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Three essays on social structure and its implications

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Abstract

This Ph.D. thesis emphasizes the importance of social structure to understand some economic, social and political outcomes. The first chapter is a political economy piece exploring the impact of the social structure of the elite on resource allocation, scapegoating strategies and violence in developing countries. It extends the framework of Acemoglu and Robinson (2006) by distinguishing between a political elite and an economic elite composed of a rich ethnic minority. It first offers a benchmark where these two elites are segregated due to endogamy. It shows that the presence of a rich ethnic minority changes the interactions between the rent-seeking political elite and the poor majority under the threat of violence. When this threat is high, the government may change its policies strategically to sacrifice the minority to popular resentment. In contrast, when some mixed marriages connect the two elites, the government may altruistically protect the minority from popular violence and reduce its use of instrumental scapegoating.

The second chapter studies how familial decision-making and familial structure impact marriage patterns in societies where arranged marriages are a dominant form of matchmaking. It introduces complex families in the Becker-Shapley-Shubik (1971,1973) matching model on marriages and defines a new concept of familial stability. The introduction of families into the marriage market generates coordination problems which can affect both the assignment and how the marital surplus is shared-out between spouses. The model predicts that we should observe a larger number of stable outcomes when marriages are arranged by parents rather than chosen by individuals. However, unlike individual-stable matchings, family-stable matchings may be inefficient. The study also shows that stable matchings depend on the type of family partitioning. Notably, when each family contains one son and one daughter, familial and individual stability are equivalent.

The third chapter analyzes the structure of the family network resulting from arranged marriages, and its determinants. When parents arrange the marriages of their

children with spouses from different families, this creates marital connections between families. The study considers a matching model in which parents first allocate a premarital investment to their children and then arrange their marriages. In this setting, the most segregated network structure is characterized by positive assortative matching with respect to family revenue and family size. But there are forces that overcome segregation. Differentiated social norms relating to gender only do not change the network structure, but those differentiating between children according to birth order or the gender of their siblings increase its connectivity. Imbalance in the sex ratio also helps connect the network, and the nature of the connection depends on which gender is scarce. Finally, the degree of revenue dispersion also impacts network connectivity. The structure of this network can in turn impact economic, social and political outcomes (Chapter 1).

Résumé

Cette thèse de doctorat met en avant l'importance de la structure sociale pour comprendre certains faits économiques, sociaux et politiques. Le premier chapitre est une analyse d'économie politique explorant l'impact de la structure sociale des élites sur l'allocation des ressources, l'utilisation stratégique de bouc-émissaires et la violence dans les pays en développement. Il étend le cadre d'analyse développé par Acemoglu et Robinson (2006) en faisant une distinction entre une élite politique et une élite économique composée d'une minorité ethnique riche. Il propose d'abord un modèle de référence dans lequel ces deux élites sont ségréguées du fait de normes endogames. Il montre que la présence d'une minorité ethnique riche modifie les interactions entre l'élite politique captatrice et la majorité pauvre sous la menace de violence. Quand cette menace est élevée, le gouvernement peut changer stratégiquement ses politiques afin d'exposer la minorité au ressentiment populaire. En revanche, quand des mariages mixtes lient les deux élites, le gouvernement peut protéger la minorité de la violence populaire et réduire son recours à l'instrumentalisation de bouc-émissaires.

Le deuxième chapitre étudie l'impact de la prise de décision au niveau familial et de la structure familiale sur les schémas de mariages dans les sociétés où les mariages sont arrangés. Il introduit des familles complexes dans le modèle de matching appliqué aux mariages à la Becker-Shapley-Shubik (1971, 1973) et définit un nouveau concept de stabilité familiale. L'introduction de familles dans le marché du mariage génère des problèmes de coordination qui peuvent modifier à la fois l'appariement des époux et la manière dont le surplus marital est partagé entre eux. Le modèle prédit qu'on devrait observer un plus grand nombre de situations stables quand les mariages sont arrangés par les parents plutôt que choisis par les individus. Mais, contrairement aux matchings stables pour les individus, les matchings stables pour les familles peuvent être inefficaces. L'étude montre aussi que les matchings stables dépendent du type de partition familiale. En particulier, quand chaque famille est composée d'un fils et d'une fille, les concepts de stabilité familiale et de stabilité individuelle sont équivalents.

Le troisième chapitre analyse la structure du réseau des familles issu des mariages arrangés, ainsi que ses déterminants. Quand les parents arrangent le mariage de leurs enfants avec des époux de différentes familles, cela crée des connexions maritales entre les familles. Cette étude considère un modèle de matching dans lequel les parents allouent d'abord un investissement prémarital à leurs enfants, puis arrangent leurs mariages. Dans ce cadre, la structure de réseau la plus ségréguée est caractérisée par de l'homogamie selon le revenu et la taille de la famille. Mais il y a des forces qui brisent cette ségrégation. Si les normes sociales qui différencient les enfants selon le genre ne modifient pas la structure du réseau, celles qui les différencient selon l'ordre de naissance et la composition de leur fratrie accroissent sa connectivité. Un déséquilibre dans le sexe-ratio permet également de connecter le réseau, et la nature de cette connexion dépend du genre le moins fréquent. Enfin, le degré de dispersion des revenus affecte également la connectivité du réseau. La structure de ce réseau peut à son tour avoir des effets économiques, sociaux et politiques (Chapitre 1).

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General Introduction

The guiding principle of this Ph.D. thesis is social structure and its importance to explain some economic, social and political outcomes. Everyday, individuals take decisions while they are embedded in a given social structure. These decisions can in turn affect social structure. Finally, this very social structure shapes information and opportunities that individuals receive, and on which their decisions rely. These issues have been studied since the second half of the 20^{th} century by anthropologists and sociologists (Polanyi 1944, Granovetter 1985, 2005), and more recently by economists, in particular with the development of the literature on economic and social networks (Jackson 2010, Bramoullé et al. 2016, Jackson et al. 2017).

This thesis adresses these issues through the study of matrimonial decisions and their importance for the creation of social structure. When two individuals marry, they create a new link between them. But they also create a new link between two families composed of a given number of individuals, who are themselves connected by marital relationships to other families. This network of families connected with each others through the marriages of their children is an essential founding basis of social structure. So, starting from a pre-existing social structure composed of families, individuals take matrimonial decisions, which create new connections between families. Thus social structure develops. In turn, this new family network leads to consequences for individuals and their families. For instance, De Weerdt et al. (2019) study a sample of 3 173 households from 712 extended family networks in the Kagera Region in Tanzania. They show that out of all private transfers among these households, 59% goes to recipients within the extended family network. Moreover, in the United States, Greenwood et al. (2014) find that in the last fifty years, individuals more likely choose a partner with similar educational levels. They show that these matrimonial choices triggered a rise in income inequality in the country. When imposing the 1960 matching patterns for marriages on the 2005 earning distribution, they find that the Gini coefficient drops from the original 0.43 to 0.35.

However, the analysis of the formation and the structure of the family network is overlooked by the economic literature. So far, matrimonial choices and their impacts on society are studied through matching models building on the seminal works of Becker (1973, 1981). But classical matching models applied to marriages (Browning et al. 2014, Chiappori 2017) cannot be used to study the structure of the family network following from individuals' matrimonial decisions. This comes from the fact that these models consider a two-sided market, with men on one side and women on the other side, deprived of any other pre-existing familial structure. So, when two individuals marry, this only affects the two of them. In equilibrium, classical matching models generate a simple network composed of disconnected couples. By contrast, if we bring back families, potentially composed of several siblings, these extended matching models create complex networks of interconnected families.

This familial dimension is particularly important in societies where marriages are arranged, i.e. in which parents choose the spouses of their children. Arranged marriages are the dominant form of matchmaking in Asia, Africa and the Middle East (Hamon and Ingoldsby 2003). For instance, a survey of 5 000 representative households conducted in Southern India in 2016 reveals that 86% of respondents had their marriages arranged (Border et al. 2017). Compared with societies in which individuals are free to choose their mate, societies in which marriages are arranged have stricter informal social norms on marriages. These norms constrain and shape the structure of the family network. In North and West Africa, the Middle East and South Asia, close-kin marriages is a widespread practice (Do et al. 2013, Hotte and Marazyan 2018). In India, children must be married within their caste, so the castes define independent marriage markets (Border et al. 2017). Using data on marriages within the German and English nobilities from the 1500s to the 1800s, Marcassa et al. (2018) find that the German nobility was much more stratified than the English nobility, because they had more stringent constraints on dowries. So, when families arrange the marriages of their children, they have to take into account their familial composition and also the social norms that prevail in society. In some populations, especially among the elites, parents also value the position that the family will have in the matrimonial network once marriages are arranged. This position depends on the matrimonial decisions they take for their children. Thus their decisions are taken strategically. Jackson (2010) discusses the example of the marriage network in Renaissance Florence. Drawing on Padgett and Ansell (1993), he suggests that the central position of the Medici family in the marriage network may have enabled them to dominate the Florentine oligarchy. Anticipated or not, the structure of the family network leads in turn to economic, social and political consequences for each family and for the whole society. If the network is well-connected, information, opportunities, and social norms can easily circulate. In contrast, Jackson et al. (2017) explain p.51 that “in sufficiently segregated networks, different behaviors, norms, and expectations can persist in different communities which, in turn, can have consequences for human capital investments, career choice, and various other behaviors”.

So, the subject of this thesis is this permanent interaction between social structure and individual decisions, studied through three theoretical research papers. The first chapter analyzes the economic, social and political consequences of matrimonial structure in an applied framework. The second chapter explores how familial structure and composition change marriage patterns when families arrange the marriages of their children. The third chapter studies the structure of the family network following from arranged marriages. From a theoretical perpective, this thesis presents an extension of matching models to study arranged marriages. So far, these family considerations have been neglected by the existing matching literature applied to marriages. It introduces explicitly and for the first time arbitrary families in the assignment game of Shapley and Shubik (1971), and studies the game in which families are the players, instead of the individuals. It also offers a new connexion between the literatures on matching and on network formation. It is the first study of the structure of the family network stemming from matching with families on the marriage market.

Chapter 1 is a political economy piece applied to developing countries where the political elite comes form the ethnic majority, while the economy is dominated by an ethnic minority of foreign origin. Examples include Chinese throughout Southeast Asia, Indians in East Africa and Lebanese in West Africa. These rich ethnic minorities are often subject to popular violence and extortion, sometimes fueled by local politicians even though they financially benefit from their presence (Bierwirth 1999, Chua 2004, Adam 2010, Bezemer and Jong-A-Pin 2013). This chapter aims at exploring the impact of the structure of the matrimonial network of these two elites on resource allocation, scapegoating strategies and violence in these countries. It extends the framework of Acemoglu and Robinson (2006), in which a rent-seeking political elite interacts with the people, by introducing an economic elite composed of an ethnic minority. We first study the case where these two elites are perfectly segregated due to strict endogamous norms. We show that the presence of the rich ethnic minority changes the interactions between the political elite and the people. When the threat of popular violence is high because of political instability or economic crisis, the government strategically changes its economic policies in order to deflect popular violence towards the rich ethnic minority. We say that the government uses a strategy of instrumental scapegoating. In contrast, when some mixed marriages connect the two elites, the government may altruistically protect the minority from popular violence and significantly reduces its uses of instrumental scapegoating. Overall, the prospect of violence is reduced. This chapter shows that the structure of the matrimonial network of the elites, depending on whether it is strictly endogamous or whether it displays some mixed unions, strongly affects the economic policies of the government, its behavior towards the rich ethnic minority and the eruption of violence in society.

Chapter 2 studies how familial decision-making and familial structure impact marriage patterns in societies where arranged marriages are the dominant form of matchmaking. It is the first study which introduces complex families in the classic matching model applied to marriages, in order to study arranged marriages (Shapley and Shubik 1971, Becker 1973, Browning et al. 2014, Chiappori 2017). It defines a new concept of familial stability, which naturally extends the concept of individual stability or *pairwise stability*. In classical matching models, a matching is stable if there are no two individuals who would rather sever their respective marriages and marry together. In our extension, a matching is stable for families if there are no two families who would rather rearrange the marriages of some of their children among themselves. With transferable utilities between spouses and within families, this chapter shows that matchings which are stable for individuals are always stable for families. By contrast, there are matching that are stable for families, but not for individuals. This implies that arranged marriages potentially generate strong tensions within families. The introduction of families into the marriage market generates coordination problems which can affect both the assignment and how the marital surplus is shared-out between spouses. The model predicts that we should observe a larger number of stable outcomes when marriages are arranged by parents rather than chosen by individuals. However, unlike individual-stable matchings, family-stable matchings may be inefficient. The study also shows that stable matchings depend on the familial structure. It seems that the more heterogenous the families in terms of size and gender distribution, the more likely we observe inefficient matchings. Moreover, the more competition, i.e. the higher the number of families for a given number of children in the population, the smaller the set of shares of surplus that support efficient matchings as family-stable. Notably, when each family contains one son and one daughter, familial and individual stability are equivalent.

Chapter 3 analyzes the structure of the family network following from arranged marriages, and its determinants. It is the first study of the characteristics of a network formed by a matching model. Just as Chapter 2, this chapter uses a matching model applied to marriages in which arbitrary families are introduced. But unlike Chapter 2, in Chapter 3 parents first allocate a premarital investment to their children and then arrange their marriages. The investment received by a child determines its quality on the marriage market. This chapter offers a simple model to generate a micro-founded rule on premarital investments. The optimal investment received by a child depends positively on its family's revenue and negatively on the number of its siblings. It also depends on informal social rules that prevail in society. Then, the chapter explores the sufficient conditions on demography, social norms and revenue dispersion to obtain a family network perfectly segregated by family size and income class. The forces that overcome segregation are then studied. Differentiated social norms relating to gender only do not change the network structure, but those differentiating between children according to birth order or the gender of their siblings increase its connectivity. Imbalance in the sex ratio, even small, also helps connect the network, and the nature of the connection depends on which gender is scarce. When girls are more numerous than boys, the family network is vertically connected through hypogamous marriages, i.e. marriages in which the family of the groom is poorer than the family of the bride. When boys are more numerous, connections are hypergamous. Finally, the degree of revenue dispersion also impacts network connectivity. The higher the revenue dispersion within income classes, the more the family network exhibits some social mix: the proportion of marital links between families of different sizes or different income classes increases. Moreover, its seems that the network structure is more connected: the number of components decreases, the size of the biggest component increases and the diameter within the biggest component decreases. In contrast, the higher the revenue dispersion between income classes, the more likely we observe a network perfectly segregated by income class. The structure of this family network can in turn impact economic, social and political outcomes reaching individuals, their families and thus the whole society, as Chapter 1 shows.

