic groups' international trade 84
Table II-7: IV first stage regressions: explaining regional trade 85
Table II-8: Regional Trade effect on ethnic wars onset 87
Table II-9: IV first stage regressions: explaining local trade 88
Table II-10: IV first stage regressions explaining country total Export and local trade in the Two-stage methodology 89
Table III-1: Climate reasons of water agreements: gravity estimation approach 100
Table III-2: Baseline results 106
Table III-3: Heterogeneity analysis 108
Table III-4: Heterogeneity analysis 111
Table III-5: Direct, PIE, GETI effects of water agreements 116
Table III-6: Climate reasons of water agreements 121
Table III-7: Strict exogeneity test of water treaties 122
Table III-8: Doubling and halving trade elasticities 123

General introduction

Let begin this thesis with a popular quote from Adam Smith that goes: “Every man lives by exchanging”. Indeed, this saying is not only true at the individual level, it also holds at the aggregate scale: international trade is a fundamental factor of economics growth, explaining a large part of the “Great Convergence” of emerging countries (Baldwin, 2017). Any country can't produce all the goods and services that people needs in its homeland. The sharp decrease in trade costs (Jacks, Meissner, and Novy, 2008), the growth of income (Baier and Bergstrang, 2001) and the political consensus about trade liberalization (sometimes called the “Washington consensus”, see Rodrik, 2006) have stimulated bilateral trade flows[1] between countries at an impressive rate these latter decades.

Figure 1 : World exports trend



Source: Author, replication from data of Federico and Tena-Junguito (2016). The value of global exports, Time of value of world exports (million $) at constant prices, relative to 1913.

[1] Data in the figure are from https://ourworldindata.org/trade-and-globalization

However, it is obvious that this increasing level of international interactions is not immune of effects on countries domestic's characteristics. At the same time, the level of trade should be affected by decisions countries make either domestically or internationally, knowingly or unintentionally. Then, international trade, by connecting nations all around the world has structurally affected countries economically, institutionally, socially and spatially. This issue becomes so central to world politics as the technological progress made in the last century has deeply connected people in the world as ever.

As a result, international trade remains a topical issue. From development policies perspective, trade has been so important that development institutions such as the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) were created, to smoothen bilateral transactions of goods and services. The GATT was specifically created to reduce trade restrictions in order to promote exchanges, reduce prices, enhance an efficient use of factors, and increase employment. In development countries, trade is seen as a powerful means that can help lift people out of poverty (despite the ambiguous results obtained by researchers, see Winter et al. 2004). In this vein, the goal of the WTO is not only to be a platform that settles world market issues but, it acts also as an international think tank that responds to developing countries needs in terms of trade. Besides, a lot of Regional Trade Agreements (RTA), which are reciprocal treaties, has been promoted to foster exchanges in the world. Besides, some single country use to propose to particular developing countries, different strategies that can help them alleviate extreme poverty, by setting up initiatives like General Scheme of Preferences (GSP). By doing so, the opportunity is given to vulnerable countries to benefit from a scheme of tariff preference that removes imports duties when exporting their products to the granter's homeland.

It clearly appears that the political, social, and economic importance of trade is not to be neglected. After all, it seems obvious that international trade affects development in many aspects. This thesis tries to analyze two of them by answering the following questions respectively in the first and second chapter: (*i*) Does trade affect the spatial distribution of population within countries? (*ii*) To what extent does trade influences ethnic conflicts? In the third chapter, instead of analyzing a link that goes from trade to

development, (*iii*) we try to comprehend the way trade reacts to an important input in goods production: the so called "water". More precisely, the question we raise in this part of the thesis is whether trade reacts to international water treaties.

International trade may be a factor of agglomeration. As a matter of fact, a sharp growth of cities' populations and particularly the increasing number of metropolitan areas, have made urban planning a more serious matter in public policy agenda. The channels that drive this growth of big cities are mainly the industrialization led by rural-urban migration. According to the World Urbanization Prospects, the urban population in the world has grown rapidly to about 4.2 billion people in 2018, more than four times the urban population in 1950[2]. Thus, urbanization appears to be a topical issue since it concerns more than a half of the world's population (55% according to World Urbanization Prospects in 2018). About seven out of ten people (68%) of the world population is projected to be living in urban areas by 2050, following the projection of the United Nation[3]. Besides, the UN World cities' report of 2016 reveals that more than 40% of the urban population is concentrated in a single city of more than one million inhabitants in 28 countries[4].

Urbanization has advantages but it also has drawbacks. In fact, urbanization, through density and competitivity, paves the way for industrialization, growth and employment thereby sustaining the agglomeration. As a consequence, in case of poor urban planning, congestions issues, high level of unemployment rate, slums, environmental issues (CO_2 emission) and inappropriate living conditions might emerge. Thus, before thinking of policies that can help manage urban areas, it seems necessary to determine the causes of its evolution. Why do large cities in terms of population still attract people? Have these urban giants been affected by the distant past distribution of economic activities?

Based, among other sources, on the theoretical works from Krugman and Livas (1991) and Krugman (1996[5]), one of the seminal empirical works that investigates the link between trade and urbanization goes back to Ades and Glaeser (1995). They analyzed two reasons behind urban population growth: international trade and institutions. The

[2] 751 million of people in 1950.
[3] https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html
[4] https://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf
[5] The working paper of this research cited in the article of Glaeser (1995) is from 1992

theoretical line of research from Krugman and Livas (1996) leads to the conclusion that closed domestic markets are a key factor that drives the emergence of urban giants. They argue that producers are more likely to choose production sites with good access to consumers to save transport costs. This will attract job seekers which will in turn fuel the demand, promoting a self-reinforcing of the agglomeration process. Accordingly, this will ensure a better access to intermediate inputs because of the proximity of the other firms. Urbanization is then driven by the concentration of the demand and the inputs in the same city. As a matter of fact, exporting from this agglomeration area is a key added value for firms, since they can benefit not only from economy of scale as they can directly rely on their existing infrastructure, but they can also benefit from a competitive work force and the proximity of intermediate inputs. On the contrary, in case of low transaction costs, goods can be shipped easily not only from the main city but also from the interland. That is part of the point made in the model of Krugman and Livas (1996). Besides, institutions could be part of the causes behind the spatial distribution of the populations (Ades and Glaeser, 1995). Actually, governments when managing policies, can purposely or unconsciously, influence the spatial distribution of the economic activities in their countries and therefore that of the population.

For the sake of clarity on the main cause(s) of urban giants, we revisit in this first chapter the work of Ades and Glaeser (1995) by handling the analysis on a panel data instead of using cross section observations. Thus, the study focuses on primate cities, define as the largest city in a country, which is by far, larger than any other city in the urban hierarchy.

This work departs from the existing literature because it handles the explanation of big cities growth by carrying out the analysis on only past colonial countries. Actually, the historical events due to colonization make these countries very interesting in terms of old and current institutional patterns. To conclude, we address the three (3) following questions in the first chapter:

- *Does trade matter in explaining primate cities populations?*
- *Apart from trade, do past institutions affect the population's location choice?*
- *Finally, we question if urban giants react regarding current institutions?*

International trade seems also to be peace-related. One of the greatest and famous policies that place international trade for the first time at the core of its strategy goes back to the world wars period in Europe. Actually, the ignominy of these wars and the fear to see it happen again inspired policy makers as well as peace and development practitioners to rely on trade as a channel of promoting peace. Different theoretical frameworks have been proposed to highlight the background of these insanities. They argue that, in case countries depend on each other through trade flows, the opportunity cost of war will increase, encouraging nations to engage some efforts for peace (Montesquieu, 1958; Kant, 1995) when a potential conflict is coming into play in their relationships. Thus, the spread of international trade and the gain from the exchanges brought new paradigms that should prevent from disputes between countries because they depend on each other. When this analysis holds at bilateral level, it may be noticed on the one hand that, gains from international trade can thereby cause frustrations.

The causes of ethnic wars can be social, economic or political. In an economic point of view, new paradigms can exacerbate the local probability of ethnic conflict or reduce it through the way they redefine the ties between people. There is an increasing challenge to peace and stability in Africa these last decades than ever. Countries such as Rwanda, Sierra Leonne, Congo, Nigeria, South Africa have been affected a lot by this issue. At least, one country over two has experience civil war in this continent. Apart from having the highest ethnic diversity, Africa comparatively to the other continents, is also characterized by a higher incidence of war (Osinubi and Osinubi, 2006[6]). Though, Elbadawi and Sambanis (2000) argue that these civil wars were not the consequence of the ethnic fragmentation. Following Michalopoulos and Papaioannou (2015), we consider in our context as ethnic wars, the conflicts characterized by political violence which involve a use of force by a group with a political purpose or motivation. This violence does not only record conflicts that take place within the context of a civil war; it also accounts for violence against civilians, militia interactions, communal conflicts and rioting.

How can trade affect conflicts in general? Massimiliano (2015), while proposing how trade can increase resilience in fragile states, exposes three main mechanisms that can lead to conflicts: the decrease in the opportunity cost of peace in case of a decline in real

[6] https://www.tandfonline.com/doi/abs/10.1080/09718923.2006.11978376

income, the rapacity behavior that leads to violent competition for point-source commodities, and the government (or rebel) taxation that can provide the means to suppress (or enhance) violence.

In Africa, Rwanda is for instance the country that hosted the most recent and insane ethnic war that shocked the world. According to the United Nations (UN), this genocide caused more than 800 thousand deaths, mostly Tutsi in Rwanda only in four months in the year 1994. Historically, even if the difference between Hutus and Tutsi had been culturally accepted by Rwanda people, some argue that these differences had been deepened by colonialism that brought them gradually to the war. On the one hand, one can argue that if internal trade were developed in Rwanda, ethnic groups (Hutu and Tutsi) would be much more tied together, that could increase the opportunity cost of ethnic war[7].

On the second hand, the intensity and duration of an ethnic war can be fueled by the support of peers at the other side of the country's border, by supplying them, goods, arms, and refuge. In this vein, it is possible that, countries which have partitioned ethnics groups will be more likely to experience ethnic group violence and/or to see it aggravate, in case they develop trade relationship over their brotherhood link. Indeed, this issue is important since during the formation of African states, 97.8% of all borders split ethnic homelands in multiple parts[8], meaning that almost all African countries are concerned with split ethnic groups issues. Particularly, about 39.5% of the 827 ethnic groups in Africa are partitioned (Michalopoulos et al., 2016). Then, trade between same ethnic groups across a border can exacerbate the social distance with homeland ethnic groups with any particular relationship. This trade is not to be neglected. Aker et al. (2014) find that common ethnicity lowers the transaction costs particularly for agricultural trade[9]. Finally, following "the Land of a Thousand Hills" history, the Hutus who are much more farmers, have been excluded from the central government, and international trade (particularly that of coffee) has been part of the issue (Kamola, 2007) that brought them to conflict. On the third hand, the domestic integration (geography) that may facilitate international trade integration of units that comprise these countries can affect the gains of the different parts. Especially, ethnic groups that benefit from the

[7] http://eprints.mdx.ac.uk/3809/
[8] http://www.mathiasiwanowsky.com/TradeandEthnicity.pdf
[9] https://www.sciencedirect.com/science/article/abs/pii/S0304387813001478

exports either because they can better ship their products, or because they have special endowment factors, will have any incentive to engage in a dispute. As a consequence, the incentive of an ethnic group conflict depends on the kind of trade partners. Therefore, the main question of Chapter 2 is:

- *How do ethnic wars in Africa react to ethnic groups' international trade, regional and internal trade of countries?*

What about the trade and water agreements? A large part of the population in the world is not aware of the quantity of water used during the production process of the goods they buy or consume. For instance, in average $15400m^3$ of water is used and polluted when producing one ton of meat from beef cattle, the equivalent of six Olympic swimming pool[10] water capacity; either around 15400 liters of water for a kilogram of this meat[11]. 3265 Liters of water are involved and polluted in the production of one kilogram of eggs, in other words 206 liters of water per egg[12]. We must also be reminded that, on average, 632[13] liters of water are consumed and polluted for the production of a bottle of 0.75 liter of wine (Bonamente et al., 2015). In the extractive industry, gold has the highest level of water footprint, estimated on average at 716.000 liters per kilogram of this metal (Hoekstra, 2015). As for crops, the water footprint statistics estimate at 214 liters, the quantity of water involved on average in the production of a kilogram of tomatoes. Thus, when shipping goods from one place to another, one must bear in mind not only the fact that a lot of water has been involved in their production, but also that some goods transported can have water content.

As it is known, water is one of the most important substances on earth, necessary for the survival of animals and plants. If there was no water, there would be no life on earth. Therefore, water resources constitute a key resource to achieve the sustainable development goals. It is essential to produce energy, to defend public health care, sustainable livelihood, ecosystem and sustainable cities (OECD). As noticed by World

[10] According to FINA (Fédération Internationale de Natation: http://www.fina.org/), an Olympic swimming pool contains on average 2500 m^3 of water (https://www.fina.org/sites/default/files/finafacilities_rules.pdf)
[11] https://waterfootprint.org/en/water-footprint/product-water-footprint/
[12] If we conjecture that an egg weights 63 grams
[13] i.e. more than 800 bottle of 0.75 liter capacity.

Bank[14], water is at the core of every aspect of development and therefore constitutes an imperative tool for the Sustainable Development Goals (SDG). It drives economic growth, supports healthy ecosystems, and is essential and fundamental for life itself. Nevertheless, regarding the increasing population growth, water becomes a scarce resource. China is for instance one of the countries that is to water shortages and water pollution.

Water issues become more serious because of the sur-exploitation of water resources and particularly regarding environment challenges. A lot of water is used, displaced or consumed in everyday life: for cooking, for sanitary needs, in industries, in agriculture, etc. Let consider the mining sector activities, particularly the extraction of gold. It is common that manual techniques that consist of panning are usually used to separate gold from the sand, stones and other sediments. Hence, a large quantity of water is used in the process. Then, apart from the fact that some rivers are emptied of their resources and/or deviated for the sake of gold extraction, chemical and other pollution from the panning areas can highly cause also damages to the ecosystem, and even affect the health of the populations that depend on these resources, that is to say the riparian[15]. Since it is found in small quantities, gold mining operations tend to cover wide areas (cite this[16]). As a matter of fact, the gold mining boom in the amazon rainforest has been the cause of the Amazon river chemical pollution. This presents a real issue since the Amazon river is shared by at least four (4) countries.

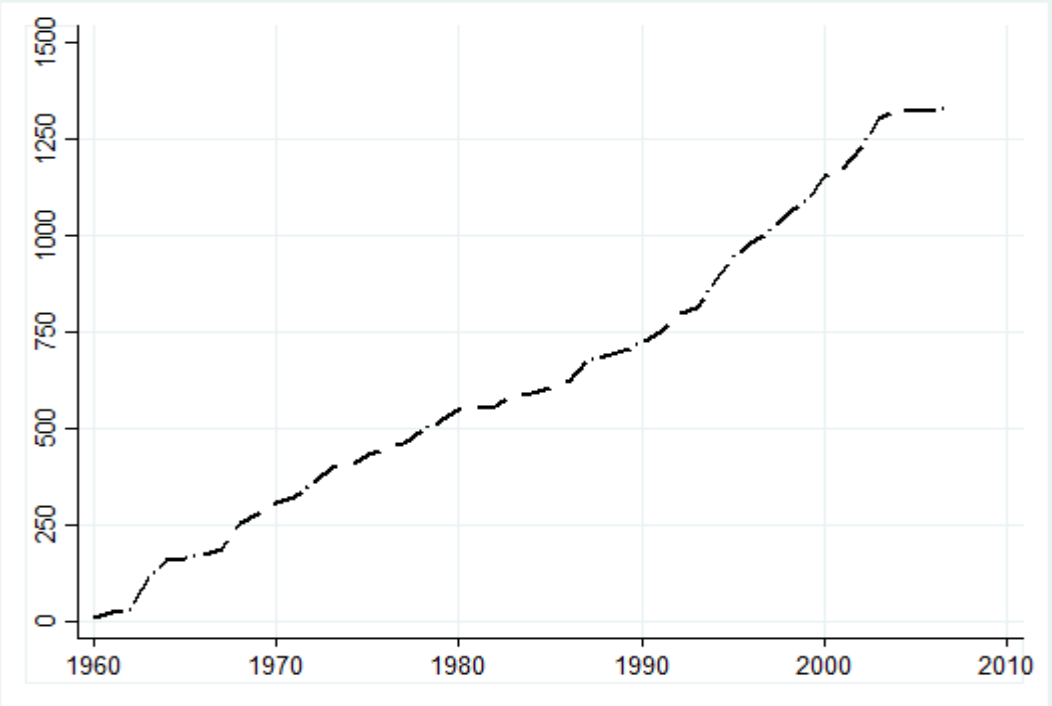
We can also observe this fact in agriculture. Farmers located upstream of rivers that cross several countries, by irrigating their farms, could pollute these latter making them unsuitable for all those located downstream. The same picture is observed during the construction of dams that obstruct the flow of water and reduce it for countries downstream of rivers. For instance, normally a dam helps population by bringing electricity, but it can betray the provision of countries downstream to the rivers or lakes. As a matter of fact, the dam of Selingue (in Mali, 140 km from Bamako) has raised a lot of voices. Apart from the riparian in Mali, and any other associations of users that were afraid for the availability of water henceforth, the countries that also share this lake also reacted to the creation of the dam. Actually, for the beginning of the power station, a

[14] https://www.worldbank.org/en/topic/water/overview
[15] https://www.brilliantearth.com/gold-mining-environment/
[16] file:///C:/Users/t/Downloads/15_Abdul-Wahab.pdf

basin of 2.2 billion cube meters of water had been created for the need of the central, and this operation had needed 6 months. Then riparian countries (and water consumption association in Mali) requested for international collaborations/meetings on the water in order to fix the rules of its usage.

As a consequence, the overexploitation of water resources can deeply affect water provision and trigger tensions since there are some populations that could be negatively impacted by the miss-exploitation of the resource. There is therefore a special need to promote international cooperation or initiate joint management collaborations to equitably manage and/or preserve water resources. In this vein, water treaties come like crucial policy initiatives that pave the way for better distribution and/or efficient use of water resources. Water management becomes a topical issue for policies in the main interest of the populations, the health and for sustainable development. In recent decades, a lot of water agreements have been signed between countries (Figure 2). The targets of these treaties are not always the same; when some of the agreements main objective is to preserve water quality, others ask for environment preservation, or join management purpose. From that point of view, these water agreements should act as restrictive policies against water sur-exploitation preventing from its miss-usage.

Figure 2 : Cumulative function of water agreements



Sources Authors

This chapter assesses the added value of these water-related collaborations at the international level. It investigates particularly the following question:

- *How (and where) does water agreement affect international trade?*

To the best of our knowledge, no study has already highlighted this relation before.

Trade and Institutions in Explaining Urban Giants: summary

The urban empirical literature provides a rule which states that the size distribution of cities within countries follows a powerful law[17]. This empirical observation known as Zipf's law states that: in countries, the largest city is about twice the size of the second largest city, three times the size of the third largest city, etc. But, in some countries the cities size distribution does not follow this law since the population size in the largest city is by far more than twice that of the second largest city in the urban hierarchy. This

[17] https://academic.oup.com/qje/article-abstract/114/3/739/1848099?redirectedFrom=fulltext

chapter aims to highlight the causes behind this deviation from the law: what are the main factors of the urban primate size?

To do so, we follow Ades and Glaeser (1995) who considered two main factors when explaining urban giants' growth; institutions and trade. It is possible that, population would prefer to live in the city, attracted by industries, firms and businesses. In fact, these latter would choose to be close to the administrative center in order to increase their probability to get permissions, authorizations and grab opportunities. Besides, governments can opt for fiscal centralization in order to take over all the cash channels. In other case, a government may also prefer decentralization in case it feels weak in managing heavy urbanization.

Political institutions are not the only drivers of urban populations. In case of bad access to international market, the main city is likely to become the platform of exports and will therefore attract people. Nevertheless, when the other cities can easily get access to the international market, the migration to the main city will certainly decrease, thus relieving the big city.

To do this, we concentrate our study on past European colonies because they show up some institutional particularities that rooted during colonization period. We observe that, countries that were densely populated hundred years ago have now small central cities while we find no relationship for the non-colonized countries. This picture shown for the first time in the field of urban economics is analogous to that of Acemoglu, Johnson and Robinson (2002). By following their argument, we argue that colonizers had settled extractive institutions in rich places[18] pushing people out of the cities. This provides a supplementary demonstration of the fact that the density in 1500 is an indicator of past institutions. Then, past colonized countries present interesting patterns in terms of institutions since colonization had deeply affected their long-term institutional trend.

When highlighting the causes behind the urban primates, we depart from existing literature in two main points. Firstly, we propose a much more extensive measure of market access, instead of using direct measure that only captures part of trade frictions. Secondly, since Head and Mayer (2002) weighted distance accounts for cities

[18] Populated places were certainly rich places.

population, we propose our own measure of bilateral distance to avoid reverse causality bias, as our dependent variable is also a measure of cities population. Finally, on the contrary to Ades and Glaeser (1995) we rely on instrumental variables methods to tackle the endogeneity not only between urban giants' growth and trade, but also regarding institutions. As for institutions, the historical mortality rates of soldiers, laborers, and bishops from Albouy (2012) during colonial times appears to be a good candidate as an excluded instrument[19]. However, the invariability of this instrument has brought us to propose a year by year zero stage regressions strategy that allows us to get time-varying instrument. We interpret this as the exogenous consequence of distant past shocks in nowadays institutional patterns. A more contemporaneous indicator by relying on the regional waves of democratization and transitions to non-democracy from Acemuglu (2017) is also used as instrument. As for the endogeneity of trade, by following the previous techniques, we rely on past genetic distance as a proxy for cultural proximity, which may impact the trust between partners and then on trade exchanges. We also introduce for the first time in the empirical a new control that was not available until now. This allows us to capture the rural-urban income gap, using intensity of night lights from outer space.

The chapter is separated in two main parts. In the first part, we investigate whether past patterns shape contemporaneous trend of primate cities. We found that, past density is an indicator of bad governance since results reveal that, on average a country that was twice more densely populated in 1500 is now a country where the share of its biggest city in the total population is smaller than in other countries. In fact, countries densely populated in 1500 were richer, increasing the incentive to settle extractive institutions that act as repulsive forces for the native population. We also found a negative influence of the past network of international trade on contemporaneous size of primate cities. The first globalization has favored land tenants (in Latin America for instance Findlay and O'Rourke, 2009) and thus urbanization was not profitable for these elite.

In the second part of this chapter, we provide instrumental variables estimates based on instruments presented above. On the contrary to Ades and Glaeser (1995), all our estimates show that the indicator of democracy, instrumented by past mortality rates

[19] For more discussion on this instrument, see also De Sousa and Lochard (2009).

and by waves of democratization, favors agglomeration in the colonial countries' biggest city. On the contrary, market access seems to not drive primate populations.

After all, the main conclusion from this chapter of the PhD thesis is that, only first cause (i.e. distant past history) and institutions matter in explaining the urban giants' size, not trade. When spreading good institutions in terms of democracy and governance, governments consciously or unconsciously favored the concentration of populations in the biggest city. Then, it is worth noting that the channels that drive this relation must be explore in order to provide public policies settlers some recommendations that can encourage populations to stay and/or go in the other areas while steel enhancing their institutions.

Beyond the Income Effect of Trade Integration on Ethnic Wars: summary

This chapter tries to shed light on three different type of trade: international trade, regional trade and internal trade. Its contribution is to propose different measures and methodologies to precisely analyze the geographical impact of trade on conflicts. We begin the debate here by exposing the three main mechanisms provided in the literature that are used to justify the relation from trade to war. Firstly, when trade shocks decrease revenue, the cost to participate to violent actions follows the same path. When trade increases tax revenues, it in turn improves the redistributive capacity of the government, reducing in fine people's incentive to get involve in conflicts. Finally, the literature also argues that resource that is highly valuable on international market generates envy and expropriation that can lead to an escalation into conflicts. In summary, the common point that emerges from these three mechanisms is that trade affects the likelihood of conflicts through the income channel. As a consequence, if we perfectly control for income, the trade effect must be insignificant. What if the trade effect remains significant? Is there another mechanism that can fuel the escalation into ethnic war apart from the pecuniary channel?

Actually, markets known as places of socialization may foster trust between partners. But, in our context, in case of ethnic favoritism, business' owners that do not belong to

the right ethnic group could be stacked, paving the way to potential conflicts. Trade can also affect the culture. On the one hand, globalization can cause cultural destruction which in turn will increase the vulnerability of the communities (Maystre et al., 2014). On the other hand, globalization by promoting new national identities/culture could redefine the relation between ethnic groups. Trade can foster the destruction of the environments through deforestation or can expose some localities to pollution that can potentially lead to a conflict. This leads to the conclusion that trade can affect the probability of war via non-pecuniary channel.

As for international trade that develops relation with people far from their country homeland, it may also weaken institutional and cultural link with neighbors in the same country. On the contrary, the international trade of ethnic groups might be a peace promoting instrument. Secondly, we approximate the strength of the ties between ethnic groups with internal trade and investigate how it affects the probability of ethnic war. We assume that the opportunity cost of war will increase since the parties within a country have a lot to lose. Local trade by reinforcing ties between communities inside the country will have a peaceful effect since it increases the opportunity cost of war of all the groups engaged. In some case, such as Nigeria, potential conflict resolution structures are set up to prevent latent or potential conflicts[20]. Regional trade, for his part, represents a diversion of socialization inside a country, but as argued by Iwanowsky (2018) ethnic networks provide social collateral to enforce contracts and can thus compensate for unfavorable institutions between countries. In fact, the intensification of trade with peers across borders could decrease the dependence with the others ethnic groups from the same country. We expect that, countries that are partitioned are more likely to experience ethnic war as long as they depend more on their peers at the other side of the border in term of trade: the ethnic network by being empowered by trade, may deter the relations with the other ethnic groups from the same country.

In order to approximate ethnic groups' income, we follow Henderson et al. (2012) by using night light pictures provided by satellites from outer space. These data are useful to approximate income particularly in developing countries because these latter often lack of reliable data at sub and/or supranational level.

[20] https://ageconsearch.umn.edu/record/11837

We then evaluate in which sense these three kinds of trade affect ethnic war. Firstly, international trade is defined as the value of goods addressed by an ethnic group out of its country homeland. We got this variable by building for the first time in the economic literature an indicator on ethnic exports by relying on a weighting scheme based on the kind of goods produced by the ethnic group. Firstly, we identify the spatial locations of over 45 agriculture products and 48 mining products across Africa that allowed us to compute a weighting scheme that indicates the level of participation of every ethnic group to its country exports. With this weighting scheme at hand, we use BACI trade by products database to compute ethnic groups exports. The regional trade is built by considering the total export of a country to its' partners with which it shared at least one ethnic group. Finally, the internal trade designs the quality of relationship between groups within the same country.

As it appears in the data description, our study relies on two types of data: the ethnic level time-varying variable (the international trade of ethnic groups), and country level time-varying variables (the regional trade and the local trade). Regarding this, this chapter comprises two main sections. In the first section, we use a commonly a widely known strategy to identify the effect of trade on war. But at least three caveats can be formulated. Firstly, the measurement of ethnic trade potentially suffers from errors that may bias the analysis, particularly with respect to the country level variables such as regional trade and local trade. Secondly, by merging aggregate data to subnational level observations, the OLS standard errors can be biased downward leading the aggregated variables to be artificially significant (Moulton, 1990). Thirdly, the methodology in the first section does not allow us to gauge the reaction of the ethnic groups' conflicts to their national context. Hence, we borrow from the urban and labor economics literature a two-step empirical analysis which allows us to overcome the weaknesses in the first section. So, the first stage regression allows us to estimate the country-year effects that depict the changes in national identities that influence conflicts after controlling for income and unobserved ethnic fixed characteristics.

In general, the results reveal that, the likelihood of peace increases when ethnic groups get involved in international trade and internal trade and decreases with regional trade. On the contrary, only international trade appears to affect countries path in explaining ethnic conflicts. As a consequence, we can therefore consider that only the international

trade integration has the potential to shape national identities and to reduce the risk of ethnic wars: the performance on the world market fosters mutual confidence, cooperation and good institutions inside nations that reduce the likelihood of ethnic conflicts.

Climate Change, Water Treaties and International Trade: summary

The literature on international trade has long studied the role of international collaboration on trade. In this vein, researchers try for instance to comprehend the effectiveness on regional trade agreements (RTA), and general agreement for trade for trade facilitation such as GATT, WTO, etc. Then, the whole literature literally ignores how international water cooperation can, for its part drive international trade. Actually, the increasing number of environment issues, coupled with the sharply growth of the population, have seriously affected water resources. The predictions for the upcoming centuries are even more frightening since climate change will be coupled with dramatic and significant reduction in precipitation and major changes in respect to the seasons. Water being an important input, its scarcity may affect goods production and thenceforth trade of agricultural and industrial goods characterized by a high-water footprint. These climate changes are at the bone for sustainable development initiatives, which comprise also institutional arrangements between nations aiming to manage water resources. This is of particular importance since more than 600 freshwater-related treaties have been signed to manage transboundary basins, according to the International Freshwater Treaties Database.

The purpose of this article is threefold. In the first section, this research analyzes how climate change drives the enforcement of Water Treaties (WTs). To date, we have no clue of what kind of climate change motivates countries to cooperate. Our variable is then a dummy indicator of the existence of a water agreement between two countries in a given year: it takes one when the two countries have signed a new agreement in a given year and zero otherwise. In the second section, this chapter aims at analyzing in to what extent these treaties have impacted international trade. We argue on the one hand that water treaties may have little or no effect because they engender too small

additional costs on production to influence international trade, or because they are just "cheap talks" and are not a real commitment to implement significant protectionist policies on water. In the second hand, we think that these treaties contribute to resolve and/or prevent conflict by fostering cooperation between riparian nations and as a result promote institutions and economic conditions thereby increasing trade. Indeed, an agreement on the usage of water upstream a river, may make available more water to the riparian located downstream the same river, fostering therefore their trade. Also, agreements on dams may stimulate the production of goods and thereby international trade. On the third hand, the possible negative effect of water agreements on trade stems from the fact that, they are implemented in order to save freshwater ecosystems and/or to foster a sustainable development. In the last section, we rely on the estimates in section two to provide a general equilibrium model that allows us to assess not only the global effect of the water treaties but also counterfactual analyses consisting of suppressing all the WTs implemented to date.

Water agreements have been receiving increasing attention in recent decades and many international institutions put interest in regulating this sector. For instance, the Institute of International Law (IIL) in 1911 provides some rules among which was noticed the prohibition of unilateral and detrimental exploitation of international basins and the requirement to develop transboundary cooperation. In 1966, while the International Law Association advocated an equitable utilization of shared watercourses, the United Nations General Assembly adopted in 1977 the United Nations Convention on the Law of the Non Navigational Uses of International Watercourses. All these efforts highlight the growing interest in managing the water resources. But it is essential to notice that the agreements on water resource have a very heterogeneous content. While some of them focused on water quality, other try to deal with irrigation, hydropower, infrastructure and under-groundwater issues. Some are motived by technical/financial cooperation and/or monitoring provisions. In terms of their objective, there are regulatory treaties that set rules to prescribe certain actions, and programmatic treaties in respect of a common program more general treaties that set out principles and norms for cooperation in transboundary basins.

In this study, the water treaties variable is built using information given by the International Freshwater Treaty Database provided by the Program in Water Conflict

Management and Transformation (College of Earth, Ocean, and Atmospheric Sciences). This database, which spans the years 1820 to 2007, gathered a full number of international, freshwater-related agreements between pair or groups of countries. The data on temperature and precipitations come from Dell et al. (2014) and those on “Floods, Storms & Droughts" come from the Centre for Research on the Epidemiology of Disasters. The virtual water associated with exports of agriculture products is built by combining statistics from Water footprint (hereafter WFP) databases and the bilateral exports of goods classified as agriculture products in BACI. The Regional Trade Agreement (RTA) variable comes from Bergstrand's homepage and Data on trade are from TRADHIST (CEPII) which provides a complete representation of bilateral trade flows between countries all around the world. Our database finally covers the period 1955-2007 and concerns 154 countries.

After all, we firstly show that while a lot of attention has been focused on water quantity, a lot of considerations are now accorded to water quality and environment purposes particularly since the year 1990s. Secondly, it clearly appears that, among climate change signals, particularly temperature drives the willingness to be engaged in a new water treaty. In fact, the first section analyses led to the conclusion that countries with higher temperature are more likely to sign water agreements. Thirdly, using a structural gravity equation with importer-year, exporter-year effects and bilateral fixed effects, the study generally reveals that agreements on water are generally a cost to free trade. This confirms the protectionist role of WTs because we find that these treaties cause a significant reduction in international trade between countries.

It also appears in the results that water protection are more effective when enforced in the framework of a water agreement than when included in a regional trade agreement; in fact, RTAs with water content seems to have no effect on bilateral trade. When we focus on agricultural exports, findings still reveal that treaties on water resources reduce agriculture goods exchanges and, without surprise, the strongest impact.

A heterogeneity analysis points out that water treaties reduce trade in Europe, Asia and America. In contrast, it clearly appears that they have boosted international trade in Africa. This positive effect in Africa may be explained by the fact that water agreements have been particularly effective in this continent to foster cooperation between countries. Regarding the results in the last section, the general equilibrium model makes

conclude have a significant effect of water treaties on trade, in particular in Asia. We find that the enforcement of the treaties has a strong negative impact in Asia. At country level, countries along the Nile and the Niger are the main winners of freshwater treaties in Africa.