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Chapter 1

Violence against Rich Ethnic Minorities: a Theory of Instrumental Scapegoating[1]

1.1 Introduction

In many developing countries, the economy can be seen to be dominated by a specific ethnic minority. The Chinese, for instance, have long played a key role throughout Southeast Asia. In the Philippines, they represent 1% of the population but control 60% of the private economy; the numbers for Indonesia are, respectively, 3% and 70% (Chua 2004). In East Africa, private economies are often controlled by "Indians", that is, descendants of Indian families who migrated during the British colonization.[2] In many countries of West Africa, the Lebanese diaspora plays a similar role.[3] Despite their importance for the economies of their countries of adoption, these rich minorities are often subject to popular violence and extortion. Well-documented episodes include attacks against Indians during the 1964 Zanzibar revolution, anti-Indian riots in Kenya in 1982, anti-Chinese riots in Indonesia in 1998, beatings and murders of Lebanese in Ivory Coast in 2011, violence against Chinese-owned factories in Vietnam in 2014, and

[1] This chapter is a joint work with my advisor Yann Bramoullé

[2] In Madagascar, Indians represent less than 1% of the population but own 50 to 60% of the country's economy (Indian Ministry of External Affairs 2002); In Tanzania, they represent 0.2% of the population and control 75% of the businesses (Puri 2013).

[3] For instance in Ivory Coast, the Lebanese represent less than 1% of the population but own 50% of the industrial sector, 99% of malls, 80% of the fish trade and export industry, 60% of the construction sector and 75% of the import and export of wood (The Daily Star Lebanon 2011).

kidnappings of Indians in Madagascar in recent years. Moreover, and as forcefully argued by Amy Chua, violence against "market-dominant" minorities seems to have been fueled by globalization, see Chua (2004). As the difference in wealth levels between rich and poor increases, popular envy and discontent increase as well, and violence may be further amplified by the actions of populist governments.[4]

More generally, local politicians seem to display an ambiguous attitude towards these communities. When times are good, business-oriented minorities seem to be warmly welcomed and well-treated. In fact, relationships between local politicians and market-dominant minorities often devolve into crony capitalism, involving favored allocation of import licenses and public contracts. Examples include Suharto's well-documented favoritism towards his Chinese cronies in Indonesia in the 1980s, Daniel Arap Moi's initial position towards Indians when he became President of Kenya in 1979 and corruption in the diamond industry in Sierra Leone. However, these same communities provide convenient scapegoats when popular discontent is brewing. Local governments often fail to protect them from popular violence, riots and looting, or even actively fan the flames of ethnic hatred. Auregan (2012) notes that Lebanese-bashing is regularly used by politicians in West Africa when the incumbent government is going through a difficult time. In 1982, following shortages and price increases in staple foods, President Moi changed position and publicly accused Indians of causing the problems.[5] Hate-filled, outrageous declarations by politicians are not uncommon, see Adam (2009).

Market-dominant minorities have received surprisingly little attention from economists.[6] Their prevalence is somewhat puzzling, however. Why would a predatory elite grant outsiders privileged access to local markets? We develop a new model to help answer this question. The key mechanism is that, thanks to the presence of a rich ethnic minority, the local elite can always avoid popular violence. When popular discontent is brewing, the elite can deflect violence towards the minority. Our analysis helps rationalize the three stylized facts identified above: the prevalence of market-dominant minorities throughout the developing world, the fact that they often find themselves the victims of popular violence and the ambiguous attitude of the local elite towards them. Overall, it provides

[4] Bezemer and Jong-A-Pin (2013) find some support for Chua's claims in Subsaharan Africa.

[5] In a widely disseminated discourse pronounced on February $6th$ 1982, Moi declared: "Instead of Indians using their advanced knowledge in business to help Africans improve their profit margins, Asians in this country are ruining the country's economy by smuggling currency out of this country and even hoarding essential goods and selling them through the backdoor", see The New York Times (1982).

[6] We review the scant existing literature below.

an aid to understanding under what conditions politicians use the rich ethnic minority as a scapegoat.

Our analysis builds on a growing literature, initiated by Acemoglu and Robinson (2006), which models interactions between an elite and a poor majority under the threat of violence. To date, most economics studies have viewed the elite as a homogenous, cohesive group. This simplifying assumption is inadequate to analyze the politics of developing countries with a market-dominant ethnic minority. We relax this assumption and introduce a rich ethnic minority in the benchmark, static model of Acemoglu and Robinson (2006). The political, rent-seeking elite chooses how much to tax formal economic activities and how much to redistribute to the people. The poor majority may decide to become violent and to appropriate resources by force. We assume that popular violence can be directed against either the political or the economic elite, reflecting the fact that specific social groups are generally targeted during violent episodes.

We show that the presence of the rich minority has a first-order impact on outcomes. We find that it always allows the local political elite to maintain its hold on power. When the economic elite is much wealthier than the political elite, it provides a natural target for popular discontent. In other cases, the government changes its policies to deflect popular violence towards the rich minority. It may reduce its tax rate and even transfer resources to the poor majority to make the economic elite a more attractive target, in effect applying a strategy of *instrumental scapegoating*. We show that scapegoating is a strategy of last resort. When the threat of violence is not overly high, the government prefers to tax the economic elite at a high rate and to buy social peace by redistributing parts of its revenues to the people. The transition between peace and violence is discontinuous and leads to non-monotonic variations in economic policies.

We then study the determinants of violence. We find that violence is more likely to emerge when the poor majority is poorer and better able to solve its collective action problem. Collective ability is likely higher in uncertain times, when stakes are higher. Therefore, our model predicts that violence is most likely to appear in times of both economic crisis and political instability. This prediction is consistent with recent evidence on anti-Jewish pogroms in Eastern Europe, see Grosfeld et al. (2017). Violence also depends on elites' incomes. Violence tends to be more likely when the economic elite becomes richer. This is consistent with Amy Chua's thesis that increases in inequality caused by globalization fueled violence against rich minorities. By contrast, an increase in the rents controlled by the political elite tend to improve its ability to buy social peace and hence to reduce violence. These countervailing effects may help explain the mixed empirical findings obtained on Chua's thesis, see Bezemer and Jong-A-Pin (2013).

Finally, we relax the assumption of complete separation between the two elites. We consider some partial social integration, for instance, via mixed marriages and shared education, leading to utility interdependence between the two groups. Sociological and anthropological studies reveal substantial variation in the degrees of integration of rich ethnic minorities. Part of this variation seems culturally determined.[7] For instance, in East African countries and Madagascar, long-established Chinese migrants seem to be better integrated than descendants of migrants from India, see Fournet-Guérin (2009). We show that social integration strongly affects outcomes. It decreases the likelihood of the rich minority becoming the target of popular violence and may incite the government to buy social peace even without material benefits. We also find that integration changes economic policies, in particular leading the government to favor a reduction in tax rate over an increase in redistribution when seeking to avoid violence.

Our analysis contributes to the literature on the political economy of developing countries. We provide one of the first analyses of the impact of the presence of a rich ethnic minority on violence and on interactions between a rent-seeking local elite and a poor majority.[8] Glaeser (2005) studies the strategic use of hatred speeches against an out-group when two political parties compete in elections. We consider a rent-seeking government here, and show how it can use economic policies strategically to deflect popular violence. Anderson et al. (2017) study the impact of weather shocks on the persecution of Jews in Medieval Europe.[9] Their empirical finding that persecution may have strong economic determinants is in line with our framework and results. In a different context, Miguel (2005) also finds that scapegoating episodes have underlying economic determinants. Using local rainfall variation, he shows that witch killings in Tanzania may be caused by decreases in income rather than by irrational beliefs or cultural norms. Oster (2004), Burke et al. (2009) and Harari and La Ferrara (2012) find similar patterns in other contexts. In a political economy framework, we show

[7]Maintaining a strong separate identity could also be a rational answer to the possibility of future violence and expulsion. Endogenizing the level of social integration would be an interesting direction for future research, see the Conclusion.

[8]Our analysis thus contributes to a large, growing literature on ethnic divisions and conflicts, see e.g. Esteban and Ray (2011), Caselli and Coleman (2013), Alesina et al. (2016).

[9]Voigtländer and Voth (2012) show that violence against Jews in medieval Germany partially determines persecution under Nazi Germany.

that scapegoating may emerge for purely economic reasons and we provide a detailed analysis of its anatomy.

The remainder of the paper is organized as follows. We present our model in Section 1.2. We analyze the interactions between the three groups under separate elites in Section 1.3. We relax this assumption and look at the impact of social integration in Section 1.4. We conclude in Section 1.5.

1.2 The model

We consider an economy composed of three groups: a local political elite, a rich ethnic minority and a poor majority. Group sizes are, respectively, n_e, n_m and n_p with $n_e, n_m \ll n_p$. Society is not democratic: the political elite takes all political decisions unless it gets ousted from power. We assume in Sections 1.2 and 1.3 that every group seeks to maximize its material payoff.[10] This means, in particular, that the political elite is purely rent-seeking and does not care about social welfare. In Section 1.4, we introduce some social integration between the economic and the political elites. We study how the interdependence in payoffs generated by such integration affects outcomes.

There are three sources of income in the economy. The political elite obtains some rents R originating, for instance, from natural resources or foreign aid. The formal sector of the economy is run by the ethnic minority and generates a taxable per capita income of y_m. People in the poor majority work in the informal sector in activities such as home-scale agriculture, self-employed sellers or peddlers, and earn a per capita non-taxable income of $y_p \ll y_m, \frac{R}{n_e}$.[11] We assume here that the poor do not work for the rich. This is a strong simplifying assumption, as it often happens in reality that some members of the poor majority are employed in firms held by the rich ethnic minority. We discuss in the Conclusion an extension in which some people from the poor majority work in ethnic-minority-owned businesses.

[10]We consider a political elite which is sufficiently small and cohesive to act as a single actor. In contrast, the poor majority may suffer from problems of collective action. As discussed in Acemoglu and Robinson (2006), these difficulties are captured in the reduced-form parameter μ below.

[11]Benjamin et al. (2014) explain p.8 that "the most common criteria used to define the informal sector are size of the activity, registration with a government agency, and keeping regular account". Following Gelb et al. (2009), we consider that registration with tax authorities is the criterion to distinguish between the formal and the informal sectors.

Interactions between the local elite, the rich minority and the poor majority take place in three stages. Given a threat state μ,[12] the political elite chooses a tax rate $\tau \in [0, 1]$ and a level of per capita transfer $t \geq 0$.[13] Formal economic activities are taxed at rate τ. People then decide whether to exert violence against the local elite (V_e), the rich minority (V_m), or to remain non-violent (N). If the political elite is not attacked, transfers are distributed to the poor majority and all individuals consume. We assume that the economic elite stays passive in what follows, for instance because the local elite severely limits what it can do. We discuss this assumption in more depth in Section 1.5.

As in Acemoglu and Robinson (2006), we assume that raising taxes is costly. These costs, $C(\tau)$, capture both direct administrative costs and the distortionary effects of taxation on the economy. We assume that $C(0) = 0$, $C' > 0$, $C'' > 0$, $C'(0) = 0$ and $C'(1) > 1$.

When there is no risk of violence, a member of the local elite earns $\pi_e = \frac{1}{n_e}(R - n_p t + (\tau - C(\tau))y_m n_m)$, a member of the rich minority earns $\pi_m = (1 - \tau)y_m$ and a member of the poor majority earns $\pi_p = y_p + t$. To maximize its payoff, the political elite simply sets $t = 0$ and $\tau = \tau^*$ such that $C'(\tau^*) = 1$. The people do not receive any transfer, and the rich minority is taxed at the level that maximizes tax revenues for the group in power.

The possibility of violence modifies the analysis quite extensively. We make the following assumptions on the effects of violence. First, popular violence is directed against one of the two elites. Second, as in Acemoglu and Robinson (2006), we assume that when there is violence, a fraction μ of the resources are destroyed and that the people share what remains among themselves.[14] Third, faced with imminent violence the political elite can flee the country and obtain a payoff π_0 coming, for instance, from money diverted towards offshore accounts in the past.

Formally, if the people revolt against the elite in power, payoffs are $\pi_e = \pi_0$, $\pi_m = (1 - \tau)y_m$ and $\pi_p = (1 - \mu)(y_p + \frac{1}{n_p}(R + (\tau - C(\tau))y_m n_m))$. If the people target the rich minority instead, members of the different groups obtain, respectively, $\pi_e = \frac{1}{n_e}(R - n_p t + (\tau - C(\tau))y_m n_m)$, $\pi_m = 0$ and $\pi_p = (1 - \mu)(y_p + t + \frac{1}{n_p}(1 - \tau)y_m n_m)$.

[12] As in Acemoglu and Robinson (2006), the motivation for introducing this parameter is to emphasize that only in some situations is there an effective threat of violence. They explain p.145 that "this could be because some circumstances are uniquely propitious for solving the collective-action problem - such as a harvest failure, a business-cycle depression, the end of a war, or some other economic, social or political crisis."

[13] Members of the economic elite are not eligible to receive these transfers.

[14] We also assume that the resources of the group that is not the target of the violence are unaffected by this destruction.

So the timing of the game is as follows.

- Nature selects a threat state μ. The political elite chooses τ and t.
- Formal economic activities are taxed. People choose between N, V_e or V_m.
- Transfers are distributed only if N or V_m has been chosen. Individuals consume.

We solve the game backwards. In the second stage and depending on tax and transfer levels, the poor majority decides whether to become violent and against which privileged group. In the first stage and anticipating popular actions, the political elite chooses public policies that maximize its material payoff.