Chapter 1 -
Trade and Institutions: Explaining Urban Giants

I. Chapter 1 - Trade and Institutions: Explaining Urban Giants

Introduction

From the 18th century to date, urbanization has been an important process all around the world and despite the apparent chaotic evolution of cities, much regularities in the spatial economy have been explained by considering economic factors only. This is typically the case of the Zipf's law[21], which is usually explained by random productivity process of local economies and migrations between cities (Eeckhout, 2004). To describe deviation from this law, it seems however necessary to introduce additional factors. For instance how to explain that Mexico city is much bigger than just twice the size of the second largest city in this country; is it the historical centralization of the political powers in that city or its unique market access to the world? This is the question addressed in this paper that aims to better understand what explains urban primacy[22]. We find that democratic institutions are the main factor behind the concentration of a nation's urban population in the main city; trade liberalization and good market access are not significant.

Our research area is related to a vast literature. The agglomeration of the population in the nation's largest city has been explained by many mechanisms, often related to political institutions (Lipton, 1977; Bates, 1981). In countries where urbanization goes hand in hand with industrialization, capital accumulation in the industrial sector can lead rent seeker' governments to favor fiscal centralization and as a consequence, the agglomeration of the population in the largest city (Davis and Henderson, 2003). In

[21] The Zipf's law states that the size of the largest cities is inversely proportional to their rank in the size distribution of cities.

[22] Our main question concerns the urban concentration in the biggest city because such a phenomenon is less understood than other forms of urban change such as urbanization, density or urban growth. Furthermore as it has been pointed out by Crenshaw and Anthony (2014), primate cities are (more than other cities) global political theaters and consequently the identification of the causal impact of globalization and institutions in these cities seems to be the most urgent/logical investigation. Obviously, additional researches on the impact of these variables on different aspects of the spatial economy, using different measures of urban concentration (see Anthony, 2014), would bring interesting additional results.

states with extensive regulation, where licenses and permits are necessary for a myriad of activities (to start a business, to hire or to fire workers, to register property and so on), the decision to be near the administrative center is beneficial since it increases the probability of getting these authorizations. Such a probability can be a powerful determinant of location choice for multinational firms which in turn attract domestic firms and migrants. Furthermore, since bribes, red tape or more generally corruption enable the obtaining of these rights, the centralization of power in the largest city is a "cash machine" for governments. Urban favoritism for the largest city may be a strategy to monopolize (or to polarize) the rent extracted by limiting the competition of bureaucrats and politicians located in other regions. Fiscal centralization not only pulls activities into the urban giants, it also pushes activities outside secondary cities. Indeed, when local governments have little power, this centralization limits the urban planning *de facto* and also leads to a kind of resistance against urbanization[23]. Without the ability to integrate new migrants into the formal sector, there is a political fear of agglomerating people. The incidence of crime or revolt is higher in cities, and this may represent an incentive for weak local governments to discourage urbanization while on the contrary, strong central government can favor its urban giant[24]. Ades and Glaeser (1995) support this thesis and find that dictatorial governments have urban giants that are 50 percent larger than democratic governments[25]. This result however, raises many questions, the most important being: which kind of institutions is the most prone to urban bias?[26] Here we challenge the conclusion of Ades and Glaeser (1995) by working on countries colonized by European powers during the past 500 years. We focus on these countries because colonization has deeply modified economies and institutions in

[23] For instance, Collier and Venables (2013) report that, in Liberia, governments have adopted a deliberate policy of reducing infrastructure investment, in order to induce a return of urban residents to the countryside. Feler and Henderson (2011) also document exclusionary policies in the development of Brazilian cities, in particular during the period of dictatorship, where localities withheld public services to deter in-migration. In contrast, the Chinese fiscal decentralization, started in the 1980s, has been a success into spreading growth by fostering competition between local authorities (Bai, Hsieh and Song, 2019).

[24] Beyond the spatial structural advantage in organizing demonstrations in area with a dense population (in factories thanks to unions or in districts thanks to neighborhood effects and organizations), urban residents located in the capital city also have an information advantage on public spending due to their education, access to the media or to the focus of media on their city (Majumdar et al. 2004).

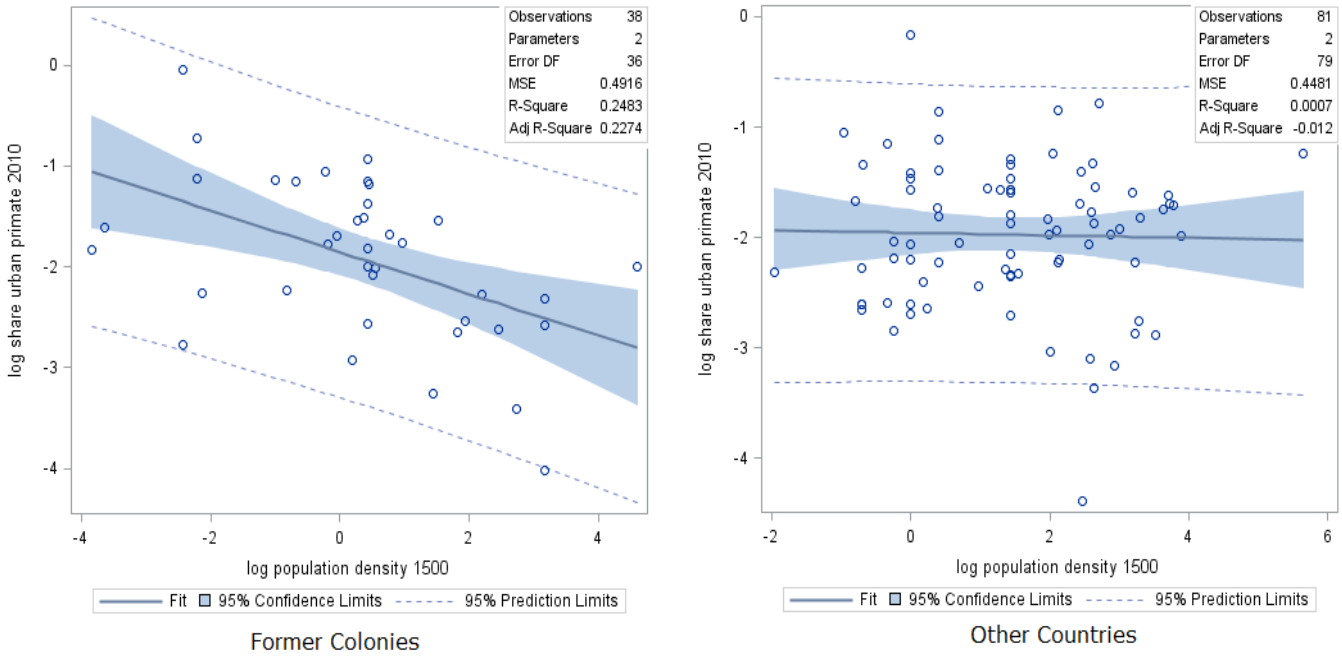
[25] A related result has been found by Henderson and Wang (2007) showing that democratization favors small cities.

[26] For instance Acemoglu, Robinson and Verdier (2004) have analyzed kleptocratic governments that succeeded in staying in power for long periods despite weak support from the population by relying on divide-and-rule tactics. Do these weak dictatorships also have an urban bias?

these countries, and while many consequences of this colonization has been analyzed in depth, the analysis in terms of urban economics is lagging behind.

As illustrated by Figure 3, former European colonies that were relatively densely populated in the 1500s now have smaller central cities[27]. By considering, along with Acemoglu, Johnson and Robinson (2002), hereafter AJR, that density in 1500 was an indicator of prosperity fostering predatory behaviors and an indicator of the difficulty of settling, leading colonizers to set up extractive institutions, we come to the logical conclusion that these institutions have reduced concentration in the central metropolis.

Figure 3: Urbanization Primacy in 2010 and Density in 1500



The main finding of AJR is that economic growth is determined by political institutions and by nothing else and in particular not by the geography and culture of nations. Are institutions also the unique determinant of urban primacy? While a vast literature on that subject explains the different size of cities by different kinds of political institutions, Krugman and Livas (1996) proved that agglomeration can emerge without political favoritism[28]: a bad market access can be a sufficient determinant. Trade restrictions, that provide advantage to one city which becomes the platform for exports and

[27] The second plot presented in Figure 3 for non-European former colonies shows that this reversal is not widespread; indeed for countries not colonized the relationship is not significant and the historical spatial economy does not explain the current one.
[28] Candau (2008) extends this model to consider how bad governance affects location choices.

catastrophically attracts all the population[29]. By contrast, trade liberalization by providing market access to other cities fosters the dispersion of activities. This conclusion has been disputed a lot; the link between the spatial economy of countries and trade integration is not monotonic, depending on the structure of the economy considered (weak congestion costs, strong share of income spent on industrial goods, etc), a good market access can also foster agglomeration in the largest city (Krugman, 1991; Behrens and Robert-Nicoud, 2014). Buenos Aires, London, Lagos, New-York, Seoul are clear examples where good market access to the world has boosted the size of cities. Faced with this theoretical debate, Ades and Glaeser (1995) found that a one-standard-deviation increase in the share of trade in GDP reduces the size of the main city by about 13 percent. Their analysis using alternative measures of trade integration (import duties and transportation spending) confirms this result; however, these variables are plagued with potential endogeneity bias, and their results using instrumental variables are not significant which leads them to question reverse causality. Nitsch (2006) using geographic characteristics as an instrument for trade, is also skeptical about the role of economic geography on urban concentration[30]. In contrast using a difference-in-difference strategy, Karayalcin and Yilmazkuday (2015) show that the Uruguay round of liberalization has reduced the relative size of mega-cities.

Our work differs from that literature on different aspects. First, since the direct measure of trade costs (e.g. tariffs used by Ades and Glaeser, 1995) only represents a part of trade frictions, we use an indirect measure of economic integration based on trade flows. Regressing bilateral trade flows on distance between partners[31] and aggregating these results using economic geography theory, we compute indicators of market access of these countries to the rest of the world. To our knowledge, this methodology first introduced by Redding and Venables (2004) and used in various studies has never been employed to study urbanization.

[29] See also Helpman (1998) and Candau (2011) concerning the determinants (and conditions) of this massive agglomeration in one city/region. Candau and Dienesch (2015) integrate in this framework, heterogeneous workers and show that only high-skilled workers increasingly choose the core region during the process of integration.

[30] Furthermore Davis and Henderson (2003) in their detailed study of urbanization also confess:

> "We experimented with a time varying measure, trade openness. This was statistically insignificant in the IV estimation. Even the sign was sensitive to which instruments were included. Thus we did not include the variable in the results presented in the tables"

[31] In contrast with the literature in international economics that use geographical distance weighted by population (or simply geographical distance) in their trade gravity equation, we compute a bilateral distance between partners that takes into account internal distance between cities in each country.

Secondly, since simple indicators of openness (e.g. exports as a percentage of GDP as used by Barrios et al.) introduce endogenous bias, we propose different instruments for market access such as the genetic distance between partners. The main idea of this instrumentation is that the genetic distance is an exogenous indicator of past international migration and of international trade roads that can explain the current trading system. We also use many controls not available until recently, such as the differential between the intensity of night lights in the city and the intensity of lights in other cities obtained from satellite pictures within a country that allows us to capture spatial income differences.

Third, our results differ from the literature. We show that the rise and fall of mega-cities are mainly explained by institutions. The basic explanation follows the AJR thesis applied to urban economics. European colonialism led to the development of inclusive institutions in previously poor areas which has favored agglomeration economies in urban giants. In contrast, introducing extractive institutions in previously prosperous areas have led to the dispersion of the population.

Section 2 presents our baseline empirical strategy, data and the first results. Section 3 presents an IV strategy and our results; Section 5 describes the conclusions of the study.

I.1 Hypothesis, data and preliminary results

I.1.1 Empirical Strategies

The aim of this paper is to study the causal impact of political institutions and international trade on the concentration of people in the biggest cities. However, before to enter into the details of these two determinants, let's first analyze the impact of institutions in general, considering all the formal and informal constraints and rules (the different codes of conduct, customs, laws, governance) that define political institutions and also economics interactions necessary to trade toward long distance) that causes the concentration of a nation's urban population in its first city. The most simple

equation allowing to describe key identification issues of this question may be the following[32]:

$$u_{it} = \alpha I_{it} + f_i + f_t + \varepsilon_{it} \quad (1)$$

Where u_{it} is the population in the biggest metropolis on the total population[33], f_t are time fixed effects to control for shocks affecting all individuals at the same time, f_i are country fixed effects aimed at capturing characteristics of countries and I_{it} the variable of institutions of the country i at the period t.

The main parameter of interest is α, the elasticity of agglomeration with respect to institutions. An unbiased OLS estimate for this parameter is obtained under the following assumption:

$$Cov(I_{i,t}, f_i + f_t + \varepsilon_{it}) = Cov(I_{i,t}, f_i) + Cov(I_{i,t}, f_t) + Cov(I_{i,t}, \varepsilon_{it}) = 0 \quad (2)$$

As it is well known when the covariance in the left hand side of this equation differs from zero, any of the three covariances on the right hand side is a source of bias. We discuss these three terms in turn in order to build our empirical strategy.

Concerning the first term, $Cov(I_{i,t}, f_i)$, there are some reasons to consider that time varying institutions depend on invariant country characteristics. For instance natural resources or the level of development may have an impact on institutions. A related concern is the fact that the degree of urban primacy may influence institutions. Agglomeration economies may be higher in countries with urban giants and incomes generated from spillover and/or pecuniary externalities can influence institutional change. This relationship is even more obvious concerning international trade, higher level of productivity in a particular sector (e.g. in finance) due to a concentration of activities in one place may influence institutions, at least the formal institutions, of a country. To analyze this bias, consider the following reversed causality between institutions and concentration:

[32] We follow here a presentation proposed by Combes, Duranton and Gobillon (2011).

[33] This share has the advantage to better take into account the size and change of the biggest cities in countries with rural economies (where the central city is not fueled solely by the flow of urban to urban migration but also by the rural one) than classical measures such as the size of the biggest city on the urban population which is moreover dependent on administrative definition of the urban population.

$$I_{it} = \beta u_{it} + \eta_i \tag{3}$$

From classic sociological theory to political modernization theory (Weber, 1909; Lerner, 1964; Lipset, 1959), there is a vast literature that defends this kind of relationship considering that the urban structure affects political mobilization and political change (see Anthony (2014) for a survey).
Using Equation (1) without time effects to simplify, yields:

$$I_{it} = \frac{\beta f_i + \eta_i}{1 - \beta\alpha} \tag{4}$$

which allow to rewrite the previous covariance as follows:

$$(1 - \beta\alpha)Cov(I_{i,t}, f_i) = \beta Var(f_i) + Cov(\eta_i, f_i) \tag{5}$$

Hence the first origin of the bias comes from the variance of individual specific characteristics $Var(f_i)$ magnified by the elasticity of institutions with respect to the concentration of people β. The second channel of an upward bias is the correlation between individual characteristics that explain institutions and urban primacy, one can think respectively to culture and productivity, which lead to conclude that such a bias is likely[34].

The other origins of bias in (2) is simple to understand, the covariance between institutions and temporal chocks (e.g. a global financial crisis), $Cov(I_{i,t}, f_i)$ may differs from zero. Finally a covariance between institutions and the error term is the usual definition of endogeneity.

To reduce each of these problems, we first look for a lagged measure of institutions or more precisely a measure of past institutional factors that explain the sustainability of urban agglomeration before the industrial revolution. We choose the density in 1500 to approximate political institutions around that period[35]. Density in 1500 is a good proxy of the current institutions according to AJR, who show that countries that were relatively rich in 1500 (density is considered as a proxy of economic prosperity) have

[34] See for instance Mokyr (2016) who describe how "cultural entrepreneurs", such as Newton, Bacon and many others in England and France, have influenced innovations and growth after 1600.
[35] Available on request, we also use urbanization in 1500 which gives the same result.

fostered predatory behaviors and extractive institutions by colonizers. We denote this variable $I_{i,1500}$. We also use a proxy for the current state of political institutions by using the binary view of Acemoglu, Naidu, Restrepo and Robinson (2017) who classify a country as democratic when different databases of political institutions (Freedom House, Polity IV) conclude as such, and dictatorial in the reverse case. This variable is denoted I_{it}.

To take into account institutions that plays a major role in explaining international trade, we regress bilateral trade flows on distance, GDPs and fixed effects and we use the estimates of fixed effects (which typically capture unobservable institutions that explain trade) and distance to build a indicator of market access (also called market potential), here after denoted Ω_{it}. To reduce the bias of omitted variable, several variables of control are also introduced among which a proxy of the income gap between the biggest city and the rest of the country. While it seems trivial to say that people move from one place to another according to income difference, this variable has never been used to analyze urban primacy until now mainly due to the lack of data at the regional level in developing countries. To approximate this spatial income gap in each country we use the differential between the intensity of night lights in the biggest city and the intensity of lights in the rest of the country from satellite pictures[36]. We also add classical controls (mainly climate data) for characteristics that are specific to country and time. All these controls are represented in the following equations by a vector C.

We start our analysis with a simple cross-sectional analysis (for the year 2010) running ordinary least squares on the following equation:

$$u_i = \alpha I_{i,t-x} + \delta \Omega_{\boldsymbol{i}} + \gamma C_i + \varepsilon_i \qquad (6)$$

where $I_{i,t-x}$ represent past institutions when the indicator of density in 1500 is used $(t - x = 1500)$ or the current level when we use binary variable of democracy $(t - x = 0)$ Many papers on the impact of institutions on urban primacy are based on this type of cross-sectional analysis. This naive regression presents all the aforementioned bias (and many other), the problem of endogeneity due omitting

[36] Henderson, Storeygard and Weil (2012) have shown that data from outer space are a good proxy of income.

variables is particularly serious. However, the advantage of this estimation is that it allows to include the invariant historical measure of institutions, $I_{i,1500}$. This variable which is also a measure of the urban primacy in 1500, helps to understand the evolution of the spatial economy of nations over a long period of time. The coefficient α, if negative, indicates a dispersion of the population from the biggest city, i.e. a reversal in the attractiveness of the biggest city.

We then rely on the panel structure of the data to tackle endogeneity issues (due to omitting variables) by estimating:

$$u_{it} = \alpha I_{i,t-x} + \delta \Omega_{\boldsymbol{it}} + \gamma C_{it} + f_i + f_t + \varepsilon_{it} \quad (7)$$

This equation is analyzed through the lens of the Fixed-Effect (FE) estimator over the period 1992-2010. This fixed effects estimator is useful to reduce the endogeneity bias of omitted variables. However, the FE procedure is useless to obtain consistent estimates of the time-invariant proxy of institution, $I_{i,1500}$, since there is a perfect colinearity between fixed effects and institutions in 1500. As a result, the FE model constraint us to use exclusively time varying institutions, I_{it}, which potentially introduce endogeneity from reversed causality.

To carry out inference on historical density, we thus use the Fixed Effects Filtered (FEF) estimator of Pesaran and Zhou (2016). This estimation is in two steps, first a FE estimation is used to obtain coefficients of the time-varying variables and these estimates are used to filter out the time-varying effects. Then, the residuals from the first step are averaged over time and computed as a dependent variable in a cross-section OLS estimation that includes historical density and trade network.
To obtain unbiased estimate of the elasticity of agglomeration with respect to the current institutions due to reverse causality, we propose two different Instrumental Variables (IV) estimations.

I.1.2 Data

- Cities

Urban concentration over the period 1962-2010 is calculated by dividing the population in the biggest city by the total population using data from the United Nations, World Urbanization Prospects. Data on density in 1500, $u_{i,1500}$, comes from the Clio-infra database on urban settlement sizes[37]. Data on urbanization in 1500 comes from AJR.

To approximate the spatial urban-income gap, Δ_{it}, we use the differential between the intensity of night lights in the biggest city and the intensity of lights in other cities obtained from satellite pictures within a country. More precisely, we draw the spatial income gap between the biggest city and the remaining area of every country by using geomatics' tools on Night Lights Data provided by the National Oceanic and Atmospheric Administration's (NOAA) from 1992 to 2010. NOAA processes the raw data collected by the United States Air Force Defense Meteorological Satellite Program (DMSP). The approach used here aims to compute for each country the mean of night lights intensity per square kilometer within areas where the largest city is located. For this purpose, we use Global Administrative Areas (GADM) shapefiles which provide an informative set of countries' administrative boundaries at national and sub-national level. We then cross them with the Natural Earth populated places database which allows keeping the most populated town location in every country. Night Lights' rasters provided by NOAA contain pixels to which are attributed digital numbers ranging from 0 to 63, reflecting the brightness of the light. We used an average value for each pixel for year in which two satellites collected the data. We compute, by country and year, the sum of pixels' values of the biggest city and the sum of pixels for the rest of the country (to approximate light intensity outside the mega-city), we divide these numbers by the geographical surface. The income gap is approximated by the difference between these two values. A lag of ten year is used to avoid reverse causality[38]. These data limit the period analyzed to 1992-2010.

- Trade

The indicator of market access is directly built from the economic geography theory, we modify the market access of Redding and Venables (2004) to take into account the specificity of our research. The first step is to estimate the following trade gravity

[37] http://www.cgeh.nl/urbanisation-hub-clio-infra-database-urban-settlement-sizes-1500-2000
[38] Robustness tests with different lags are presented in Appendix I.4.1.

equation on bilateral exports, coming from COMTRADE, with individual fixed effects (f_i^x, f_i^m) and distance using a pseudo-maximum likelihood (PPML) estimator[39]:

$$X_{ij} = -\varepsilon \ln \tau_{ij} + a_i f_i^x + a_j f_j^m + v_{ij} \quad (8)$$

where bilateral trade costs τ_{ij} take the following common specification:

$$\tau_{ij} = dist_{ij} \exp(\delta_1 b_{ij} + \delta_2 c_{ij} + \delta_3 l_{ij})$$

With b_{ij}, c_{ij}, l_{ij} are dummies characterizing bilateral trade barriers, respectively a border, past colony links and a common language, $dist_{ij}$ is a weighted measure of distance between cities. The literature usually uses two kind of distance, the simple distances between capitals and a distances between capitals weighted by the population of each countries. Since simple distances between capitals poorly represent the geography of trade costs (in particular for large countries) and introduce bias in the estimation (e.g. over-estimation of the border effect), many articles routinely use the weighted measure proposed by Head and Mayer (2002) and freely available from the *GeoDist* database of the CEPII. This distance between country i and j is calculated as follows:

$$dist_{ij} = \sum_k (pop_k / pop_i) \sum_l (pop_l / pop_j)\, d_{kl}$$

where pop_k and pop_l are the population of the *largest cities* k and l. In brief, distances are weighted by the share of the biggest city in the total population which is also our dependent variable. Thus it seems obvious that we cannot use such a measure to explain the concentration of the population in the nation's largest city without introducing endogeneity bias. We thus deviate from the literature by building our own measure using a weighting scheme based on internal distance between the capital and its cities:

$$dist_{ij} = \frac{d_{ij}}{d_i d_j} \quad with\ d_i = \sum_k dist_{ik}\,,\ d_j = \sum_l dist_{jl}$$

[39] Following the work of Silva and Tenreyro (2006), the use of pseudo-maximum likelihood estimators (Poisson and derived econometric models) is justified for treating heteroskedasticity and dealing with the presence of zero trade values.

Where d_{ij} is the distance in km between the biggest cities i and j of each partners, and d_i is the internal distance i.e. the sum of all distance between the biggest city i and all other cities k belonging to the same country.

Lastly an important part of the gravity equation making the link between theory and empiric are fixed effects f_i^x and f_j^x (and their symmetric expressions) that allow to obtain the predicted value of supply and market capacity[40]. Using these predicted values, with our weighted measure of bilateral distance, and estimates of the trade elasticity ε give the market access:

$$\Omega_i = (\exp(f_i^m))^{\widehat{\alpha}_i} + \sum_{j \neq i} [(\exp(f_j^m))^{\widehat{\alpha}_j} dist_{ij}^{-\hat{\varepsilon}} \, b_{ij}^{\widehat{\delta_1}} \, c_{ij}^{\widehat{\delta_2}} \, l_{ij}^{\widehat{\delta_3}}] \quad (9)$$

The gravity equation is estimated in cross-sections to obtain a market access that varies over time, Ω_{it}.

To get rid of multicollinearity problems in estimating (7) and also of the fact that the market potential can be endogenous to the size of mega-cities, we also use an historical measure of the market access not linked to trade flow but to trade relationship: we calculate an indicator of networks, the so-called out-degree of trade, measuring the number of arcs pointing to partners on the total number of nodes in the bilateral trade network of countries in 1900[41].

- Institutions

Concerning institutions, one of the most recent dichotomous measure of democracy proposed by Acemoglu, Naidu, Restrepo and Robinson (2017), hereafter ANRR is chosen. This index, running from 1960 to 2010, combines information from several sources including Freedom House and Polity IV databases. ANRR classify a country as democratic when several databases conclude as such. We also use the instrument of ANRR, who exploit regional waves of democratization and transitions to non-democracy as a source of exogenous variation in democracy. More precisely ANRR divide the world

[40] Individual fixed effects also captures internal trade costs that are specific to each country. Thus at the difference of Redding and Venables (2004) we decide to not include a measure of internal distance beside these fixed effects to avoid double counting (Redding and Venables (2004) makes the critical assumption that every country is a circle which lead them to consider the following formula for internal distance: $\tau^{-\varepsilon} = dist^{-\varepsilon/2}$ with $dist = 0.66(\frac{area}{\pi})$; where $area$ is the surface of the country in km^2).

[41] See Appendix I.4.2 which describes in details how this indicator has been built.

in seven regions, R_i (where i is a country in Africa, East Asia and the Pacific, Eastern Europe and Central Asia, Western Europe and other developed countries, Latin America and the Caribbean, the Middle East and the North of Africa, and South Asia) and consider a dummy D_{it_0} taking 1 when the country i is a democracy at the start of the period. Finally democracy in country i is influenced by democracy in the set of countries $J_i = \{i' : i' \neq i, R_{i'} = R_i, D_{i't_0} = D_{it_0}\}$ which gives the following instrument of political governance:

$$G_{it} = \frac{1}{|J_i|} \sum_{i' \in J_i} G_{i't} \tag{10}$$

In the words of ANRR, G_{it} is the jack-knifed average of democracy in a region × initial regime cell, i.e. a distance-weighted average of democracy among "neighbors". In order to avoid confusion, it is noteworthy that the "geographical components" of this instrument are radically different from the ones included in the market access, the geographical distance is not taken into account and the neighborhood has a wide definition (e.g. every country in Africa).

For robustness checks regarding the variable of democracy, we also use the polity2 variable, from the Polity-IV project and the Freedom House indices of political rights (PR) and civil liberty (CL).

The mortality rates of soldiers, laborers, and bishops during colonial times, used to instrument institutions, come from Albouy (2012).

- Other

Climate data, such as annual precipitation and temperature comes from the CERDI's database. Genetic distance data are used to instrument the market access. These data, based on parts of the DNA that varies through random mutation and drift, comes from Spolaore and Wacziarg (2018) who use information on human micro-satellite variation (Pemberton et al., 2013) at the population (not country) level which are then match to countries using ethnic composition data. More precisely, we use the ancestral genetic distance of Spolaore and Wacziarg (2018) who match to populations as they were in 1500 AD.

I.1.3 First results

Table I-1, Column (1) and Column (2) examines the cross-sectional patterns running ordinary least squares specification as described in Equation (6) to illustrate the raw data patterns by regressing the log share of urban primacy in 2010 on two different indicators of democracy. In Column 1, based on AJR, this indicator is the log of density in 1500. The bias of reversed causality is reduced by using this historical variable, but this advantage comes at a cost: the effects of the current political institutions cannot be analyzed. In Column 2, we use the indicator of democracy of ANRR. These two columns make our results comparable with the literature on urban primacy that often use cross-sectional data, but as discussed at length in Section 1, this specification may provide biased estimates of the variables of interest. Then, in Column (3), (4), (5) and (6), we exploit the panel structure of the data to tackle endogeneity issues by estimating Equation (7) using the Fixed Effects (FE) and the Fixed Effects Filtered (FEF) models.

In Column 1, the elasticity of urban primacy to past density is significant, high and negative, revealing a reversion in the size of the urban concentration relatively to its total population. On average a country that was twice more densely populated in 1500 is now a country where the share of its biggest city in the total population is 23% smaller than in other countries. We argue that the level of density in 1500 being a proxy of bad governance in the following centuries (countries densely populated in 1500 were richer, which was an incentive to set extractive institutions[42]) represents a repulsive force for the native population. This mechanism is consistent with the finding of Nunn and Puga (2012) that rugged terrains were chosen in Africa because these places afforded protection to those being raided during the slave trade. The other side of this result is that countries with a weak concentration of the population in the nation's largest city in 1500 have benefited of inclusive institutions, such as the development of institutions of private property, that made the growth of urban giants profitable by developing agglomeration economies. As in the cross-section analysis, the impact of past density is

[42] Incentive to set extractive institutions may have also been magnified by the fact that high density countries were also countries were it was harder to settle for colonizers in reason of opposition and/or in reason of disease, as a result the colonial rulers may have concentrated their capital in one unique location, a port for instance, in order to extract rent at the minimal cost.

still negative and significant (Column, 4-5) using the Fixed Effects Filtered (FEF) estimator of Pesaran and Zhou (2017). Finally in Column 2, 3 and 6, the indicator of democracy is always significant and influences positively the population growth in the biggest city. All these results go against the finding of Ades and Glaeser (1995) who find that bad governance fosters urban concentration at the top of the urban hierarchy.

In Column (1), the past network of trade is also significant and negative. This negative impact of the past network of international trade may be related to the particular specialization of some countries, the first globalization has favored land tenets in Latin America for instance (Findlay and O'Rourke, 2009) and thus urbanization was possibly not profitable for this elite. As a result this group may have put in place policies against cities and in particular against large cities that were a fertile land for industrialization. The introduction of fixed effects (Column 5) confirms this result, since the coefficient of the past network, albeit smaller, is still significant. However the introduction of an indicator of the current democracy raises some doubt about the validity of this variable of past network which is no longer significant (Column 6) and thus no longer used in the rest of the paper. Indeed this indicator of past network, reflect more past political institutions and networks between kings than between traders.

Columns 3 and 4 present the positive impact of the market access. This result supports the thesis that a decrease in trade costs, at least in the first step of development, exacerbates regional disparities (Krugman, 1991). Activities and people tend to concentrate where there is a large market and the market is large where activities are concentrated; trade openness fosters this circular causality of agglomeration in the biggest city.

Regarding controls, the income gap approximated by the difference in night lights between the biggest cities and other cities has the expected positive impact.

The negative impact of temperature in the cross-section analysis (Columns 1-2) may be driven in some countries by the indirect effect of new technologies such as air-conditioning or large investment infrastructures (e.g. dam) that have improved conditions of life in many cities that were initially inhospitable. Once individual fixed effects are introduced, capturing the heterogeneity of countries on these aspects, temperatures are no longer significant (Columns 3-6).

Table I-1: Urban Reversal

	OLS	**OLS**	**FE**	**FEF**	**FEF**	**FEF**
Past Institution (Density in 1500)	-0.234			-0.226	-0.252	
	(0.060)[a]			(0.007)[a]	(0.007)[a]	
Democracy		0.705	0.036			0.076
		(0.319)[b]	(0.025)[b]			(0.028)[a]
Past Trade Network (Outdegree in 1900)	-0.616	-0.613			-0.418	-0.208
	(0.134)[a]	(0.236)[b]			(0.110)[a]	(0.185)
Market Access			0.067	0.026		
			(0.028)[b]	(0.010)[b]		
Income (Night Lights Data)	-0.003	-0.019	0.065	0.062	0.058	0.094
	(0.051)	(0.082)	(0.001)[a]	(0.028)[b]	(0.029)[a]	(0.031)[a]
Landlock	0.057	0.044		0.223	0.206	0.567
	0.310	0.446		0.186	0.123	(0.146)[a]
Temperature	-0.818	-1.132	0.026	0.002	-0.055	-0.055
	(0.380)[a]	(0.449)[a]	(0.821)	(0.134)	(0.135)	(0.135)
Humidity	-0.175	-0.182	-0.006	-0.005	-0.001	-0.001
	(0.128)	(0.118)	(0.593)	(0.011)	(0.011)	(0.011)
Constant	0.216	0.662	-2.441			
	(1.223)	(1.174)	(0.374)			
R-square	0.549	0.447	0.999			
Observations	30	30	315	322	277	270

Note: OLS estimator in Column 1-2, Fixed effects (FE) in Column 3, Fixed Effects Filtered (FEF) in Column 4-6. All variables are in Log. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. Data on urban primacy are from the World Development Indicators. Data on density in 1500 from the Clio-infra database on urban settlement sizes, data on urbanization in 1500 from Acemoglu Johnson and Robinson (2002). The binary variable of democracy comes from Acemoglu, Naidu, Restrepo and Robinson (2017). The income gap between the biggest city and other cities is approximated by the differential between the intensity of night lights in the biggest city and the intensity of lights in other cities obtained from satellite pictures. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. Fixed Effect estimations include a full set of year and country fixed effects.

I.2 IV Strategy

The main drawback of the previous analysis concerns the reverse causality of trade and political institutions, indeed, as discussed in Section 2, political institutions may be influenced by the spatial economy and furthermore international trade is often dependent of the performance of the biggest city. To take into account these links, we propose a two-stage least squares (2SLS) estimation strategy, with a "zero-stage" to find suitable instruments for these institutions in the first stage. This 2SLS identification strategy with a zero-stage is inspired by Docquier et al. (2016).

I.2.1 Two steps SLS identification strategy with a zero-stage

The zero-stage is based on the finding that the mortality rate faced by settlers is a good instrument of the current institution (AJR). Since this proposition has stirred up questions (Albouy, 2012)[43], we also take a more contemporaneous variable by using the regional waves of democratization and transitions to non-democracy as an instrument (this is the instrument used by ANRR, already described in the previous section).

Denoting H_i the historical mortality rates of soldiers, laborers, and bishops during colonial times (source: Albouy, 2012), I_i the indicator of democracy (source: ANRR), and G_i the measure of political governance based on waves of democratization (defined by Equation (10)), we estimate the following equation:

$$I_i = \beta H_i + \gamma G_i + v_i \tag{11}$$

This equation is simply an extension of AJR using a different dependent variable (democracy instead of expropriation risks), and an additional variable G_i. Finally while AJR estimates this equation for one year only, we regress it on each year of our sample which gives an historical-geographical instrument, denoted $\widehat{H_{it}^{g}}$ that varies over time[44]. Democracy effect identification will come from this time-varying predicted instrument $\widehat{H_{it}^{g}}$ that captures the discretionary variations in institutions. It reflects the exogenous component of democracy variable as a consequence of distant past shocks in the contemporaneous institutions trend.

Concerning the endogeneity of trade, we follow the same strategy by using the ancestral genetic distance (Spolaore and Wacziard, 2018). The relevance condition asserting that this variable is a good instrument to predict the endogenous dependent variable, i.e. trade, is well established. For instance, Guiso, Sapienza and Zingales (2009) find that genetic distance is a good proxy for cultural proximity, which impacts on the trust between two partners and then on trade exchanges. Spolaore and Wacziard (2018) present clear evidences that genetic distance acts as a temporary barrier to the diffusion of innovations and development. Giuliano, Spilimbergo and Tonon (2014) find that

[43] See however the response of AJR (2012).

[44] In other terms, from the estimation of (11) we compute a different $\widehat{H_{i}^{g}} \equiv \hat{\beta} H_i + \hat{\gamma} G_i$ for each year between 1962 and 2010.

genetic distance is a good proxy for transportation costs between countries in reason of international migrations. The variations in genetic distance are partially explained by international migrations which partially cause international trade via business and social networks. See for instance Rauch and Trindade (2002) on the impact of the ethnic networks on trade. The market access is then regressed on ancestral genetic distance, denoted D_i^g, for each year of our sample, which enables to get an instrument of the market access based on genetic distance that varies over time, hereafter denoted $\widehat{D_{it}^g}$.

The first step explains the variation of institutions by using the exogenous variable of institutions defined in the previous step:

$$I_{it} = \varsigma \widehat{H_{it}^g} + f_i + f_t + C_{it} + \chi_{it} \tag{12}$$

and in a similar way the variation over time of the market access:

$$\Omega_{it} = \varrho \widehat{D_{it}^g} + f_i + f_t + C_{it} + v_{it} \tag{13}$$

The interest of this first step is that ς is estimated from within changes in $\widehat{H_{it}^g}$ which, by depending on the distance-weighted average of democracy among neighbors, is an exogenous variable of the current urban primacy. In a similar way ϱ is not estimated by cross-country difference but by within changes of a genetic distance between partners which is certainly not a function of trade. Individual fixed effects in the two equations are particularly important to control for differences in the level of development. The term C_{it} represents three variables of control that are used in the two stages: the precipitation, the temperature and the gap in the intensity of night lights.

Finally the second step uses the predicted values of the "historical-geographical" institutions and of the predicted value of "genetic" market access as follows:

$$u_{it} = \hat{\varsigma} \widehat{H_{it}^g} + \hat{\varrho} \widehat{D_{it}^g} + f_i + f_t + C_{it} + \epsilon_{it} \tag{14}$$

I.2.2 Results of the Zero-Stage

Table I-2 confirms the positive impact of waves of democratization on institutions. Results are less clear concerning the effect of the mortality rate of colonizers. Coefficients associated to the colonizers mortality rate are significant only between 1962 and 1972 which may suggest an erosion of the bad influence of past colonial institutions. However, additional estimations provided in the online appendix shows that the initial result of AJR is verified over the whole period when we use a different indicator of democracy, i.e. the mortality rate of colonizers explains institutions as measured by the polity 2 index of democracy, the Freedom House indices of political rights (PR) and civil liberty (CL). It is also noteworthy that this indicator of mortality has a small impact on institution in comparison with waves of democratization[45].

Table I-2: Democracy (ANRR index), zero stage

	1962	**1965**	**1972**	**1982**	**1992**	**2002**	**2010**
Waves of democratization	0.957	0.961	0.696	0.810	0.894	0.929	0.979
G_i	(0.076)[a]	(0.076)[a]	(0.216)[a]	(0.161)[a]	(0.153)[a]	(0.198)[a]	(0.149)[a]
Mortality rate of colonizers	-0.030	-0.042	-0.165	-0.063	-0.076	0.028	0.010
H_i	(0.017)[c]	(0.017)[b]	(0.096)[c]	(0.080)	(0.087)	(0.066)	(0.067)
Constant	0.147	0.206	0.783	0.338	0.383	-0.038	-0.016
	(0.127)	(0.123)	(0.470)	(0.362)	(0.425)	(0.328)	(0.296)
R-squared	0.773	0.776	0.515	0.356	0.427	0.558	0.538
Observations	35	35	36	36	36	36	36

Note: OLS estimator. Mortality rate variable is in Log. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The mortality rate of colonizers (in log) comes from Albouy (2012). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2017), denoted ANRR in the title of this table, and instrumented with their instrument based on waves of democratization.

In Table I-3 we present some of the zero-stage of the market access. Throughout the period we find a negative impact of the genetic distance on the market access.

[45] Not reported here we also compute our instrument by using only the predicted value of the indicator of governance based on the waves of democratization (i.e. by excluding the mortality rate such as $\widehat{H_i^g} \equiv \hat{\gamma} G_i$) and we find similar results in the following stages. The small estimates of H_i (see Table I-2) may explain why our results hold with and without this variable.

Table I-3: Market Access, zero stage

	1962	1972	1982	1992	2002	2010
Genetic Distance	-0.421	-0.360	-0.550	-0.393	-0.345	-0.364
	(0.108)[a]	(0.159)[b]	(0.187)[b]	(0.192)[b]	(0.188)[b]	(0.105)[b]
Constant	0.820	-0.115	0.328	0.813	1.602	1.422
	(0.321)[b]	(0.481)	(0.565)	(0.587)	(0.585)[a]	(0.313)[a]
R-square	0.185	0.066	0.095	0.047	0.037	0.151
Observations	37	38	38	38	38	37

Note: OLS estimator. All variables are in Log. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. Data on genetic distance in 1500 are from Spolaore and Wacziarg (2018). The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII.

I.2.3 Results of the first stage

Table I-4 (Column 1) presents the first stage described by Equation (12). As expected our historical and geographical instrument based on mortality rates and on waves of globalization significantly explains the level of democracy. This first stage confirms the different results obtained by AJR and ANRR. The coefficients on the instrument variables are highly significant. We present the F-test statistics that reject the joint null effect hypothesis of these IVs and they are above 10, the threshold proposed by Staiger and Sotck (1997). As a robustness check we also run an estimation by excluding the mortality rate in the zero-stage, and thus by using an instrument in this first step only based on the waves of democratization. We do not report this estimation since results are almost identical (we find a coefficient of 0.871 with a RSE of 0.052).

Column (3) presents the first stage regressing the market access on its instrument with various controls (see Equation (13)). As required, the instrument of trade openness based on genetic distance significantly explains the market access. This result confirms, in a different way, the main finding of Giuliano, Spilimbergo and Tonon (2014) that genetic distance captures transportation costs between countries.

Column (2) and (4) propose a simple test to verify that there is no other problems of endogeneity in this strategy by analyzing whether the market access explains the current level of democracy. Indeed the causal link of globalization on democracy has be discussed a lot by economists and political scientists (e.g. Milner and Mukherjee, 2009) and not directly addressed in this paper until now. Our result confirms the finding of this

literature that trade openness does not explain the process of democratization (when adequate IV are used).

Column (3) shows that the instrument of the market access has no impact on institutions, while Column (4) shows that the instrument of institutions does not impact on the market access.

Table I-4: Democracy and Trade, First stage

	Democracy ANRR				**Polity2**			
	Democracy Eq (12)		Market Acces Eq (13)		Democracy Eq (12)		Market Acces Eq (13)	
Democracy ($\widehat{H_{it}^{g}}$)	0.944	0.918		0.021	0.864	0.843		0.001
Instru: Mortality+Waves	(0.038)[a]	(0.042)[a]		(0.017)	(0.037)[a]	(0.040)[a]		(0.001)
Market Access ($\widehat{D_{it}^{g}}$)		-0.352	-1.005	0.993		-7.461	-1.005	-1.003
Instru: Genetic dist		(0.328)	(0.093)[a]	(0.085)[a]		(4.623)	(0.093)[a]	(0.085)[a]
Temperature	-0.646	-0.847	0.622	0.457	-7.081	-7.148	0.622	0.440
	(0.318)[b]	(0.341)[b]	(0.196)	(0.191)[b]	(4.474)	(4.806)	(0.196)	(0.190)[b]
Precipitation	-0.006	-0.002	-0.006	-0.009	-0.202	-0.086	-0.006	-0.009
	(0.042)	(0.045)	(0.017)	(0.012)	(0.571)	(0.614)	(0.017)	(0.013)
Constant	1.920	2.878	-1.834	-1.353	20.785	28.925	-1.834	-1.311
	(0.928)[b]	(1.063)[a]	(0.574)[a]	(0.555)[b]	(13.060)	(14.744)[a]	(0.574)[a]	(0.556)[b]
R-square	0.74	0.73	0.98	0.98	0.76	0.75	0.98	0.98
Observations	1705	1535	1623	1535	1705	1535	1623	1535
F-test	604.99	236.90	116.38	76.10	556.77	225.97	116.38	73.78

Note: 2SLS procedure. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using genetic distance in 1500 from Spolaore and Wacziarg (2018). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2017) and instrumented with their instrument, denoted ANRR, based on waves of democratization and with the mortality rate of colonizers provided by Albouy (2012). All estimations include time effects and individual fixed effects.

Column (5), (6), (7) and (8) present exactly the same specification with a different measure of democracy. We use the variable Polity2 instead of the variable of democracy of ANRR. Results are not affected by this change.

I.2.4 Results, second stage

Table I-5 (Column 1) shows the results obtained by estimating the second stage described by Equation (14). Column 2 presents a "half-naive" estimation, where the democracy is instrumented but the market access is not. Column 3 presents the symmetrical estimation, where the market access is instrumented while the democracy is not.

In all estimations reported in Table I-5, whatever the specification used, we find that the indicator of democracy, instrumented by past mortality rates and by waves of democratization favors agglomeration in the biggest city[46]. These results indicate that the negative impact of democracy found by Ades and Glaeser (1995) and Henderson and Wang (2007) may be due to a lack of control and/or to endogeneity bias. Another possibility, which is more interesting, is that there is something specific in our sample of countries. Ades and Glaeser (1995) for instance consider a sample of seventy countries without considering the history of these States. Our analysis is slightly different since we focus our research exclusively on countries colonized by Europeans 500 years ago following the arguments of AJR and of many historians that the long run effects of colonization are still unclear. As a result, it is possible that countries not colonized by Europeans have developed institutions that shape differently their economic geographies.

Concerning the second hypothesis, the market access is never significant, which reveals how the previous results done without controls on time-varying institutions and without an exogenous measure of trade openness were misleading. This is in accordance with the skeptical view of Ades and Glaeser (1995) and Henderson and Wang (2007) about the impact of international trade on the urban pattern. The same estimations are done in Column (4), (5) and (6) but with the variable polity2 and based on the first step of Columns (5) and (6) of the previous Table I-4. The estimation of (14) in Column (4), which is the most careful estimation correcting for the endogeneity of the market access and of institutions, provides the same result than Column 1[47].

[46] When we compute the instrument of democracy by only considering waves of democratization, we get a very similar result not reported here but available on request (the coefficient is equal to 0.115 and highly significant with a RSE of 0.036).

[47] On the contrary the naive estimation in Column (5), where the market access is not instrumented, shows that this variable is significant (however only at 10%), revealing the interest of the IV strategy concerning the impact of trade integration on urban primacy.

Table I-5: Trade, Institutions and Urban Primacy

dep:	**Democracy ANRR**			**Polity2**		
	Eq (14)	Naive reg		Eq (14)	Naive reg	
Market Access (Ω_{it})		0.048			0.052	
		(0.031)			(0.031)[c]	
Market Access ($\widehat{\varrho D_{it}^{g}}$)	-0.158		-0.146	-0.250		-0.148
Instru: Genetic	(0.145)		(0.173)	(0.154)		(0.166)
Democracy (I_{it})			0.038			0.007
			(0.016)[a]			(0.004)[c]
Democracy ($\widehat{\varsigma H_{it}^{g}}$)	0.104	0.092		0.009	0.006	
Instru: Mortality+Waves	(0.034)[a]	(0.034)[a]		(0.004)[b]	(0.004)[c]	
Light	0.085	0.074	0.075	0.083	0.071	0.081
	(0.021)[a]	(0.021)[a]	(0.020)[a]	(0.021)[a]	(0.021)[a]	(0.020)[a]
Temperature	0.218	0.051	0.171	0.225	0.022	0.159
	(0.136)	(0.121)	(0.135)	(0.136)[c]	(0.120)	(0.133)
Precipitation	-0.008	-0.007	-0.006	-0.007	-0.006	-0.007
	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)	(0.012)
Constant	-1.753	-1.761	-1.551	-1.492	-1.636	-1.508
	(0.373)[a]	(0.346)[a]	(0.369)[a]	(0.352)[a]	(0.334)[a]	(0.386)[a]
R-square	0.99	0.99	0.99	0.99	0.99	0.99
Observations	306	306	306	306	306	306

Note: 2SLS procedure. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using genetic distance in 1500 from Spolaore and Wacziarg (2018). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2017) and instrumented with their instrument, denoted ANRR, based on waves of democratization and with the mortality rate of colonizers provided by Albouy (2012). All estimations include time effects and individual fixed effects.

I.2.5 Non parametric estimation: matching estimator approach

The previous results are based on a linear functional relationship and on strong assumptions regarding the IV strategy. The combination of non-random selection into the process of democratization and the omission of non-linear relationships, can biased estimates. By finding for each observation in the treatment group, a statistical "twins" in the control group with the same characteristics, and by using these observations to compute a counterfactual outcome without treatment for the observations at hand, matching estimators potentially address these problems without specifying any parametric assumption, and are thus used here as an alternative strategy.

For any observation, we observe the treatment I_{it} (democratic regime or not) and the outcome for this treatment: the relative size of the largest city under a democracy, denoted $u_{it}(1)$, or under another regime, denoted $u_{it}(0)$. We use the Average Treatment

Effect on the entire sample (ATE) and the Average Treatment effect for the Treated (ATT) by performing the nearest neighbor matching (Abadie and Imbens, 2006). At least two assumptions are crucial, the first one is the "conditional mean independence" leading to assume that the political regime I_{it} is independent of urban primacy $u_{it}(1)$ and $u_{it}(0)$, conditional on a set of covariates. The second is the stable-unit-treatment-value assumption (SUTVA) or the "non-interference" assumption, leading in our case to consider on the one hand that the treatment I_{it} is identical for each treated observation and on the second hand that being under a democratic regime in a given country does not influence untreated urban primacy.

We retain covariates used in the previous section apart from temperature and precipitation, to which we add country-year GDP per capita and the rural population growth. Using these covariates for the five nearest neighbors, Table I-6 (Row 1 and 3) presents the ATEs and ATTs. Since the nearest-neighbor matching estimators may not be consistent when matching on more than one variable[48], Table I-6 (Row 2 and 4) also presents bias-corrected estimator results. Reported ATEs and ATTs are positive, statistically significant and then confirm results obtained in the previous section. Democracy causes an increase in the relative size of the biggest city by an average of 1.39 (i.e. $e^{0.332}$) point. The sensitivity analysis based on different nearest neighbors (1 to 4) confirms this conclusion.

Table I-6: Average effect of democracy on log urban primacy

		Outcome: log_Prim_pop
	# of observation (# of Democracies)	703 (532)
(1)	A-I ATEs	0.514 (0.053)[a]
(2)	A-I ATEs (Bias adjusted)	0.285 (0.059)[a]
(3)	A-I ATTs	0.645 (0.060)[a]
(4)	A-I ATTs (Bias adjusted)	0.332 (0.066)[a]
(5)	ATT (Propensity score matching)	0.25 (0.121)[b]

Note: Matching procedure, all variables are in Log. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. Data on democracy, the treatment, is from Acemoglu, Naidu, Restrepo, Robinson (2016).

[48] see Abadie and Imbens (2006)

As a robustness check, in particular regarding the selection bias, we also use the propensity-score estimator. In contrast with the previous matching procedure, propensity-score matching relies on only one characteristic which is the probability of being in democracy conditionally on covariates; therefore, the matching procedure can be less precise. We adopt a logit model to estimate these propensity scores. The covariates are the same ones used for matching earlier. In practice, we take into account the fact that the propensity scores are estimated rather than known when calculating standard errors[49]. Table I-6 presents this PSM-ATT which is computed by calculating the average of the difference between the observed and potential outcome for each observation in the treated group. This last analysis confirms the results obtained so far, the urban primacy has been promoted by democratic regimes.

I.2.6 Discussions

The link between urban planning and institutions studied here is binary (dictatorship versus democracy) which makes our paper more easily comparable to the literature. However, political regimes are richer than this simple binary difference and many interesting results are certainly hidden by this presentation. This is well summarized by Duranton (2008) who wrote that "this type of explanation [i.e. Ades and Glaeser (1995)] implicitly assumes fairly strong state institutions able to tax their countryside and redistribute the proceeds to the primate city. On the contrary, it may be argued that undemocratic and unstable regimes are weak and favor primate cities by default" (see Appendix I.4.5). We find that in democratic states, the political regime has no role whatever the urban pattern. In contrast, in countries with weak dictatorship and with an urban giant, more democracies foster the development of the largest city, maybe by "default" as argued by Duranton (2008).

[49] The newest command in Stata allows this.

I.3 Conclusion

Institutions and first cause matter, not trade, in explaining the relative fall of the biggest cities in former European colonies. Our analysis documents the *negative* effects of bad governance on the current level of urbanization. We find that the reversal in urban primacy is due to past institutions related to colonization. Bad governance and extractive institutions inherited from colonization have reduced the population growth of the biggest city in many countries.

Regarding the literature, we have improved the analysis on different aspects by working with panel data (e.g. the analysis of Ades and Glaeser (1995) is in cross-section only), by using new controls (e.g. satellite data lights, market access measures) and new instruments (settlers mortality, waves of democratization) to explain urban primacy. All our different strategies (using OLS, IV, matching techniques) lead to the same conclusion: the democracy of the former European colonies has favored cities at the top of the urban hierarchy. As a result, we do not share the conclusion of Ades and Glaeser (1995) who wrote that what "was true in Rome, 50 B.C.E., is still true in many countries today", on the contrary, we document that dictatorship is no longer a force of agglomeration in the biggest cities of our sample. This result has concrete consequences, it means that in many countries where democratic institutions are improved, we can forecast a more significant growth of the biggest city than what has been predicted until now with major implications for infrastructures, public health, sanitation, productivity and inequality.

I.4 Appendices

I.4.1 Appendix A: Light nights and urban primacy

Table I-7 presents our baseline estimation using the FE estimator with different retarded measure of income gap approximated by the differential of night lights between the biggest city and the rest of the country. The current differential seems to have no effect (Column 1), while the differential of light intensity in the night observed five (Column 2) or ten years ago (Column 3) explains the current attraction of the biggest city.

Table I-7: Effect of the constructed light night gap on urban primacy

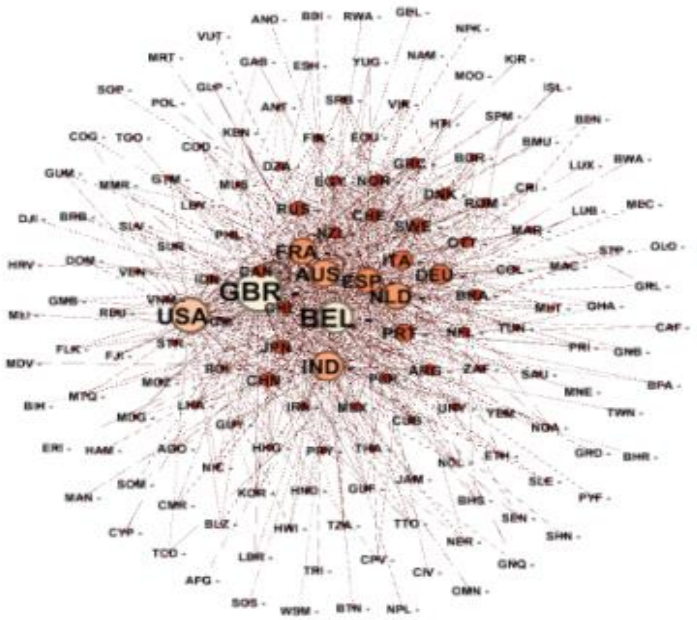
	(1)	(2)	(3)
	FE	FE	FE
Light gap (level)	0.029		
	(0.021)		
Light gap (Lag = 5)		0.074	
		(0.032)[b]	
Light gap (lag = 10)			0.085
			(0.024)[a]
Temperature	0.193	0.553	0.848
	(0.186)	(0.256)[b]	(0.277)[a]
Humidity	-0.022	-0.027	-0.020
	(0.019)	(0.028)	(0.017)
Constant	1.241	0.425	-0.067
	(0.541)[b]	(0.733)	(0.802)
R-squared	0.983	0.982	0.989
Observations	686	505	322

Note: FE estimator. All variables are in Log. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The income gap (Light gap) between the biggest city and other cities is approximated by the differential between the intensity of night lights in the biggest city and the intensity of lights in other cities obtained from satellite pictures (1992-2010). All estimations include a full set of year and country fixed effects.

I.4.2 Appendix B: Outdegree Indicator of Network

Historical data on trade comes from Fouquin and Hugot (2016). Working with historical data obviously lead to deal with entities that does not exist in 1900 (e.g. colonial empires). To compute a network indicator at the level of countries (as they are known today), we assume that a country trading to a group of countries is connected to all of these countries. For instance when Italy traded with "Italian East Africa" we consider that Italy was connected to Eritrea, Somalia and Ethiopia. In the reverse case where "Italian East Africa" traded with Italy, we assume that Eritrea, Somalia and Ethiopia were connected with Italy. The nature of this database explains why we have not go beyond an indicator of network based on "links", indeed building the network of trade flows would lead to make critical assumptions on the distribution of trade between countries. Figure below presents this network.

Figure 4: World Trade Network in 1900



Source: Authors

The size of vertices is proportional to the number of outcoming arcs: a large circle indicates that the corresponding country exports to a large number of exporting

countries. Considering a dummy variable taking, L_{ij} taking one when country i and j are trade connected, and zero otherwise, the outdegree measure is computed as follows:

$$O_{ij} = \frac{\sum_{j \neq i} L_{ij}}{N - 1} \tag{15}$$

where i is the exporter and N represents the number of node/country in this network.

I.4.3 Appendix C: Theoretical foundation of the market access

Here we briefly present the theory behind the Redding and Venables (2004) methodology to build the market access variable.

In standard urban economics model of the NEG (e.g. Krugman and Livas, 1998), individuals consume a composite basket of different varieties produced under increasing returns and sold under monopolistic competition. These goods are exchanged between cities and with the rest of the world under iceberg trade costs denoted τ. Agents lives in monocentric cities and have to commute to work in the central business district where jobs are located. Market clearing on the goods market gives the following export equation (denoted X_{ij}, expressed in value) from city i to j:

$$X_{ij} = \tau_{ij}^{-\varepsilon} \frac{Y_j}{P_j} S_i \tag{16}$$

where ε is the relative elasticity of export with respect to bilateral trade costs i.e. $\varepsilon = \partial \ln(X_{ij}/X_{jj}) / \partial \ln(\tau_{ij})$, Y_j is the nominal income of each importing partner j that depends on wage, commuting costs and land rent. The term s_i takes into account the exporting capacity of firms located in i (mainly the number of firms and the factory price that depends on wage and markup). Lastly, P_j is a reversed measure of the price index in j that depends on trade costs and prices, called supplier access of importer j (since it is a weighted sum of the supplier market capacities):

$$P_j = s_j \tau_{jj}^{-\varepsilon} \sum_{i \neq j} s_i \tau_{ij}^{-\varepsilon} \tag{17}$$

Now considering the gravity Equation (16), one can remark that the term $\tau_{ij}^{-\varepsilon} Y_j / P_j$ is a measure of the real income of consumers/importers located in j net of transportation costs, in other words it represents the market access of firms that exports from i to j. The aggregate market access obtained from the location i is thus given by:

$$\Omega_j = \tau_{ii}^{-\varepsilon} \frac{Y_i}{P_i} + \sum_{i \neq j} \tau_{ij}^{-\varepsilon} \frac{Y_j}{P_j} \tag{18}$$

I.4.4 Appendix D: Alternative measures of democracy in the zero stage regressions

To verify that the non-significant effect of colonizers mortality rate presented above is a statistical issue depending on the characteristics of the dependent variables which is dichotomous, we provided robustness check for these first stage regressions concerning institutions using other measures of democracy, usually exploit in the literature and mainly used in the construction of ANNR index of democracy. That is to say, the polity 2 score of democracy, and the Freedom House indices of political rights (PR) and civil liberty (CL). When polity-2 score ranges from -10 to 10 with a higher score indicating more democracy, the PR and CL indices range from 1 to 7 with a higher score indicating less freedom. The estimations confirm a negative and significant effect of colonizers mortality rate on these different measures of democracy and a positive and still highly significant impact of waves of democratization.

Table (Tab3-1) presents this first stage for some years and confirms the negative sign of colonizers mortality rate on democracy and the positive impact of waves of democratization on the polity2 score of democracy.

Table I-8: Democracy (Polity 2 score), zero stage

	1962	1972	1982	1992	2002	2010
Waves of democratization	10.228	12.025	11.301	14.209	12.446	10.616
Z i	(1.605)[a]	(2.757)[a]	(2.586)[a]	(1.347)[a]	(2.284) [a]	(2.215)[a]
Mortality rate of colonizers	-2.560	-2.777	-2.559	-1.756	-1.013	-1.297
M i	(1.203)[b]	(1.406)[c]	(1.199)[b]	(0.843)[b]	(0.705)	(0.760)[c]
Constant	7.693	6.939	5.660	2.288	0.346	3.074
	(5.613)	(6.467)	(5.648)	(3.872)	(3.320)	(3.185)
R-square	0.659	0.632	0.424	0.669	0.642	0.515
Observations	35	36	36	36	36	36

Note: OLS estimator. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The mortality rate of colonizers (in log) comes from Albouy (2012). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2016) and instrumented with their instrument based on waves of democratization.

Countries where colonizers face high mortality rate have now a lower level of democracy than other countries. This result is significant over a large part of the period (excepted four years around the end). Notice also the erosion of this historical heritage, the coefficient of the mortality rate declines from -2.5 in 1962 to -1.3 in 2010.

The results are similar when using the Freedom House indices of political rights (PR) and civil liberty (CL).

Table I-9: Democracy (PR, CL), zero stage

	CL						
	1995	2000	2002	2004	2006	2008	2010
Waves of democratization	-3.181	-2.684	-2.918	-2.670	-2.522	-2.597	-2.259
Z i	(0.460)a	(0.519)a	(0.500)a	(0.473)a	(0.436)a	(0.476)a	(0.491)a
Mortality rate of colonizers	0.931	0.675	0.660	0.722	0.601	0.617	0.658
M i	(0.161)a	(0.237)a	(0.228)a	(0.200)a	(0.194)a	(0.198)a	(0.222)a
Constant	2.206	2.593	2.676	2.073	2.465	2.537	2.112
	(0.857)b	(1.129)	(1.100)	(0.932)b	(0.830)a	(0.868)a	(1.005)b
R-square	0.719	0.574	0.588	0.568	0.548	0.520	0.427
Observations	36	36	36	36	36	36	36
	PR						
	1995	2000	2002	2004	2006	2008	2010
Waves of democratization	-3.663	-4.098	-3.848	-3.778	-3.815	-4.047	-3.754
Z i	(0.456)a	(0.627)a	(0.619)a	(0.632)a	(0.609)a	(0.650)a	(0.684)a
Mortality rate of colonizers	0.982	0.449	0.499	0.602	0.441	0.561	0.518
M i	(0.155)a	(0.246)c	(0.262)c	(0.274)b	(0.248)c	(0.240)b	(0.253)b
Constant	2.039	4.414	3.911	3.373	4.080	3.836	3.778
	(0.731)a	(1.222)a	(1.148)a	(1.190)a	(0.909)a	(0.791)a	(0.966)a
R-square	0.695	0.573	0.604	0.577	0.616	0.640	0.530
Observations	36	36	36	36	36	36	36

Note: OLS estimator. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The mortality rate of colonizers (in log) comes from Albouy (2012). Data on democracy, the political rights (PR) and civil liberties (CL) indices, are from Freedom House dataset. Waves of democratization variable, is from ANRR (2017).

I.4.5 Appendix E: Deepening the analysis

In this appendix we analyze whether our results can be generalized inside our categorization of democracy *versus* dictatorship and whether the existence of urban giant can shape our result. We conjecture that for a democratic regime, the existing urban pattern has no role. To win an election, politicians need to win in different regions and cities and thus the degree of democratization *in these countries* may not be a determinant of urban bias and of urban primacy. Considering now an unstable dictatorship, such a regime may have a too weak power to reverse the spatial pattern of a country where activities are dispersed; but the situation can be different in these regimes if there is already an urban giant. In a weak dictatorship, it can be efficient to concentrate the governmental policy in the biggest city.

How to define a "weak dictatorship" or the "existence" of an urban primacy? We consider that dictatorship (as defined by ANRR) with weak military power are weak dictatorship. We calculate the average "military personal on labor force ratio" over the period 1992-2010 and each country is labeled as "high military power country" ("low military power country") when its associated group mean ratio is equal or above (below) the 75 percentile of its density. While this computation is certainly not exhaustive, it undoubtedly covers cases of weak dictatorships. Concerning democracy, based on ANRR, we create a dummy variable taking one when the country has never experienced a period of dictatorship during all the period and zero when it had experienced at least one year of dictatorship.

Finally based on the Zipf's law, establishing that within a country, the size of the largest cities is inversely proportional to their rank, a dichotomous measure of the current existence of urban primacy is built. A country is considered as exhibiting urban primacy if its most populous city has more than twice the population of the second city. On the contrary, this variable takes zero when the second city in the urban hierarchy has more than half of the population of the biggest city.

In Table I-10 (column 1 & 2) we study how the share of the population in the biggest city evolves in countries with democratic rules and where the level of urban primacy is low. In that case, there is no evidence that institutions influence the relative growth of the biggest city. Similar results are obtained in democratic countries with urban giants. The

hypothesis that an urban bias can be beneficial to democratic regime (for instance to win election) in countries where an urban giant dominates the landscape is not obvious; there is no apparent relationship between political institutions and urban primacy in countries already democratized whatever the urban pattern. On the opposite in countries with weak dictatorship and urban primacy, more democracies foster the development of the largest city (see Table I-10, col 3). The same result is obtained concerning countries that already host an urban giant, i.e. in countries where the biggest city is higher that the size predicted by the Zipf's law, democracies favors the agglomeration of the population there.

Table I-10: First and Second Nature of Urban Giants

	(1)	(2)	(3)	(4)
Density 1500	-0.184	-0.174	0.081	-0.262
	(0.039)a	(0.037)a	(0.065)	(0.027)a
Market Access	1.018	0.559	-1.054	-0.411
Instru: Genetic	(0.660)	(0.620)	(0.428)c	(0.321)
Democracy	-0.065	-0.008	0.166	0.136
Instru: Mort+ANRR	(0.153)	(0.125)	(0.039)a	(0.027)a
Light gap	-0.013	-0.020	0.272	0.127
	(0.055)	(0.054)	(0.067)a	(0.056)b
Temperature	0.256	0.083	-0.204	-0.005
	(0.159)	(0.095)	(0.463)	(0.156)
Precipitation	0.015	0.022	-0.063	-0.010
	(0.022)	(0.018)	(0.010)a	(0.017)a
Constant	-5.021	-0.631	1.445	-1.340
	(1.854)a	(0.434)a	(1.712)	(1.057)
R-square	0.994	0.995	0.999	0.998
Observations	81	99	54	180

Note: Column (1): Democracy without urban primacy, Column (2): Democracy with urban primacy, Column (3): Weak dictatorship with urban primacy, Column (4): All with urban primacy. Estimation: 2SLS procedure, all variables are in Log. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using genetic distance in 1500 from Spolaore and Wacziarg (2017) and the mortality rate of colonizers from Albouy (2012). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2016) and instrumented with their instrument, denoted ANRR, based on waves of democratization and with the mortality rate of colonizers provided by Albouy (2012). All estimations include a full set of year and country fixed effects.