We now analyze the benchmark case without a rich ethnic minority. If the people remain non-violent, they obtain $\pi_p = y_p + t$, while members of the elite obtain $\pi_e = \frac{1}{n_e}(R - n_p t)$. If the people overthrow the elite, they obtain $\pi_p = (1-\mu)(y_p + \frac{1}{n_p}R)$ and members of the elite flee the country $\pi_e = \pi_0$. We see three domains emerging. First, the people may not rebel even when the elite captures all rents. This is an equilibrium if $(1-\mu)(y_p + \frac{1}{n_p}R) < y_p$, which is equivalent to $\mu > \mu_{threat} = R/(R + y_p n_p)$. If the cost of violence falls below this threshold, however, the people do not peacefully accept a situation with no redistribution. The elite may avoid violence by redistributing part of the rents. More precisely, it sets the lowest possible transfer, i.e., the transfer $\hat{t}$ that makes people indifferent between violence and non-violence. Formally, $\hat{t} = (1-\mu)\frac{R}{n_p} - \mu y_p$. In that case, an elite member earns $\frac{1}{n_e}(R - n_p\hat{t}) = \frac{1}{n_e}\mu(R + n_p y_p)$. This is an equilibrium as long as such *self-protective redistribution* is not excessively costly for the elite. If $\pi_e < \pi_0$, the elite rationally decides to flee the country. This is equivalent to $\mu < \mu_{exile} = n_e\pi_0/(R + n_p y_p)$. To sum up:

Proposition 1.1. *Suppose that there is no rich ethnic minority. If $\mu \geq \mu_{threat}$, the political elite captures all rents and the poor majority does not rebel. If $\mu_{exile} < \mu < \mu_{threat}$, the political elite redistributes positive transfers $\hat{t}(\mu) = (1-\mu)\frac{R}{n_p} - \mu y_p$ and people remain peaceful. If $\mu < \mu_{exile}$, the people overthrow the political elite.*

When the cost of violence takes intermediate values, the political elite *buys social peace* by transferring resources to the people on the condition that they remain non-violent. Since $\hat{t}(\mu_{threat}) = 0$, the transition to the regime of positive transfers is continuous. As the cost of violence decreases, this transfer increases until it reaches the point where it leaves the elite too impoverished.

We represent graphically these three equilibrium regions in Figure 1.1.[15] We represent the material payoff of a member of the poor majority in red, and the payoff of a member of the political elite in blue. The threshold μ_{threat} is defined at the point where the payoff of the people without transfer and the payoff the people would get if they attacked the political elite intersect. The threshold μ_{exile} is defined at the point where the payoff of the elite redistributing parts of its rents to the people and the payoff the elite would get if it fled the country intersect.

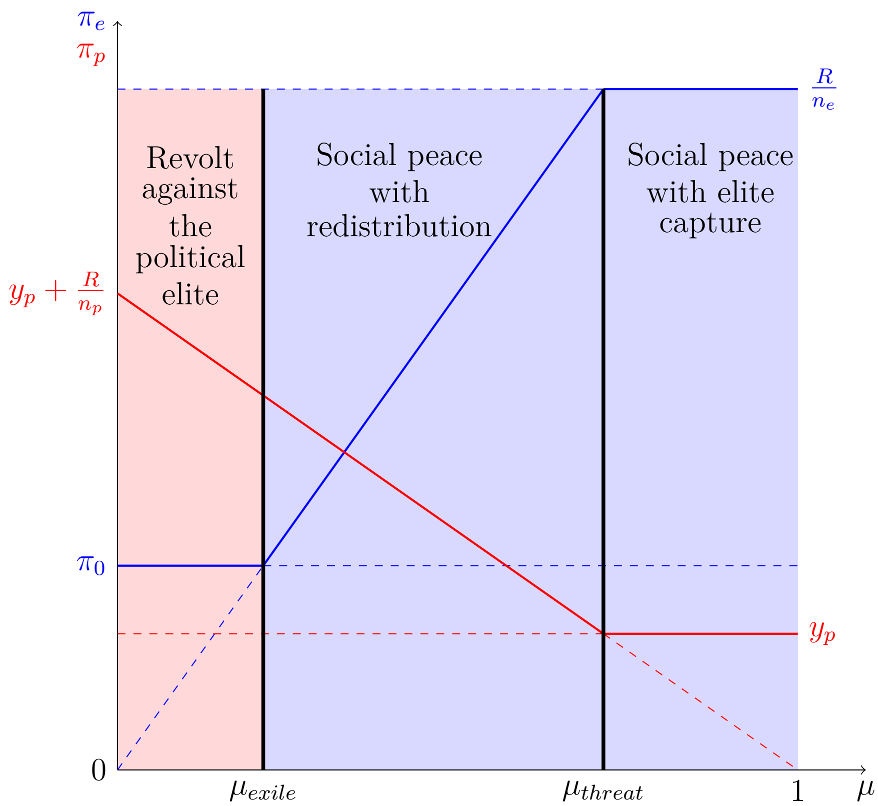

Figure 1.1 – Equilibrium regions in the absence of a rich ethnic minority

How do changes in parameters affect outcomes? A decrease in y_p or n_p leads to an increase in both μ_{threat} and μ_{exile}. When the poor majority is poorer or less numerous, violence is more attractive, making it more difficult for the political elite to buy social peace. Violence is thus more likely to emerge when the poor majority is poorer and more able to solve its collective action problem. By contrast, as rents R increase observe that μ_{threat} increases while μ_{exile} decreases. On the one hand, the elite is richer, which

[15] We use the following numerical example: $R = 5000$, $n_e = 10$, $\pi_0 = 150$, $y_p = 2$, $n_p = 1000$. We represent π_e at a scale of 1:50.

makes it a more ready target for popular discontent. On the other hand, the elite is both more able and more willing to buy social peace, since it has more to lose by leaving the country. Overall, the range of parameters over which the poor majority receives a positive transfer expands and violence is less likely to occur.

1.3 Separate elites

In this section, we characterize the unique subgame perfect equilibrium of the game in the presence of a rich ethnic minority. We find that the existence of this third group enriches the analysis substantially, even when this group does not or cannot act to avoid violence. We first informally discuss its effects and then state our main result formally and discuss its implications in more detail.

First, the presence of the rich minority increases the political elite's payoff via increased tax revenues. This increase in payoffs is double-edged. While the government has more resources at its disposal - and hence can more easily influence outcomes - it also becomes a more attractive target for popular violence. However, this negative effect is outweighed by a second, key consequence. The rich minority represents another group that can be attacked by the poor majority. We find that the political elite can now always avoid being overthrown. The government can deflect popular anger towards the rich ethnic minority.

We study precisely when and how the political elite is likely to sacrifice the rich ethnic minority. We find that the difference in wealth between the two elites plays a crucial role. Two domains emerge. On the one hand, the ethnic minority may be richer, after tax τ^*, than the political elite. This happens when $(1-\tau^*)y_m n_m > R + (\tau^* - C(\tau^*))y_m n_m$. In that case, the government is not threatened by popular violence. The rich minority provides a natural target for popular discontent due to its large wealth. The government then simply sets its preferred policies of high tax and zero transfers and lets violence run its course when μ is low. Despite its rent-seeking behavior, the government ends up protected from popular anger by the presence of the rich minority.

On the other hand, the ethnic minority may be poorer than the political elite after tax τ^*. Formally, $(1-\tau^*)y_m n_m < R + (\tau^* - C(\tau^*))y_m n_m$. In that case, we find that buying social peace is preferred by the government when the cost of violence is intermediate, while deflecting violence towards the minority is preferred when the cost of violence is low. To buy social peace, the government increases the levels of transfers as the cost of violence decreases, while leaving its tax unchanged. To turn the minority into a scapegoat, the government abruptly changes transfer and tax levels. Two cases emerge. When the ethnic minority is richer before tax than the political elite, the government simply lowers its tax rate and does not need to provide transfers. The ethnic minority becomes temporarily richer and hence provides a more attractive target. However, when the ethnic minority is poorer before tax than the political elite, the government now has to cancel its tax and make a positive transfer. The transfer is needed to provide an extra incentive for people to attack the ethnic minority, since it will not occur if the government is overthrown. In either case, the government deliberately manipulates its economic policies to deflect popular violence towards the rich ethnic minority. *Scapegoating is instrumental here*, and emerges as a way for the political elite to maximize its monetary payoff.

We next state our result formally. We introduce the following notations, and provide a detailed proof in Appendix 1.A. As in Proposition 1.1, introduce $\mu_{threat^e} = [R+((\tau^* - C(\tau^*))y_m n_m]/[R + ((\tau^* - C(\tau^*))y_m n_m + y_p n_p]$ and $\mu_{threat^m} = [(1-\tau^*)y_m n_m]/[(1-\tau^*)y_m n_m + y_p n_p]$. These are the cost of violence values that leave the poor majority on the verge of attacking the political elite (μ_{threat^e}) or the rich minority (μ_{threat^m}). Let $\hat{t}$ be the transfer that makes people indifferent between violence against the government and non-violence: $\hat{t}(\mu) = (1-\mu)[R + ((\tau^* - C(\tau^*))y_m n_m]/n_p - \mu y_p$. When the economic elite is richer than the political elite before tax but poorer after tax, define $\bar{\tau}$ as the unique tax rate that satisfies $(1-\bar{\tau})y_m n_m = R + (\bar{\tau} - C(\bar{\tau}))y_m n_m$ and $\mu_{scapegoat} = (1-\bar{\tau})y_m n_m/[R+((\tau^* - C(\tau^*))y_m n_m + y_p n_p]$. When the economic elite is poorer than the political elite before tax, define $\bar{t} = (R - y_m n_m)/n_p$ and $\mu_{scapegoat} = y_m n_m/[R + ((\tau^* - C(\tau^*))y_m n_m + y_p n_p]$. We show in Appendix 1.A that $\mu_{scapegoat}$ is precisely the value that makes the government indifferent between buying social peace and deflecting violence towards the rich ethnic minority.

Proposition 1.2. *Consider a society composed of a local political elite, a rich ethnic minority and a poor majority.*
1. If $(1-\tau^*)y_m n_m > R + (\tau^* - C(\tau^*))y_m n_m$:
- If $\mu \geq \mu_{threat^m}$, then $\tau = \tau^*$, $t = 0$ and there is no violence.
- If $\mu_{threat^m} > \mu$, then $\tau = \tau^*$, $t = 0$ and the poor majority attacks the rich minority.
2. If $(1-\tau^*)y_m n_m < R + (\tau^* - C(\tau^*))y_m n_m$:
- If $\mu \geq \mu_{threat^e}$, then $\tau = \tau^*$, $t = 0$ and there is no violence.
- If $\mu_{threat^e} \geq \mu > \mu_{scapegoat}$, then $\tau = \tau^*$, $t = \hat{t}(\mu)$ increases when μ decreases and there is no violence.

- *If $\mu_{scapegoat} > \mu$, then the poor majority attacks the rich minority. If $y_m n_m > R$, then $\tau = \bar{\tau}$, $t = 0$ while if $y_m n_m < R$, then $\tau = 0$, $t = \bar{t}$.*

We represent graphically the thee equilibrium regions for the third regime[16] in Figure 1.2. The threshold μ_{threat^e} is defined at the point where the payoff of the people without transfer and the payoff the people would get if they attacked the political elite intersect. The threshold $\mu_{scapegoat}$ is defined at the point where the payoff of the elite redistributing parts of its rents to the people and the payoff the elite would get if it deflected violence towards the ethnic minority intersect.

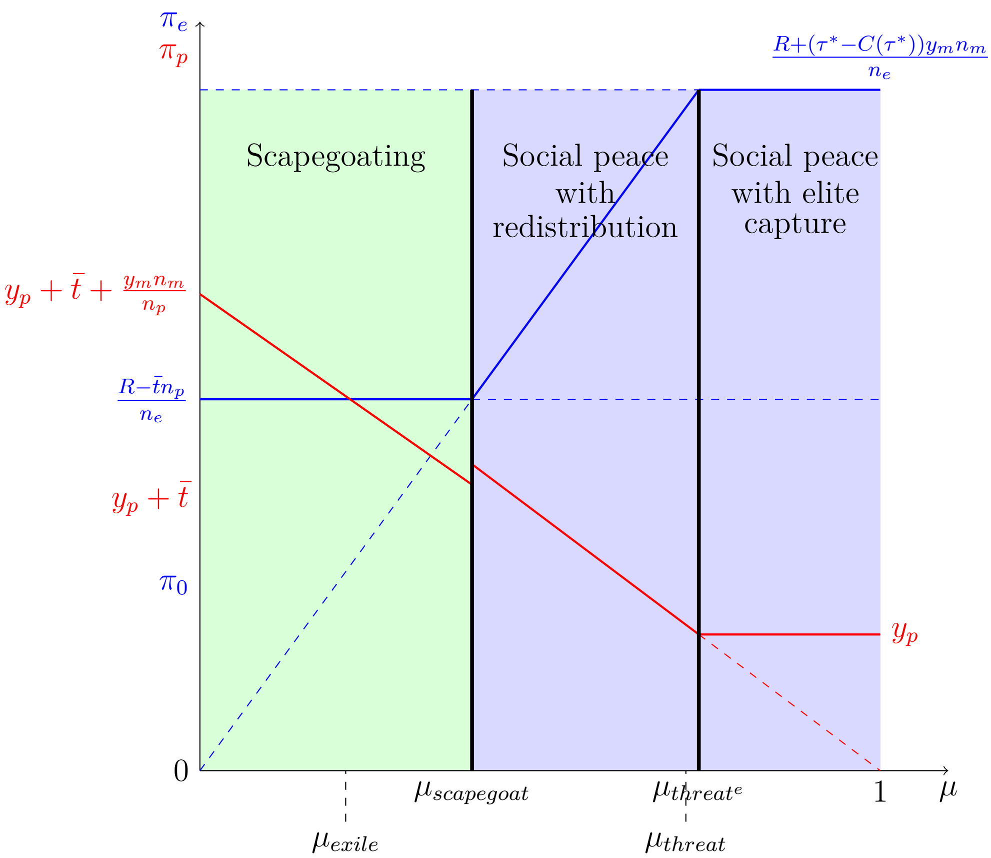

Figure 1.2 – Equilibrium regions in the presence of a rich ethnic minority

Let us highlight four implications of Proposition 1.2. First, as already mentioned, the political elite now always avoids popular violence. In particular, it can redirect the

[16]The third regime is when the economic elite is poorer than the political elite before tax, i.e. $y_m n_m < R$. We use the following numerical example: $R = 5000$, $n_e = 10$, $y_p = 2$, $n_p = 1000$, $y_m = 300$, $n_m = 10$, $C(\tau) = \frac{3}{2}\tau^2$. This leads to $\tau^* = 1/3$ and $\bar{t} = 2$. We represent π_e at the scale of 1:60.

threat of violence and stay in power even in situations where it would flee the country in the absence of a rich ethnic minority.

Corollary 1.1. *In the presence of a rich ethnic minority, the local political elite can always maintain its hold on power and avoid popular violence.*

In a way, the economic elite acts as a fuse for the political elite. When the risks of an uprising become too strong, the government alters its public policies so as to become a less attractive target. This result shows that scapegoating can appear for purely material reasons, absent considerations of religion, hate or identity.[17] In reality, local elites of course have other margins of behavior than economic policies. They typically control the media, for instance, and can use the media to incite ethnic hatred. We discuss these issues in more detail in the Conclusion.

An important implication is that local elites should be particularly motivated, ex-ante, to attract an economically dominant minority to their country. In addition to the monetary benefits expected from such a move, the minority community may provide a convenient way to contain future popular discontent. If the risks of violence are low, the community's expected benefits from moving in the country may be high. The ethnic minority may then gain, in expectation, from moving in and running the formal economy of the country, while being aware that it could end up being the victim of violence in specific circumstances.

Second, we find that even a purely selfish political elite prefers to buy social peace when the prospects of violence are not overly high. Turning the economic elite into a scapegoat is, in a way, a last resort strategy. Buying social peace is less costly for the government as it can still tax the economic elite heavily. Making itself poorer than the economic elite is not rational for the local elite, except when the prospects of violence are very high. Interestingly, this effect arises even in a static framework that does not account for future losses. In a dynamic framework, violence against the rich ethnic minority would also lead to reductions in future tax revenues and may further incite the local elite to buy social peace (see the Conclusion).

Corollary 1.2. *When the political elite is richer after tax than the economic elite and when the threat of violence is not overly high, the government prefers to buy social peace rather than sacrifice the rich ethnic minority.*

[17]Adding a behavioral parameter in the model capturing ethnic hatred would make the scapegoating strategy of the local elite even more efficient. For instance, we could assume that the poor majority overcomes its collective problem more efficiently when violence is targeted at the rich ethnic minority, i.e. $\pi_p = (1 - \mu/r)(y_p + t + \frac{1}{n_p}(1 - \tau)y_m n_m)$ with $r > 1$.

Third, optimal public policies vary with the cost of violence. Suppose that the economic elite is poorer after tax than the political elite. Then the optimal tax rate decreases discontinuously at the transition between peace and violence, while the optimal transfer varies discontinuously and non-monotonically. Transfers increase with a decrease in μ under peace but decrease when the government decides to sacrifice the minority.[18] Since the government is poorer due to the drop in tax from τ^* to 0, the transfers required to avoid popular violence are lower.

Corollary 1.3. *At the transition between peace and violence, optimal tax and transfer levels decrease discontinuously.*

Fourth, let us examine how changes in parameters affect outcomes. We see, first, that the range of parameters under which violence occurs expands as μ, y_p or n_p decreases. Thus, violence against rich ethnic minorities is more likely to happen when the poor majority is poorer and better able to act collectively. Next, increases in the rents of the political elite and in the revenues of the economic elite may have opposite effects. When R increases, the political elite becomes wealthier and hence a priori provides a more attractive target. Society may switch from regime 1 to regime 2 in Proposition 1.2. Within regime 2 and when $y_m n_m < R$, we see that $\mu_{scapegoat}$ is decreasing in R. Higher rents make the scapegoating strategy relatively more costly in that domain, however, which reduces the prospects of violence. With higher rents, the political elite is thus both better willing and better able to prevent violence. By contrast, the economic elite is a more attractive target when y_m or n_m increases, and society may then switch from regime 2 to regime 1. Within regime 1, μ_{threat^m} increases. Within regime 2 and when $y_m n_m < R$, $\mu_{scapegoat}$ also increases as the government has stronger incentives to sacrifice the economic elite. Prospects for violence increase when the ethnic minority becomes richer.[19]

These predictions are consistent with empirical evidence. Bezemer and Jong-A-Pin (2013) use data from the Minority At Risk Project over the period 1984-2003 to test the prediction, put forward by Chua (2004), that the combination of democracy and globalization leads to more violence against market-dominant ethnic minorities in developing countries. They find support for this prediction in Sub-Saharan African, but not in other parts of the world. Our analysis can help explain these findings. Bezemer

[18] When $y_m n_m < R$, we show in Appendix 1.A that $\bar{t} < \hat{t}(\mu'_{scapegoat})$.

[19] In contrast, the impacts of R, y_m and n_m on $\mu_{scapegoat}$ in regime 2 when $y_m n_m > R$ are ambiguous because of indirect effects due to changes in $\bar{\tau}$, the optimal tax rate under violence.

and Jong-A-Pin (2013) (p.110) stress that “low violence thresholds are due to Africa’s uniquely high poverty levels”, which is consistent with our prediction that the prospects for violence increase when y_p decreases. They also argue that the nature of globalization in Africa was such that the rise in income differences between the ethnic minority and the rest of the population was sharper than in other parts of the world. A combined decrease in y_p and increase in y_m unambiguously increases violence prospects against the ethnic minority in our model.

In a recent analysis, Grosfeld et al. (2017) study anti-Jewish pogroms in Eastern Europe between 1800 and 1927. They find that a severe, negative agroclimatic shock increased the probability of a pogrom by 3.8 percentage points at times of increased political uncertainty and had no effect on the likelihood of pogroms in times of a relative political stability. Thus, violence seems most likely to occur under both negative economic shock and political instability. These findings are consistent with our results, which predict that violence is most likely when both y_p and μ are low, i.e., at times where the people are particularly poor and better able to act collectively. When the political situation is uncertain, people have a strong incitation to solve their collective action problem. Grosfeld et al. (2017) also find that the occupation in which Jews specialized locally has a strong impact on violence. In particular, specialization in crafts, industry and transport sector does not seem to affect the probability of pogroms, while specialization in moneylending or grain trading does. Our analysis suggests a simple explanation. This differential effect could potentially be explained by differences in wealth levels attained in different occupations.

Our analysis has relied, so far, on the assumption that the political and economic elites form two separate groups. This assumption seems to apply particularly well to two communities: Indians throughout East Africa and the Lebanese in West Africa. Adam (2010) documents the very poor level of social integration of Indians in East-African societies. Indians typically live in separate residential neighborhoods, attend denominational schools, go to community hospitals and belong to select clubs. They essentially marry within their own communities, and are intent on preserving their culture of origin in all its dimensions (religion, language, clothing, food). Bierwirth (1999) shows that the Lebanese community is also socially marginalized in Ivory Coast. Endogamy is prevalent, and resented: “there has been very little intermarriage between Lebanese immigrants and Africans, a fact that most Africans deeply resent.” (p.95). In addition, only 10% of the Lebanese-Ivorian population has acquired Ivorian citizenship. Most of this community thus cannot vote and is, in fact, politically excluded.

As in the model, the political elite appears to benefit from the presence of these communities in two ways: through the vital role they play in local economies and through their usefulness as convenient scapegoats. See, in particular, the discussions in Adam (2010) on p.3 and in Bierwirth (1999) on p.83 and p.93. In stable times, the ethnic communities benefit from local elites' support, for instance, through favored allocation of import licenses and public contracts, Chua (2004) (2004, p.148-149). In Kenya, Daniel Arap Moi first protected the Indian minority politically when he became president in 1979, "granting them relative economic freedom while affirmatively directing lucrative opportunities to a select few of them.", Chua (2004) (2004, p.157).

In other times, the political elite may fan the flame of ethnic hatred by pointing out the supposedly excessive wealth of these communities, either publicly accusing them of taking advantage of the resources of their host country, or through direct discriminatory actions targeting, and thereby highlighting, their assets. In 1983, for instance, the Tanzanian government launched an "Anti-Saboteur" campaign against fraudulent traffic that clearly targeted Indians, see Adam (2009). In Ivory Coast, Bierwirth (1999) explains that: "In 1992 and again in 1996, highly publicized sweeps were made by government officials to track down 'tax evaders' in the commercial quarters of Abidjan. In addition, both the official and opposition presses publish the names and pictures of Lebanese miscreants, helping to sustain the image of the Lebanese 'menace'" (p. 93). In Kenya, the economy deteriorated in 1981, leading in December to shortages of rice and flour and large increases in the price of staple food. President Moi then changed his position towards Indians and publicly accused them in February 1982 of causing these shortages and price increases, see The New York Times (1982). Violence erupted in August. A coup was attempted to oust Moi, which quickly failed. Many Indian homes and shops were looted, while Moi kept voicing anti-Indian sentiment throughout. His ambiguous attitude towards Indians was, more generally, instrumental in helping him stay in power until 2002. This is consistent with our analysis, in which the political elite manages to deflect popular violence towards the ethnic minority, particularly in times of economic crisis and political instability.

It is interesting to notice here that most public accusations launched by the incumbent political elites against the ethnic minorities are about the wealth of these communities. These accusations seem to aim at convincing the poor majority that the only group in society that manages very well is the ethnic minority. This is consistent with our model in which the political elite strategically changes its economic policies for the ethnic minority to *appear* the richest group is society, and thus the most likely to be subject to the violence of the poor. We could extend our model to capture explicitly this strategy of information disclosure by the political elite, especially as post-tax relative wealth levels of the different elite groups are likely difficult to observe. The political elite could exert costly propaganda efforts to expose the wealth of the ethnic minority. The local elite would strategically choose the optimal level of propaganda effort to manipulate the masses and deflect popular violence towards the ethnic minority when the threat of violence is high.

The segregation between the economic and political elites is not absolute, however. Historical patterns reveal a substantial degree of variation in integration caused, in part, by cultural factors. In the next section we explore how partial social integration between the two elites affects their interactions, public policies and violence.

1.4 Partial integration

In this section, we consider some partial level of social integration between the political and the economic elite. Members of these two groups may share the same socialization venues, may send their children to the same schools and may interact frequently in the workplace. As a consequence, they may also marry members of the other group. To fix ideas, we focus on mixed marriages in what follows; our modelling and results apply to broader forms of integration.

We now assume that all adult individuals in society get married and that spouses care about each other's payoffs. For simplicity, we assume that the sizes of both elite communities are the same: $n_m = n_e$. Define f as the proportion of mixed marriages between the rich ethnic minority and the local political elite. We consider a low enough value of f in what follows. We also assume that members of the poor majority never marry members of the elite. Let α be the marital coefficient of altruism with $0 < \alpha < 1$. The utility u_i of individual i with payoff π_i married to individual j with payoff j is then $u_i = \pi_i + \alpha\pi_j$. Therefore, social integration generates interdependence in utilities between the two groups.

As a consequence, mixed marriages introduce some dissension within groups. The utility of a member of the local elite is equal to $(1 + \alpha)\pi_e$ if he married within his community and $\pi_e + \alpha\pi_m$ if he married a member of the rich ethnic minority. Since f is low, we maintain our assumption that the local elite is able to act as a single actor. More precisely, the political elite seeks to maximize the average utility in the group, which is now equal to

$$u_e = (1 + \alpha(1 - f))\pi_e + \alpha f \pi_m$$

Introduce $\beta = \alpha f/(1 + \alpha(1 - f))$. Observe that u_e is proportional to $\pi_e + \beta\pi_m$ and that β is increasing in f and in α. Social integration leads the political elite to partially take into account the interests of the economic elite. By contrast, note that the average utility of a non-elite member is equal to $u_p = (1 + \alpha)\pi_p$ and the incentives of the poor majority are unchanged.

Social integration has two direct effects. It first changes the preferred policies of the political elite in the absence of violence. Indeed, we have:

$$\pi_e + \beta\pi_m = \frac{1}{n_e}[R - n_p t + (\tau(1 - \beta) - C(\tau) + \beta)y_m n_m]$$

and the tax rate τ^*_β that maximizes the political elite's average utility satisfies $C'(\tau^*_\beta) = 1 - \beta$. This tax rate is decreasing in f and α. As both elites become more integrated, their payoffs become more interdependent and the political elite then reduces its tax levy on the economic elite. Interestingly, by reducing its wealth, it makes the political elite less likely to be threatened by popular violence. Thus, *social integration reduces the local elite's rent-seeking behavior* and hence its likelihood of being attacked.

Second, social integration changes the government's incentives when the ethnic minority is very rich and provides a natural target for popular violence. More precisely, suppose that the ethnic minority is richer after tax τ^*_β than the political elite. This is the counterpart to the first domain in Proposition 1.2. When the cost of violence is not overly high, and in the absence of government intervention, the people attack the minority. Due to social integration, however, the government now stands to gain from intervening and protecting the minority. The government may buy social peace even when not directly threatened by popular violence. In a way, such *altruistic protection* is the opposite of instrumental scapegoating.

We now characterize the subgame perfect equilibrium of the game under partial integration. As in Proposition 1.2, the equilibrium depends on the relative after-tax wealth situations of the two communities. (We provide a detailed proof in Appendix 1.A). However, the two domains now have different boundaries and yield different optimal policies. In the first regime, the ethnic minority is richer after the altruistic tax τ^*_β than the political elite. This happens when $(1 - \tau^*_\beta)y_m n_m > R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m$. Define

$\mu_{threat^m_\beta} = (1-\tau^*_\beta)y_m n_m/[(1-\tau^*_\beta)y_m n_m + y_p n_p]$. This is the cost of violence value below which the people are ready to attack the rich minority. When $\mu < \mu_{threat^m_\beta}$, the government first provides some altruistic protection for the minority. We show that to diffuse the threat of violence, the government increases the tax rate as μ decreases. This reduces the wealth of the minority and hence its attractiveness as a target. Of course, this also makes the political elite a more attractive target. When f is low enough, however, the political elite stops offering altruistic protection before this can put it at risk. Below a critical level $\mu = \mu_{protec}$, maintaining peace is too costly and the government will let popular discontent run its course. In that case, the government chooses its policies the same way as when there is no integration. We represent graphically the equilibrium regions for this first regime[20] in Figure 1.3. On the left, we represent the case with separate elites, and one the right the case with social integration. The threshold μ_{threat^m} (respectively $\mu_{threat^m_\beta}$) is defined at the point where the payoff of the people without transfer and the payoff the people would get if they attacked the ethnic minority intersect. On the right, the threshold $\mu_{protect}$ correspond to the point at which the altruistic protection of the political elite backfires.