Chapter 2 - Beyond the Income Effect of Trade Integration on Ethnic Wars

II. Chapter 2 - Beyond the Income Effect of Trade Integration on Ethnic Wars

Introduction

The objective of this paper is to deepen our understanding of the impact of trade on ethnic conflicts inside each nation (civil war) in Africa. Many conflicts are rooted in the long term of a national history, but transnational links and interactions with other states can also influence civil wars. In particular, international trade is considered to affect conflicts by three mechanisms. The first one is the opportunity cost effect, when trade shocks decrease revenue, the cost to participate to violent actions follows the same path[50]. The second one, is the resource effect, formal trade fosters tax revenues and then can improve the capacity of the government to buy peace by financing public goods and by redistributing funds to rebels[51].

The third one, is the rapacity effect, a resource that is highly valuable on international market generates envy and expropriation that can escalate into conflicts[52].

All these mechanisms have a common ground, trade affects conflicts by its impact on real incomes[53]. This means that by properly controlling for income, trade should have an insignificant effect on conflicts. To test this, we use night light pictures provided by satellites from outer space (Henderson et al., 2012) to approximate income at the *ethnic level*, and find that trade still has a significant impact on conflicts. Why? Our thesis is that beyond its monetary effect, trade has many other consequences on institutions, culture, and on the environment that can play on conflicts. Markets are places of socialization and then trade by fostering exchanges may have a role in building trust between communities. Obviously, such a peaceful effect can be reversed if the situation is considered as unfair. From a theoretical point of view, the exposure to trade implies that

50 Montesquieu (1758), Mayer, Martin and Thoenig (2008.a).

51 See Angrist and Kugler (2008) who analyze how the increase in the price of coca in Columbia, in part driven by the American demand, has raised revenues for the guerrilla.

52 The rapacity effect is often analyzed by studying trade in mineral products. According to Cali (2015) a 10% increase in the price of oil, raises the risk of conflict by 2.2 percent on average across countries.

53 See also Calvo and Mercier (2019).

only the more productive firms enter the export market while the least one are forced to exit (Melitz, 2003), however this "fair game" can be distorted by bad governance and deficient institutions. For instance in countries characterized by ethnic favoritism it is possible that firms with a sufficient productivity to export are stuck on the domestic market simply because they don't belong to the right group, which may generate grievance against the system[54].

The same resentment may occur in the case of forced trade, defined by Fleurbaey (2015) as a situation where "the disadvantaged agent would no longer accept the trade if his disadvantage was removed"[55].

In this last case, the income effect of trade can be offset by an ethical one. Indeed forced trade can be a Pareto improvement bringing pecuniary benefits to all parties however the unethical nature remains because the benefit of the exploited ethnic group is conditional to its disadvantage.

Concerning culture, on the one hand, globalization is at the source of cultural destruction which may render communities more vulnerable (e.g. Maystre, Olivier, Thoenig and Verdier, 2014). On the other hand, the process of cultural homogenization can also help to relativize differences between ethnic groups and/or can be an opportunity to build a new culture by hybridization[56].

In that case, globalization by promoting a new *national identity* can have a peaceful effect. Finally, trade can affect the environment of different groups (via deforestation or the rise of local pollution haven) that can be at the source of conflicts.

These non-pecuniary effects of trade, can be different depending on the market geographical scale at which transactions are done. International trade can be selective, fostering trade between a community and a far distant partner, and can then weaken institutional and cultural links inside a country. In other term international trade can be a substitute to local/internal trade and can thus separate communities. Local trade can have stronger peaceful effect at least if it is based on voluntary trade and not on unequal resources (i.e. forced trade) which can pave the way for ethnic conflicts. Regional trade

[54] Chaney (2016) presents a model where firms with the potential to export, are prevented from doing so because they lack sufficient liquidity. One can extrapolate this model by considering that if governments provide these liquidities arbitrary (crony capitalism) then the outcome becomes economically unfair.

[55] Forced trade occurs when the source of trade is related to the economical position of agents (e.g. inequality). Sexual tourism is an emblematic example but one can think of many other exchanges apparently less scandalous that can be classify in this category.

[56] See Rauch and Trindade (2009), Cowen (2002) and Caplan and Cowen (2004).

with neighbor countries can have ambiguous effects. Like international trade it represents a diversion of socialization inside the country, but as argued by Iwanowsky (2018) ethnic networks provide social collateral to enforce contracts and can thus compensate for unfavorable institutions between countries.

Finally, the interest to analyze these three different types of trade is also based on the fact that different types of goods are traded at different geographical scales and involved different economical, political and social effects. In Africa, mineral resources and specific agricultural products (e.g. coffee, cotton etc) represent a significant part of export, while more basic goods are exchanged on internal or regional markets and concern very different people. This means that the conflict effect of trade can be different depending on the geographical trade scale analyzed.

Consequently, this article contributes to the literature of trade by studying three different type of trade. Using the geographical distribution of 175 crops on a 10 km by 10 km cell grid (Monfreda et al., 2008) and the spatial distribution of mineral resources in Africa, we build a proxy of *the international trade of ethnic groups* concerning agricultural and mineral products. In addition, considering the total value of trade (and not only agricultural and mineral products), we also compute a indicator of *regional trade between countries that share at least one ethnic group*. Finally, we compute an indicator of *internal/domestic trade* to analyze its effect on conflicts. We find that at least two different types of trade have a very similar effect: international and national trade integration reduce the likelihood of war. This finding holds whatever the specification or the empirical strategy adopted (i.e. with different controls, estimators, IV strategies). Results concerning the regional trade integration (between countries that share at least one ethnic group) are less robust nonetheless a positive effect is obtained once the endogeneity bias due to reverse causality is taken into account.

All these results are obtained by controlling for income, which is an argument in favor of our thesis that trade, has effects beyond revenues affecting for instance culture, institutions and the environment of ethnies. Putting differently trade affect conflicts, not solely via its income effect, but by an explanatory beam that is related to the “national identity” of countries. The national identity is a collective product that implied repeated exchanges between different ethnic groups to build people's sense of belonging to the

same nation. Trade, depending on its nature, can foster or deter this national identity (via the institutional/cultural/environmental channels already described).

To verify how trade affects national identities and finally conflicts, we propose a two-step approach. The first stage assesses the importance of the variation of income at the ethnic level against other variations occurring at the national level as a source of conflict. The source of identification is based on the fact that some ethnic group have been partitioned by arbitrary borders while other ethnies have not[57], and thus the "national identity" of these two different ethnic groups are certainly different. Ethnic groups that have been splitting between two different countries have followed different social, cultural, institutional, and even economical path in comparison with non-partitioned ethnic groups. Formally, we regress the likelihood of civil conflicts on national time-varying characteristics (captured with country-year fixed effects), incomes at the ethnic level (that vary over time), ethnic and time fixed effects. The second stage uses the country time varying effects, interpreted as a measure of the "changing national identity", estimated in the first stage and regress its predicted value on the total exports of countries (and a set of time dummies and controls). The idea is that time varying effect obtained in the first step captures all the effects that play on conflicts that are not related to income, such as cultural, environmental or institutional effects. Instrumental variables are used to deal with estimation bias. The main finding is that export significantly reduces conflicts via other channel of diffusion than the income gain.

We are not aware of any work using proxies of income and trade data at ethnic groups' level, or that develops a similar two-stage approach to study civil wars[58]. However this article has been influenced by Gleditsch (2007) and Martin et al. (2008.b). Gleditsch (2007) analyzes trade between neighborhood countries (approximated by a ratio of import on GDP of countries that share a border). He finds that the likelihood of peace is much more higher for countries which are highly trade-integrated with their neighboring countries than for countries with no trade (the risk of conflict is divided by 2). We find the opposite result by going beyond the the pooled model of Gleditsch (2007) by using fixed effects in order to treat the endogeneous bias due to omitted time-

[57] Indeed, in many African countries a significant fraction of the population belongs to ethnic groups that are partitioned among different states, see Michalopoulos and Papaioannou. (2016) for a deep analysis of the long-run consequences of ethnic partitioning in Africa.

[58] This two-stage regression is now a standard method in urban economics to analyze agglomeration economies (Combes, Duranton and Gobillon, 2008) and in labor economics (Abowd et al., 1999).

invariant characteristics, and an IV strategy to account for the fact that regional trade is also a function of conflicts. There are some anecdotal evidences of our result. For instance the Movement of Democratic Forces of Casamance, a violent separatist movement in Senegal, was composed of a partitioned ethny, the Diola, and was supported by the neighboring Guinea-Bissau and Gambia precisely because of the influence of the Diola in these countries (Michalopoulos and Papaioannou, 2016).
Martin et al. (2008b) consider a different dimension of trade, instead of analyzing regional trade, they take into account the total amount of trade (more precisely a ratio of multilateral trade flows on income). They use fixed effects and develop an IV strategy and find a non-linear effect of trade integration on conflicts depending on the intensity of conflicts. For low-intensity civil wars, trade openness increases the probability of a conflict while the reverse holds for high-intensity wars. In comparison with Martin et al. (2008b), we also analyze domestic and regional trade and we propose a two-stage analysis enabling to infer the impact of trade on all specific characteristics of countries that vary over time and that impact on ethnic wars conditioned on incomes.

There is also research that partly overlaps with what we do, yet with very different objectives and with different methodologies. We briefly present these studies in the next section. The rest of the paper is structured as follow. Section 2 and 3 present respectively the empirical strategy and the results concerning the direct impact of the three different types of trade integration on conflicts. Section 4 discusses our two-step approach and presents results concerning the impact of trade on time-varying characteristics of countries (e.g. cultural changes) that affects wars.

II.1 1 Empirical strategy

II.1.1 A brief review of the literature

More than half of the world's nations have been affected by civil wars in the past fifty years[59]. As a result, economists, social and political scientists have made great efforts to better understand the causes of these conflicts. Economic factors such as the ability to

[59] According to Blattman and Miguel (2010) who consider civil war as a conflict that leads to at least twenty five battle deaths per year.

finance a rebellion, political instability and a rich endowment of resources significantly explain civil wars (Fearon and Laitin, 2003; Collier and Hoeffler, 2004; Hegre et al., 2001). Other determinants such as ethnic fragmentation, political grievances, and income inequality are also common causes of these conflicts (Hegre and Sambanis 2006; Laitin 2007; Michalopoulos and Papaioannou, 2016). Finally the effect of international trade, first on income and then on conflict, has been analysed by many authors. A good example is Bazzi and Blattman (2014) who analyze how income affects the risk of political instability using data on export price shocks. Their objective is to study how these shocks, by catastrophically impacting on income, influence conflicts. However, in their own words, "this paper uses trade shocks as an *example*", and quite logically the authors do not dig into the detail of who trade with who or about the different effects of trade as we do here. In comparison, the current study is not interested by income shocks, quite the opposite, our analysis aims to purge the distributional effect of trade on income to analyze whether there is a residual effect precisely due to other factors.

There are finally many case studies analyzing the link between international trade and conflicts. Studying the 1994 genocide in Rwanda that occurred during an economic crisis brought on by the collapse of international coffee prices, Kamola (2007) describes how the production of coffee, implemented by colonizers, driven by an external demand has shaped the economy but also the distribution of power and finally conflicts between Hutu and Tutsi. Still considering the impact of coffee trade, but this time in Columbia, Dube and Vargas (2013) find that the sharp fall in international prices of this good during the 1990s has caused more violence in coffee-producing municipalities than in other municipalities. A reversed relationship has been found for mineral products: a 10 percent increase in the price of oil raises the number of conflict events by 2 percent in Nigeria according to Cali (2015). Similar results have been found for the Democratic Republic of Congo (Maystadt et al. 2014), and for Sub-Saharan Africa (Berman and Couttenier. 2015). Our work differs from these studies according to the data used, the theory tested and the empirical strategy proposed.

II.1.2 International, regional and internal trade at the ethnic group level

In this section we analyze three types of trade, internal trade inside a nation, the regional trade of countries where ethnic groups have been partitioned between nations and the international trade of ethnic groups. As explained in introduction these different type of trade may have a different impact on conflicts due to the nature of goods exchanged, and to the different individuals and ethnies that are involved. As a result it is possible that these exchanges due to their differences affect conflicts differently. There is obviously no data on trade at the ethnic level, which involves important assumptions to approximate these flows. Trade variables come from BACI, a database developed by the CEPII, and are combined with other sources, hereafter described, to measure these three different type of variables.

- The international trade of ethnic groups, ϕ°_{rit}.

International trade data at the subnational level in Africa, and even more, data at the ethnic level are not available; we thus use a weighting strategy based on trade of particular goods: agricultural goods and natural resources. Formally the sum of exports in the agricultural sector, denoted a, and the mining sector, m , are taken into account as follows:

$$\phi^{\circ}_{rit} = \sum_{a=1}^{45} (P_{ria} \times X_{ita}) + \sum_{m=1}^{48} (P_{rim} \times X_{itm}) \tag{19}$$

X_{itk} represents country i exportation at year t for a good in sector $k = a, m$; indice a designs the agricultural goods and indice m the mining goods. The weight P_{ria} is the ratio of the ethnic group production of a good in the agriculture sector on it national output, such as $P_{ria} = \frac{E_{ria}}{E_{ia}}$ where E_{ria} is the sum of the mean production of crop a by the ethnic group r (in country i) over the period 1997-2003, and E_{ia} is the sum of the mean production of crop a in country i over the same period.

As for agricultural products, after identifying natural resources location toward Africa, we construct ethnic weight of every resource product as $P_{rim} = \frac{S_{rim}}{\sum_g S_{gim}}$, where S_{rim} is the

area (surface) of the ethnic group where the mine m is localized and S_{gim} represents the surface of each of the ethnic groups g in the country i that exploits this resources m.

It is noteworthy to note that, we focus on exportation of agricultural goods and mineral products because these two sectors represent an important share of exportation in Africa.

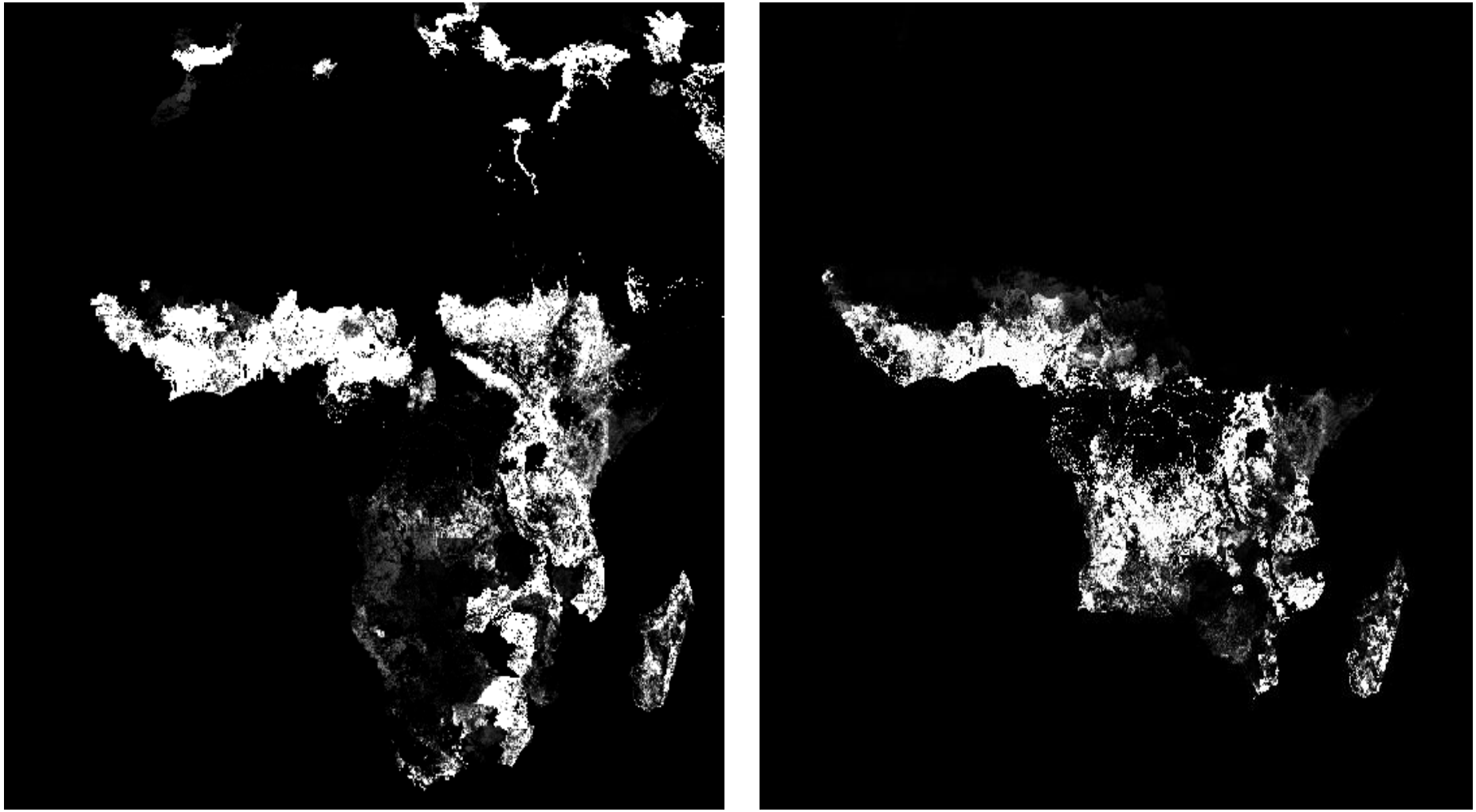
Since the weighting scheme is based on the production of agricultural and mineral goods at the ethnic group's level, we have to geolocate these productions and then to match them with the geographical boundary of ethnic groups.

Concerning the agricultural sector, we rely on geographical global data set (raster) of croplands on a 5 minute by 5 minute (10 km by 10 km) latitude/longitude grid extracted from EarthStat[60] that provides information on land use concerning "Harvested Area and Yield" (see Monfreda et al., 2008). This database contains raster on 175[61] agricultural products with four raters per crop comprising pixels of 10 times 10 square kilometers over the period 1997-2003. As a result, we have information on (i) the average proportion harvested for a given agricultural product; (ii) the average number of hectares harvested per pixel; (iii) the total production of the crops in tons over each pixel; and (iv) the quality of the data according to their sources. We mainly use raster about the production of crops (in tons) in order to account for that some agricultural products are harvested more than once a year. Figure 5 shows the coverage of cotton and cassava in Africa. The more a pixel is bright, the higher the production within the area covered.

[60] http://www.earthstat.org/

[61] It should be noticed that upstream work has been done to match the products name from EarthStat with those from Baci. At the end of this exercise, 47 raster out of the 175 in EarthStat were retained.

Figure 5: Crops production imagery: cotton and cassava



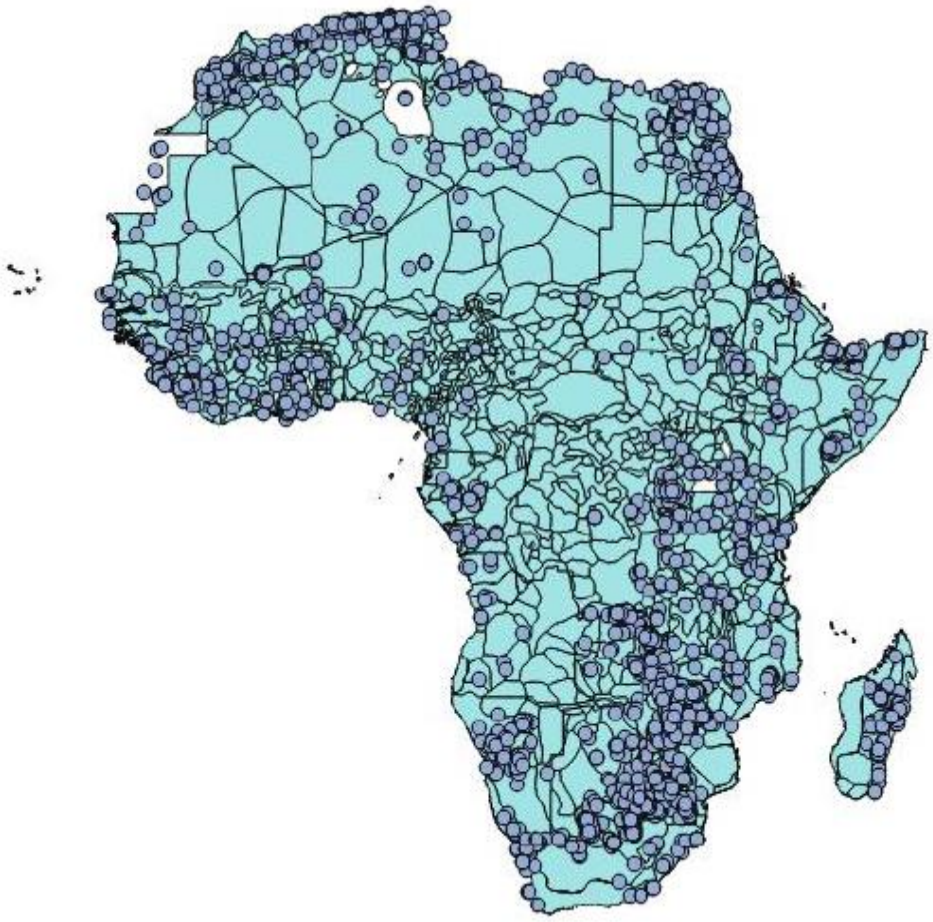
Source: Authors with Rasters from EARTHSTAT

These data are then merged with the spatial coverage of ethnic group reported by Murdock (1959) and digitized by Nathan Nunn[62]. Finally we calculate the production within each ethnic groups area for the different crops identified (48 different crops), which gives E_{ria}. Once divided by the national production E_{ia}, we get our weight of the national export P_{ria}.

Concerning mining resources, we use the U.S. Geological Survey[63] enabling to locate mining resources toward Africa. This survey provides data on the spatial location of a large panel of mineral resources all around the world (Mineral Resources Data System / MRDS) with the name of the deposit, the deposit description, the geological features, the data source and references[64]. Then, we merge the Murdock (1959) map of ethnographic regions shape file, with countries boundaries[65] and finally with the resources locations shapefile in order to identify in which ethnic group and country the natural resources are located in order to get S_{gim}, P_{rim} and ϕ^{o}_{ritm}. Figure 5 illustrates the result of this computation.

[62] https://worldmap.harvard.edu/data/geonode:murdock_ea_2010_3
[63] https://mrdata.usgs.gov/mrds/
[64] https://mrdata.usgs.gov/mrds/package.php
[65] ESRI Shape file format: http://www.maplibrary.org/library/stacks/Africa/index.htm

Figure 6: Mineral resources location in Africa at the Ethnic/country level



Source: Author's map based on Murdock (1959) and the Mineral Resources Data System.

- The regional trade of countries where ethnic groups have been partitioned between nations, ϕ_{it}^{Split}.

We compute the sum of bilateral exports of countries that share at least one ethnic group:

$$\phi_{it}^{Split} = \sum_{j} X_{ijt} \tag{20}$$

where X_{ijt} represents time varying trade between two countries i and j that shares at least one ethnic group. We consider neighboring trade because the likelihood of civil wars for countries where ethnic groups have been partitioned seems strong (Michapoulos and Papaioannou, 2016). We argue that, on top of the ancestral ties between people, the intensification of trade with peers across borders may deter the

relations with the other ethnic groups from the same country. In other words, the ethnic network or the strength of ethnic ties may affect the dependence with other ethnic groups inside their country. To identify countries that share the same ethnic groups, we use the database of Michapoulos and Papaioannou (2016) where an ethnic group is considered as partitioned when at least 5 percent of its ancestral area belongs to more than one country.

- The local trade of ethnic groups, ϕ_{it}.

Internal flows come from EORA Database Input-Output Tables[66]. This database contains the Input-Output tables for 195 countries and allows computing an indicator of internal trade (the sum of the final demand and trade between sectors). This indicator is often used in international economics to measure the internal trade of nations.

II.1.3 Estimation

For each type of trade we estimate the following equation:

$$\Pr(War_{rit}) = \gamma_0 + \gamma_1 \begin{cases} \phi_{it} \\ \phi_{it}^{Split} \\ \phi_{rit}^{\circ} \end{cases} + \gamma_2 Y_{rit} + \gamma_2 E_{rit} + Z_{it} + f_r + f_i + f_t + \varepsilon_{rit} \quad (21)$$

where the probability of war, (War_{rit}), is approximated by the onset of a new ethnic civil war and comes from the Ethnic Power Relation (EPR) database compiled by Wimmer et al. (2009). It is a binary variable taking one when an ethnic group is engaged in a new ethnic war in a given year and zero otherwise. These data disentangle pure civil war from ethnic war[67] based on PRIO/UCDP conflicts database.

[66] Data can be download at https://worldmrio.com/countrywise/

[67] More precisely, Wimmer, Cederman and Min (2009) define ethnic wars as follows: "we distinguish between ethnic and nonethnic conflicts using the aims of the armed organization and their recruitment and alliance structures (...)We identify as "ethnic" the aims of achieving ethnonational self-determination, a more favorable ethnic balance-of-power in government, ethnoregional autonomy, the end of ethnic and racial discrimination, language and other cultural rights, and so forth. In ethnic wars, armed organizations

We measure the income of an ethnic homeland r in country i at time, Y_{rit}, by exploiting night light pictures provided by satellites. These data are useful to approximate income particularly in developing countries because these latter often lack of reliable data at sub and/or supranational level (Henderson et al., 2012). In order to get night lights intensity at ethnic group level, we use ESRI African countries shapefile that we merge with Murdock (1959) ethnic group's boundaries shapefile. Night lights raster come from the National Oceanic and Atmospheric Administration (NOAA) and are available from 1992 to 2013. A raster contain pixels of approximately one kilometer square. Every pixel is associated to a number that goes from 0 to 63 indicating the brightness of the light. These raster are matched with the shapefile (Murdock, 1959) obtained earlier and the mean night lights density is computed within each ethnic group-country boundaries for every year. Since satellite pictures do not distinguish gaze flaring activities from real lights, we exclude the corresponding spatial areas.

The ethnic-country-year controls E_{rit} characterizes ethnic groups that are excluded from the central government[68]. This variable is equal to 1 when the ethnic group is excluded from the central government and 0 otherwise.

Z_{it} is a vector of country level variables that account for country-year specific effects, we use two variables: GDP growth (source: World Bank WDI), an indicator of democracy (source: Policy-IV project, variable: *Polity2*).

Finally f_r denotes time invariant ethnic characteristics or ethnic fixed effects, f_t allowed to get rid of time specific shocks that can drive the relation between ethnic wars and the interest variables, f_i control for countries characteristic that are invariant in time. Instead of relying on contemporaneous variables at the right-hand side of our specification, we use their lags by one year to alleviate endogeneity issues. However, this concern still persists since we should not probably account for unobservable and/or observable time-varying indicators that may also drive the relationship at issue. For the sake of this respondent, we rely on instrumental variables approach by providing and discussing instruments for each of the endogenous variables, in the previous sections.

---

also recruit fighters predominantly among their leaders' ethnic group and forge alliances on the basis of ethnic similarity".

[68] See EPR (https://icr.ethz.ch/data/epr/) for more details.

Concerning the estimator, the use of a logit model augmented with ethnic fixed-effects leads to a loss of a significant number of observations (Martin et al. 2008a, Martin et al. 2008b). To avoid this loss of data, we can compute a time-demean transformation of each variable within each unique ethnic group-country combination[69], and apply an ordinary least square (OLS) estimator on these transformations. This procedure corresponds exactly to a within Fixed-Effects estimation with a Frich-Waugh transformation method. In our context, this equates to a linear probability model by using the within regression estimator. However, we rely on this logit model to assess the effect of ethnic groups' time invariant characteristics on the probability of ethnic conflicts (Table II-5 in Appendix A)

II.2 1 Results about the effects of trade on conflicts

II.2.1 Trade and conflicts without income effect

We successively estimate Equation (21) by using our indicator of international, ethnic-regional and internal trade. Whatever the indicator considered, the inclusion of time-varying variables (Polity and GDP growth) does not affect results. We find that international trade as well as internal trade fosters peace between ethnic groups. It is noteworthy that we control here for income at the ethnic level, thus this result leaves room to consider that trade have peaceful effects that may be related to other channels.

[69] A time-demean transformation of a variable X_{rit}, denoted ΔX_{rit}, is given by $\Delta X_{rit} = X_{rit} - \overline{X_{ri}}$ where $\overline{X_{ri}}$ is the mean of the variable X_{rit} over time of each ethnic group in every country. This transformation allows absorbing the fixed-effects.

Table II-1: International Trade effect on ethnic wars onset

	(1)	(2)	(3)	(4)	(5)	(6)
	International trade		Regional trade		Internal trade	
	FE	**FE**	**FE**	**FE**	**FE**	**FE**
Trade (ϕ_{it}, ϕ_{it}^{Split}, ϕ_{rit}°)	-0.0013	-0.0012	-0.0000	0.0004	-0.0049	-0.0058
	(0.0005)[b]	(0.0005)[b]	(0.0007)	(0.0009)	(0.0021)[b]	(0.0022)[a]
Rest of Trade			0.0022	0.0019		
			(0.0017)	(0.0017)		
Income (Y_{rit})	-0.0042	-0.0040	-0.0044	-0.0040	-0.0036	-0.0031
	(0.0021)[b]	(0.0021)[c]	(0.0021)[b]	(0.0021)[c]	(0.0020)[c]	(0.0020)
Excluded ethnic groups	0.0079	0.0095	0.0065	0.0092	0.0044	0.0082
	(0.0032)[b]	(0.0036)[a]	(0.0033)[c]	(0.0039)[b]	(0.0026)[c]	(0.0032)[b]
Polity2		0.0004		0.0006		0.0008
		(0.0003)		(0.0004)		(0.0003)[a]
GDPgrowth		0.0002		0.0004		0.0005
		(0.0001)[a]		(0.0002)[b]		(0.0002)[a]
Constant	-0.0093	-0.0082	-0.0263	-0.0236	0.1006	0.1233
	(0.0080)	(0.0079)	(0.0127)[b]	(0.0127)[c]	(0.0487)[b]	(0.0507)[b]
Observations	5,57	5,57	5,554	5,554	5,586	5,586
R-squared	0.018	0.018	0.015	0.017	0.013	0.016
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Ethnic Group-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is a binary variable taking 1 when an ethnic group is engaged in a new ethnic war in a given year. All explanatory variables are lagged by one year. Trade designs respectively International trade, Internal trade and Regional trade. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]) ([b]) ([c]) denote significance at the 1, 5 and 10 percent level respectively.

A conflict may be costly in various ways for ethnic groups since insecurity and the destruction of trade facilities may compromise the shipping of products and/or the functioning of the exchange platforms (such as markets places, exports platforms, etc.). Even if we conjecture that the use of one year lag of the interest variables is enough to tackle the reverse causality issue, the endogenous bias due to uncontrolled confounding variables issue may still keep doubt on the reliability of the results in Table II-1. We therefore rely on instrumental variables (IV) strategy to overcome this issue.

- International trade

To correct the endogeneity of international trade at the ethnic group, we rely on weather conditions (temperature) as a source of discretionary variation of ethnic trade.

Good weather conditions are reliable instruments in our case because a large part of the African population depends on agriculture activities and since 95% of cultivated land in Africa is not irrigated[70], weather matters. We compute an indicator of temperature at ethnic level, with the CHELSA[71] dataset that provides high spatial resolution of mean, maximum and minimum temperatures and mean precipitation for the Earth's land surface, for the years 1979 to 2013. A good weather in terms of temperature may provide favorable conditions for agricultural exploitation. As shown in Table II-6, moderate temperature fosters trade, while higher level temperature negatively affects the international trade of ethnic groups. We thus use these instruments to run the IV regressions. As a result, the coefficient on international trade is still significant and negative[72] , more foreign trade reduces the risk of escalating into war (Table II-2, Column 1 and 2).

The exclusion restriction condition behind our IV estimation is that weather conditions, particularly temperature in our case, can affect the probability of ethnic conflicts only through trade. This argument is supported by Burke et al. (2015) who prove that climate conditions do not drive conflicts alone[73]. Nevertheless, researches in the field of psychology state that hot temperature can stimulate violence behavior by directly affecting feelings of hostility that can lead to aggressive thoughts (see Anderson, 2001). Accounting for this argument should lead to a violation of the exclusion restriction condition: hot temperature can drive violence and in turn may be positively correlated to ethnic groups likelihood to conflicts. In such a case, we can infer that our estimated coefficient is biased upward, and since our estimated coefficient is negative, the real causal effect should bound to be negative also.

- Regional Trade

[70] https://www.worldbank.org/en/programs/cooperation-in-international-waters-in-africa
[71] Climatologies at High resolution for the Earth's Land Surface Areas
[72] We provide robustness check to this finding by also capturing trade with the total exports at country level. Actually, we estimate the same relationship by using the country total exports to gauge if results from our constructed ethnic exports data still hold. We keep using the same instrument (ethnic level temperature) for trade to make results comparable. As we expected, the results confirm that international trade is a peace promote. Actually, the IV regression leads to a coefficient of -0.0342 significant at 10%.
[73] https://www.annualreviews.org/doi/pdf/10.1146/annurev-economics-080614-115430

Regarding regional trade, we deal with the endogeneity issue by using a variable of remoteness (Rem_{it}) widely used in the literature of trade (Baier et Bergstrand, 2004, Martin et al., 2008a,b, Candau and Dienesch, 2015) . We restrict here the panel of partners j to countries that share at least one ethnic group with country i. Then, the remoteness instrument for the regional trade in this case is:

$$Rem_{it} = -ln\left(\sum_{j\neq i}^{R} \frac{GDP_{jt}}{d_{ij}}\right) \quad (22)$$

where R is a set of partners with which country i share at least an ethnic group.