In the second regime, the ethnic minority is poorer after tax τ^*_β than the political elite. Formally, $(1-\tau^*_\beta)y_m n_m < R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m$. The political elite is now a natural target for popular anger. Define $\mu_{threat^e_\beta} = [R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m]/[R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m + y_p n_p]$ as the critical level of the cost of violence below which the poor majority is ready to attack the local elite. Note that since $\tau^*_\beta < \tau^*$, $\mu_{threat^e_\beta} < \mu_{threat^e}$. As discussed above, the reduction in rent-seeking behavior induced by social integration also provides some protection against violence. When μ falls below this threshold, the government modifies its economic policies to buy social peace. However, the optimal policies are deeply altered by social integration. Without integration, Proposition 1.2 tells us that in this domain, $\tau = \tau^*$ and t increases when μ decreases. By contrast, with integration, $t = 0$ and τ decreases as μ decreases. We discuss these policy changes in more detail below. The decrease in tax reduces the wealth of the political elite and its attractiveness as a target. When μ is too low, however, buying social peace is too costly and the local elite sacrifices the rich minority. Let $\mu_{scapegoat_\beta}$ denote the value of the cost

[20] The economic elite is richer, after tax, than the political elite, i.e. $(1-\tau^*)y_m n_m > R + (\tau^* - C(\tau^*))y_m n_m$. We use the following numerical example: $R = 5000$, $n_e = 10$, $y_p = 2$, $n_p = 1000$, $y_m = 1100$, $n_m = 10$, $C(\tau) = \frac{3}{2}\tau^2$, $\beta = 0.1$. This leads to $\tau^* = 1/3$ and $\tau^*_\beta = 0.3$. We represent π_e at the scale 1:68.3 on the left, and $\pi_e + \beta\pi_m$ at the scale 1:75.8 on the right.

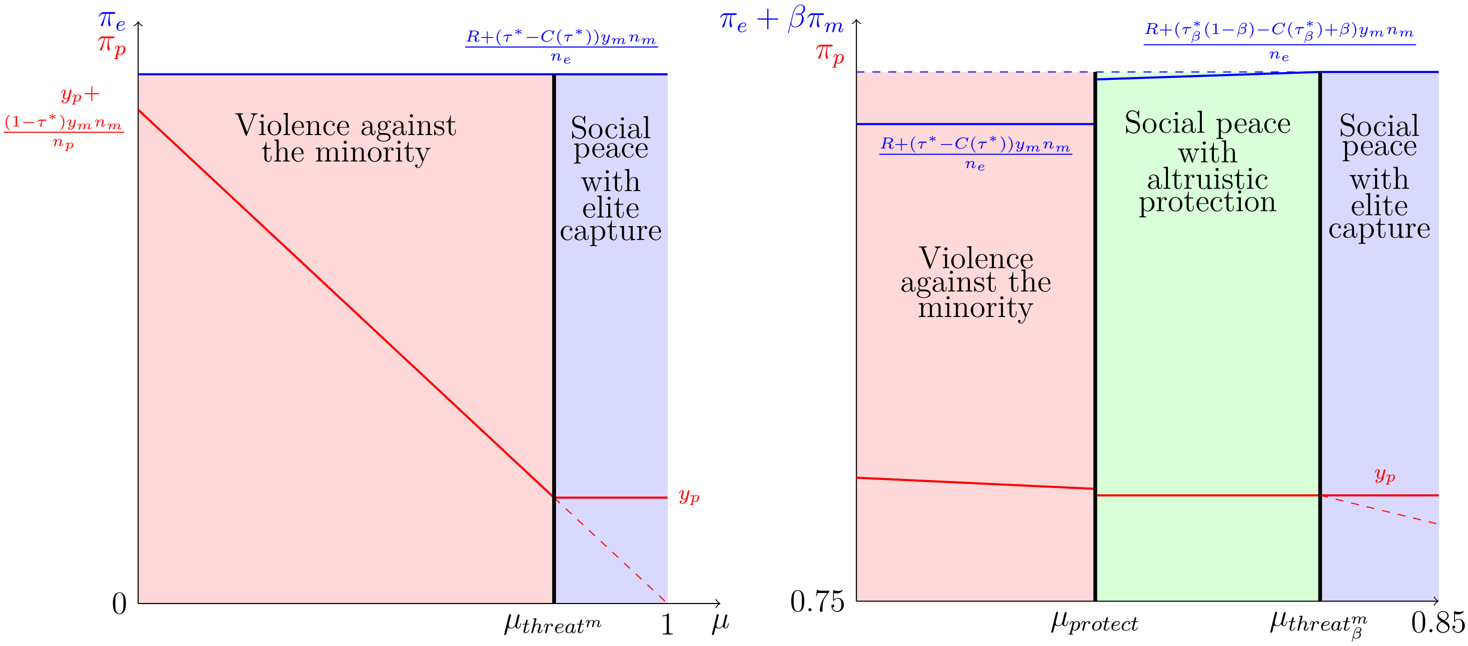

Figure 1.3 – Altruistic protection

of violence below which the minority is sacrificed. We see that $\mu_{scapegoat_\beta}$ decreases as β increases. Social integration reduces the use of instrumental scapegoating.

Proposition 1.3. *Suppose that the local political elite and the rich ethnic minority are socially integrated with f low enough.*

1. If $(1-\tau^*_\beta)y_m n_m > R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m$.

- If $\mu \geq \mu_{threat^m_\beta}$, then $\tau = \tau^*_\beta$, $t = 0$ and there is no violence.

- If $\mu_{threat^m_\beta} > \mu > \mu_{protec}$, then τ increases as μ decreases and there is no violence.

- If $\mu_{protec} > \mu$, then the poor majority attacks the rich minority. If $(1-\tau^*)y_m n_m > R+(\tau^*-C(\tau^*))y_m n_m$, then $\tau = \tau^*$, $t = 0$. If $(1-\tau^*)y_m n_m < R+(\tau^*-C(\tau^*))y_m n_m$, then $\tau = \bar{\tau}$, $t = 0$.

2. If $(1-\tau^*_\beta)y_m n_m < R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m$.

- If $\mu \geq \mu_{threat^e_\beta}$, then $\tau = \tau^*_\beta$, $t = 0$ and there is no violence.

- If $\mu_{threat^e_\beta} \geq \mu > \mu_{scapegoat_\beta}$, then τ decreases as μ decreases and there is no violence.

- If $\mu_{scapegoat_\beta} > \mu$, then the poor majority attacks the rich minority. If $y_m n_m > R$, then $\tau = \bar{\tau}$, $t = 0$ while if $y_m n_m < R$, then $\tau = 0$, $t = \bar{t}$.

We next highlight two further implications of Proposition 1.3. First, social integration always reduces the prospects of violence. For instance, we show in Appendix 1.A that μ_{protec} and $\mu_{scapegoat_\beta}$ decreases in β. As both elites become more integrated, the local elite engages more often in altruistic protection and less often in instrumental scapegoating. We also show that this property actually holds for any level of integration f.

Corollary 1.4. *As social integration between elites increases, the prospect of violence decreases.*

Second, we find that social integration changes the optimal policies implemented to buy social peace. Without social integration, the government only cares about its monetary payoff. It then sets the revenue-maximizing tax rate and increases its transfer as μ decreases, see Proposition 1.2. With social integration, the government also cares about the monetary payoff of the economic elite. This makes a decrease in the tax rate more attractive than an increase in transfers, since lower tax yields higher payoffs for the economic elite.

Corollary 1.5. *Under social integration, the local elite prefers to reduce the tax rate rather than increase transfers in order to buy social peace.*

Our analysis seems to be in agreement with documented patterns. To illustrate, consider Indonesia under the rule of General Suharto. Suharto and his family were very close to wealthy Chinese businessmen. He had started to form these privileged relationships while he was still an army officer. Once President, Suharto granted entrepreneurial Chinese economic freedoms and some very lucrative opportunities. For instance, he granted Sudono Salim, formerly known as Liem Sioe Liong and one of his main cronies, franchises in banking, flour milling and telecommunications (Chua 2004, p.44). In return, these Chinese businessmen financed the public and personal projects of Suharto. For instance, they financed the Tama Mini theme park monorail on behalf of Suharto's wife and established business partnerships with Suharto's children. "Throughout much of the eighties and nineties, no one outside of his family - not even high-ranking cabinet ministers - was closer to Suharto than these cronies, who spent hours every week golfing with the president, planning their joint investments.", Chua (2004, p.152). Interestingly, and in agreement with our framework, Suharto used his political power to protect the Chinese when they were threatened. "He suppressed anti-Chinese labor movements, like the one in North Sumatra in 1994 that turned into a bloody riot again Chinese Indonesians. He extinguished all forms of anti-Chinese dissent and press, even jailing a prominent Jakarta journalist who published an anti-Chinese article.", Chua (2004, p.151). Our model predicts the emergence of such altruistic protection when both elites are socially integrated.

We could also easily consider social integration between the rich ethnic minority and the poor majority. We analyze a version of the model with partial integration between these two groups in Appendix 1.B. We show that our main results are robust if integration levels are low enough. More generally, prospects of violence also decrease as integration increases. This effect now has two causes. First, the people now have less incentives to attack the rich minority, since they would suffer from this violence due to utility interdependence. Second, connections with the rich minority also makes people wealthier, and hence less likely to use violence. Interestingly, we also show that scapegoating may not be a viable option for the political elite when integration is high. The political elite may then not necessarily avoid political violence. Therefore when the risk of violence is high, the political elite may have an incentive to prevent social integration between the poor majority and the rich ethnic minority.

The role played by such broader integration is well illustrated by the case of Madagascar. Madagascar contains no less than three minorities playing a disproportionate role in the economy: the descendants of 19^{th} century Indian and Chinese migrants as well as recent Chinese migrants. The long-established Chinese community is considered to be quite integrated compared to the Indian community. As Fournet-Guérin (2009) points out: "Chinese are buried in the municipal cemetery; they do not live in a particular area; they are Catholic like most of the urban Malagasy population". By contrast, the Indian community remains a closed, endogamous community. Its members, also called "Karana", are strongly attached to their religions and traditions. Consistently with our analysis, despite similar levels of wealth, the Chinese community is less subject to kidnappings and shop destructions than the Indian community (La Lettre de l'Océan Indien 2013).

Interestingly, the new wave of Chinese immigration induces very different reactions. Whereas the old Chinese community is well assimilated into broader Malagasy society, as shown by the high rate of mixed marriages and the high proportion of mixed race Sino-Malagasy who usually view themselves as Malagasy and bear Malagasy names (Fournet-Guérin 2006), the new Chinese are much less well-perceived. As Tremann

(2013) explains: "although xenophobia against the Chinese in Madagascar is relatively low, the arrival of a new group of temporary Chinese immigrants, who clearly stand out owing to the fact that they live in urban areas and make their presence felt in economic spheres to do with consumerism, has led to a partial shift in the position of outlets for Malagasy frustrations, with the new Chinese now taking on the role of scapegoats" (p.11). According to her, "local anger towards the Chinese and the negative perceptions of their presence that underpin it are partly shaped by a lack of social interaction with the Malagasy" (p.11).

In South Asia, the Chinese are typically not well-integrated. However, Thailand constitutes an interesting exception. According to Chua (2004), "many Thai Chinese speak only Thai and consider themselves as Thai as their indigenous counterparts. Intermarriage rates between the Chinese and the indigenous majority are much higher than elsewhere in South Asia" (p.179). And indeed, there is relatively little anti-Chinese animus in Thailand: "the fact remains that ethnic relations today between the Chinese and indigenous Thais in Thailand are remarkably civilized" (p.180).

Overall, and consistent with our analysis, the level of social integration indeed seems to be a key determinant of violence targeted at a specific community.

1.5 Discussion and conclusion

In this paper, we analyze violence against rich ethnic minorities. We study how the presence of a rich minority affects interactions between a rent-seeking local elite and a poor majority. We show that the local elite can maintain its hold on power by sacrificing the rich minority to popular discontent. Such instrumental scapegoating emerges even for purely material reasons. The model predicts that violence is more likely to occur when the poor majority is poorer and has better collective ability, when the ethnic minority is richer or when the rents controlled by the local elite are lower. In addition, scapegoating is a strategy of last resort. We then consider some partial social integration between the two elites. We find that the elite's integration reduces violence and affects economic policies.

We obtain these results in a parsimonious framework, built by introducing a rich ethnic minority in charge of the formal economy into the benchmark model of Acemoglu and Robinson (2006). Our analysis is based on a number of simplifying assumptions, including: (1) a group subject to violence loses all its local wealth, (2) the model is static, (3) the local elite can only use economic policies to try and redirect violence, (4) the rich minority cannot act to avoid violence, (5) members of the poor majority cannot work for the rich minority and (6) the level of social integration between the two elites is exogenous. We believe that the model's simplicity constitutes a strength of the analysis. Our results show that violence deflection and instrumental scapegoating constitute deep phenomenons, emerging from the interplay of elementary forces. Moreover, as discussed next, our main results are very likely robust to relaxing these simplifying assumptions. Our current setup thus likely captures some of the key ingredients giving rise to scapegoating in reality. This is consistent with the empirical prevalence of market-dominant minorities and scapegoating across widely different cultural, historical and spatial contexts.

Let us next discuss these simplifying assumptions in more detail. (1) The assumption that an elite group subject to popular violence loses all its local wealth may be appropriate to explain the most extreme scapegoating episodes. To rationalize the low and medium levels of violence often observed, we relax this assumption in Appendix 1.C. We assume that the group subject to violence only loses a fraction θ of its wealth. We find that our main results are robust. The three key domains uncovered in Propositions 1.2 and 1.3 and the comparative statics are qualitatively unchanged. Further, a decrease in θ reduces the prospects of violence and the transfers needed to buy social peace.

(2) Introducing dynamic considerations provides a natural direction for future research. With multiple periods, violence entails an additional cost to the local elite in the form of lost future tax revenues. Therefore, we expect the likelihoods of violence and scapegoating to be decreasing with the discount factor in a dynamic extension. Our current conditions then likely provide tight upper bounds on the emergence of violence. Dynamics would also yield another reason explaining why violence may be particularly likely to occur under political instability, since autocratic leaders who are uncertain to stay in power may not care much about future tax losses.

(3) In reality, local elites may have different means to try and redirect violence. Through their control of the military, they could provide military and logistic support to popular violence against ethnic minorities. They also generally control the media and can launch communication campaigns targeted against the minorities. These other means generally make it easier to redirect violence, and hence are likely substitutes of economic policies.

(4) We assumed in this analysis that the rich minority cannot act to prevent violence. Observe that it could simply be prevented to do so by the local elite, who holds all the power. In reality, market-dominant minorities may try to appease tensions and to buy social peace themselves. They can also intervene in local politics and, for instance, give support to opposition groups. If an autocratic government decides to sacrifice a rich minority, however, it should generally have the power to enforce its decision.

(5) An additional assumption we make is that the poor do not work for the rich minority. In reality, it is often the case that some members of the poor majority are employed in firms held by the rich ethnic minority.[21] Relaxing this assumption would generate some interdependence between the fraction of the poor majority who work in these firms and the rich minority. The strength of this interdependence would depend on the wage they are paid in these firms, and possibly on the quality of their relationship in the workplace.[22] High wages and good relationships at work would likely lower the prospect of violence, in a similar fashion as in Appendix 1.B. In contrast, low wages and disrespectful relationships could be even more detrimental.

(6) In reality, the level of social integration between the different social groups could also be endogenous. Either elite could, in particular, decide to stay segregated. If the likelihood of violence is high, the political elite may rationally decide to forbid intermarriages and social mixing in order to keep a convenient scapegoat at its disposal. This could be a powerful hidden rationale behind ethnic and religious purity propaganda. This would allow the political elite to maintain a clear distinction between the two ethnic groups, so that the masses could continue to identify themselves to the local elite and the strategy of instrumental scapegoating could remain efficient. Notice also that scapegoating, in turn, further aggravates the isolation of the ethnic minority in society. Whereas, as shown in Section 1.4, integration decreases the likelihood of violence against the ethnic minority, it may also diminish its ability to leave the country and resettle elsewhere. A community with past experience of violence could therefore decide to maintain its cohesiveness and deliberately avoid integration, at the risk of increasing

[21] According to the Indian Association Uganda, Indian-owned businesses employ more than 1 million "indigenous" people (Global Press Journal 2016).

[22] Relationships between the poor majority and the ethnic minority in the workplace are documented to be tense. For instance, Global Press Journal (2016) reports that "Many Ugandans say Indian employers don't treat them fairly. "They are the worst employers in Uganda", says Angela Atuha, a Makere University Business School student who worked at an Indian-owned clothing store during her gap year. They pay low wages and provide poor working conditions, she says. "They will never let a black person, however qualified, take up a high position in their companies," she says."

its likelihood of experiencing future scapegoating episodes. In a dynamic framework, these joint strategic behaviors of the political elite on the one hand, and of the ethnic minority on the other hand, may help explain hysteresis and persistence effects on the nature of the groups that are shown as “scapegoats”.

More generally, this framework also suggests a better understanding of the evolution of the elite group, taking into account the fact that informal norms on marriage mixing take time to evolve. This would help explain why, in some situations, the two elites fail to escape the “scapegoating trap” in which they remain segregated, while in other contexts, the two elites merge through mixed marriages. In social contexts where there is no ethnic distinction between the elites who own the political assets and those who own the economic assets, as it was the case for instance between the nobility and the rising bourgeoisie in the sixteenth-eighteenth-century western Europe, we observed an evolution of marital practices from strict endogamy towards more mixing between these two groups. We could imagine that informal norms on marriage mixing evolve more rapidly when there is no ethnic marker which further distinguishes the two elites. This quicker evolution could explain why in such situations, the two elites manage to escape the “scapegoating trap”. It is also likely that when the political elite cannot efficiently use the economic elite as a scapegoat, it becomes rational to integrate this elite through marriages to strengthen their economic and political alliance.

Appendix

1.A Proofs

Proof of Proposition 1.2

The elite maximizes its payoff π_e under the constraint: $\max(\pi_p(N), \pi_p(V_m)) \geq \pi_p(V_e)$.

When the minority is richer after tax τ^* than the local elite, the government always chooses the policies that maximize its payoff and is never attacked by the people since $(1-\tau^*)y_m n_m \geq R + (\tau^* - C(\tau^*))y_m n_m \Rightarrow \forall \mu, \pi_p(V_m|\mu, \tau^*, 0) \geq \pi_p(V_e|\mu, \tau^*)$. For μ such that $\pi_p(N|\tau^*, 0) \geq \pi_p(V_m|\mu, \tau^*, 0) \Leftrightarrow \mu \geq \mu_{threat^m} = (1-\tau^*)y_m n_m/[(1-\tau^*)y_m n_m + y_p n_p]$, the people remain pacific; otherwise they attack the minority.

When the minority is poorer after tax τ^* than the local elite, three domains emerge. For μ such that $\pi_p(N|\tau^*, 0) \geq \pi_p(V_e|\mu, \tau^*) \Leftrightarrow \mu \geq \mu_{threat^e} = [R+(\tau^*-C(\tau^*))y_m n_m]/[R+(\tau^* - C(\tau^*))y_m n_m + y_p n_p]$, the government chooses $(\tau, t) = (\tau^*, 0)$ and there is no violence; otherwise, the local elite needs to modify its policies to avoid violence.
The government may use *self-protective redistribution*, i.e. maximize its payoff under the contraints that the people is indifferent between remaining pacific and attacking them, formally $\pi_p(N|\tau, t) = \pi_p(V_e|\mu, \tau)$ and that the people prefer remaining pacific rather than attacking the minority, formally $\pi_p(N|\tau, t) \geq \pi_p(V_m|\mu, \tau, t)$. The first constraint leads the elite to keep the tax rate at τ^* and set the transfer $\hat{t} = (1-\mu)[R+(\tau^* - C(\tau^*))y_m n_m]/n_p - \mu y_p$, which is continuous at μ_{threat^e} ($\hat{t}(\mu_{threat^e}) = 0$) and increases as μ decreases. The second constraint is respected for $\pi_p(N|\tau^*, \hat{t}) \geq \pi_p(V_m|\mu, \tau^*, \hat{t}) \Leftrightarrow \mu \geq \mu_1 = (1-\tau^*)y_m n_m/[R + (\tau^* - C(\tau^*))y_m n_m + y_p n_p]$. The payoff of the elite, $\pi_e(N|\tau^*, \hat{t}) = \mu[R + (\tau^* - C(\tau^*))y_m n_m + y_p n_p]/n_e$, decreases as μ decreases.
Alternatively, the government may use *instrumental scapegoating*, i.e. maximize its payoff under the constraints that the people is indifferent between attacking them or attacking the minority, formally $\pi_p(V_m|\mu, \tau, t) = \pi_p(V_e|\mu, \tau)$ and that the people prefer at-

tacking the minority rather than remaining pacific, formally $\pi_p(V_m|\mu,\tau,t) \geq \pi_p(N|\tau,t)$. The first constraint yields $(1-\mu)(y_p + \frac{1}{n_p}(R+(\tau-C(\tau))y_m n_m)) = (1-\mu)(y_p + t + \frac{1}{n_p}(1-\tau)y_m n_m) \Leftrightarrow t = (R+(\tau-C(\tau))y_m n_m - (1-\tau)y_m n_m)/n_p$. Two cases have to be distinguished: if $y_m n_m \geq R$, $\bar{\tau}$[23] exists; therefore the local elite chooses $(\tau,t) = (\bar{\tau},0)$ and gets a payoff $\pi_e(V_m|\bar{\tau},0) = [R+(\bar{\tau}-C(\bar{\tau}))y_m n_m]/n_e$. If $R > y_m n_m$, they choose $(\tau,t) = (0,\bar{t})$ with $\bar{t} = (R-y_m n_m)/n_p$ and receive a payoff $\pi_e(V_m|0,\bar{t}) = y_m n_m/n_e$. The second constraint is respected for $\pi_p(V_m|\mu,\bar{\tau},0) \geq \pi_p(N|\mu,\bar{\tau},0) \Leftrightarrow \mu \leq \mu_2 = (1-\bar{\tau})y_m n_m/[(1-\bar{\tau})y_m n_m + y_p n_p]$ if $y_m n_m \geq R$, (resp. $\mu \leq \mu_{2'} = y_m n_m/(R+y_p n_p)$ if $y_m n_m < R$).

The local elite chooses *self-protective impoverishment* for μ such that $\pi_e(N|\tau^*,\hat{t}(\mu)) \geq \pi_e(V_m|\bar{\tau},0) \Leftrightarrow \mu \geq \mu_{scapegoat} = (1-\bar{\tau})y_m n_m/[R+(\tau^*-C(\tau^*))y_m n_m + y_p n_p]$ if $y_m n_m \geq R$ (resp. $\mu \geq \mu_{scapegoat'} = y_m n_m/[R+(\tau^*-C(\tau^*))y_m n_m + y_p n_p]$ if $R > y_m n_m$).

Since we have $\mu_1 < \mu_{scapegoat} < \mu_2$, and $\mu_1 < \mu_{scapegoat'} < \mu_{2'}$, the second constraints of the maximization problems never bind.

Note that the transfer is discontinuous at $\mu_{scapegoat'}$:

Proof: $\bar{t} = \hat{t}(\mu) \Leftrightarrow \mu = [y_m n_m + (\tau^*-C(\tau^*))y_m n_m]/[R+(\tau^*-C(\tau^*))y_m n_m + y_p n_p] \equiv \mu_3$.

As $\mu_{scapegoat'} < \mu_3$, *and* $\hat{t}'(\mu) < 0$, *therefore* $\bar{t} < \hat{t}(\mu_{scapegoat'})$. □

Note also that all the thresholds decrease as y_p or n_p increase.

And $\partial\mu_{threat^e}/\partial R = y_p n_p/[R+(\tau^*-C(\tau^*))y_m n_m + y_p n_p]^2 > 0$

$\partial\mu_{threat^e}/\partial y_m = (\tau^*-C(\tau^*))n_m y_p n_p/[R+(\tau^*-C(\tau^*))y_m n_m + y_p n_p]^2 > 0$

$\partial\mu_{threat^m}/\partial y_m = (1-\tau^*)n_m y_p n_p/[(1-\tau^*)y_m n_m + y_p n_p]^2 > 0$

$\partial\mu_{scapegoat'}/\partial y_m = (R+y_p n_p)n_m/[R+(\tau^*-C(\tau^*))y_m n_m + y_p n_p]^2 > 0$

$\partial\mu_{scapegoat'}/\partial R < 0$ (obvious).

Proof of Proposition 1.3

The local elite chooses which strategy brings more utility, between the maximization of its utility u_e under the constraint: $u_p(N) \geq \max(u_p(V_m), u_p(V_e))$ and the maximization of its payoff π_e under the constraint: $u_p(V_m) \geq \max(u_p(N), u_p(V_e))$.

With partial integration, three domains emerge, even in the configuration where the minority is richer after tax τ^*_β than the elite.

For μ high enough, the local elite chooses $(\tau^*_\beta, 0)$ and the people remain pacific. This is

[23] $\bar{\tau}$ is such that $R+(\tau-C(\tau))y_m n_m = (1-\tau)y_m n_m$

an equilibrium for $u_p(N|\tau^*_\beta, 0) \geq u_p(V_m|\mu, \tau^*_\beta, 0) \Leftrightarrow \mu \geq \mu_{threat^m_\beta} = (1-\tau^*_\beta)y_m n_m/[(1-\tau^*_\beta)y_m n_m + y_p n_p]$, if the minority is richer after tax τ^*_β than the local elite (resp. $u_p(N|\tau^*_\beta, 0) \geq u_p(V_e|\mu, \tau^*_\beta) \Leftrightarrow \mu \geq \mu_{threat^e_\beta} = [R+(\tau^*_\beta - C(\tau^*_\beta))y_m n_m]/[R+(\tau^*_\beta - C(\tau^*_\beta))y_m n_m + y_p n_p]$ if the minority is poorer).
We have $\partial\mu_{threat^e_\beta}/\partial R = y_p n_p/[R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m + y_p n_p]^2 > 0$
$\partial\mu_{threat^e_\beta}/\partial y_m = (\tau^*_\beta - C(\tau^*_\beta))n_m y_p n_p/[R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m + y_p n_p]^2 > 0$
$\partial\mu_{threat^m_\beta}/\partial y_m = (1 - \tau^*_\beta)n_m y_p n_p/[(1 - \tau^*_\beta)y_m n_m + y_p n_p]^2 > 0$

When μ falls below these thresholds, the local elite choose whether to buy social peace or let the people attack the minority.

When the minority is richer after tax τ^*_β than the local elite, the local elite may provide an *altruistic protection* to the minority, i.e maximize its utility under the constraints that the people is indifferent between remaining pacific rather and attacking the minority, formally $u_p(N|\tau, t) = u_p(V_m|\mu, \tau, t)$ and that the people prefer remaining pacific rather than attacking the local elite, formally $u_p(N|\tau, t) \geq u_p(V_e|\mu, \tau)$.
The first constraint leads the local elite to choose $(\tau, t) = (\tilde{\tau}_1, 0)$ with $\tilde{\tau}_1$ such that $(1 - \tau)y_m n_m/[(1 - \tau)y_m n_m + y_p n_p] = \mu$, or $(\tau, t) = (\tilde{\tau}_2, \tilde{t}_2)$ with $\tilde{\tau}_2$ such that $C'(\tau) = 1/\mu - \beta$ and $\tilde{t}_2 = (1/\mu - 1)(1 - \tilde{\tau}_2)y_m n_m/n_p - y_p$.
The local elite always choose first $(\tilde{\tau}_1, 0)$, as $\tilde{t}_2$ is negative at $\mu_{threat^m_\beta}$.
Proof: at $\mu_{threat^m_\beta}$, $\tilde{t}_2 \geq 0 \Leftrightarrow \tilde{\tau}_2(\mu_{threat^m_\beta}) \leq \tau^*_\beta$. *However, as* $\mu_{threat^m_\beta} < 1$, *we have* $\tilde{\tau}_2(\mu_{threat^m_\beta}) > \tau^*_\beta$, *indeed* $\tilde{t}_2 < 0$ *at* $\mu_{threat^m_\beta}$. □
The tax rate is continuous ($\tilde{\tau}_1(\mu_{threat^m_\beta}) = \tau^*_\beta$) and $\tilde{\tau}_1$ is increasing as μ decreases.
Proof: we derive $(1 - \tilde{\tau}_1)y_m n_m = \mu[(1 - \tilde{\tau}_1)y_m n_m + y_p n_p]$ *with respect to* μ *and we get* $(\mu - 1)\tilde{\tau}'_1(\mu) = [(1 - \tilde{\tau}_1)y_m n_m + y_p n_p]/(y_m n_m) \Rightarrow \tilde{\tau}'_1(\mu) < 0$. □
Obviously, $\tilde{\tau}_2$ is increasing as μ decreases.
The second constraint can be binding, in which case the local elite has to choose (τ, t) such that $u_p(N|\tau, t) = u_p(V_m|\mu, \tau, t) = u_p(V_e|\mu, \tau)$: we call this *global protective impoverishment*.