This indicator is a good candidate to explain trade because it contains two important factors of a gravity equation, distance with partners and theirs GDPs, that explain the lion share of the variation in bilateral trade. A country with low remoteness has more alternative sources of exports and is therefore more open to trade. In the regression, we also control for trade with the rest of countries that do not share an ethnic group with country i (is different from countries in R), called in the different tables "Rest of Trade".

We find in Table (Table II-2, Column 3 and 4) a new result; ethnic/regional trade fosters wars. In Appendix D we lead a robustness check by modifying our indicator of regional trade by using imports (instead of export) from partners with which country i shares an ethnic group. We also follow Gleditsch (2007) by building an indicator of regional trade using imports from partners with which country i shares a border. Similar results are obtained whatever the indicator used (see Appendix D). These results contrast with the seminal result of Gleditsch (2007) who find that the risk of conflict is divided by two when countries are highly trade-integrated with their neighboring partners.

- Internal Trade

The results with internal trade are also not immune to endogeneity problems. Actually, ethnic war can disrupts trade by affecting trade facilities and by corroding trust between communities. As for international trade, we rely on the weather conditions to predict country production on which our indicator of internal trade is built. The precipitation data comes from the precipitation raster of CHELSA. In addition to this instrument, we

also consider the three years lag of internal flows as a source of it contemporaneous variation in Column 6. The results from the first stage regressions are presented in Table II-9. The findings from the second-stage IV regressions reveal that internal trade unambiguously promotes peace; however, this integration has less impact on ethnic conflicts than the international ethnic trade integration effect (see Table II-2, column 5 & 6).

Table II-2: International Trade effect on ethnic wars onset

	(1)	(2)	(3)	(4)	(5)	(6)
	International trade		Regional trade		Internal trade	
	IV	**IV**	**IV**	**IV**	**IV**	**IV**
Trade (ϕ_{it}, ϕ_{it}^{Split}, ϕ_{rit}°)	-0.1170	-0.1185	0.0165	0.0266	-0.0065	-0.0082
	(0.0610)[c]	(0.0576)[b]	(0.0060)[a]	(0.0096)[a]	(0.0031)[b]	(0.0035)[b]
Rest of Trade			-0.0031	-0.0063		
			(0.0025)	(0.0034)[c]		
Income (Y_{rit})	-0.0044	-0.0044	-0.0048	-0.0029	-0.0015	-0.0007
	(0.0021)[b]	(0.0021)[b]	(0.0022)[b]	(0.0021)	(0.0022)	(0.0020)
Excluded ethnic groups	0.0087	0.0092	-0.0054	0.0053	-0.0023	0.0028
	(0.0032)[a]	(0.0036)[b]	(0.0045)	(0.0034)	(0.0023)	(0.0028)
Polity2		0.0001		0.0043		0.0013
		(0.0003)		(0.0016)[a]		(0.0005)[a]
GDP growth		0.0001		0.0003		0.0003
		(0.0001)		(0.0002)[c]		(0.0001)[b]
Constant	0.0622	0.0626	-0.0315	-0.0211	0.1532	0.1900
	(0.0394)	(0.0373)[c]	(0.0132)[b]	(0.0127)[c]	(0.0743)[b]	(0.0810)[b]
Observations	5,57	5,57	5,528	5,528	4,202	4,202
R-squared	0.017	0.018	0.018	0.020	0.012	0.016
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Ethnic Group-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is a binary variable taking 1 when an ethnic group is engaged in a new ethnic war in a given year. All explanatory variables are lagged by one year. Trade designs respectively International trade, Internal trade and Regional trade. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]) ([b]) ([c]) denote significance at the 1, 5 and 10 percent level respectively.

II.3 Inference from a two-step strategy

II.3.1 Empirical strategy

The previous analysis aims at using commonly and widely known strategy to identify the effect of trade on war. But at least three caveats can be formulated.

Firstly, the measurement of ethnic trade potentially suffers of errors that may bias the analysis. Secondly, by merging aggregate data (country level variables) to micro observations (ethnic groups) we make a strong assumption of independent disturbances which may be not verified for data with grouped structure (Moulton, 1990). This is particularly the case of estimates concerning regional and internal trade, which are country-level variables. In that case, OLS standard errors can be biased downward leading the aggregated variables to be artificially significant. Furthermore single-stage estimation is problematic because we mislead country shocks affecting conflicts with idiosyncratic risk, e.g. a particular type of ethnic groups has an endemic risk of conflict not totally controlled due to missing variables.

Thirdly, our specification suffers of various problems. To make them clear, let's rewrite the Equation (23) in its simplest form by dropping the time dimension, all the variables of control and by focusing on international trade as follows:

$$Pr(war_{ri}) = \gamma_0 + \gamma_1 \overset{\circ}{\phi}_{rit} + f_r + f_i + \varepsilon_{ri} \tag{23}$$

An unbiased estimate for γ_1 is obtained under the following assumption:

$$Cov\left(\overset{\circ}{\phi}_{ri}, f_r + f_i + \varepsilon_{ri}\right) = Cov\left(\overset{\circ}{\phi}_{rit}, f_i\right) + Cov\left(\overset{\circ}{\phi}_{rit}, f_r\right) + Cov(\overset{\circ}{\phi}_{rit}, \varepsilon_{ri})=0 \tag{24}$$

When the covariance in the left hand side of this equation differs from zero, any of the three covariances on the right hand side is a source of bias. Since this equation is the workhorse model in economics and in political sciences when analyzing conflicts, we propose to discuss these covariances successively.

Concerning the first term $Cov\left(\overset{\circ}{\phi}_{ri}, f_i\right)$, there are many reasons to consider that the time-varying trade integration of ethnic groups depend on invariant country characteristics. For instance the level of development (industrialized or not) and the technology used often characterizes a country, and are crucial determinants of trade. For instance to capture comparative advantage, Costinot (2009) used country (and product) fixed effects. Furthermore many political and economic institutions are country-specific and influence the trade integration of nations. For instance, the concept of forced trade that we define in the introduction clearly evolves in an institutional framework that depends on the long run history of nations, it is thus quite naïve to consider that the covariance between $\overset{\circ}{\phi}_{rit}$ and f_i is null.

The second term $Cov(\overset{\circ}{\phi}_{ri}, f_r)$ is interesting to discuss using the theory of factor endowments (Heckscher, Ohlin and Samuelson) and of the resource curse theory (Corden and Neary, 1982) from the point of view of regional economics. When a resource, valuable on the international market, is discovered in one region, often in one ethnies, the wage and price increase in this sector are spreading throughout the whole economy, including in sectors with no productivity gains which generate a loss of competitiveness[74]. Consequently the industrial and agricultural sectors that are owned by other ethnic groups are in difficulties (ask for fiscal redistribution, which in reaction fosters the desire of independence of the exporting resource ethnic group, and this situation sometimes degenerates into conflicts) which affects their export. To sum up, the factor endowment of ethnic group, f_r, being a natural resources or not, is highly correlated with the trade exchange of this ethnic group $\overset{\circ}{\phi}_{ri}$.

The third term $Cov(\overset{\circ}{\phi}_{rit}, \varepsilon_{ri})$ is the classical origin of an endogeneous bias. While in the previous section, we have devoted significant effort to address this last issue, the first two points remain problematic. We thus propose a two stages estimation approach[75] that resolves partially these problems. The first stage is an estimation of the probability of wars on income (Y_{rit}), on country-year effects ($f_i \times f_t$), ethnic group's fixed effects (f_r) such as:

$$Pr(war_{rit}) = \gamma_1 Y_{rit} + f_i \times f_t + f_r + \varepsilon_{rit} \tag{25}$$

The estimation of the country-year fixed effects ($\widehat{f_i \times f_t}$) is interpreted as the change in national identities that influences conflicts after controlling for observed (Y_{rit})[76] and unobserved (f_r) ethnic characteristics.

[74] See Corden and Neary (1982). We are particularly grateful to Peter Neary to have discussed with us the implication of "booming sector and de-industrialization" at the regional scale.

[75] As a robustness check of the analysis in the first section, we could have followed Berman and Couttenier (2015) by using a specification at country level as in Bazzi and Blattman (2014); where the dependent variable is a dummy that equals 1 if at least one ethnic conflict event was recorded during year t in country i. Nevertheless, this will not allow us to account for ethnic group level income; in fact studying the effect of trade on conflicts beyond the ethnic groups' income effect is one of the essential points of this study.

[76] Income can also be endogenously determined by conflicts. Here, we still present results with a lag of one year to reduce this problem; similar results with different lag are also obtained (not reported but available on request).

Thus this method allows exploiting the fact that there are two kinds of ethnic groups, some that belong exclusively to one country and those that are shared by at least two countries[77]. The former dimension helps to identify changes over time within countries, while the latter provides the identification that accounts for differences between countries over time. The identification of differences in term of wars between countries comes from the ethnic groups that have been partitioned. Indeed as shown by Michalopoulos and Papaioannou (2016), these ethnies share the same characteristics that we control for with ethnic fixed effects f r , then everything that varies for these partitioned ethnic groups inevitably comes from the national context and then measured by the country-year fixed effects ($\widehat{f_i \times f_t}$).

Finally this approach by differentiating ethnic effects from country trends, resolves the problem of $Cov\left(\phi_{ri}^{\circ}, f_i\right) \neq 0$ (as the next stage will make clear).

In the second step, we analyze how trade, now measured at the country i and time t level, can explain change in national identities ($\widehat{f_i \times f_t}$) that affects conflicts:

(26)

$$\widehat{f_i \times f_t} = \gamma_1 \begin{cases} \phi_{it} \\ \phi_{it}^{Split} \\ \phi_{rit}^{\circ} \end{cases} + Z_{it} + f_t + \varepsilon_{it}$$

These equations allow capturing how trade, by affecting change in the national identity $f_i \times f_t$, explains civil conflicts. In other words, we assess here the extent to which, the three kind of trade drive the country-year endemic propensity to ethnic war. Since these changes are not related to the income changes of ethnic groups, our second stage enables to assess the effect of trade on non-monetary variables. As briefly discussed in the introduction, $f_i \times f_t$ may be interpreted as the "national identity" of a country on which globalization has various effects. The process of cultural

[77] This strategy is used in urban economics to identify the source of agglomeration economies at the urban level (Combes et al 2008). Wages are explained by city-time effects (here nation-time) and individual fixed effect (here ethnic groups fixed effects) to control for characteristics such as the human capital of individuals. Then in a second stage, the predicted value of city-time effects are regressed on the city density (here national exports).

homogenization can help to relativize differences between ethnic groups and/or can be an opportunity to build a new culture by hybridization[78].

In that case, globalization has peaceful effects[79]. Obviously, trade can have effect on $f_i \times f_t$ that are unrelated to culture. The resource curse is a well-known example. Extraction of highly profitable resources sold on the world market can foster bad governance. In turn, institutional change with its share of injustice is a fertile ground for conflicts. Maybe less known, the relocation of polluting firms in developing countries are often the cause of a reduction/delay in the restrictiveness of environmental law at the national level (see Candau and Dienesch, 2017), and this may lead to a destruction of the local environment of some ethnic groups. Since these pollution haven are clearly motivated by international trade, the coefficient γ_1 also capture these kinds of effect.

II.3.2 Results

Table II-3 presents the first stage results from the estimation of Equation (26). In Column (1), we consider only ethnic group's level of income as explanatory variables. Column (2) performs the same regression as Column (1) by accounting for some of the country level time-varying and observable characteristics. In Column (3) we consider the full set of country level-time varying particularities by introducing the country-year fixed-effects.

The main finding in this table is that the income growth of ethnic groups reduces the risk of ethnic conflict even if we control for the full set of country year covariates. This result confirms at the local level what has been analyzed until now at the national one in the literature. It is noteworthy to observe the significant change in the R-squared from the first to the third column. Indeed, even if the first column shows that there is a correlation between wars and income, this latter alone seems to be a poor predictor of

[78] Rauch and Trindade (2009) provide a theoretical foundation to analyze the creation of cultural goods by hybridization. They find that globalization is detrimental because the destruction of local cultures reduces the possibility of hybridization and generates a cultural blowback. On the contrary to Cowen (2002) view of globalization as a positive process of creative destruction. Caplan and Cowen (2004) defends that no great culture has risen in isolation. The fear that globalization builds up a culture of the least common denominator, has been modeled by Francois and van Ypersele (2002) who analyzes the pro and cons of the dumbing down argument.

[79] After all in Europe, the reunification of Germany has been a success in part thanks to its export performance at the world level.

wars. The introduction of the full set of country-year covariates in Table II-3, Column (3), improves the goodness-of-fit measure of our regression. This confirms that country level time varying characteristics are important and need to be account for when explaining ethnic wars.

Table II-3: First stage regression

Dep var: Ethnic war (war_{rit})	(1)	(2)	(3)
Log Income	-0.0043	-0.0040	-0.0037
	(0.0019)[b]	(0.0019)[b]	(0.0022)[c]
Polity2		0.0004	
		(0.0002)[c]	
GDP growth		0.0005	
		(0.0002)[a]	
Constant	-0.0133	-0.0115	-0.0037
	(0.0070)[c]	(0.0069)[c]	(0.0022)[c]
Observations	6,348	6,348	6,348
R-squared	0.011	0.013	0.260
Ethnic Group-Country FE	Yes	Yes	Yes
Year FE	No	No	No
Country × Year FE ($f_i \times f_t$)	No	No	Yes

Notes: The dependent variable is a binary variable taking 1 when an ethnic group is engaged in a new ethnic war in a given year. All explanatory variables are lagged by one year. Column 1 and 2 are estimated without taking into account country-year characteristics. Column 3 accounts for both year FE and country-year effects. Results look exactly the same when we do not introduce year FE in column 3. The predicted country-year FE are extracted from this latter regression. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively.

Table II-4 presents the second stage of our analysis, by showing the results of the effect of our three kinds of trade on countries time-varying determinant of the risk of ethnic conflicts. The results in Columns (1), (2), (4), (5), (7) and (8) are first analyses and do not account for the endogeneity issues.. On the one hand, these results show that, both international ethnic trade and local trade are negatively associated to the probability of a country to experience an ethnic war. On the second hand, the coefficients on regional trade are not significant, while that of the internal trade, albeit negative, is not significantly robust (only weakly significant in Column 8).

Since reverse causality is likely, we need to find valid instruments to address this endogeneity issue of our three variables of interest.

Concerning international trade, we resolve the endogeneity issue by considering the remoteness variable as described previously (with some minor changes: since we now consider total trade, the sum in Equation (22) is done on all the trade partners of country *i* all around the world). In a similar way, the endogeneity issue concerning regional trade is solved by relying on the regional remoteness instrument proposed in Equation (22). Finally, to deal with the endogeneity bias on internal trade we use the weather conditions (precipitations, also drawn from raster of CHELSA) at the country level, and the two years lag of the internal flows. Here, we account for the level of interaction between people within countries, by using their population density as a control variable.

The first stage estimations for the IV results in column (3), (6) and (9) of Table II-4 are presented respectively in column (1), (2) and (3) of Table Table II-10 (Appendix F). The results on total trade are close to that obtained in the first section (see Table II-2, column 1 and 2). On the contrary, the effects of regional and internal trade on the probability of countries risk of ethnic conflicts are not significant.

Table II-4: Second stage regression: Country fixed effects regression

Dep var : $f_i \times f_t$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	International trade			Regional trade			Local trade		
Trade (ϕ_{it}, ϕ_{it}^{Split}, ϕ_{rit}°)	-0.0052	-0.0053	-0.0087	-0.0014	-0.0013	0.0010	-0.0035	-0.0032	-0.0023
	(0.0021)[b]	(0.0021)[b]	(0.0046)[c]	(0.0016)	(0.0015)	(0.0011)	(0.0021)	(0.0019)[c]	(0.0014)
Rest of Trade				-0.0030	-0.0034	-0.0047			
				(0.0018)[c]	(0.0022	(0.0029)			
Polity2		-0.0008	-0.0008		-0.0003	-0.0003		-0.0005	-0.0006
		(0.0005)	(0.0006)		(0.0006)	(0.0006)		(0.0005)	(0.0005)
GDP growth		0.0005	0.0008		0.0004	0.0004		0.0005	0.0009
		(0.0004)	(0.0004)[c]		(0.0004)	(0.0004)		(0.0004)	(0.0004)[b]
Density								-0.0004	0.0014
								(0.0030)	(0.0027)
Constant	0.0242	0.0239	0.0402	0.0171	0.0181	0.0202	0.0781	0.0733	0.0458
	(0.0107)[b]	(0.0096)[b]	(0.0220)[c]	(0.0112)	(0.0123)	(0.0141)	(0.0473)	(0.0437)	(0.0291)
Estimator	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV
Observations	569	569	480	421	421	418	536	536	445
R-squared	0.070	0.080	0.051	0.069	0.078	0.070	0.057	0.064	0.072
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This Table presents the results from the second step (Equation (26)). All explanatory variables are lagged by one year. Trade designs respectively International trade, Internal trade and Regional trade. Predicted values of time-varying country effects are used as dependent variables and come from Column 3 of Table II-3. Robust standard errors clustered at "Country" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively.

This two-step analysis helps us to better distinguish the effect of trade on income to other effects. While the one-step approach presented in the first section supports the thesis that both internal and international trade have a peaceful effect, the current analysis relativize the role of internal and regional trade. Only international trade integration has a robust significant negative effect on ethnic conflicts. Consequently at the end of this careful analysis, we consider that only the effect of international trade integration effect has the potential to shape national identities and to reduce the risk of ethnic wars.

Conclusion

The beneficial impact of international trade on peace is an old idea that has been at the heart and soul of many trade agreements in Europe, in Latin America and in Africa. Integration in the world economy has been conceived as a way that promotes peace. The contribution of this paper is to propose different measures and methodologies to precisely analyze the geographical impact of trade on conflicts. More precisely we build indicators of international, regional and internal trade and assess their effects on conflicts at the level of ethnic groups. We propose original empirical strategies, among which a two stages analysis enabling to separate the income effect to other effects of trade.

We find that international trade clearly favors peace while internal and regional trades seem less significant. To the famous quotation of Arrow (1972), that “virtually every commercial transaction has within itself an element of trust”, we reverse the causality and guess that the performance on the world market fosters mutual confidence, cooperation and good institutions inside nations that reduce the likelihood of ethnic conflicts.

II.4 Appendices

II.4.1 Appendix A: First resuts

We also test the effect of some ethnic group's controls that are time invariant on the probability of ethnic war when ethnic trade and ethnic income are controlled for (See Table II-5). We then consider: dummy variable taking 1 in case of the presence of a major lake/river (source: Michapoulos and Papaioannou, 2016), a variable indicating the distance from the sea, a dummy variable taking 1 when an on-shore oil field and gas deposit is in the historical homeland of an ethny (called *petroleum*, source: the Petroleum Dataset v.1.1); a geographical variable such as the Log of ethnic groups' homeland surface(*lnkm2split*, source: Global Mapping International/Colorado Springs), a binary variable taking 1 when a city with a population larger than 20 000 in 1400 was in the historical homeland (called *city1400*, Chandler, 1987); a variable indicating the ethnic group population in the 1960s.

Table II-5: Results from naïve regressions

	(1)	(2)	(3)
	International trade	Internal trade	Regional trade
	Logit	Logit	Logit
Trade	-0.0635	-0.0878	-0.3391
	(0.0617)	(0.0748)	(0.1385)[b]
Income	-0.4210	-0.4869	-0.4938
	(0.1290)[a]	(0.1223)[a]	(0.1238)[a]
Excluded ethnic group	1.4729	0.9372	1.2706
	(0.5725)[b]	(0.4531)[b]	(0.5080)[b]
River	-0.3031	-0.5979	-1.3582
	(0.5254)	(0.5182)	(0.5673)[b]
Distance from sea	1.3573	1.6835	0.7867
	(0.8606)	(0.8439)[b]	(0.8036)
Petroleum	-0.1082	-0.1282	-0.1960
	(0.4913)	(0.4824)	(0.7837)
Land surface	0.3462	0.2283	0.1439
	(0.2007)[c]	(0.1865)	(0.1852)
City1400	0.4730	0.5509	0.6393
	(0.6334)	(0.5981)	(0.6321)
Population1960	0.2195	0.0447	0.0160
	(0.1915)	(0.1149)	(0.1342)
Constant	-12.7101	-10.4668	-1.2566
	(2.7066)[a]	(1.9478)[a]	(3.7211)
Observations	5,566	5,496	5,582
Pseudo R-squared	0.2753	0.2424	0.2707

Notes: The dependent variable is a binary variable taking 1 when an ethnic group is engaged in a new ethnic war in a given year and 0 otherwise. All the time varying explanatory variables are lagged by one year. Trade designs respectively International trade, Internal trade and Regional trade. Robust standard errors clustered at the "Country pair" level reported in parentheses. ([a]) ([b]) ([c]) denote significance at the 1, 5 and 10 percent level respectively.

II.4.2 Appendix B: First-stage IV estimates, explaining ethnic groups' international trade

The following tables present the first stage regressions used in Table II-2, column (1) and (2). It shows a strong and positive relation between temperature and ethnic groups' international trade. We can also use the mean temperature (($Max_Temperature + Min_Temperature$) /2) at the ethnic groups' level as instrument, but this measure seems less relevant. For instance, a very high level of temperature recorded during a relatively temperate period can bias the average temperature during that period and conversely. In the meantime, a very high level of temperature during a given period is sufficient to dammage (or negatively affect) the growth of agricultural crops, particularly in Africa where agricultural technologies (ex: greenhouse cultivation, irrigation practices) are less available. As a consequence, we think that it is more meaningful to using both the minimum and maximum temperature variables that we have constructed from the rasters proposed by CHELSA.

Table II-6: IV first stage regressions: explaining ethnic groups' international trade

	International trade	
	(1)	(2)
Min Temperature	3.3024	3.4202
	(0.6394)[a]	(0.6509)[a]
Max Temperature	-1.1613	-1.3089
	(0.4469)[a]	(0.4566)[a]
Ethnic group Income	-0.0019	-0.0034
	(0.0051)	(0.0051)
Excluded ethnic group	0.0094	-0.0020
	(0.0193)	(0.0202)
Polity2		-0.0029
		(0.0008)[a]
GDP growth		-0.0007
		(0.0004)[c]
Constant	-16.3772	-16.1294
	(4.7937)[a]	(4.6871)[a]
Observations	5,57	5,57
R-squared	0.165	0.168
F-Test	26.68	13.87
Year FE	Yes	Yes
Ethnic Group--Country FE	Yes	Yes

Notes: This table presents the first stage regressions results concerning the IV estimations in column 1 and 2 of Table II-2. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]) ([b]) ([c]) denote significance at the 1, 5 and 10 percent level respectively. We present the F-tests statistics on instruments; they are always above the critical value of 10, recommended by Staiger and Stock (1997).

II.4.3 Appendix C: First-stage IV estimates, explaining regional trade

The following tables present the first stage regressions used in Table II-2, Column (3) and (4). The remoteness instrument is restrained to the panel of partners *j* with which countries *i* shares at least one ethnic group: we name this instrument regional remoteness. The high significance of the coefficients on the instrument and the F test of weak instruments in these first-stage regressions sufficiently reveal that the regional remoteness is reasonably a strong instrument for regional trade.

Table II-7: IV first stage regressions: explaining regional trade

	Regional trade	
	(1)	(2)
Regional remoteness	-0.8364	-0.5761
	(0.1862)[a]	(0.1635)[a]
Rest of Trade	0.3199	0.3136
	(0.0926)[a]	(0.0879)[a]
Ethnic group Income	0.0377	-0.0288
	(0.0547)	(0.0495)
Excluded ethnic group	0.8261	0.2653
	(0.1094)[a]	(0.1178)[b]
Polity2		-0.1332
		(0.0110)[a]
GDP growth		0.0047
		(0.0028)[c]
Constant	-13.9745	-9.9041
	(3.6814)[a]	(3.2686)[a]
Observations	5,528	5,528
R-squared	0.340	0.399
F-Test	39.16	23.54
Year FE	Yes	Yes
Ethnic Group--Country FE	Yes	Yes

Notes: This table presents the first stage regressions results concerning the IV estimations in column 5 and 6 of for estimations in Table II-2. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]) ([b]) ([c]) denote significance at the 1, 5 and 10 percent level respectively. We present the F-tests statistics on instruments; they are always above the critical value of 10, recommended by Staiger and Stock (1997).

II.4.4 Appendix D: Robustness check analyses of the impact of Regional trade with imports

To make our analysis comparable with Gleditsch (2007), in Table II-8, we build our indicator of regional trade on importations (instead of export as in the text). In Column 1 and 2 we compute an measure of the regional integration by summing all the import from countries that share at least one ethnic groups with the country i studied. In Column 3 and 4 we use the variable of Gleditsch that sums all the import from neighboring countries. The same positive effect than the one presented in the text is obtained. The difference between our result and the negative sign found by the seminal paper of Gleditsch (2007) may come from the additional controls introduced here.

Table II-8: Regional Trade effect on ethnic wars onset

	(1)	(2)	(3)	(4)
	Regional trade		Regional trade	
	Importations		Importation: Gleditsch	
	IV	IV	IV	IV
Regional Trade	0.0169	0.0255	0.0332	0.0792
	(0.0060)[a]	(0.0090)[a]	(0.0121)[a]	(0.0287)[a]
Rest of Trade	-0.0133	-0.0190	-0.0177	-0.0384
	(0.0047)[a]	(0.0062)[a]	(0.0070)[b]	(0.0142)[a]
Income	-0.0090	-0.0094	-0.0130	-0.0194
	(0.0030)[a]	(0.0031)[a]	(0.0041)[a]	(0.0062)[a]
Excluded ethnic groups	-0.0042	0.0058	-0.0110	0.0101
	(0.0042)	(0.0034)[c]	(0.0066)[c]	(0.0041)[b]
Polity2		0.0036		0.0104
		(0.0013)[a]		(0.0038)[a]
GDP growth		0.0009		0.0011
		(0.0003)[a]		(0.0004)[a]
Constant		0.0360		0.0035
		(0.0239)		(0.0190)
Observations	5,469	5,469	5,386	5,386
R-squared	0.017	0.020	0.022	0.023
Year FE	Yes	Yes	Yes	Yes
Ethnic Group-Country FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is a binary variable taking 1 when an ethnic group is engaged in a new ethnic war in a given year. All explanatory variables are lagged by one year. Regional trade in column (1) and (2) designs imports from all the countries with which country *i* shares an ethnic group. The endogeneity on this variable is tackled using regional remoteness on imports partners with which country *i* shares an ethnic group. *Rest of Trade* in column (1) and (2) captures imports from all the other countries with which country *i* does not share an ethnic group. Regional trade in column (3) and (4) designs imports from all the countries with which country *i* shares a border. The endogeneity on this variable is tacled using regional remoteness on imports partners with which country *i* shares a border. *Rest of Trade* in column (3) and (4) captures imports from all the other countries with which country *i* does not share a border. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]) ([b]) ([c]) denote significance at the 1, 5 and 10 percent level respectively.

II.4.5 Appendix E: First-stage IV estimates, explaining countries' local trade

The following table presents the first stage regressions used in Table II-2, column (5) and (6). It provides sufficient evidence that precipitations drives internal trade in accordance with our expectations.

Table II-9: IV first stage regressions: explaining local trade

	Local trade	
	(1)	(2)
Country Precipitation	0.0077	0.0075
	(0.0023)[a]	(0.0023)[a]
Local trade(lag3)	0.5875	0.5864
	(0.0236)[a]	(0.0240)[a]
Ethnic group Income	0.0299	0.0309
	(0.0111)[a]	(0.0111)[a]
Excluded ethnic group	0.1000	0.1061
	(0.0420)[b]	(0.0412)[b]
Polity2		0.0018
		(0.0022)
GDP growth		-0.0000
		(0.0009)
Constant	9.4759	9.5047
	(0.5453)[a]	(0.5543)[a]
Observations	4,734	4,734
R-squared	0.802	0.802
F-Test	392.47	370.06
Year FE	Yes	Yes
Ethnic Group--Country FE	Yes	Yes

Notes: This table presents the first stage regressions results concerning the IV estimations in column 3 and 4 of Table II-2. Robust standard errors clustered at "Ethnic group and country" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. We present the F-tests statistics on instruments; they are always above the critical value of 10, recommended by Staiger and Stock (1997).

II.4.6 Appendix F: First-stage IV estimates

The following table presents the first stage regressions used in Table II-4. The remoteness indicator, the precipitations and the regional remoteness of countries appear to be strong instruments respectively in their corresponding first stage IV regression. It is worth noting that, the instruments used in this two-stage methodology are the same as in the first section, particularly for countries internal and regional trade, because they are same variables throughout the paper.

Table II-10: IV first stage regressions explaining country total Export and local trade in the Two-stage methodology

	(1)	(2)	(3)
	International trade	Internal trade	Regional trade
Remoteness	-2.5770		
	(0.5973)[a]		
Regional Remoteness			-1.2461
			(0.3558)[a]
Country level Precipitations	0.1293	0.0055	
	(0.0516)[b]	(0.0026)[b]	
Country level Precipitations square		-0.0001	
		(0.0007)	
Local trade(lag3)		0.9975	
		(0.0111)[a]	
Rest of Trade			0.7169
			(0.1962)[a]
Polity2	0.0015	0.0007	0.0888
	(0.0534)	(0.0020)	(0.0536)
GDP growth	0.0064	0.0021	-0.0212
	(0.0130)	(0.0027)	(0.0182)
Density		-0.0028	
		(0.0088)	
Constant	-51.5302	0.0364	-22.8002
	(12.9587)[a]	(0.2768)	(6.4555)[a]
Observations	580	505	489
R-squared	0.277	0.977	0.435
F-Test	13.67	2848.43	12.27
Year FE	Yes	Yes	Yes

Notes: This table presents the first stage regressions results concerning the IV estimations in column 3, 6 and 9 respectively in Table II-4. Robust standard errors clustered at "country" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. We present the F-tests statistics on instruments; they are always above the critical value of 10, recommended by Staiger and Stock (1997).

Chapter 3 -
Climate Change, Water Treaties and International Trade

III. Chapter 3 - Climate Change, Water Treaties and International Trade

III.1 Introduction

More than 40% of the world population lives at close proximity to a fresh water resource. The number of rivers that cross and/or separate countries are numerous: more than 151 countries share transboundary river basins which are often vital for agricultural production. During the past century, pollution, population and economic growth have affected water resources[80] and in the next century climate change will have dramatic consequences with a significant reduction in precipitation and major changes in respect of wet/dry seasons. This will affect the production and trade of agricultural and industrial goods characterized by a high water footprint (e.g. a single cotton T-shirt requires 2,500 liters of freshwater[81]). Consequently, climate change can be a catalyst for institutional arrangements between nations aiming to manage water resources. In particular, international watercourses offer a unique opportunity to fathom the effect of climate change on WTs over time since more than 600 freshwater-related treaties have been signed to manage transboundary basins[82].

Surprisingly few studies have been undertaken to try to explain the rationale behind the implementation of WTs. To the best of our knowledge, only Tir and Ackerman (2009) explain how political institutions (preponderant power distribution, democratic governance), development and water scarcity increase the likelihood of international river cooperation between contiguous riparian states. In contrast to this study, we focus on the effects of climate change by considering exogenous variables such as temperature, drought, precipitation, floods and storms. Taking into account these different variables is important in order to identify which kind of climate change fosters

[80] See for instance Duarte, Pinilla and Serrano (2014) who analyzes the water footprint of the Spanish agricultural sector over a long period of time (1860-2010).
[81] See Debaere (2014)
[82] According to the International Freshwater Treaties Database

the development of WTs. We find that only temperature change significantly explains the development of WTs. Precipitation, floods and storms have no effect.

Beyond the link between climate change and WTs, we aim to understand the impact of these bilateral treaties on international trade. While it is a common knowledge among economists that international trade can be a way to cope with the impact of climate change by enabling water-poor countries to import water-intensive goods in order to alleviate the pressure of scarcity (see Candau, Regnacq and Schlick, 2019), it is not clear how current policies such as WTs affect international exchanges. Moreover, in the absence of any studies, opposing arguments about the effects of such treaties are equally credible.

First, these treaties may have little or no effect because they engender too small additional costs on production to influence international trade. This argument has been used to question the validity of the pollution haven hypothesis. For instance, Smarzynska Javorcik and Wei (2003) argue that environmental norms' costs are too small in comparison to other costs to influence the relocation of polluting firms to countries with laxer standards[83]. Since many WTs include environmental standards, the same kind of argument about the insignificant impact of these policies can be applied. The absence of impact can also come from the fact that these treaties are "cheap talk" and are not a real commitment to implement significant protectionist policies on water.

It is also possible that these treaties contribute to resolve/prevent political conflict by fostering cooperation between riparian nations[84] and as a result promote institutions and economic conditions thereby increasing trade. This second hypothesis, that WTs foster international trade may be defended by also considering the multilateral effects of these treaties. Indeed, a treaty on water protection between two countries can enable downstream countries to use more water (or water of better quality), fostering agricultural production and export[85]. Finally, some treaties in respect of large dams, by

[83] Candau and Dienesch (2017) debunk this latter argument.
[84] Hensel and Brochman (2008) for instance show that the presence of a WT decreases the potential for militarization and Zawahri and Gerlak (2009) discuss how securing access to freshwater has fostered cooperation in Africa. However as shown by Dinar (2009) even such a relationship is not sure, this author indeed develops a theoretical model (also tested on seventy-four country dyadic observations) and suggests an inverted U-shaped curve for the relationship between water scarcity and cooperation.
[85] Agreements on water are often bilateral, according to the Atlas of International Freshwater Agreements, two-thirds of basins have three or more riparian states, but only 20 percent of the agreements signed are multilateral.

producing hydroelectricity, may stimulate the production of goods and thereby international trade.

Third, WTs may have a negative trade effect if they are implemented in order to save freshwater ecosystems and/or to foster a sustainable development[86]. For instance the United Nations Convention (on Non-Navigational Uses of International Watercourses) is concerned with "equitable and reasonable use" and "the obligation not to cause significant harm" to other States in the same basin. The ASEAN Agreement on the Conservation of Nature and Natural Resources recommends "to promote environmentally sound agricultural practice by, inter alia, controlling the application of pesticides, fertilizers and other chemical" and "to promote pollution control and the development of environmentally sound industrial processes and products". The Convention on Environmental Impact Assessment in a Transboundary Context (Appendix I) provides a list of activities that are forbidden or regulated. These three examples are just illustrative of the increasing number of WTs that may negatively influence the export of agricultural and industrial goods. Of course, this may be mere rhetoric i.e. *de jure* concerns about water issues, but if WTs are *de facto* applied with a stringent implementation they have the potential to imply a loss of competitiveness.

Our methodology is based on a long tradition in the extant literature that analyzes the effects of regional trade agreements (RTAs) on trade. Using gravity equations, it has been found that RTAs have been successful in promoting trade growth in Europe (Mayer, Vicard, Zignago, 2019), North America (Caliendo and Parro, 2015) and Africa (Candau, Guepie and Schlick, 2018). Our analysis is linked to this literature since recent trade agreements go beyond tariffs and include provisions on capital mobility, competition, regulation of the labor market and environmental policies that are often related to water issues. The effect of environmental provisions on international trade has not yet been studied[87] but many works have analyzed these so-called "deep RTAs" in general and have found ambiguous results. Mattoo et al. (2017) find that deep agreements lead to more trade creation and less trade diversion than shallow

[86] In case of emission leakages and transboundary spillovers, WTs may be a tool to coordinate and to legitimize green lobbying on environmental policy outcomes. See Conconi (2003) and Mason, Umanskaya and Barbier (2018) who analyze the conditions under which lobby influence the environmental policy including water regulation.

[87] Baghdadi, Zarzoso and Zitouna (2013) found that environmental provisions of RTAs reduce polluting emissions. This is an important result but regarding our concern it is a result on which we can only speculate about the related effect on international trade.

agreements[88]. Kohl, Brakman and Garretsen (2016) find instead that agreements including domestic regulatory policies reduce trade.

Since RTAs are very heterogeneous in their contents, a consensus is hard to reach. By focusing on WTs, our aim is to reduce this heterogeneity in order to provide a clearer analysis. Indeed the definition of WTs is very concrete. First, all of the international freshwater treaties that are included in the database must address freshwater as a *consumable resources* in order to be included. Second, WTs address non-navigational issues such as water management, flood control, hydropower projects, or allocations for consumptive or nonconsumptive uses in international basins. Third, these treaties should state in some way how these items are addressed by the signatories to be included in the database. Documents dealing primarily with navigation, fishing, or border issues are excluded and in a similar way document that are too flaw about the water services are also excluded.

Our results confirm the protectionist role of WTs, we find that these treaties cause a significant *reduction* in international trade between countries in almost all continents. We compare this result to the effect of RTAs with water content and find that these provisions have no effect on bilateral trade. This might be an interesting results for environmental economics and management: water protection appears to be more effective when enforced in the framework of a WT than when included in a RTAs. Putting differently while is often defended that in front to climate change and to achieve development goals, countries need to retool trade agreement in order to include social and environmental issues (e.g. Shaffer and Fleurbaey, 2018), the current thesis based on water, defends instead the enforcement of treaties on specific topics.

Pursuing our analysis at the continental scale, we find that WTs reduce trade in Asia and in America and foster international trade in Africa. The content of the WTs explains this outcome as African treaties on freshwater are less related to environmental issues and often include joint management and technical cooperation provisions, which are helpful in stimulating international trade. Cooperation on watercourses stimulates further cooperation and the growth of the agricultural sector which is the main African export engine.

[88] See Bagwell, Bown and Staiger (2016) for a review.

Using these results, we undertake a counterfactual analysis consisting of suppressing all the WTs implemented to date. We find that the enforcement of a WT has a strong negative impact on international trade in all countries except African countries. The effects are the strongest in Asia due to the high elasticity of trade there. At country level, countries along the Nile and the Niger are the main winners of freshwater treaties in Africa.

The remainder of the paper is organized as follows. In Section II, WTs are briefly outlined. In Section III, the data and the empirical strategy deployed are discussed as well as the main results of the gravity structural estimation. Section IV presents the counterfactual analysis and the final section outlines the study's conclusion.

III.1 About water treaties

Negotiations and treaties in respect of international rivers have a long history. Focusing on the 20th century, some basic rules were established by the Institute of International Law (IIL) in 1911, among which was the rule prohibiting unilateral and detrimental exploitation of international basins and the requirement to develop transboundary cooperation. In 1966, the International Law Association advocated an "equitable utilization" of shared watercourses and proposed best practices in respect of water management (public participation, flexible allocation methods, conflict resolution). In 1997, the United Nations General Assembly adopted the United Nations Convention on the Law of the Non Navigational Uses of International Watercourses. This convention followed the UNECE Water Convention[89] adopted in Helsinki in 1992 and amended in 2003 in order to allow accession by countries outside the UNECE region. These two global conventions promote the development of institutions that foster sustainable development.

However, these conventions have only been ratified by a limited number of countries. Europe is the most advanced continent since the majority of basin countries have ratified the UNECE Water Convention with the aim of facilitating cooperation in order to

[89] More precisely called the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

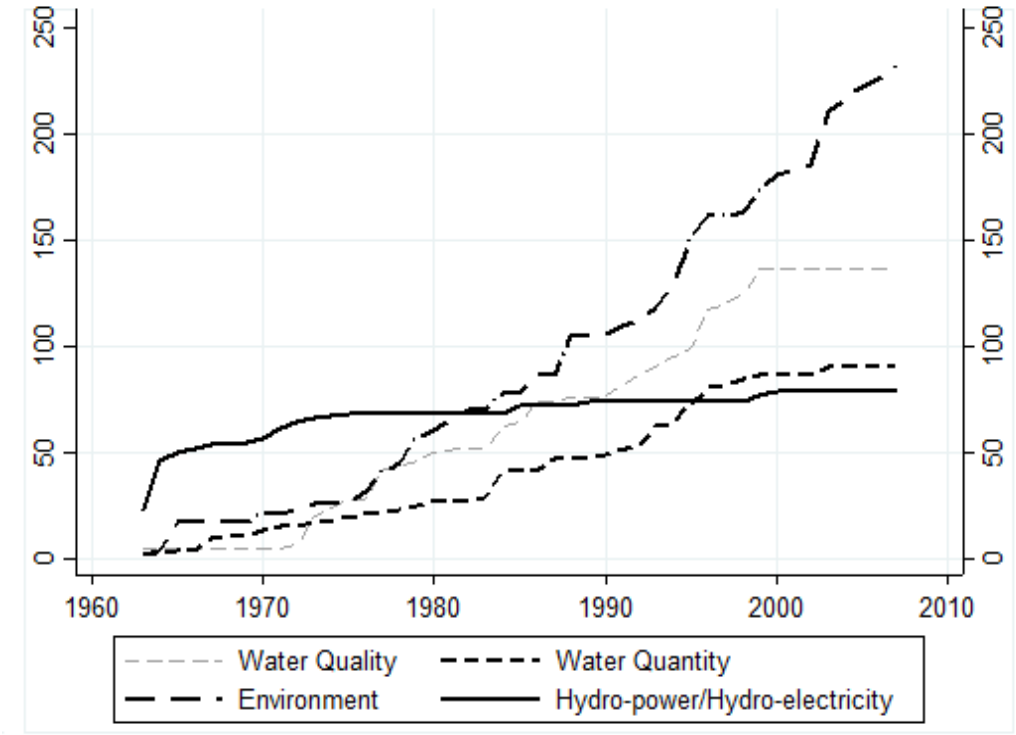
ensure the sustainable use of transboundary water resources. Countries in North America have also signed a significant number of treaties with a notable legal principles component in the governance architecture of basins. In Southern Africa, an important Water Protocol has been signed by members of the Southern Africa Development Community, and finally many African countries have signed the African convention on the conservation of nature and natural resources that includes provision on water. In Asia, treaties are less global and more regional/bilateral, such as the agreement between Kazakhstan and China, or the agreement between China and Russia on management and protection of Transboundary Rivers.

In brief, international or regional WTs have a very heterogeneous content. They cover, inter alia, water quality, irrigation, hydropower, infrastructure (barrages, canals, dykes) and under-groundwater[90]. Some treaties contains technical/financial cooperation and/or monitoring provisions (e.g. mechanisms to monitor treaty compliance), and define the compensation schemes applicable in exchange for water rights or access. The objectives of WTs also vary from one treaty to another. There are a) regulatory treaties that set rules to prescribe certain actions (e.g. water allocation) or to proscribe others (e.g. pollution emissions), b) programmatic treaties in respect of a common program (e.g. dam construction) or,c) more general treaties that set out principles and norms for cooperation in transboundary basins.

Past analysis in respect of the Transboundary Freshwater Dispute Database (TFDD) reveals that most treaties address hydroelectric and water supplies, rather than water quality issues (Hamner and Wolf, 1998; Beach et al., 2000)[91]. On recent data, we find a different picture. Figure 7 classifies the treaties according to the four different treaty subject matters: the environment, water quality, water quantity and hydro-power/electricity generation. We find that during the 1990s, an increasing number of treaties relating to the environment and to water quality were signed. The number of treaties relating to dams, however, in that period had clearly reached a plateau.

[90] Only three transboundary aquifers have an operational arrangement for water cooperation: the Genovese aquifer, the Nubian Sandstone aquifer, the Northwestern Sahara aquifer system.
[91] These analyses also show that bilateral treaties outnumber multilateral treaties which may explain the difficulty to manage the resource without a systemic agreement.

Figure 7: Water Treaties Contents



Source: Authors.

Depending on the level of country development, the incentive to sign a WT, as well as the nature of the treaty, can vary. These treaties are certainly influenced by the level of specialization in the industrial sector (e.g. polluting firms) and in the agricultural sector. Indeed 70% of the fresh-water used in this last sector is an intermediate input of the agricultural sector. Consequently, depending of the climate and of the agricultural technology available, the need to enforce WTs is going to be more or less pressing.

We test this hypothesis which has previously only been partially addressed by Tir and Ackerman (2009). These authors presented a Cox regression of river treaties taking into account institutional variables (democracy, power distribution) and the availability of water but with strong assumptions that cast doubts on their results in the light of climate change. For instance, due to data limitations, they consider that the total amount of water available per country is invariant over time. Data on temperature, drought, precipitation, floods and storms are not taken into account. To date, we have no clue of what kind of climate change motivates countries to cooperate and it seems thus important to consider these variables. To do so, consider that a water agreement is

signed when the utility gain, Γ_{odt}, is higher that the negotiation cost, C_{odt} for a country-pair (o, d) at year t such as:

$$\Gamma_{\text{odt}} > C_{\text{odt}} \tag{27}$$

by assuming with Martin, Mayer and Thoenig (2012) that C_{odt} is the unobserved component of the decision process submitted to stochastic shocks, then the inequality (27) is transformed into a probability of water agreement formation. We now have to choose the distribution of C_{odt} that determines the functional form taken by this probability. Assuming a Type I extreme value distribution concerning C_{odt} (see Train, 2003), we get the functional form which is a logit probability:

$$P(WT_{\text{odt}} = 1) = \frac{\exp(\Gamma_{\text{odt}})}{\exp(\Gamma_{\text{odt}})+1} \tag{28}$$

where the gains depends here on climatic conditions:

$$\Gamma_{\text{odt}} = \alpha Clim_{ot} + \beta Clim_{dt} + C_{od} + f_o + f_d + f_t \tag{29}$$

where WT_{odt} is a dichotomous indicator of the existence of a water agreement between country o and country d at time t ; it takes one when the two countries have signed a new agreement in a given year and zero otherwise[92]. This dummy is built from the International Freshwater Treaty Database[93] provided by the "Program in Water Conflict Management and Transformation" (College of Earth, Ocean, and Atmospheric Sciences[94]). This database gathered a full number of international, freshwater-related agreements between pair or groups of countries. These treaties concern "water as a scarce or consumable resource, a quantity to be managed, or an ecosystem to be improved or maintained [...] water rights, water allocations, water pollution, principles for equitably addressing water needs, hydropower/reservoir/flood control development, and environmental issues and the rights of riverine ecological systems". Agreements concerning fishing rights, navigation rights and tariffs, or delineation of rivers as borders are mentioned in some treaties.

[92] A full explanation on the construction of the variable WWT_{odt} is provided in the "Data and estimators" subsection.

[93] https://transboundarywaters.science.oregonstate.edu/content/international-freshwater-treaties-database.

[94] Oregon State University.

$Clim_{ot}$ and $Clim_{dt}$ are a set of climatic variables consisting in temperature, precipitation, floods, storms and droughts. Data on temperature and precipitations come from Dell et al. (2014) and data on "Floods, Storms & Droughts" come from the Centre for Research on the Epidemiology of Disasters[95]. f_o (f_d) and f_t design respectively countries fixed effects and year specific effects. These fixed effects takes into account the technology used in the agricultural and/or the availability of water in each country. C_{od} is a set of control variables that allow to account for time-invariant ties within each pair of countries such as colonial relations, same language, same border.

[95] Available on request at https://www.emdat.be/

Table III-1: Climate reasons of water agreements: gravity estimation approach

	(1)	(2)	(3)	(4)
	Logit	Probit	LPM	LPM
Origin Temperature	6.869	2.551	0.357	0.365
	(2.394)[a]	(0.763)[a]	(0.043)[a]	(0.043)[a]
Origin Precipitation	-0.183	-0.027	-0.011	-0.014
	(0.475)	(0.171)	(0.012)	(0.012)
Origin Drought	0.334	0.148	0.008	0.006
	(0.179)[c]	(0.070)[b]	(0.011)	(0.011)
Origin Flood	-0.015	0.003	-0.014	-0.015
	(0.174)	(0.066)	(0.007)[c]	(0.008)[b]
Origin Storm	-0.769	-0.271	-0.004	-0.005
	(0.305)[b]	(0.108)[b]	(0.008)	(0.008)
Destination Temperature	8.211	2.873	0.368	0.377
	(2.584)[a]	(0.803)[a]	(0.043)[a]	(0.043)[a]
Destination Precipitation	-0.149	-0.017	-0.011	-0.014
	(0.481)	(0.171)	(0.012)	(0.012)
Destination Drought	0.327	0.148	0.006	0.004
	(0.181)[c]	(0.070)[b]	(0.011)	(0.011)
Destination Flood	-0.004	0.009	-0.011	-0.012
	(0.173)	(0.066)	(0.008)	(0.008)
Destination Storm	-0.770	-0.263	-0.005	-0.005
	(0.305)[b]	(0.108)[b]	(0.008)	(0.008)
log Distance	-1.809	-0.780	-0.084	
	(0.095)[a]	(0.042)[a]	(0.009)[a]	
Contiguity	0.348	0.293	1.005	
	(0.149)[b]	(0.057)[a]	(0.092)[a]	
Comcol	1.309	0.604	0.017	
	(0.188)[a]	(0.073)[a]	(0.021)	
Smctry	-0.476	-0.175	0.716	
	(0.200)[b]	(0.085)[b]	(0.129)[a]	
Constant	-43.010	15,597	-1.159	-2.084
	(7.710)[a]	(2.651)[a]	(0.191)[a]	(0.219)
Observations	190,739	190,739	832,333	832,333
Pseudo R-squared	0.319	0.319	0.014	0.003
Origin-Destination FE	*No*	*No*	*No*	*Yes*
Origin FE	*Yes*	*Yes*	*Yes*	*Yes*
Destination FE	*Yes*	*Yes*	*Yes*	*Yes*
Year FE	*Yes*	*Yes*	*Yes*	*Yes*

Robust standard errors clustered at the "country pair" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively.
In column (3) & (4), all coefficients are multiplied by 10 for readability and presentation purposes.

Table III-1 presents results from the estimation of Equation (29)). We also estimate this relationship using a Probit in Column 2 and a Linear Probability Model (LPM) in Column 3 and 4.

The first interesting result of Column 1-3 is the difference between climatic conditions that are rarely significant and traditional bilateral variables such as distance that strongly explain the enforcement of water treaties. However, while precipitation, drought and flood do not motivate a political action toward WTs, temperatures are significant both at the origin and at destination. Temperature is the most and rapidly perceived indicator of climate change raising awareness on global warming and explaining the enforcement of water treaties. It is interesting to observe that this result holds despite the fact that we control for country heterogeneity and proximity[96].

Since the Logit (and Probit) model does not support well the high number of fixed effects, we use in Column 4 the Linear Probability Model (LPM) with origin-destination fixed effects (instead of traditional bilateral variables). This last estimation confirms that countries with higher temperatures are more likely to sign a WT.

III.2 Estimating Elasticity

III.3 The Structural Gravity Equation

To analyze the effect of WT on trade we use a simple structural gravity equation. Instead of presenting the theoretical model in detail (postponed to Section 4), we start by this gravity equation that explains bilateral flows between country o and country d, denoted X_{od}, such as:

$$X_{\mathrm{odt}} = \phi_{od} \frac{Y_o}{\Pi_o^{1-\sigma}} \frac{Y_d}{P_d^{1-\sigma}} \tag{30}$$

where σ is the elasticity of substitution between varieties ($\sigma > 1$), ϕ_{od} a reversed measure of trade costs τ_{od} ($\phi_{od} = \tau_o^{1-\sigma}$ i.e an indicator of trade openness) between o and d , Y_d and Y_o the aggregated expenditures/incomes at the destination of exports d

[96] This finding is verified in the Online Appendix A where a robustness check is done by considering the choice to sign an agreement country by country (and not on a bilateral basis).

and at origin o. $\Pi_o^{1-\sigma}$ represents the market potential in o. This term is sometimes considered as an indicator of the market access from o and/or called outward multilateral resistance because it represents a GDP share weighted measure of trade cost resistance that exporters in o face when shipping their goods to consumers on their own and outward markets. The term $P_d^{1-\sigma}$ in this gravity equation (30) is the accessibility-weighted sum of exporters o capabilities also called inward multilateral resistance since it is a reversed measure of the openness of a nation to import from the world. Anderson and Yotov (2010) also consider this term as the buyer's incidence because it represents the weighted sum of trade costs paid by buyers.

This gravity equation is estimated using the pseudo-maximum likelihood (PML) estimator as follows:

$$X_{\mathrm{odt}} = \exp(\alpha + f_{ot} + f_{dt} + \phi_{odt} + \epsilon_{odt}) \tag{31}$$

where f_{ot} and f_{dt} are time-varying countries-specific effects approximating exporting and importing capacity, $Y_{o,s}/\Pi_{o,s}^{1-\sigma_s}$ and $E_{o,s}/P_{o,s}^{1-\sigma_s}$ in Equation (30) at time t, α is a constant.

To control for other bilateral relationships, binary bilateral variables are used i.e. dummies for colonial links, borders, common language and physical distance. Since this strategy raises doubts regarding the possibility of omitted variables, we compare results with estimations including bilateral fixed effects f_{od} to control for all unobserved time-unvarying bilateral determinants of exports (Baier and Bergstrand, 2007; Magee, 2008).

Consequently trade costs in (31) take the following form:

$$\phi_{\mathrm{odt}} = \psi RTA_{odt} + \lambda WT_{odt} + f_{od} \tag{32}$$

where RTA_{odt} takes 1 at the year t when a regional agreement between these countries enters into force and zero otherwise. In a similar way, WT_{odt} (for Water Treaty) takes 1 after the signature of a water agreement. As the data source provides only the signing date of the treaties documents, we assume that, once adopted, the agreement is valid till the end of the period considered (i.e. 2007). This is obviously a strong assumption; we thus also lead estimation by considering that WT_{odt} takes 1 only during the first five years after the signature. We also consider a dummy WT_{odt} for a period of ten years.

III.4 Data and estimators

The Water Agreement variable (WT_{odt}) is a dummy indicator built from the International Freshwater Treaty Database[97] provided by the "Program in Water Conflict Management and Transformation" (College of Earth, Ocean, and Atmospheric Sciences[98]). This database, which spans the years 1820 to 2007, gathered a full number of international, freshwater-related agreements between pair or groups of countries. To build our dummy of WTs, we extract from the International Freshwater Treaty Database, all the international water treaties since 1920 and countries that are involved in each of them. The groups that signed the treaties are comprised of two countries in case of bilateral agreements and more than two in case of multilateral agreements. Afterwards, we generate, for each treaty, a set of the bilateral combinations of countries that comprised the signing group. Consequently, the number of bilateral combinations per treaty per year is given by $n! = n \times (n-1) \times (n-2) \times \ldots \times 1$, with $n \geq 2$; n designing the number of countries involved in the treaty. The constructed variable takes one in years when the agreement is signed and zero otherwise. It still takes one, even in years a country had signed more than one agreements that have the same issue. We firstly generate the water agreement's onsets per issue before gathering them within a general water agreement whatever the issue. Since, we only have the signing date of the agreements, we also provide on top of the general water agreement onset dummy, two other indicators based on the assumptions that a treaty is effective respectively during 5 years and 10 years.

The virtual water associated with exports of agriculture products is built by combining statistics from Water footprint (hereafter WFP) databases[99] and the bilateral exports of goods classified as agriculture products in BACI. The virtual water designs the quantity of water involves in the production process of a traded goods. These statistics are proposed in cubic meters of water per ton of production. The Water footprint network uses to produce information about the amount of water used in the production process

[97] https://transboundarywaters.science.oregonstate.edu/content/international-freshwater-treaties-database
[98] Oregon State University
[99] https://waterfootprint.org/en/resources/waterstat/product-water-footprint-statistics/

of goods and services. It tells not only about the volume of water consumed in the production of goods such as wheat, rice, maize, cotton, but it informs also about more than one process products. The WFP distinguishes three main components of water used in the process of production of products, depending on their sources. (i) The green component of water footprint consists of water from *precipitation that is stored in the root zone of the soil and evaporated, transpired or incorporated by plants*. (ii) The blue part of water footprint designs that from *surface or groundwater resources and is either evaporated, incorporated into a product or taken from one body of water and returned to another, or returned at a different time*. (iii) Finally, the Grey portion of water footprint indicates *the volume of fresh water required to assimilate pollutants to meet specific water quality standards*. With these informations at hand, we firstly make a correspondence between agriculture products (comprising crops and animal) from WFP database and those of BACI. We then compute, for each agriculture goods the green, blue and grey component of their virtual water. Finally, we sum up these three values for every agriculture product, and we aggregate all the agriculture good's virtual water to get the agriculture exports virtual water variable.

The Regional Trade Agreement (RTA_{odt}) variable comes from Bergstrand's homepage[100].

Data on trade are from TRADHIST (CEPII[101]) which provides a complete representation of bilateral trade flows between countries all around the world. Specific bilateral characteristics come from GEODIST (CEPII) and are coded one (zero otherwise) when country-pairs are contiguous ($contig_{ij}$), when one country of the pair was the colonizer of the other (col_{ij}), whether the two countries were formerly parts of the same country ($smctry_{ij}$), and when at least 9% of the population in both countries speak the same language ($lang_{ij}$). The Gross domestic Product (GDP) data is also extracted from CEPII.

Our database covers the period 1955-2007 and concerns 154 countries.

Equation (31) is estimated with the Poisson Pseudo-Maximum-Likelihood (PPML) estimator routinely used in the trade literature in order to handle zero trade flows and

[100] https://www3.nd.edu/~jbergstr/
[101] Centre d'études prospectives et d'informations internationales.

heteroscedasticity[102]. To manage the large number of FE (exporter/importer-year fixed effects alongside with country pair fixed effects), we rely on a method developed by Correia et al. (2019)[103].

III.5 Baseline results

Table III-2 presents the findings obtained from Equation (31). In Column 1, where an exhaustive set of country-year varying characteristics and country-pair FE are introduced, we find that water agreements unambiguously cause a reduction of bilateral trade[104].

In Column 2, we modify our dummy of WT that now takes one during the first five years after which the agreement has been signed, and in Column 3, the dummy takes one during ten years. In each regression we confirm the previous negative impact of these treaties.

To be sure that the results obtained so far are not the result of an aggregation bias and to test whether the sign of the WTs elasticity changes with the sector considered and/or with the water content of international trade we lead two additional investigations. In Column 4 we consider only trade in agricultural goods and in Column 5 the dependent variable is the "virtual water" of agricultural trade. As already emphasized, the agricultural sector is by far the highest consumer of water (around 70% of the total consumption in the world according to the FAO) and it is thus interesting to take a particular attention to this sector.

In each case, we still find that WTs reduce trade exchanges and without surprise the strongest impact is observed in the agricultural sector.

[102] See Silva Santos and Tenreyro (2006) for the seminal article and Silva Santos and Tenreyro (2011) who show that the Poisson pseudo maximum likelihood estimator performed better than other estimators even when the conditional variance is far from being proportional to the conditional mean and even when the dependent variable has a very large proportion of zeros. Finally Head and Mayer (2015) compare several estimators and favor the PPML estimator. Interestingly Fally (2015, Proposition 1) demonstrates that the estimated fixed effects with PPML are perfectly consistent with the multilateral resistances of the theoretical model.

[103] https://arxiv.org/abs/1903.01690

[104] The same regression has been done with a temporal trend and is not reported here because exactly the same results have been obtained.

In the Online Appendix B we analyze the potential endogeneity from the simultaneity between trade and water agreements by using the test proposed by Wooldridge (2002) and used by Baier and Bergstrand (2007) concerning RTAs. The rationale behind this test is that there is no anticipation when the future level of WTs ($WT_{ij,t+1}$) is uncorrelated with the current trade flows. We find a strict exogeneity of water treaties (i.e. a non-significant effect of $WT_{ij,t+1}$ on trade, see Table III-7, highlighting that there is no obvious reverse causality.

Table III-2: Baseline results

	(1)	(2)	(3)	(4)	(5)
dependent var =>	Total trade			Agri	Agri Virtual Water
Water Agreements	-0.132	-0.069	-0.087	-0.250	-0.177
	(0.048)[a]	(0.034)[b]	(0.028)[a]	(0.056)[a]	(0.086)[b]
RTAs	0.191	0.190	0.186	-0.014	0.560
	(0.030)[a]	(0.030)[a]	(0.030)[a]	(0.038)	(0.167)[a]
Constant	22.143	22.144	22.147	12.749	
	(0.013)[a]	(0.013)[a]	(0.013)[a]	(0.019)[a]	
Observations	829,491	829,491	829,491	165,512	84,51
R-squared	0.990	0.990	0.990	0.979	0.994
Country pair FE	Yes	Yes	Yes	Yes	Yes
Origin*Year + Dest *Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at the "country pair" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively.
In Col 1, the dummy WT takes one for the year when a water treaty is signed, in Col 2 WT takes one during the first five years after the signature and in Col 3 during the ten years that follow.

III.6 Heterogeneity analysis

We aim to test whether the effect of water agreements varies across space. Depending on the level of development (and of institutions) it is indeed possible that some WT are *de jure* and not *de facto*, i.e. not applied in certain regions of the world, while in other regions these agreements may be more effective impacting on trade and welfare. Due to the fact that some rivers flow across continents, we estimate Equation (31) on a continental basis. Such a choice is motivated by the localized characteristic of the resource which cross countries at the continental level. We follow the Water Conflict Management and Transformation program at the Oregon State University, which

considers four continents: Africa, America, Asia, Europe. We also lead robustness check by separating North America and the Central and South America, the results obtained are similar.

In all the Columns of Table III-3, we use the set of fixed and time varying effects presented previously as well as RTAs in order to be sure that the coefficient of WTs does not take into account other confounding factors[105].

Coefficients are negative and significant in Europe, in America[106] and in Asia. The coefficient seems particularly strong is Asia (-0,509) and such a strong result may come from the lack of control on the dimension ijt, indeed at the exception of RTAs, we have no other variable that varies over space and time. We thus introduce a variable counting the number of General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO) members in the country pair and a dummy taking one in the case of a bilateral conflict and zero otherwise[107][108]. With these additional controls the effect of WTs are almost unchanged in all continents at the exception of Asia where we get a more realistic effect of -0.302.

[105] RTAs are introduced systematically but not reported in tables to save space (results are conventional and similar of what has been obtained in the previous section).

[106] To test the heterogeneity inside the continent, we also create a dummy considering North America (Canada, USA, Mexico) and the rest of the America. We find the same negative impact of WTs. The coefficient is equal to -0.164 (RSE: 0.08) in North America and -0.933 (RSE:0.164) in Central and South America.

[107] The GATT/WTO membership comes from the CEPII database. Bilateral conflicts are militarized Interstate Disputes (MID) from the Correlates of War (COW) project (https://www.correlatesofwar.org/data-sets). This dummy takes the value one when MID in the original database takes the values 3, 4 or 5, which correspond respectively to the (i) "display of force" (e.g. a decision of mobilization or a border violation), (ii) "the use of force" (e.g. an attack or an occupation of territory) and (iii) an "interstate war" (more than 1000 military deaths).

[108] To save space the coefficient of these controls are not presented, we find that the GATT/WTO membership significantly impact trade (0.406, RSE: 0.179) while bilateral conflicts are not significant.

Table III-3: Heterogeneity analysis

	(1)	(2)	(3)	(4)
WT in Africa	0.118	0.127	0.204	0.319
	(0.111)	(0.108)	(0.076)[a]	(0.084)[a]
WT in Europe	-0.099	-0.091	-0.018	-0.034
	(0.056)[c]	(0.061)	(0.038)	(0.029)
WT in Asia	-0.509	-0.302	-0.477	-0.329
	(0.080)[a]	(0.152)[a]	(0.098)[a]	(0.077)[a]
WT in America	-0.315	-0.312	-0.289	-0.297
	(0.084)[a]	(0.085)[a]	(0.072)[a]	(0.070)[a]
Constant	22.1	22.1	22.1	22.1
	(0.015)[a]	(0.015)[a]	(0.015)[a]	(0.015)[a]
Observations	829491	829491	829491	829491
R-squared	0.990	0.990	0.990	0.990
Country pair FE	Yes	Yes	Yes	Yes
Origin*Year + Desti*Year FE	Yes	Yes	Yes	Yes

Note: Robust standard errors clustered at the "country pair" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively. In all column RTAs in Africa, Asia, America and Europe have been introduced. In column 2, GATT/WTO membership and a dummy for bilateral conflicts have been added.

In Column 3 and 4, we do not use these ijt controls but we introduce the dummy taking 1 respectively during the five and ten years that a WT has been signed. All the previous results are verified at the exception of WT in Africa that are now significant and positive. This positive effect may be explained by the fact that water agreements have been particularly effective in Africa to foster cooperation between countries. For instance Zawahri and Gerlak (2009) describe the growing creation of commissions between riparian states to promote shared water management in the areas of flood control, technical assistance, and infrastructure development in the Congo, Zambezi, and Orange/Senqu River basins. These negotiations as well as the institutionalization of relationship may have been a vector to develop regional trade.

In the Online Appendix C, we treat another source of heterogeneity that concerns the content of WTs. Indeed as already discussed in the first section of this paper, some treaties are signed to promote water quality while others have a very different aims such as the production of hydroelectricity. We find that treaties with a content related to water quality reduces trade in Asia, while restriction on water quantity reduces trade in

America. Treaties on economic and sustainable development also affect negatively bilateral export. More surprisingly treaties on hydropower have also a negative impact on bilateral trade[109]. By destabilizing the society, these large projects may have a detrimental effect on international trade and on the capacity to produce and to export (at least on the short run that we study). It is also possible, that such a desegregation of the data without enough observations for each WTs contents provides a biased picture that should be taken with caution.

III.7 Water treaties versus Regional Trade Agreements on Water

Beside these conventions on water, the other kind of international treaties not included in our database are RTAs with environmental provisions related to water quality and/or water resources. Protection of the water resources with regulation against water pollution are indeed often clearly mentioned[110], in particular concerning the management of transboundary river basins. For instance, the Bulgaria-EC, art. 81(2) establishes that "Cooperation shall concern: - combating local, regional and transboundary air and water pollution- water quality, particularly of transboundary waterways (including the Danube and of the Black Sea)". In a similar way the COMESA aims to "take measures to control trans-boundary, air and water pollution arising from mining, fishing and agricultural activities." The East African Community, art. 111(2) stipulates that "action by the Community relating to the environment shall have the following objectives: to ensure sustainable utilization of natural resources like lakes." These quotations come from the codebook of the database TREND (TRade & ENvironment Database) that identifies 300 different types of environmental provisions in 730 trade agreements (Morin, Dür and Lechner, 2019)[111] . We use this dataset to

[109] This result was not expected since a strong correlation between energy production and economic growth reported in the literature logically invites us to consider hydropower as a positive determinant of bilateral trade. Such a negative result might be explained by taking into account the fact that some hydropower projects are not inclusive, in particular in developing countries where there have sometimes been financed without taking into account the lives and production of local communities.

[110] Sometimes (albeit rarely) it is also stipulated that water is a "sensitive subject" that cannot be liberalized by the RTAs. For instance in the CETA, art. X.08(1) it is written that "water in its natural state, such as water in lakes, rivers, reservoirs, aquifers and water basins, is not a good or a product and therefore, except for Chapter XX – Trade and Environment and Chapter XX – Sustainable Development, is not subject to the terms of this Agreement."