When the minority is poorer after tax τ^*_β than the local elite, the local elite may use *self protective redistribution*, which is the same strategy as in Proposition 1.2 except that payoffs are replaced by utilities. The first constraint leads the local elite to choose $(\tau, t) = (\hat{\tau}_1, 0)$ with $\hat{\tau}_1$ such that $[R+(\tau - C(\tau))y_m n_m]/[R+(\tau - C(\tau))y_m n_m + y_p n_p] = \mu$, or $(\tau, t) = (\hat{\tau}_2, \hat{t}_2)$ with $\hat{\tau}_2$ such that $C'(\tau) = 1 - \beta/\mu$ and $\hat{t}_2 = (1 - \mu)[R + (\hat{\tau}_2 - C(\hat{\tau}_2))y_m n_m]/n_p - \mu y_p$.
The local elite always choose first $(\hat{\tau}_1, 0)$, as $\hat{t}_2$ is negative at $\mu_{threat^e_\beta}$.
Proof: $\hat{t}_2 \geq 0 \Leftrightarrow \hat{\tau}_2(\mu_{threat^e_\beta}) - C(\hat{\tau}_2(\mu_{threat^e_\beta})) \geq \tau^*_\beta - C(\tau^*_\beta)$. *However, as* $\mu_{threat^e_\beta} <$

1, *we have* $\hat{\tau}_2(\mu_{threat^e_\beta}) < \tau^*_\beta < \tau^*$, *and because we know that the function* $\tau - C(\tau)$ *is concave and reaches its maximum for* τ^*, *we necessarily have* $\hat{\tau}_2(\mu_{threat^e_\beta}) - C(\hat{\tau}_2(\mu_{threat^e_\beta})) < \tau^*_\beta - C(\tau^*_\beta)$. *Indeed* $\hat{t}_2 < 0$ *at* $\mu_{threat^e_\beta}$. □

The tax rate is continuous ($\hat{\tau}_1(\mu_{threat^e_\beta}) = \tau^*_\beta$) and $\hat{\tau}_1$ is decreasing as μ decreases.

Proof: we derive $R+(\hat{\tau}_1 - C(\hat{\tau}_1))y_m n_m = \mu[R+(\hat{\tau}_1 - C(\hat{\tau}_1))y_m n_m + y_p n_p]$ *with respect to* μ *and we get* $(1-\mu)\hat{\tau}_1'(\mu)(1-C'(\hat{\tau}_1)) = [R+(\hat{\tau}_1 - C(\hat{\tau}_1))y_m n_m + y_p n_p]/(y_m n_m) \Rightarrow \hat{\tau}_1'(\mu) > 0$ *since* $C'(\hat{\tau}_1) < 1$ *as* $\hat{\tau}_1 < \tau^*$. □

Obviously, $\hat{\tau}_2$ is decreasing as μ decreases.

The second constraint can bind such that the local elite has to choose *global protective impoverishment*.

The elite may also decide to *let the people attack the minority* or use *instrumental scapegoating*, i.e. maximize its utility under the constraint that the people prefer attacking the minority rather than remaining pacific or attacking the elite.

When the minority is richer after tax τ^*_β than the local elite, two situations emerge. If the minority is richer after tax τ^* than the local elite, the constraint that the people prefer attacking the minority rather than the local elite when they use their most preferred policy $(\tau^*, 0)$ is not binding. The local elite chooses $(\tau, t) = (\tau^*, 0)$ and they get a utility $u_e(V_m|\tau^*, 0) = [R + (\tau^* - C(\tau^*))y_m n_m]/n_e$. When the minority is poorer after tax τ^*, the constraint is binding and the local elite chooses τ and t which maximize their utility and such that $u_p(V_m|\mu, \tau, t) = u_p(V_e|\mu, \tau)$: the local elite chooses $(\tau, t) = (\bar{\tau}, 0)$ and gets a utility $u_e(V_m|\bar{\tau}, 0) = [R + (\bar{\tau} - C(\bar{\tau}))y_m n_m]/n_e$.

When the minority is poorer after tax τ^*_β than the local elite, the policies and utilities of the local elite for *instrumental scapegoating* are the same as in Proposition 1.2.

The local elite never use *global protective impoverishment* (GPI) for a β low enough.

Proof: GPI gives to the elite a utility $u_e(N|\tau_{gpi}, t_{gpi}) = (1+\beta)(1-\tau_{gpi})y_m n_m/n_e$. *GPI is not defined for tax rates lower than* $\bar{\tau}$, *therefore we necessarily have* $\tau_{gpi} \geq \bar{\tau}$. *Non-protection and instrumental scapegoating give a constant utility to the elite, and for every configuration we have* $u_e(N|\tau_{gpi}, t_{gpi}) < u_e(V_m|\tau, t)$ *when* $\beta \to 0$. *Indeed there must exist a* β *for which the elite never uses GPI.* □

There exist a threshold μ_{protec}, when the minority is richer after tax τ^*_β, and $\mu_{scapegoat_\beta}$ when the minority is poorer, that separates peace to violence against the minority.

Proof: When buying social peace, either through altruistic protection or self-protective redistribution, the problem of the elite is to choose τ *and t that maximize* $u_e = \pi_e + \beta\pi_m$ *under the constraint* $\max(u_p(V_e), u_p(V_m)) \leq u_p(N)$. *Only* $u_p(V_e)$ *and* $u_p(V_m)$ *depend on* μ*: as* μ *decreases,* $\max(u_p(V_e), u_p(V_m))$ *increases, so the set* (τ, t) *satisfying the* *constraint shrinks, and therefore the maximum lowers and $u_e(N|\tau,t)$ decreases. However $u_e(V_m|\tau,t)$ is independent of μ. We have that if the optimal policy of the elite is (τ^*,t^*) for μ and $(\tau^{*'},t^{*'})$ for $\mu' < \mu$, and if $x(\tau^*,t^*) = V_m$, then $x(\tau^{*'},t^{*'}) = V_m$. Indeed $\exists\bar{\mu}$ such that $\mu < \bar{\mu} \Rightarrow V_m$ and $\mu > \bar{\mu} \Rightarrow N$. $\square$*

These thresholds decrease as β increases.

Proof: as global protective impoverishment gives a lower utility to the elite than altruistic protection and self-protective redistribution, μ_{protec} and $\mu_{scapegoat_\beta}$ are bounded from below by the threshold μ_{gpi} for which the elite is indifferent between global protective impoverishment and no protection or instrumental scapegoating.
$u_e(N|\tau_{gpi},t_{gpi})$ increases as β increases while $u_e(V_m|\tau^*,0)$, $u_e(V_m|\bar{\tau},0)$ and $u_e(V_m|0,\bar{t})$ are constant. Indeed, μ_{gpi} decreases as β increases.$\square$

In general, higher integration reduces the prospects of violence.

Proof: we prove that if the maximization problem of the elite leads to non violence for a given β, it cannot lead to violence against the minority for a higher β.
Suppose we have N for β' and V_m for $\beta \geq \beta'$. Let (τ^*,t^*) be solution to β.
$\beta \geq \beta', \quad \forall(\tau,t), \quad (\pi_e + \beta\pi_m)(\tau,t) \geq (\pi_e + \beta'\pi_m)(\tau,t)$, *then*
$\max \pi_e + \beta\pi_m \geq \max \pi_e + \beta'\pi_m \Rightarrow \pi_e(\tau^*,t^*) \geq \pi_e(\tau^*,t^*) + \beta'\pi_m(\tau^*,t^*)$.
We have a contradiction. $\square$

1.B Extension with Partial Integration Between the Ethnic Minority and the People

We consider the same modelling and notations as in Section 1.4, except that mixed marriages are only possible between members of the people and members of the rich ethnic minority.
Thus $u_p = (1+\alpha(1-f))\pi_p + \alpha f\pi_m$ or $u_p = \pi_p + \beta\pi_m$, with $\beta = \alpha f/(1+\alpha(1-f))$.
Assume that $n_p = kn_m$, with $k \geq 1$.
Note that the maximum proportion of intermarriage between the ethnic minority and the people is $f_{max} = n_m/n_p = 1/k$ and as a consequence, β_{max} decreases as k increases.
We assume here that k is fixed, and study the impact of β on outcomes.
The utility of the political elite is unaffected, so its optimal policies are the same as in Section 1.3, that is τ^* such that $C'(\tau^*) = 1$ and $t^* = 0$.
We compute the new thresholds for μ_{threat^e} and μ_{threat^m} in this configuration:
μ_{threat^e} is such that the people is indifferent between peace and violence towards the

political elite, i.e. $y_p + \beta(1-\tau^*)y_m = (1-\mu_{threat^e})[y_p + \beta(1-\tau^*)y_m + (R + (\tau^* - C(\tau^*))y_m n_m)/n_p]$

μ_{threat^m} is such that the people is indifferent between peace and violence towards the ethnic minority, i.e. $y_p + \beta(1-\tau^*)y_m = (1-\mu_{threat^m})[y_p + (1-\tau^*)y_m n_m/n_p]$.

In this setting, $\mu_{threat^e} \geq \mu_{threat^m} \Leftrightarrow R + (\tau^* - C(\tau^*))y_m n_m \geq (1-\beta k)(1-\tau^*)y_m n_m$. We note here that, unlike the benchmark model of Section 1.3, μ_{threat^e} may be larger than μ_{threat^m} even when $(1-\tau^*)y_m n_m \geq R + (\tau^* - C(\tau^*))y_m n_m$.

We assume here that β is such that $\mu_{threat^e} \geq \mu_{threat^m}$. Thus for a β high enough, the *ethnic minority never acts as a natural target for popular violence*.

Moreover, $\mu_{threat^e} = [R + (\tau^* - C(\tau^*))y_m n_m]/[y_p n_p + \beta(1-\tau^*)k y_m n_m + R + (\tau^* - C(\tau^*))y_m n_m]$, so μ_{threat^e} decreases as β increases..

Let us now consider the strategies that the government may use when μ falls below μ_{threat^e}. The political elite can use *self-protective redistribution*, i.e. maximize its payoff under the constraints that the people is indifferent between remaining pacific and attacking them, and that the people prefer remaining pacific rather than attacking the ethnic minority. The first constraint leads the elite to tax the ethnic community at the tax rate $\hat{\tau}$ such that $C'(\hat{\tau}) = 1 - \beta k$, which decreases as β increases, and set the transfer $\hat{t} = (1-\mu)[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m]/n_p - \mu[y_p + \beta(1-\hat{\tau})y_m]$ which increases as μ decreases, and decreases as β increases. The second constraint is satisfied for μ such as $u_p(N|\hat{\tau},\hat{t}) \geq u_p(V^m|\hat{\tau},\hat{t}) \Leftrightarrow \mu \geq (1-\beta k)(1-\hat{\tau})y_m n_m/[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]$.

The political elite can alternatively use *instrumental scapegoating*, i.e. maximize its payoff under the constraints that the people is indifferent between attacking them or attacking the minority, and that the people prefer attacking the minority rather than remaining pacific.

The first constraint yields $(1-\mu)[y_p + \beta(1-\tau)y_m + (R + (\tau - C(\tau))y_m n_m)/n_p] = (1-\mu)[y_p + (1-\tau)y_m n_m/n_p + t] \Leftrightarrow \bar{t} = [R + (\tau - C(\tau))y_m n_m - (1-\beta k)(1-\tau)y_m n_m]/n_p$. If $y_m n_m \geq R$, and if there exists $\bar{\tau}_\beta$ such that $R + (\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m = (1-\beta k)(1-\bar{\tau}_\beta)y_m n_m$, then the political elite uses the policies $(\bar{\tau}_\beta, 0)$ to induce violence towards the minority. But this $\bar{\tau}_\beta$ is necessarily lower than $\bar{\tau}$ (defined in Section 1.3) and decreases as β increases. Moreover, such a $\bar{\tau}_\beta$ might not exist. In particular, for $\beta \geq (y_m n_m - R)/(k y_m n_m)$, there does not exist such a $\bar{\tau}_\beta$. When $\bar{\tau}_\beta$ does not exist or when $R > y_m n_m$, the political elite has to chose a tax rate equal to 0, and a transfer $\bar{t} = [R - (1-\beta k)y_m n_m]/n_p$ in order to induce instrumental scapegoating. The second constraint is respected for $\mu \leq (1-\beta k)(1-\bar{\tau}_\beta)y_m n_m/[y_p n_p + (1-\bar{\tau}_\beta)y_m n_m]$

if $y_m n_m \geq R$ and if $\bar{\tau}_\beta$ exists; and for $\mu \leq (1-\beta k)y_m n_m/[R + y_p n_p + \beta k y_m n_m]$ otherwise.

The political elite chooses *self-protective redistribution* for μ such that $\pi_e(NV|\hat{\tau},\hat{t}) \geq \pi_e(V^m|\bar{\tau}_\beta, 0)$, if $\bar{\tau}_\beta$ exists; and for μ such that $\pi_e(NV|\hat{\tau},\hat{t}) \geq \pi_e(V^m|0,\bar{t})$, otherwise.

The thresholds for scapegoating are respectively:

$\mu_{scapegoat} = (1-\beta k)(1-\bar{\tau}_\beta)y_m n_m/[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]$ and $\mu_{scapegoat} = (1-\beta k)y_m n_m/[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]$.