[111] http://www.chaire-epi.ulaval.ca/en/trend

create a dummy of all water agreements that deal with water issues. First, we retain RTAs that include statements on water pollution concerns and/or rivers, basins and lakes management. Secondly, since the TREND database only provides the names of the trade agreements, we match the list of members (countries) that are involved in these RTAs. Finally, we follow the same method presented earlier for our Water Agreements variable (see section 3.2 Data and estimators) to propose a new indicator of RTAs which deals specifically with water management (called "RTAs Water" in the different table of results).

In reason of the potential collinearities between RTAs, RTAs with water provision and WTs we introduce these variables successively in the estimation of the gravity equation (31). In Column 1 of Table III-4 only our new dummy of RTAs with a content concerning water resource is introduced, the coefficient is significantly positive, albeit relatively small. In Column 2, the dummy of WTs is added without affecting the previous results, by fostering trade RTAs with water provision have the opposite effect than WTs. This result is counter-intuitive and not in line with discussions on the effect of "green" RTAs. Indeed several analysts consider that these environmental clauses are often ambitious and conclude that these kind of RTAs are laboratories where negotiators experiment and promote new provisions that are often effectively implemented (Baldwin and Low 2009; Morin, Brandi and Berger, 2019). Conducing a survey of government officials, trade negotiators and other experts, Clive and Yamaguchi (2018) report that according to respondents "these RTAs were a significant factor in the improvement of wastewater treatment systems [...] and have encouraged exporters to develop environmental certification to comply with standards and hence avoid risk to reputation and potential liability damages". This survey is however based on a very limited number of respondents, but it indicates that a negative sign is expected and not the positive one reported here. It is likely that the positive effect obtained in our analysis comes from the lack of control, representing more the positive effect of RTAs in general than the positive effect of RTAs with water provisions. In Column 3 we thus control for RTAs and find that RTAs with water provision are finally unsignificant. This confirms the skeptical analysis of some researchers that view environmental provisions as "fig leafs" enabling to make trade agreements more suitable for voters and their representatives (Berger, Brandi and Bruhn, 2017). In Column 4, the coefficient of WTs is almost unaffected by the introduction of RTAs dummies.

Table III-4: Heterogeneity analysis

	(1)	(2)	(3)	(4)
	Export flows			
RTAs Water	0.032	0.032	0.020	0.020
	(0.016)[a]	(0.016)[a]	(0.016)	(0.016)
RTAs			0.190	0.190
			(0.030)[a]	(0.030)[a]
Water Treaties		-0.148		-0.133
		(0.050)[a]		(0.048)[a]
Constant	22.2	22.2	22.1	22.1
	(0.002)[a]	(0.002)[a]	(0.013)[a]	(0.013)[a]
Observations	829491	829491	829491	829491
R-squared	0.990	0.990	0.990	0.990
Country pair FE	Yes	Yes	Yes	Yes
Origin*Year + Desti*Year FE	Yes	Yes	Yes	Yes

Robust standard errors clustered at the "country pair" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively.

III.8 General Equilibrium Analysis

The previous analysis provides the trade elasticity of WT but by controlling for multilateral resistance and other bilateral or individual characteristics this estimation gives only the partial effect of WT. For instance an agreement between two countries can have a negative impact of their trade, but can also have positive (or negative) effects on trade with other partners, which is typically captured by individual fixed effects. In a similar way, WT can have income effects by affecting revenues in sectors where water is an important input. To analyze the general equilibrium effects of WT, we need to present in detail the model from which the structural gravity Equation (30) comes from. To study how WT have globally affected international trade, we lead a counterfactual analysis consisting in suppressing all WTs. Our analysis is thus an ex-post exercise in the same vein of Caliendo and Parro (2015) and Mayer, Vicard and Zignago (2018) that consist to quantify what would be the costs of un-doing what have been achieved. Such an exercise seems interesting in a period where trade integration is put into question in many part of the world and when at the same time climate change calls for action in particular regarding water. We use the theoretical model of Arkolakis, Costinot and

Rodriguez-Clare (2012) in its most simple form for reasons of transparency: a) the estimation of trade friction obtained in the previous section can be used directly without additional data such as tariffs and input-output data that are often lacking (in particular for African countries) and/or based on many assumptions, b) the model based on perfect competition, imposes the minimal assumptions and provides results that are easy to interpret.

III.8.1 Methodology and data

To assess the general equilibrium effect of water treaties, we use the theoretical model of Arkolakis, Costinot and Rodriguez-Clare (2012) where the real market potential of exporters in the structural gravity Equation (30) is defined by:

$$\Pi_o^{1-\sigma} = \sum_{d=1}^{n} (\tau_{od}/P_d)^{1-\sigma} Y_d \tag{33}$$

while the price index of the consumption basket in the destination country is:

$$P_d^{1-\sigma} = \sum_{o=1}^{n} (\tau_{od}/\Pi_o)^{1-\sigma} Y_o \tag{34}$$

Considering a Log-differentiation of the gravity Equation (30) we present, hereafter and step by step, the impact of a change in trade costs due to WT.

By focusing our analysis on a change of ϕ_{od} in the numerator of (30), from ϕ_{od} to ϕ_{od}^c we obtain the direct effect of trade costs. The upper-script c is used to characterize the counterfactual experiment. This direct effect takes the following simple form:

$$Direct_{od} = \phi_{od} = \frac{\phi_{od}^c}{\phi_{od}} = \exp[\psi(WT(1)_{od} - WT(0)_{od})] \tag{35}$$

where WT(0) means no treaty on water and WT(1) the enforcement of a treaty. The "dot" is used in this paper to represent the proportional change in a variable between its

initial value and the counterfactual scenario[112]. As shown in this equation (35), the direct effect does not take into account price indices.

Now adding in this analysis how multilateral resistances vary after regional trade liberalization gives the *Price Index Effect* of WTs[113]:

$$PIE_{od} = \frac{\Pi_o \, P_d}{\Pi_o^c P_d^c} \exp[\psi(WT(1)_{od} - WT(0)_{od})] \tag{36}$$

To compute this, we first use the estimate of ψ obtained from Equation (32). Then we use the result of the gravity regression to measure trade costs ϕ_{od}, i.e. $\phi_{od} \equiv exp\left[\hat{\psi} WT_{odt}\right]$. Using this measure of ϕ_{od} with expenditures Y_o and Y_d in Equation (33) and (34) with the contraction mapping of Head and Mayer (2015) gives the multilateral resistances Π_o and P_d. Then using the previous measure of ϕ_{od}, we get from Equation (35) the counterfactual trade costs ϕ_{od}^c, i.e. $\phi_{od}^c \equiv \phi_{od} \exp\left[\hat{\psi}(WT(1)_{od} - WT(0)_{od})\right]$. Using again the contraction mapping with ϕ_{od}^c and with the same expenditures Y_o and Y_d provides the counterfactual multilateral resistances Π_o^c and P_d^c. All these findings give the *PIE* of water treaties presented in Equation (36). This equation takes into account multilateral resistance, i.e. any change between a pair of countries gives counterfactual changes in trade flows for all country pairs that are taken into account in prices indices. Then trade diversion, which is a reduction of trade flows from outside the block after an agreement is taken into account.

The computation of the PIE is based on the assumption that WTs do not affect incomes. However it is obviously possible that WTs affect incomes and wages in sectors that use water in an intensive way. Taking into account this change, the General Equilibrium Trade Effect (GETI), is defined as follows:

$$PIE_{od} = \frac{Y_o' X_d'}{Y_o \; X_d^c} \frac{\Pi_o \, P_d}{\Pi_o^c P_d^c} \exp[\psi(WT(1)_{od} - WT(0)_{od})] \tag{37}$$

[112] The literature usually work with a "hat", a notation here preserved to notify the predicted value of coefficients.

[113] Head and Mayer (2015) call this effect the Modular Trade Impact in reference to Anderson (2011). We prefer the term Price Index Effect which may be more telling.

Where Y_o' and X_d' denote respectively the production at the origin and the expenditure at destination after a change due to WTs.

The GETI allows quantifying the fact that a treaty affects both signatory and non-signatory members by diverting trade from partners outside the block (Viner, 1950). This diversionary effect turns out to be very concrete in the case of water basins/rivers that are shared by many countries. An agreement or a disagreement between two upstream countries can have either a beneficial or deleterious effect on third countries depending on how the resource is managed upstream. The potential for trade diversion is substantial since the number of shared basins/rivers is large[114].

Considering the production side with labor as the sole factor of production in each country $i = (o, d)$, $Y_i = w_i L_i$, and by assuming that the change in the labor force is constant, gives $\dot{w} = \dot{Y}$. Since trade deficit are constant, change in expenditures equals change in incomes (indeed with $X_d = w_d L_d(1 + d_d)$ where d_d is the deficit of country d, gives $\dot{X}_d = \dot{w}_d = \dot{Y}_d$). To determine the equilibrium change in income we use the share of expenditure of consumers in o spent on goods produced in d, $\pi_{od} = X_{od}/X_o$. Finally, the change in expenditure due to a trade shock is given by:

$$\dot{\pi}_{od} = \frac{\dot{\phi}_{od}\dot{Y}_o^{1-\sigma}}{\sum_l \pi_{ld}\dot{\phi}_{ld}\dot{Y}_l^{1-\sigma}} \tag{38}$$

Inserting this expression in the market clearing enables to solve the system and to get the income change due to the removal of a WT:

$$\dot{Y}_d = \frac{1}{Y_d}\sum_{o=1}^{n} \frac{\pi_{od}\dot{\phi}_{od}\dot{Y}_o^{1-\sigma}}{\sum_l \pi_{ld}\dot{\phi}_{ld}\dot{Y}_l^{1-\sigma}} \dot{Y}_o X_o \tag{39}$$

Using the direct effects calculated earlier, with Y_o approximated by GDPs, and the trade share π_{od} of each country o, gives from (39) a system of equations defining $\dot{Y}_o$, which

[114] Nine different countries share the Congo, Niger, Nile, Rhine, and Zambezi, and at least five different nations are concerned by the Amazon, Aral Sea, Ganges Brahmaputra-Meghna, Jordan, Kura-Araks, La Plata, Lake Chad, Mekong, Neman, Tarim, Tigris Euphrates-Shatt al Arab, Vistula, and Volga basins (Wolf et al., 1999).

once inserting in the trade share expenditure (38)[115], gives the General Trade Equilibrium Impact (GETI) of WT: $\dot{\pi}_{od}\dot{Y}_d$.

The general equilibrium analysis is computed on a database that comprises 154 countries. Since we need a square dataset for the analysis, the countries that constitute the sample are those which allow to get not only a balanced panel database but also have information on trade with self (internal trade flows). These internal flows that depict the expenditure made to get goods produce domestically, allow calculating multilateral resistances after a change in trade costs. To approximate these internal flows that are generally defined by country production minus it's exports, we rely on the Input-Output Tables proposed by EORA Database. We consider the year 2000 to assess the impact of a change in water agreements and we take Finland as a reference. Our results are independent of this choice (however to avoid any doubt about that, we have checked that changing reference country does not modify our results; these results are available on request).

III.8.2 Results

The experiment in Table III-5 is to turn off dummies of WTs in order to calculate the counterfactual trade flows for all pairs. Column 1 reports the trade elasticity estimated previously, Column 2 the direct effect of WT. We lead the experiment separately for each continent, considering that WTs agreements are suppressed in one place only. For instance the first line in Table III-5 gives *the amount of trade created of WTs in Africa* in a world where Asia, America and Europe already have their current WTs when the direct effect (Column 2), the PIE (Column 3), and the GETI (Column 4) are taken into account. Line 2 considers the trade creation due to WTs in Europe *ceteris paribus* in particular when WTs in Africa, Asia, and Europe are not modified. The PIE and GETI are the median values of the real/counterfactual trade ratio for countries relevant in the experiment. These calculations are computed for members and non-members for each variable in the following separated columns of Table III-5.

[115] To resolve the system we need an estimate of the constant elasticity of substitution between variety, we use $\sigma = 4.03$ which is the number obtained in the meta-analysis of Head and Mayer (2014).

Table III-5: Direct, PIE, GETI effects of water agreements

	Coeff	PTI	MTI		GETI	
Members	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**No**
*Water agreement * Africa*	0.118	1.125	1.009	1	1.025	0.997
*Water agreement * Europe*	-0.099	0.906	0.995	1.003	0.992	1.008
*Water agreement * Asia*	-0.509	0.601	0.962	1.017	1.037	1.163
*Water agreement * Americas*	-0.315	0.73	0.986	1.015	0.919	0.963

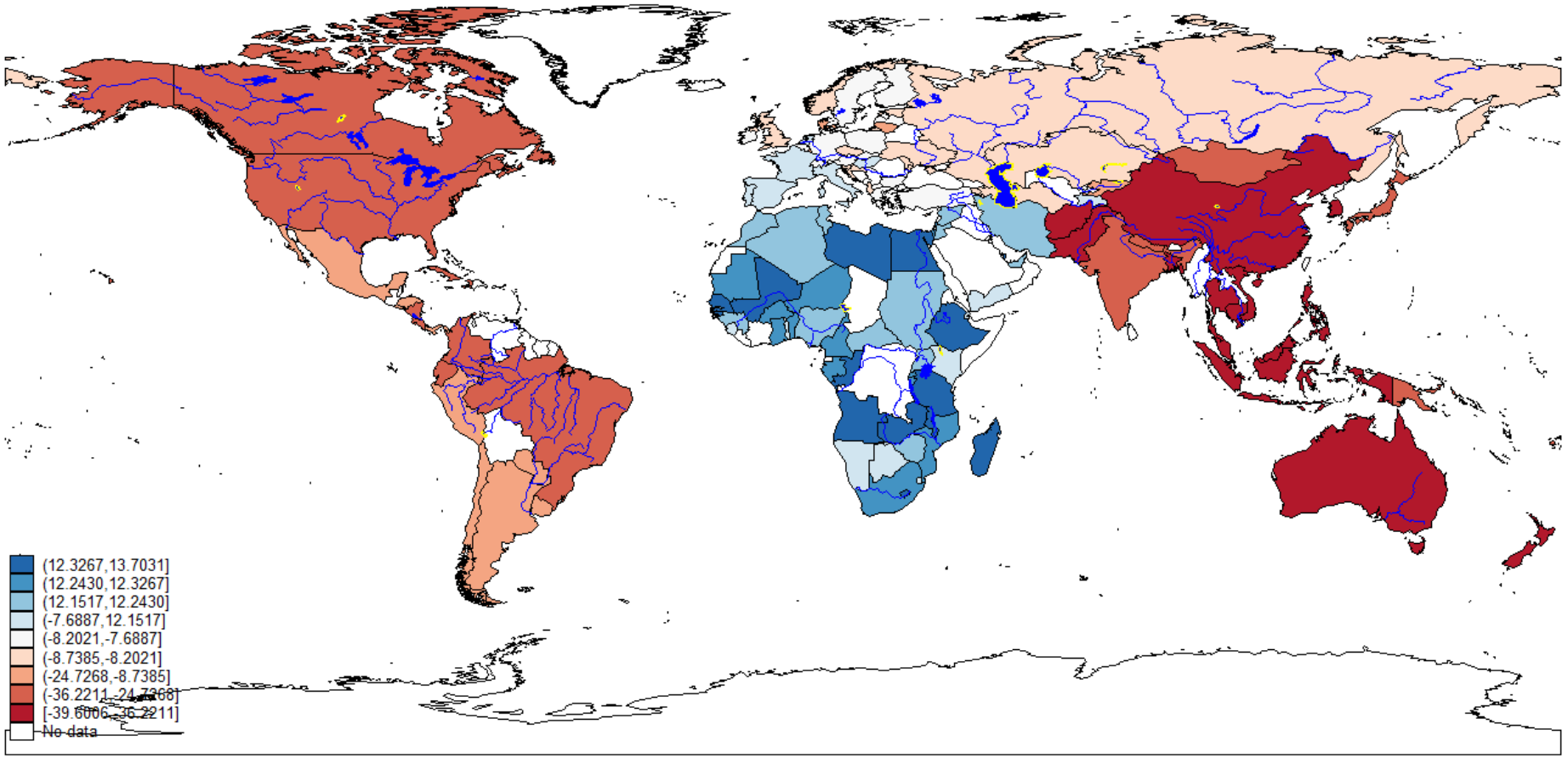
Notes: The MTI, GETI are the median values of the real/counterfactual trade ratio for countries relevant in the experiment.

The direct impact of WTs is an increase in the delivered price of goods exported in Europe, in America and in Asia which lead to reduction of trade there. The effect is the strongest in Asia due to the high trade elasticity of WT. However while the direct effect leads to a strong reduction, the fact to take into account the price index effect gives a less radical result (trade change by 4% (=1-0.962)). Such a result comes from the fact that with WTs, members suffers a loss of competitiveness and then the market access for partners outside the bloc is easier, which counteract partially the direct negative effect.

The opposite results are obtained in Africa, where the delivered price of exported goods decreases without WTs. The 'third country effect' however tends to minimize this result. While water agreements have a high direct positive effect (+12%), they also divert trade from partners outside the bloc, the PIE leads to an increase of trade around 1%.

Considering now the following column, it is first noteworthy that there is a small difference between the PIE and the GETI, which illustrates that the shock implemented is a small change in trade costs with weak effect on incomes. This is particularly true in Europe where the amount of trade is almost unaffected by the GETI. However in Africa, the improvement in income due to WTs leads to an increase of international trade from to 1% to 2.5%. In Appendix C we lead some sensitivity analysis by doubling (and dividing by two) the current trade elasticities in order to analyze how results are affected. We find that while significant changes occur at the level of the PTI, the final picture (once multilateral effects are taken into account) is very similar to the one taken here.

Figure 8: The Impact of No Water Treaties on Trade (GETI)



Source: Authors

We then analyze the past shocks at the national level and report the result of WTs on trade with GETI on Map in Figure 8. Countries sharing Nile and Niger are countries that lose the most from a removal of WTs. In contrast the multilateral effect of WTs in Asia is strong, hence a withdrawal of these agreement leads to the strongest increase in trade and income in China, Pakistan, Thailand, Vietnam and Cambodia. We lack data to lead this counterfactual analysis for small countries like Bhutan and Laos, but this would certainly reinforce the result obtained here. For instance in Bhutan, hydropower accounts for 32% of the country's total exports and 8% of its gross domestic product in 2018. The detrimental effect of no WTs is smaller in America for the simple reason that basins are smaller and less shared than in Asia.

III.9 Conclusion

The history of international water treaties dates as far back as 2500 BC and it is even stated that the first treaty in the history of mankind was a water treaty[116]. But surprisingly these WTs have not been analyzed in details by economists, or more precisely only the link to water conflicts has been studied. While this analysis is crucial, it is now time to deepen our understanding of these treaties. First, we aim to know what are the exogenous factors (i.e. beyond conflicts), that motivate the enforcement of these treaties. We find that many climatic variables have a weak influence at the exception of temperatures which strongly (and in a very robust way) explain WTs. In the context of climate change and of a hotter earth, such a result indicates that many more WTs are going to be enforced in the future.

Second, if the literature suspect that WTs can resolve conflicts, it is surprising to not analyze how such a strong effect can influence other variables. To the best of our knowledge, the current analysis is the first assessment of the consequences of transboundary freshwater treaties on trade. There is various reason to consider that WTs influence international trade going from a positive effect along a pacification of economical and political relationship and a better sharing of a common resource, to a negative effect linked to the fact that these treaties may impose new environmental regulation on producers and then of the cost of production limiting the capacity to

[116] see https://www.un.org/waterforlifedecade/transboundary_waters.shtml

export. To analyze this issue, we use the most advanced tools in international trade allowing to control for omitted variables, such as comparative advantages and specific characteristics of countries that vary over time (importers and exporters' time effects) or bilateral relationships such as the presence of shared basin/rivers, common language or political ties (by bilateral fixed effects and specific dummies such as RTAs).

We find that WTs signed in Asia and America have a significant negative effect on the international trade of members of these treaties. The content of treaties explains this outcome, since many WTs have been implemented to foster the sustainable development of resources. By contrast in Africa, WTs have boosted international trade, perhaps by being part of conflicts' resolution processes and/or by fostering agricultural development. Understanding what distinguishes African countries and the treaties implemented there from what happens in the rest of the world in greater detail is beyond the scope of this paper but offers an intriguing area for further research. We also find that WTs have a significant effect on trade while RTAs that include provisions on water are not significant. This is an important result in term of international management; it is indeed often argued that trade agreements should be modified to take into account environmental and social issues. From the point of view of the current analysis on water, it would be more efficient to directly negotiate treaties on these topics instead of adding provisions to existing RTAs that are rarely enforced.

Our contribution is mainly positive by analyzing the impact of WTs on welfare in a very simple trade model. This work can be pursued by using a more sophisticated model (i.e. a multi-sector models, monopolistic competition, variable markups) and by investigating the welfare effect of these water treaties. This last exercise is a promising challenge, requiring to analyze how water services enter in the utility function and to estimate (or to calibrate) the preference parameter in order to assess whether WTs can be simultaneously trade reducing and welfare improving.

III.10 Appendices

III.10.1 Appendix A: Climate reasons of water agreements, unilateral estimation approach

In this appendix we analyze how results regarding the formation of water agreements are affected by deviating from the bilateral analysis and by analyzing the incentive to sign an agreement in *o* regarding climatic conditions in this country:

$$WT_{ot} = \alpha Clim_{ot} + f_o + \phi_{odt} + \epsilon_{ot} \quad (40)$$

where WT_{ot} is the Water Agreement variable and $Clim_{ot}$ the vector of climatic conditions described in the text.

Table III-6 provides the results of this estimation using first a Logit model. For robustness check, we also build a dependent variable that tells about the total number of water agreements signed by a country during a given year. Since this latter appears to be a count variable, we rely on appropriate estimation techniques such as Poisson estimator, Negative Binomial regression and Zero Inflated Poisson regressor, that help account for this kind of data. In Column 1 we introduce temperature alone in order to avoid problems of multicollinearity. We find that hotter temperatures explain the enforcement of water treaties. Not reported here the same estimations has been done by inserting in a similar way precipitation, floods, storms and droughts separately and in each cases these variables were not significant. This is verified in Column 2-5 where temperature is the sole variable that significantly explains water treaties.

Table III-6: Climate reasons of water agreements

	(1)	(2)	(3)	(4)	(5)
	Water agreements				
Temperature	0.639	0.633	1.319	1.011	0.854
	(0.176)[a]	(0.178)[a]	(0.203)[a]	(0.217)[a]	(0.167)[a]
Precipitation		0.022	-0.095	-0.039	0.042 c
		(0.054)	(0.072)	(0.065)	(0.022)c
Drought		0.266	0.107	0.372	0.189
		(0.306)	(0.386)	(0.361)	(0.356)
Flood		-0.114	-0.050	-0.228	-0.073
		(0.242)	(0.286)	(0.286)	(0.325)
Storm		-0.201	-0.486	-0.193	-0.611
		(0.323)	(0.314)	(0.366)	(0.412)
Constant	-17.07	-17.128	-36.053	-31.144	-26.362
	(3.597)[a]	(3.630)[a]	(2.575)[a]	(0.101)[a]	(2.089)[a]
Observations	3024	3024	7828	7828	7828
R-squared	0.135	0.136		0.274	
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Country fixed effects and year fixed effects are account for in all columns. The first and second columns results are based on logit estimations. The third, the fourth and fifth columns results come respectively from "Poisson estimator", "Negative binomial regression" and a "Zero inflated Poisson regressor".

a: p<0.01, b: p<0.05, c: p<0.1

We thus find here the same result than what has been reported with the bilateral equation. More precisely temperature is the critical variable to sign an agreement.

III.10.2 Appendix B: Reverse causality test

In the table below, we analyze the reliability of our estimations with regard to reverse causality issues. As proposed by Wooldridge (2002), we check the possibility that trade and water agreements variables can be co-determinate by testing if there is an anticipation behavior in trade when a future treaty is going to be enforced ($WT_{od,t+1}$). The strict exogeneity test consists in the absence of potential feedback effect. We then augment our preferred results in Table III-2 with future level of water treaties ($WT_{od,t+1}$).

In column (1), we firstly rely on a parsimonious specification to test the significativity of the coefficient on $WT_{od,t+1}$. In columns (2) and (3), we move to more complete specifications that include all our main rights hand variables and the result on $WT_{od,t+1}$ always remains unchanged. More concretely, the results in Table III-7 show a non-significant effect of $WT_{od,t+1}$ confirming that there is no feedback effect from trade to water treaties.

Table III-7: Strict exogeneity test of water treaties

	(1)	(2)	(3)
	Export flows		
Water Agreements			-0.128 a
			(0.048)
Water Agreements (t+1)	-0.101	-0.078	-0.083
	(0.063)	(0.061)	(0.062)
RTAs		0.213 a	0.213 a
		(0.030)	(0.030)
Constant	22.175 a	22.085 a	22.086 a
	(0.000)	(0.013)	(0.013)
Observations	804,766	804,766	804,766
R-squared	0.990	0.990	0.990
Country pair FE	Yes	Yes	Yes
Origin *Year + Destin*Year FE	Yes	Yes	Yes

Robust standard errors clustered at the "country pair" level reported in parentheses. ([a]), ([b]), ([c]) denote significance at the 1, 5 and 10 percent level respectively.

III.10.3 Appendix C: Sensitivity of results to changes in trade elasticities

Many estimators have been used in the literature on the trade gravity equation before to reach the current consensus concerning the PPML estimator. Consequently, these analyses provide a neat picture on how our results could be affected with another estimator. Using the Tobit/Heckman estimator provide higher coefficients of trade agreement than the PPML estimator while the Zero Inflated Poisson (ZIP) ML estimator gives a similar coefficient (Martin and Pham (2015)). In a similar way, comparing the PPML estimator with the OLS estimator (truncated and not), the threshold Tobit of Eaton and Tamura (1994), the poisson and gamma pseudo-maximum likelihood estimator, Head and Mayer (2014) find that in each case the PPML yields smaller estimates of the trade gains compared to these estimators. More precisely with PPML the coefficient of RTAs is equal to 0.29 while the highest coefficient is obtained with the LSDV (least squares with country dummies) and equals 0.63. To conclude, our results based on PPML are conservative in the sense that other estimators would provide a stronger effect of WTs on trade and then on welfare. Thus at the top of Table (Table III-8) we test how results are affected by doubling all our elasticity by two. Results are sensitive to this dramatic change, in particular the direct effect (PTI) is strong but once general equilibrium effects are taken into account, the final picture in term of MTI and GETI.

Table III-8: Doubling and halving trade elasticities

	Coeff * 2	**PTI**	**MTI**		**GETI**	
	Yes	**Yes**	**Yes**	**No**	**Yes**	**No**
*Water agreement * Africa*	100%	13%	0%	0%	3%	0%
*Water agreement * Europa*	100%	-9%	0%	0%	-1%	1%
*Water agreement * Asia*	100%	-40%	-4%	2%	5%	17%
*Water agreement * Americas*	100%	-27%	-1%	1%	-9%	-5%
	Coeff / 2	**PTI**	**MTI**		**GETI**	
	Yes	**Yes**	**Yes**	**No**	**Yes**	**No**
*Water agreement * Africa*	-50%	-6%	0%	0%	-1%	0%
*Water agreement * Europa*	-50%	5%	0%	0%	0%	0%
*Water agreement * Asia*	-50%	29%	2%	-1%	-2%	-8%
*Water agreement * Americas*	-50%	17%	1%	-1%	4%	2%

Source: Authors

The elasticities obtained with PPML are smaller than those with other estimators but they are however still high. WTs reduce trade by around 8% ($e^{-0.087} - 1$) in the general case (coef from Table III-2, Col 3), but at the continental level the coefficient used in simulations may be considered as too high to be realistic, in particular for Asia. Robustness analysis, consisting to introduce new controls specific to pair of countries and varying over time (level ijt) have indeed shown that these continental elasticities can be divided by two. At the bottom of Table III-8 we thus divide all the previous elasticities by two and analyse how the effects vary. The strongest effect is obtained in Asia, where with elasticity twice smaller, the change in welfare is only 5% higher.

General conclusion

There have been growing concerns about the links between the increasing importance of trade and development issues. In this thesis, we provided new data and rely on advance technical tools to provide some answers to three important interrogations in the fields of international economics. The importance of the studies stems not only from the fact that they address topical issues, but also because they lead to specific economic developments that should help countries to re-think about some measures of public interest. The findings and conclusions presented are mainly drawn from empirical analyses of the underlying questions.

Foremost, we give new insight into the effect of trade on the spatial distribution of population within countries. By analyzing the population growth at the top of the urban hierarchy, we test two hypotheses explaining the rise of mega-cities: trade and political institutions. We find that democratic institutions are the main factor behind the concentration of a nation's urban population in the main city. Contrary to the literature, our results reveal that extractive institutions reduce the size of the biggest city. This finding should alert the public administrations in these countries to not fail to develop measures and initiatives that should limit urban agglomeration while institutions are being improved.

In the second chapter, we question the implications of international, regional and domestic trade, in explaining ethnic disputes by controlling for income effects using satellite data on night lights. As a result, we find that domestic and international trade integrations have peaceful effects while regional trade integration fosters civil conflicts. For the sake of enhancing the existing methodology and to comprehend if country patterns that drive the probability of ethnic war are influenced by trade, we also present a two-step approach. In the first stage, country time-varying effects that explain conflicts, purged of income effects, are estimated and are interpreted as a proxy of changes in national identities. In a second step we analyze how trade integration affects these national identities. The latter step reveals that only international trade integration builds a new national identity that reduces the likelihood of ethnic wars. Since, African

countries are still looking for solutions in undermining the insecurity on the continent; we consider that this chapter can help to shed lights on a certain number of aspects. Thus, by relying on some arguments and empirical evidences, our findings reveal that trade integration in the world market can be also part of the solutions. Pan-African organizations and African governments needs to consider how best to exploit this channel to reduce particularly ethnic conflict around the continent.

Finally, we analyze the reaction of international trade to international water treaties. Before reaching that analysis, this chapter aims at highlighting how climate change has affected the enforcement of Water Treaties (WTs). Among different climate indicators, only temperature has fostered the formation of international cooperation on water resources. Besides, we conduct empirical analysis on the basis of the most recent advancement in the structural gravity model in the literature on international trade and find that freshwater-related treaties have caused a decrease in bilateral trade in Europe, Asia and America but have fostered trade in Africa. In general, WTs that protect the water resources reduce trade. Results differ in Africa where WTs are less related to environmental issues and include joint management and technical cooperation measures which stimulate international trade. We also go through a general equilibrium model that allows us to provide the global effect of WTs and we find that they have a significant effect on trade, in particular in Asia. The first major conclusion that can be drawn from this section is that water agreements have a real effect even if this impact differs from one continent to another. The second conclusion is that it is more effective to implement water agreements especially instead of RTAs with provisions that concern the management of transboundary basins if policies want to be really effective in handling international water issues.

Even though this thesis seems to be an elaborated peace of work, it is not immune to criticism. Besides, the realization of this work has generated new ideas that deserve consideration for future works. In particular, as shown in the first chapter of this Ph.D. thesis, countries past and contemporaneous institutional patterns are the main causes of the urban giants' growth. In sum, the study concludes that democracy goes hand in hand with agglomeration in past colonial countries. We can suggest five (5) extensions or developments that can be made to this research. Firstly, in order to shed light on the reasons behind our findings, we could extend the present framework by accounting for

the following question: is it the attractiveness of these biggest cities or their demography patterns that drive their population growth in case where countries are improving their institutions? Secondly, a related extension would be to analyze the case where our dependent variable is an economic growth of primate cities. Thirdly, from a methodological point of view, the great challenge of the empirical analysis in this chapter has been to find time-varying historical instruments. We overcome this problem by proposing year-by-year regressions whose predicted values allowed us to generate country-year instruments. One would like to go a step further to provide statistical validity of this approach, even if we are confident of the reliability of our approach, because the robustness check with a semi-parametric method confirms our findings. In addition to this issue, it would also have been preferable to deal with the endogeneity of the rural-urban income gap by providing exogenous instruments that may determine its discretionary variation. Fourthly, the further step that would certainly be promising for this literature will be to move to microeconomics analysis to capture the market access variable. We have indeed gone one step further from the existing literature by relying on a market access variable that encompasses several indicators of trade costs. However, the latter still did not account for domestic factors that are also part of trade costs, such as the existence of infrastructure, and reflects poorly their quality, which should either allow goods to be exported directly, or easily convey to the main export platform. Thus, the microeconomic analysis should be based on a survey in the potential secondary cities, and should allow for instance to identify the availability of facilities that can help in transporting goods either to the main city or directly to the international market. Information on transaction costs[117] such as the distance of paved road to the urban giants, the distance of paved road to the nearest border, and dummy indicators that capture whether there exists exports' facilities or whether the region uses to produce cash crops, etc. should be collected. This variable should be regressed on a variable depicting the difference between the urban giants' growth and that of the secondary cities. Finally, one could distinguish the analysis by accounting for the nature of goods exchange. In fact, the picture will be more contrasted when it comes to separating the manufacturing sector exports from the agriculture sector exports (that need space and land), since the latter can keep the work force from converging to the main city.

[117] As argued in the economic literature (see for instance Behrens et al., 2018) transaction costs may determine the spatial distribution on economic activities.

As for the second chapter, one of its' limitations is the lack of data that can help evaluate more precisely not only the internal or domestic trade, but also the ethnic network regarding trade. Further research should be done to improve and provide more reliable constructed indicators of trade that can help alleviate this limitation. Also, beyond channels that bring from trade to war, income and institutions' quality are always mentioned in the literature, but they have never really been tested. Thus, further analyses should address this issue in order to give a solid empirical background to these theoretical arguments. This chapter could also benefit from several extensions. Our constructed income variable might be a rough description of ethnic wealth, since the repartition of night lights within the ethnic areas should be very heterogeneous or dispersed, particularly in rural areas. In these areas, the amount of light is often concentrated in single places (for instance around marketplaces or administrative centers; etc.). One could imagine that this may just signal the presence of the government through a public lighting programs rather than the level of income in the area. Besides, our argument which supported that trade with peers across the border should be conflict promoting do not account for the total ethnic network. Trade within two countries that share at least one ethnic group can also be drawn by ethnic migration outside their country's homeland. The same picture should be observed when analyzing internal trade effect on ethnic peace since internal trade can be foster by internal ethnic group population's migration.

In the third chapter, we find that addressing water issues in the world generally leads to a compulsion of international trade of members particularly in Europe, Asia and America. By contrast, in Africa these water agreements have boosted international trade, perhaps by being part of a conflict resolution process and/or by fostering agricultural development. In the last part of this chapter, we provide in addition to the partial effect of water treaties on trade, general equilibrium effects that account successively for the price index effects, the multilateral resistance and changes in countries' incomes and wages. But it worth noting that the model that helps to draw the general equilibrium effects account only for labor as a factor of production. Then, it would likely for future works to rely on more sophisticated model that accounts not only capital in the production function, but also that would distinguish different sectors in the economy. It will also be useful to undertake a welfare effect analysis in order to gauge if the loss in trade is associated to other gains that are beneficial for the populations.

References

[1] Abowd, J. M., F. Kramarz, and D. N. Margolis (1999). High wage workers and high wage firms. Econometrica 67(2), 251–334.

[2] Acemoglu, D., Naidu, Restrepo and Robinson (2017), 'Democracy Does Cause Growth', forthcoming Journal of Political Economy

[3] Acemoglu, D., Robinson, J. A. and T. Verdier, (2004), 'Kleptocracy and Divide-and-Rule: A Model of Personal Rule', Journal of the European Economic Association, 2(2-3):162-192.

[4] Acemoglu, D., S. Johnson, and J A. Robinson (2002), 'Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution'. The Quarterly Journal of Economics, 117(4): 1231-1294.

[5] Acemoglu, D., S. Johnson, and J A. Robinson (2012), 'The Colonial Origins of Comparative Development: An Empirical Investigation: Reply'. American Economic Review, 102(6): 3077–311

[6] Ades, A. and E. Glaeser (1995), 'Trade and Circuses: Explaining Urban Giants', Quarterly Journal of Economics 110: 195-227.

[7] Albouy, D. (2012), 'The Colonial Origins of Comparative Development: An Empirical Investigation: Comment', American Economic Review, 102 (6): 3059-76.

[8] Anderson, J. E., van Wincoop, E., 2003. Gravity with Gravitas: A Solution to the Border Puzzle. The American Economic Review 93 (1): 170–192.

[9] Anderson, J., 2011. The Gravity Model. The Annual Review of Economics 3 (1), 133–160.

[10] Anderson, J., Yotov, Y., 2010. The Changing Incidence of Geography. American Economic Review 100, 2157–2186

[11] Angrist, J,D. and D. Kugler (2008), Rural windfall or a new resource curse? coca, income and civil conflict in colombia. The Review of Economics and Statistics, 90(2): 191-215.

[12] Anthony, R. M., (2014), 'Bringing up the past: Political experience and the distribution of urban populations', Cities, Volume 37, Pages 33-46

[13] Arkokalis, C., Costinot A., Rodriguez-Clare A., 2012. New Trade Models, Same Old Gains ? The American Economic Review, 102 (1): 94-130.

[14] Arkolakis C, A Costinot, D Donaldson, Rodríguez-Clare A ., 2019. The Elusive Pro-Competitive Effects of Trade. The Review of Economic Studies, Volume 86, Issue 1, Pages 46–80.

[15] Arrow, K., 1972, Gifts and Exchanges, Philosophy and Public Affairs 1(4), 343-362.

[16] Baghdadi, Leila ; Martínez Zarzoso, Inmaculada ; Zitouna, Habib, Are RTA agreements with environmental provisions reducing emissions? Journal of International Economics Volume 90, Issue 2, 90.2: 378-390.

[17] Bai, C-H., C-T. Hsieh and Z., Song (2019), 'Special Deals with Chinese Characteristics', forthcoming in NBER Macroeconomics Annual.

[18] Baier S. L., Bergstrand J. H., 2001. The growth of world trade: tariffs, transport costs, and income similarity. Journal of International Economics, 53(1): 1-27.

[19] Baier, S. and Bergstrand, J. (2004), "Economic Determinants of Free Trade Agreements", Journal of International Economics, 64, 29–63.

[20] Baier, S. L., Bergstrand, J.H., 2007. Do Free Trade Agreements Actually Increase Members' International Trade?" Journal of International Economics, 71 (1) : 72-95.

[21] Baldwin, R. and P. Low. 2009. Multilateralising Regionalism: Challenges for the Global Trading System. Cambridge: Cambridge University Press.

[22] Baldwin, R., (2016), The Great Convergence, Information Technology and the New Globalization. The Belknap Press of Harvard University Press.

[23] Bates, R. H, (1981), Markets and States in Tropical Africa: The political basis of agricultural policies. Berkeley: University of California Press.

[24] Bazzi S, Blattman C. 2014. Economic shocks and conflict: evidence from commodity prices. Am. Econ. J. Macroeconomics. 6(4):1–38.

[25] Beach, H., Hamner J., Hewitt J., Kaufman E., Kurki A., Oppenheimer J., Wolf A., 2000. Transboundary Freshwater Dispute Resolution. Tokyo: United Nations University Press.

[26] Behrens, K., Brown, W. M., & Bougna, T. (2018). The World Is Not Yet Flat: Transport Costs Matter!, The Review of Economics and Statistics, 100(4): 712-724.

[27] Behrens, K, Mion, G, Murata, Y, Südekum, J, 2018. Quantifying the Gap between Equilibrium and Optimum Under Monopolistic Competition, HSE Working papers WP BRP 185/EC

[28] Behrens, K. and F. Robert-Nicoud (2014), 'Survival of the Fittest in Cities: Urbanisation and Inequality', The Economic Journal, 124(581): 1371-1400.

[29] Berger A., C. Brandi and D. Bruhn, 2017. Environmental Provisions in Trade Agreements: Promises at the Trade and Environment Interface. German Development Institute, Briefing Paper 16.

[30] Berman, N., and M. Couttenier. 2015. "External Shocks, Internal Shots: The Geography of Civil Conflicts." The Review of Economics and Statistics, vol. 97, issue 4, 758-776

[31] Blattman, C., and E. Miguel (2010): "Civil War," Journal of Economic Literature, 48(1), 3-57.

[32] Bosker M and J de Ree (2014), Ethnicity and the spread of civil war. Journal of Development Economics, vol 108(C), 206-221.

[33] Calì, M. (2015) Trading Away from Conflict Using Trade to Increase Resilience in Fragile States. World Bank Report.

[34] Caliendo, L., Parro F., 2015. Estimates of the Trade and Welfare Effects of NAFTA, The Review of Economic Studies, 82(1): 1-44.

[35] Calvo, T. and Mercier, M., 2019. Analyse économique des causes des guerres civiles: un état des lieux. DIAL Working Paper 2019 / 11.

[36] Candau F., Jean S., 2009. What Are EU Trade Preferences Worth for Sub-Saharan Africa and Other Developing Countries? in Trade Preference Erosion: Measurement and Policy Response ed B. Hoekman, W. J. Martin et C. A. Primo Braga. Palgrave MacMillan Issues.

[37] Candau, F. (2008), 'Good Governance, Trade and Agglomeration', Papers in Regional Science, 87(4): 483-504.

[38] Candau, F. (2011), 'Is Agglomeration Desirable?', Annals of Economics and Statistics, 101/102: 203- 228.

[39] Candau, F. and E. Dienesch (2015), 'Spatial distribution of skills and regional trade integration'. The Annals of Regional Science, 54(2): 451-480.

[40] Candau, F., E., Dienesch, 2017. "Pollution Haven and Corruption Paradise" Journal of Environmental Economics and Management, Volume 85, pp 171-192.

[41] Candau, F., Guepie, G., Schlick, J., 2019. Moving to autarky, trade creation and home market effect: an exhaustive analysis of regional trade agreements in Africa. Applied Economics, 51(30): 3293-3309.

[42] Candau, F., Regnacq C., Schlick, J., 2019. Climate Change and the Revealed Comparative Advantage of Water. F.R.E.I.T Working Paper 1602.

[43] Caplan, B, and T Cowen. 2004. Do We Underestimate the Benefits of Cultural Competition? American Economic Review, 94(2): 402407.

[44] Chandler, T. (1987): Four Thousand Years of Urban Growth: An Historical Census. Edwin Mellon Press, Lewiston, NY.

[45] Chaney, T., 2016, Liquidity constrained exporters. Journal of Economic Dynamics & Control, vol. 72 , 141-154.

[46] Clive George and Shunta Yamaguchi, 2018. Assessing Implementation of Environmental Provisions in Regional Trade Agreements. OECD Trade and Environment Working Papers 2018/01

[47] Collier, P. and A. J. Venables (2013), 'Housing and Urbanization in Africa: unleashing a formal market process', Centre for the Study of African Economies, Working Paper Series 2013-01, University of Oxford.

[48] Collier, Paul, and Anke Hoeffler. 2004. “Greed and Grievance in Civil War.” Oxford Economic Papers, 56(4): 563–95.

[49] Combes, P.-P., G. Duranton, and L. Gobillon (2008). Spatial wage disparities: Sorting matters! Journal of Urban Economics 63(2), 723–742.

[50] Combes, PP., G. Duranton and L. Gobillon, 2011. 'The identification of agglomeration economies', Journal of Economic Geography, 11(2): 253–266.

[51] Conconi, P., 2003. Green Lobbies and Transboundary Pollution in Large Open Economies. Journal of International Economics 59: 399-422.

[52] Correia S., Guimarães P., Zylkin T., 2019. PPMLHDFE: Fast Poisson Estimation with High-Dimensional Fixed Effects. [econ.EM : https://arxiv.org/abs/1903.01690].

[53] Costinot, A., and Rodríguez-Clare, A., 2014. Trade Theory with Numbers: Quantifying the Consequences of Globalization. In Gopinath, G, E. Helpman and K. Rogoff (eds), Handbook of International Economics, Chapter 4, Volume 4.

[54] Cowen T. (2002) Creative destruction: How globalization is shaping the worlds cultures. Princeton. NJ: Princeton University Press. Desmet

[55] Crenshaw E.M. and R. M Anthony (2014), City Size and Political Contention, International Journal of Sociology, 44(4):7-33.

[56] Davis, J. and J.V. Henderson (2003), 'Evidence on the political economy of the urbanization process', Journal of Urban Economics 53: 98–125.

[57] De Sousa, J. and J. Lochard, 2009. Histoire coloniale et commerce international, Revue économique, 3(60): 635-645.

[58] Debaere, P., 2014. The Global Economics of Water: Is Water a Source of Comparative Advantage? American Economic Journal: Applied Economics, 6(2): 32–48.

[59] Dell, M., B F Jones, B A Olken, 2014. What Do We Learn from the Weather? The New Climate–Economy Literature. Journal of Economic Literature, Vol. 52, No. 3, pp. 740-798.

[60] Dinar, S., 2009. Scarcity and cooperation along international rivers. Global Environmental Politics, 9(1):109–135.

[61] Docquier, F., E. Lodigiani, H. Rapoport and M. Schiff, Emigration and democracy, Journal of Development Economics 120 (2016) 209–223.

[62] Duarte, R., V Pinilla, A Serrano, 2014. The water footprint of the Spanish agricultural sector: 1860–2010. Ecological Economics, Vol. 108, pp 200-207.

[63] Dube, O., and J. Vargas. 2013. “Commodity Price Shocks and Civil Conflict: Evidence from Colombia.” Review of Economic Studies 80 (4): 1384–1421.

[64] Duranton, G., (2008), 'Viewpoint: From cities to productivity and growth in developing countries', Canadian Journal of Economics, 41(3):689-736

[65] Eaton, J., Tamura, A., 1994. Bilateralism and Regionalism in Japanese and U.S. Trade and Direct Foreign Investment Patterns. Journal of the Japanese and International Economies 8 (4), 478 – 510.

[66] Eeckhout, J. (2004), Gibrat's Law for (All) Cities, American Economic Review, 94(5): 1429-1451.

[67] Fally, T., 2015. Structural Gravity and Fixed Effects, Journal of International Economics, 97 (1): 7685.

[68] Fearon, James D. 2006. “Ethnic Mobilization and Ethnic Violence.” In The Oxford Handbook of Political Economy, ed. Barry R. Weingast and Donald A. Wittman, 852–68. Oxford and New York: Oxford University Press.

[69] Fearon, James D., and David D. Laitin. 2003. “Ethnicity, Insurgency, and Civil War.” American Political Science Review, 97(1): 75–90.

[70] Feler, L. and J.V. Henderson (2011), 'Exclusionary policies in urban development: Under-servicing migrant households in Brazilian cities', Journal of Urban Economics, 69(3):253-272.

[71] Findlay, R. and K.H. O'Rourke (2009), Power and Plenty: Trade, War, and the World Economy in the Second Millennium. Princeton U Press.

[72] Fleurbaey M, 2015. Forced trades in a free market, in C. Binder, G. Codognato, M. Teschl, Y. Xu (eds.), Individual and Collective Choice and Social Welfare. Essays in Honor of Nick Baigent, Springer.

[73] Francois, Patrick and van Ypersele, Tanguy. 2002. On the Protection of Cultural Goods. Journal of International Economics 56(2): 359 369.

[74] Gasiorek, M., Peter Holmes, Jim Rollo, Zhenkun Wang, Javier Lopez Gonzalez, Maximiliano Mendez Parra, Maryla Maliszewska, Wojtek Paczynski, Xavier Cirera, Dirk Willenbockel, Francesca Foliano, Marcelo Olarreaga, Kamala Dawar (2010): Mid-term Evaluation of the EU’s Generalised System of Preferences, CARIS – Centre for the Analysis of Regional Integration at Sussex

[75] Giuliano, P., A. Spilimbergo and G. Tonon (2014), 'Genetic distance, transportation costs, and trade', Journal Economic Geography, 14 (1): 179-198.

[76] Gleditsch K, 2007. Transnational Dimensions of Civil War. Journal of Peace Research, vol. 44, no. 3, 2007, pp. 293–309.

[77] Gouel C, and D Laborde (2019), The Crucial Role of International Trade in Adaptation to Climate Change. NBER Working Paper No. 25221.

[78] Guiso, L., P. Sapienza and L. Zingales (2009), 'Cultural Biases in Economic Exchange?', The Quarterly Journal of Economics, 124 (3): 1095-1131.

[79] Hamner, J.,Wolf, A., 1998. Patterns in International Water Resource Treaties: The Transboundary Freshwater Dispute Database. Colorado Journal of International Environmental Law and Policy, Yearbook.

[80] Harris, C. (1954), “The Market as a Factor in the Localization of Industry in the United States”, Annals of the Association of American Geographers 64:315–348.

[81] Head K., T Mayer. Market Potential and the Location of Japanese Firms in the European Union. The Review of Economics and Statistics, 2004, 86 (4), pp.959-972.

[82] Head K., T. Mayer. Regional wage and employment responses to market potential in the EU. Regional Science and Urban Economics 36 (2006) 573–594

[83] Head, K. and T. Mayer (2002), 'Illusory Border Effects: Distance Mismeasurement Inflates Estimates of Home Bias in Trade', CEPII Working Paper 2002-01.

[84] Head, K., Mayer, T., 2014. Gravity Equations : Workhorse, Toolkit, and Cookbook. in Gopinath, G, E. Helpman and K. Rogoff (eds), Handbook of International Economics, Chapter 3, Volume 4.

[85] Hegre, H, N Sambanis,. 2006. Sensitivity Analysis of Empirical Results on Civil War Onset. The Journal of Conflict Resolution, 50(4): 508–535.

[86] Hegre, H, T Ellingsen, S Gates, and N. P. Gleditsch. 2001. “Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992.” American Political Science Review, 95(1): 33–48.

[87] Helpman, H., (1998), The Size of Region, In D. Pines, E. Sadka, and I. Zildcha (eds.). Topic in public economics. Theorical and Applied Analysis. Cambridge: Cambridge University Press: 33-54.

[88] Henderson J. V., Storeyguard A., Weil D. N., 2012, Measuring Economic Growth from Outer Space, American Economic Review, 102(2):994-1028.

[89] Henderson, J. V. and H.G. Wang (2007), 'Urbanization and City Growth: the Role of Institutions', Regional Science and Urban Economics, 37(1): 283-313.

[90] Henderson, J. V., A. Storeygard and D. N. Weil. (2012), 'Measuring Economic Growth from Outer Space', American Economic Review, 102(2): 994–1028

[91] Hensel, P., Brochmann, M., 2008. Armed Conflict over International Rivers. Paper presented at the American Political Science Association Annual Meeting, Boston, MA.

[92] Iwanowsky M., 2018. The Role of Ethnic Networks in Africa: Evidence from Cross-Country Trade. WP Institute for International Economic Studies, Stockholm University.

[93] Jacks, David S., Christopher M. Meissner and Dennis Novy. 2008. "Trade Costs, 1870-2000." American Economic Review, 98(2):529-34.

[94] Kamola I (2007) The global coffee economy and the production of genocide in Rwanda, Third World Quarterly, 28:3, 571-592

[95] Karayalcin, C. and H. Yilmazkuday (2015), 'Trade and Cities', World Bank Economic Review, 29(3): 523-549.

[96] Kaufmann, D., A. Kraay and M. Mastruzzi (2010), The worldwide governance indicators : methodology and analytical issues, Policy Research Working Paper Series 5430, The World Bank.

[97] Khol, T., Brakman, S., Garretsen, H., 2016. Do Trade Agreements Stimulate International Trade Differently ? Evidence from 296 Trade Agreements. The World Economy, 39 (1) : 97-131.

[98] Kiszewski A., Mellinger A., Spielman A., Malaney P., Sachs SE., and Sachs J. 2004. “A Global Index Representing The Stability of Malaria Transmission”. The American Journal of Tropical Medecine and Hygiene, 70(5) 486-98

[99] Krugman, P. and E.R. Livas (1996), 'Trade policy and the Third World metropolis', Journal of Development Economics, 49(1): 137-150.

[100] Krugman, P., (1991), 'Increasing Returns and Economic Geography', The Journal of Political Economy, 99(3): 483-499

[101] Laitin, David D., 2007. Nations, States, and Violence. Oxford & New York: Oxford University Press

[102] Lerner, D., (1958), The Passing of Traditional Society: Modernizing the Middle East. New York: Free Press.

[103] Lipset, S. M. (1959), 'Some Social Requisites of Democracy: Economic Development and Political Legitimacy', American Political Science Review, 53(1): 69–105.

[104] Lipton, M. (1977), Why Poor People Stay Poor: Urban Bias in World Development, Cambridge, MA: Harvard University Press.

[105] Magee, C. S. P., 2008. New Measures of Trade Creation and Trade Diversion, Journal of International Economics, 75 (2) : 349-362.

[106] Majumdar, S., A. Mani and S. Mukan (2004), 'Politics, information and the urban bias', Journal of Development Economics, 75(1): 137-165.

[107] Mariani F, M. Mercier and T. Verdier (2018), Diasporas and conflict. Journal of Economic Geography, Volume 18, Issue 4, July 2018, Pages 761–793.

[108] Marshall, M G. and K Jaggers (2007), Polity IV Project: Dataset Users' Manual, George Mason University and Center for Systemic Peace.

[109] Martin P., Mayer T., and M., Thoenig, 2008a. Make Trade Not War? Review of Economic Studies, 75, 865-900.

[110] Martin P., Mayer T., and M., Thoenig, 2008b. Civil War and International Trade. Journal of European Economic Association, 6(2-3):541-550.

[111] Mason, C.F., Umanskaya, V.I., Barbier, E. 2018. Trade, Transboundary Pollution, and Foreign Lobbying. Environmental Resource Economics 70: 223.

[112] Mattoo A, A Mulabdic, M. Ruta, 2017. Trade Creation and Trade Diversion in Deep Agreements, World Bank Policy Research Working Paper n. 8206.

[113] Mayer T, Vicard V, Zignago S., 2019. The Cost of Non-Europe, Revisited. Economic Policy, Volume 34, Issue 98, Pages 145–199.

[114] Maystadt, J-F., G. De Luca, P. G. Sekeris, J. Ulimwengu, and R. Folledo. 2014. "Mineral Resources and Conflicts in DRC: A Case of Ecological Fallacy?" Oxford Economic Papers 66 (3): 721–49.

[115] Maystre N., Olivier J., Thoenig M., Verdier T., 2014. Product-Based Cultural Change: Is the Village Global? Journal of International Economics Volume 92, Issue 2, Pages 212-230

[116] Melitz M, J. S., 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, Econometrica , 71(6), 1695-1725.

[117] Merrill, J., 2008. Water Management and Decision-Making in the Nile Basin: A Case Study of the Nile Basin Initiative. University of South Florida, https://scholarcommons.usf.edu/etd/402.

[118] Michalopoulos S., 2012. "The Origins of Ethnolinguistic Diversity", American Economic Review, 102(4), 1508-39.

[119] Michalopoulos S.,and Papaioannou E, 2016. The Long Run Effects of the Scramble for Africa, American Economic Review, 106(7), 1802-1848.

[120] Milner V. H. and B. Mukherjee (2009), 'Democratization and Economic Globalization', Annual Review of Political Sciences, 12(1):163–81

[121] Mokyr, J., (2016), A Culture of Growth: The Origins of the Modern Economy, Princeton University Press.

[122] Monfreda, C., N. Ramankutty, and J. A. Foley (2008), Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000, Global Biogeochem. Cycles, 22, GB1022, doi:10.1029/2007GB002947.

[123] Montesquieu, (1758), De l'esprit des lois

[124] Morin, JF, A. Dür and L. Lechner, 2018. Mapping the trade and environment nexus: Insights from a new dataset, Global Environmental Politics, vol. 18(1).

[125] Morin, JF, C Brandi and A Berger. 2019. The Multilateralization of PTA Environmental Clauses - Scenarios for the Future? in Shifting Landscape of Global Trade Governance (edited by M. Elsig, M. Hahn, and G. Spilker). Cambridge: Cambridge University Press : 207-231.

[126] Moulton, B. R., 1990. An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units. The Review of Economics and Statistics, Vol. 72, No. 2, pp. 334-338

[127] Murdock, G. P. (1959): Africa: Its Peoples and their Culture History. McGraw-Hill.

[128] Nel P.,and Righarts M, 2008. Natural Disasters and the Risk of Violent Civil Conflict, International Studies Quarterly, 52(1), 159-185.

[129] Nitsch, V., (2006), 'Trade Openness and Urban Concentration: New Evidence', Journal of Economic Integration 21(2), 340-362.

[130] Nunn, N. and D Puga (2012), 'Ruggedness: The Blessing of Bad Geography in Africa', Review of Economics and Statistics, 94(1):20-36.

[131] Pemberton, T. J., M. DeGiorgio, and N. A. Rosenberg (2013), 'Population Structure in a Comprehensive Genomic Data Set on Human Microsatellite Variation', G3: Genes, Genomes, Genetics, 3(5): 903-919.

[132] Pesaran, H. and Q. Zhou (2016), Estimation of time-invariant effects in static panel data models, Econometric Reviews, 37(10): 1137-1171.

[133] Rauch J.E. and R. Trindade, 2009. Neckties in the tropics: a model of international trade and cultural diversity. Canadian Econ Journal, 42(3): 809-1205.

[134] Rauch, J E. and V. Trindade (2002), 'Ethnic Chinese Networks in International Trade', Review of Economics and Statistics, 84(1): 116-130

[135] Redding, S., and A. Venables, 2004 “Economic Geography and International Inequality,” Journal of International Economics 62:1 (2004), 53– 82.

[136] Rodrik, D., 2018. What Do Trade Agreements Really Do? Journal of Economic Perspectives, 23(2) : 73-90.

[137] Rodrik, D., World Bank, (2006). Goodbye Washington Consensus, Hello Washington Confusion? A Review of the World Bank's "Economic Growth in the 1990s: Learning from a Decade of Reform". Journal of Economic Literature, 44(4), 973-987.

[138] Santos Silva, J. and S. Tenreyro (2006), 'The log of gravity', The Review of Economics and Statistics, 88: 641-658.

[139] Santos Silva, J., Tenreyro, S., 2011. Further Simulation Evidence on the Performance of the Poisson-PML Estimator. Economics Letters 112 (2), 220–222.

[140] Santos Silva, S., Tenreyro, S., 2006. The Log of Gravity. Review of Economics and Statistics, 88: 641-658.

[141] Shaffer G., M. Fleurbaey 2018, “Adapting trade policy to social, environmental, and development goals”, T20 Policy Brief Draft.

[142] Smarzynska Javorcik, B. S., Wei, S-J., 2003. Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth? The B.E. Journal of Economic Analysis & Policy, 3(2): 1-34.

[143] Spolaore, E., and R. Wacziarg (2018), 'Ancestry and Development: New Evidence', 33(5): 748-762.

[144] Staiger, D. and J. Stock (1997), 'Instrumental Variables Regression and Weak Instruments', Econometrica, 65(3): 557-586.

[145] Tir J. and J.T. Ackerman, 2009. Politics of formalized river cooperation. Journal of Peace Research, 46(5):623–640.

[146] Viner, J., 1950. The Customs Union Issue. Carnegie Endowment for International Peace: New York.

[147] Weber, M. (1909), Urbanization and Social Structure in the Ancient World, in Weber: Selections in Translation, edited by W. G. Runciman, 290–314. Cambridge: Cambridge Univ. Press

[148] Wimmer A., Cederman LE., and B., Min, 2009. Ethnic Politics and Armed Conflict: A Configurational Analysis of a New Global Data Set. American Sociological Review, 74(2):316-337.

[149] Winters, L., Alan, Neil McCulloch, and Andrew McKay. 2004. "Trade Liberalization and Poverty: The Evidence So Far." Journal of Economic Literature, 42 (1): 72-115.

[150] Wolf A, Arius J, Danielson J, Ward B., Pender J., 1999. International River Basins of the World. Water Resources Development, Vol. 15, No. 4, 387-427.

[151] Wooldridge, J. M., 2002. Econometric Analysis of Cross-Section and Panel Data. MIT Press, Cambridge, MA.

École doctorale Sciences Sociales et Humanités (481)
Laboratoire :
Centre d'Analyse Théorique et de Traitement des données économiques (CATT)
Université de Pau et des Pays de l'Adour (UPPA)
Contact:
tchapo.gbandi@univ-pau.fr

Cities, Ethnic Wars and Water: Three essays in International Economics

Abstract

International trade is one of the key factors that have deeply reorganized the world economy. This thesis addresses three different topics in the field of international economics. It firstly brings new insights on the contribution of international trade to the geographical distribution of populations in countries and secondly, determines trade effect on ethnic conflicts. Afterwards, this document examines the reaction of world trade to international water agreements that increasingly emerged in recent decades as a tool for sustainable and socially equitable development. The contributions of this document stem not only from the originality of the topics discussed and the methodologies adopted, but it also proposes and builds more appropriate indicators that are better suited to capturing the issues under analysis.

Thus, the first chapter assesses whether international trade is relevant in explaining the development of large cities in past European colonies. We argue that trade restrictions can provide an advantage to one city, which may become the platform for exports and catastrophically attracts people. By contrast, trade liberalization, by providing market access to other cities, fosters the dispersion of economic activities and consequently a dispersion of the population. The empirical investigations have led to the conclusion that international trade does not drive the size of large cities in the former colonized countries. Only institutions drive the size of primate cities: democracy goes hand in hand with agglomeration.

The second chapter analyses the relationship between trade and insecurity in African countries. Focusing on ethnic conflicts, this part of the thesis argues that the type of trading partners determines the opportunity cost of an ethnic conflict. The international trade of ethnic groups, the regional trade and countries' internal trade may have heterogeneous effects on peace. The data analyses results support this prediction by pointing out that international ethnic trade and countries' internal trade are peace-promoting tools unlike trade between countries that share at least one ethnic group, which appears as a factor of ethnic conflicts. However, only international ethnic trade seems to reshape the national identity of countries, which in turn reduces the likelihood of ethnic conflicts.

In the last chapter of the thesis, we discuss the growing concern about the international management of shared water resources. As water constitutes an important input in the production of goods, it seems necessary to assess the effectiveness of international water agreements with regards to trade after several decades of implementation. One can argue that these agreements are just "cheap talk", or rather pragmatic attempts to meet the sustainable development objectives to take actions for better water management. Conversely, these agreements, by allowing a better allocation of water resources between countries, can also stimulate production (especially agricultural production) and ultimately trade. Thus, this chapter firstly sheds light on the climate change indicators that are the main drivers of the increasing implementation of shared water resources' agreements. Secondly, it examines whether these agreements affect international trade before proposing their overall effects on countries. In general, the study reveals that water agreements, motivated in particular by high temperature signals, represent a cost to free trade in Europe, Asia and the Americas, except in Africa. Therefore, it seems that these water agreements have substantial environmental protection contents that restrict trade.

Résumé

Le commerce international est l'un des éléments majeurs qui a restructuré profondément la vie des nations et de l'économie mondiale. Cette thèse aborde trois sujets différents dans le domaine du commerce international. Elle apporte en premier lieu, de nouveaux développements sur la contribution du commerce international à la répartition géographique des populations au sein des nations et détermine en second lieu son influence sur les conflits ethniques. Ensuite, elle analyse la réaction des échanges mondiaux aux accords internationaux sur l'eau qui s'érigent ces dernières années comme un outil important du développement durable et socialement équitable. Les contributions de ce document, tiennent non seulement de l'originalité des questions traitées et des méthodes utilisées, tout en proposant et en exploitant des mesures mieux indiquées pour capter les faits analysés.

Dans le premier chapitre, nous analysons si le commerce international a eu un rôle dans le développement des grandes villes des anciens pays colonisés. D'un point de vue théorique, un accès difficile au marché mondial de biens pourrait amener la principale ville à devenir la plateforme des exportations, attirant ainsi les populations. Dans le cas contraire, il y aura une meilleure répartition de l'activité économique dans le pays, et par conséquent moins d'incitation des populations à s'agglomérer dans la capitale. Notre analyse montre que le commerce international semble ne pas affecter la taille des grandes villes dans les anciens pays colonisés. Les institutions restent par contre déterminantes pour expliquer la taille des villes : la démocratie est source de concentration des populations dans les grands centres urbains des pays en développement.

Le second chapitre examine la relation entre le commerce et l'insécurité dans les pays africains. En nous concentrant sur les conflits ethniques, cette partie met en avant le fait que le type de partenaires à l'échange déterminerait le coût d'opportunité à un conflit ethnique. Les résultats obtenus valident cette intuition en démontrant que les échanges internationaux des ethnies, le commerce régional et le commerce interne d'un pays ont des effets hétérogènes sur la promotion de la paix. Ainsi, il ressort que le commerce international des ethnies et le commerce interne des pays ont des effets pacificateurs contrairement au commerce entre pays qui partagent au moins un groupe ethnique. Cependant, seul le commerciale international des ethnies semble remodeler l'identité nationale qui à son tour réduit la probabilité de conflits ethniques.

Le dernier chapitre se concentre sur la fulgurante augmentation des coopérations internationales concernant la gestion des bassins d'eau communs. L'eau étant un élément essentiel des processus de production des biens, il conviendrait de savoir, après plusieurs décennies d'implémentation, l'impact de ces accords sur le commerce. En effet, trois hypothèses concurrentes peuvent être émises. Il se pourrait que ces accords ne soient que des discours politiques sans conséquences réelles n'impactant pas le commerce. Il est aussi possible que ces accords se matérialisent par des tentatives pragmatiques visant à respecter les objectifs de développement durable et dans ce cas, il est probable que ces accords ont un effet négatif sur le commerce. A l'inverse, ces accords permettant une meilleure allocation des ressources en eau entre pays, peut aussi stimuler la production (notamment agricole) et *in fine* les échanges commerciaux. En général, les résultats révèlent que les accords sur l'eau, motivés en particulier par les hausses de température, représentent un coût au libre-échange en Europe, en Asie et en Amérique (mais pas en Afrique), il semble donc que ces accords sur l'eau ont un contenu de protection environnementale important qui limitent les échanges commerciaux

Ph.D. THESIS

UNIVERSITY OF PAU (UPPA)
Doctoral School of Social Sciences and Humanities (ED SSH-481)

Ph. D. dissertation in Economics

by Tchapo GBANDI

Publicly defended on July, 9th 2020

CITIES, ETHNIC WARS AND WATER: THREE ESSAYS IN INTERNATIONAL ECONOMICS

Research center:
Center for the Analysis of Trade and Economic Transition (CATT)

COMMITTEE

EVALUATORS

- Julie LOCHARD — Professor, Université Paris-Est Créteil (UPEC)
- Mathieu COUTTENIER — Professor, Université de Lyon, ENS Lyon

EXAMINERS

- Marion MERCIER — Researcher, CNRS, LEDa-DIAL, Université Paris Dauphine-PSL
- Serge REY — Professor, Université de Pau et des Pays de l'Adour (UPPA)
- Théophile BOUGNA — Researcher in Economics, World Bank Group

ADVISOR

- Fabien CANDAU — Professor, Université de Pau et des Pays de l'Adour (UPPA)

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Centre d'Analyse Théorique et de Traitement des données économiques

Center for the Analysis of Trade and economic Transitions