Both thresholds $\mu_{scapegoat}$ are decreasing in β:

Proof:

1/ $\mu_{scapegoat} = (1-\beta k)(1-\bar{\tau}_\beta)y_m n_m/[R+(\hat{\tau}-C(\hat{\tau}))y_m n_m+y_p n_p+\beta k(1-\hat{\tau})y_m n_m] = [R+(\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m]/[R+(\hat{\tau}-C(\hat{\tau}))y_m n_m+y_p n_p+\beta k(1-\hat{\tau})y_m n_m]$, by definition of $\bar{\tau}_\beta$.

Derivation with respect to β gives:

$(\bar{\tau}'_\beta(1-C'(\bar{\tau}_\beta))y_m n_m \times [R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m] - [R + (\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m] \times [\hat{\tau}'(1-C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k\hat{\tau}' y_m n_m])/[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]^2$

Only the sign of the numerator matters:

$\overbrace{\bar{\tau}'_\beta(1-C'(\bar{\tau}_\beta))y_m n_m}^{\text{A}} \times \overbrace{[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]}^{\text{B}} - [R+(\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m] \times [\hat{\tau}'(1-C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k\hat{\tau}' y_m n_m]$

$\bar{\tau}_\beta$ is decreasing with β, so $\bar{\tau}'_\beta < 0$. $\bar{\tau}'_\beta < \tau^*$, so $C'(\bar{\tau}_\beta < 1$. Therefore we have A<0. We obviously have B positive, so A×B is negative.

$-\underbrace{[R + (\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m]}_{\text{C}} \times \underbrace{[\hat{\tau}'(1-C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k\hat{\tau}' y_m n_m]}_{\text{D}}$

C is obviously positive. D can be rewritten:

$\hat{\tau}'(1-C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k\hat{\tau}' y_m n_m = k(1-\hat{\tau})y_m n_m + (1 - C'(\hat{\tau}) - \beta k)\hat{\tau}' y_m n_m$, but by definition $C'(\hat{\tau}) = 1 - \beta k$ so $1 - C'(\hat{\tau}) - \beta k = 0$ and D is indeed equal to $k(1-\hat{\tau})y_m n_m$, which is positive. Thus C×D is positive.

Therefore A×B-C×D is negative, so $\mu_{scapegoat}$ is decreasing in β. □

2/ Derivation with respect to β for the second threshold gives:

$([-k y_m n_m] \times [R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m] - (1-\beta k)y_m n_m \times [\hat{\tau}'(1-C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k\hat{\tau}' y_m n_m])/[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]^2$

Only the sign of the numerator matters:

$\overbrace{[-k y_m n_m] \times [R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + y_p n_p + \beta k(1-\hat{\tau})y_m n_m]}^{\text{A}} - [(1-\beta k)y_m n_m \times [\hat{\tau}'(1-$

$C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k \hat{\tau}' y_m n_m]]$
The first part A is negative. We have to focus on the second part of the numerator: $-\underbrace{(1-\beta k)y_m n_m}_{\text{B}} \times \underbrace{[\hat{\tau}'(1-C'(\hat{\tau}))y_m n_m + k(1-\hat{\tau})y_m n_m - \beta k \hat{\tau}' y_m n_m]}_{\text{C}}$
Part B is positive and C is exactly equal to D, in the first part of the proof, so C is positive. Thus B×C is positive, so the numerator is of the form A-(B×C), thus the numerator is negative, so $\mu_{scapegoat}$ is decreasing in β. □
The payoff of the political elite when is uses instrumental scapegoating is $\pi_e(V^m|\bar{\tau}_\beta, 0) = [R + (\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m]/n_e$ or $\pi_e(V^m|0, \bar{t}) = (1-\beta k)y_m n_m/n_e$. Note that if β is high enough the political elite might prefer to leave the country and get π_0 if $\pi_0 \geq [R + (\bar{\tau}_\beta - C(\bar{\tau}_\beta))y_m n_m]/n_e$ or $\pi_0 \geq (1-\beta k)y_m n_m/n_e$.
In this case, the political elite will use the self-protective redistribution as long as $\pi_e(NV|\mu, \hat{\tau}, \hat{t}) \geq \pi_0 \Leftrightarrow \mu \geq n_e\pi_0/[R + (\hat{\tau} - C(\hat{\tau}))y_m n_m + \beta k(1-\hat{\tau})y_m n_m + y_p n_p] \equiv \mu_{exile}$, which is decreasing with β.

1.C Extension with Partial Violence

No rich ethnic minority
In case of violence against the elite, payoffs become:
$\pi_e(V_e) = (1-\theta)R/n_e$ and $\pi_p(V_e|\mu) = (1-\mu)(y_p + \theta R/n_p)$.

The domains uncovered in Proposition 1.1 are qualitatively unchanged.
We find that $\mu_{threatPV} = \theta R/(\theta R + y_p n_p) < \mu_{threat}$ and
$\mu_{exilePV} = [\pi_0 n_e - (1-\theta)R]/(\theta R + y_p n_p) < \mu_{exile}$
Moreover, $\hat{t}_{PV} = (1-\mu)\theta R/n_p - \mu y_p$.

Separate elites
In case of violence against the local elite, payoffs become:
$\pi_e(V_e|\tau) = (1-\theta)\left[R + (\tau - C(\tau))y_m n_m\right]/n_e$ and
$\pi_p(V_e|\mu, \tau) = (1-\mu)\left[y_p + \theta[R + (\tau - C(\tau))y_m n_m]/n_p\right]$ with $\pi_m(V_e|\tau)$ unchanged.
In case of violence against the minority, payoffs become: $\pi_m(V_m|\tau, t) = (1-\theta)(1-\tau)y_m$ and $\pi_p(V_m|\mu, \tau, t) = (1-\mu)\left[y_p + t + \theta(1-\tau)y_m n_m/n_p\right]$ with $\pi_e(V_m|\tau, t)$ unchanged.

The domains uncovered in Proposition 1.2 are qualitatively unchanged.
We find that $\mu_{threat^e_{PV}} = \theta[R + (\tau^* - C(\tau^*))y_m n_m]/[\theta(R + (\tau^* - C(\tau^*))y_m n_m) + y_p n_p] < \mu_{threat^e}$ and $\mu_{threat^m_{PV}} = \theta(1-\tau^*)y_m n_m/[\theta(1-\tau^*)y_m n_m + y_p n_p] < \mu_{threat^m}$.
We find $\mu_{scapegoatPV} = ((1-\bar{\tau})y_m n_m - (1-\theta)[R + (\tau^* - C(\tau^*))y_m n_m])/(\theta[R +$

$(\tau^* - C(\tau^*))y_m n_m] + y_p n_p)$ and $\mu_{scapegoat'PV} = [\theta(1-\tau_{V_m})y_m n_m - (1-\theta)[(\tau^* - C(\tau^*)) - (\tau_{V_m} - C(\tau_{V_m}))]y_m n_m]/(\theta[R + (\tau^* - C(\tau^*))y_m n_m] + y_p n_p)$ and we have $\mu_{scapegoatPV} < \mu_{scapegoat}$ and $\mu_{scapegoat'PV} < \mu_{scapegoat'}$.
Moreover, we have $\mu_{1PV} = \theta(1-\tau^*)y_m n_m/(\theta[R + (\tau^* - C(\tau^*))y_m n_m] + y_p n_p)$, $\mu_{2PV} = \theta(1-\bar{\tau})y_m n_m/[\theta(1-\bar{\tau})y_m n_m + y_p n_p]$ and $\mu_{2'PV} = \theta(1-\tau_{V_m})y_m n_m/(\theta[R + (\tau_{V_m} - C(\tau_{V_m}))y_m n_m] + y_p n_p)$.
We always have $\mu_{1PV} < \mu_{scapegoatPV}$, $\mu_{2PV} > \mu_{scapegoatPV}$ and $\mu_{2'PV} > \mu_{scapegoat'PV}$; while $\mu_{1PV} < \mu_{scapegoat'PV}$ for θ higher than a certain threshold.
$\hat{t}_{PV} = (1-\mu)\theta[R + (\tau^* - C(\tau^*))y_m n_m]/n_p - \mu y_p$.

One difference from the benchmark analysis is as follows. About *instrumental scapegoating*, let us define τ_{V_m} such that $C'(\tau) = 1 - \theta/(1-\theta)$.
The policy chosen is: $(\bar{\tau}, 0)$ if $(1-\tau_{V_m})y_m n_m \geq R + (\tau_{V_m} - C(\tau_{V_m}))y_m n_m$; and (τ_{V_m}, t_{V_m}), with $t_{V_m} = \theta[R + (\tau - C(\tau))y_m n_m - (1-\tau)y_m n_m]/n_p$ if $(1-\tau_{V_m})y_m n_m < R + (\tau_{V_m} - C(\tau_{V_m}))y_m n_m$. Note that $\tau_{V_m} \leq \tau^*$ and τ_{V_m} decreases as θ increases while t_{V_m} increases as θ increases.

Partial integration

The local elite's utility in case of violence becomes: $u_e(V_m|\tau, t) = [R - n_p t + (\tau(1 - \beta(1-\theta)) - C(\tau) + \beta(1-\theta))y_m n_m]/n_e$ and $u_e(V_e|\tau) = [(1-\theta)R + (\tau(1-\beta-\theta) - (1-\theta)C(\tau) + \beta)y_m n_m]/n_e$, while its utility in case of peace is unaltered.

The domains uncovered in Proposition 1.3 are qualitatively unchanged.
We find that $\mu_{threat^e_{\beta PV}} = \theta[R + (\tau^*_\beta - C(\tau^*_\beta))y_m n_m]/[\theta(R + (\tau^*_\beta - C(\tau^*)_\beta)y_m n_m) + y_p n_p] < \mu_{threat^e_\beta}$ and $\mu_{threat^m_{\beta PV}} = \theta(1-\tau^*_\beta)y_m n_m/[\theta(1-\tau^*_\beta)y_m n_m + y_p n_p] < \mu_{threat^m_\beta}$.

The policy chosen for *altruistic protection* is: first $(\tilde{\tau}_{1PV}, 0)$ with $\tilde{\tau}_{1PV}$ such that $\theta(1-\tau)y_m n_m/[\theta(1-\tau)y_m n_m + y_p n_p] = \mu$, and then $(\tilde{\tau}_{2PV}, \tilde{t}_{2PV})$ with $\tilde{\tau}_{2PV}$ such that $C'(\tau) = \theta/\mu - \beta + (1-\theta)$ and $\tilde{t}_{2PV} = (1/\mu - 1)\theta(1-\tilde{\tau}_{2PV})y_m n_m/n_p - y_p$.
Note that $\tilde{\tau}_{1PV}$ and $\tilde{\tau}_{2PV}$ increase as θ increases.

The policy chosen for *self-protective redistribution* is: first $(\hat{\tau}_{1PV}, 0)$ with $\hat{\tau}_{1PV}$ such that $\theta[R + (\tau - C(\tau))y_m n_m]/(\theta[R + (\tau - C(\tau))y_m n_m] + y_p n_p) = \mu$, and then $(\hat{\tau}_{2PV}, \hat{t}_{2PV})$ with $\hat{\tau}_{2PV}$ such that $C'(\tau) = 1 - \beta/[1 - \theta(1-\mu)]$ and
$\hat{t}_{2PV} = (1-\mu)\theta[R + (\tau - C(\tau))y_m n_m]/n_p - \mu y_p$.
Note that $\hat{\tau}_{1PV}$ and $\hat{\tau}_{2PV}$ increase as θ increases.

The policy chosen for *no protection* and for *instrumental scapegoating* is slightly different from the benchmark. Here, the most preferred policy of the local elite in case of violence against the minority is: $(\tau^*_{\beta PV}, 0)$ with $\tau^*_{\beta PV}$ such that $C'(\tau) = 1 - \beta(1-\theta)$. Note $\tau^*_\beta \leq \tau^*_{\beta PV} \leq \tau^*$ and $\tau^*_{\beta PV}$ increases as θ increases.

If the minority is richer after tax $\tau^*_{\beta PV}$ than the elite, they choose $(\tau^*_{\beta PV}, 0)$.
While if the minority is poorer, the local elite max $u_e(V_m)$ by choosing τ and t such that that $u_p(V_m|\mu,\tau,t) = u_p(V_e|\mu,\tau) \Leftrightarrow t_{\beta V_m} = \theta[R+(\tau-C(\tau))y_m n_m-(1-\tau)y_m n_m]/n_p$. The constraint that $t_{\beta V_m} \geq 0$ leads to the following policy: we define $\tau_{\beta V_m}$ such that $C'(\tau) = 1-\beta-\theta/(1-\theta)$, which is the optimal tax rate of the local elite in case of violence against the minority after integrating the constraint $t_{\beta V_m}$ within their objective function. If $(1-\tau_{\beta V_m})y_m n_m \geq R+(\tau_{\beta V_m}-C(\tau_{\beta V_m}))y_m n_m$, the local elite chooses $(\bar{\tau}, 0)$, while if $(1-\tau_{\beta V_m})y_m n_m < R+(\tau_{\beta V_m}-C(\tau_{\beta V_m}))y_m n_m$, they choose $(\tau_{\beta V_m}, t_{\beta V_m})$. Note that $\tau_{\beta V_m}$ decreases as θ increases and $t_{\beta V_m}$ increases as θ increases.

The local elite may use *global protective impoverishment strategy* and we also find that for β small enough, the local elite never uses it, provided that θ is not too low.

As in the benchmark analysis, there exist thresholds $\mu_{protectPV}$ and $\mu_{scapegoat_\beta PV}$ at which the local elite decides to let the minority be attacked by the people. The impact of θ on these thresholds is ambiguous.

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Chapter 2

Arranged Marriages under Transferable Utilities

2.1 Introduction

In many societies, marriage is a decision taken at the family level. Examples range from Renaissance Europe[1] to contemporary rural Kenya[2]. In fact, arranged marriages are still prevalent in many parts of the developing world[3]. In the survey conducted in India in 2003 by Luke and Munshi (2011), 89.5% of the 4 000 respondents reported that their marriage was "arranged" by their parents, and 88.7% of their children's marriages were also arranged. Even in Western countries, where arranged marriages are considered to have disappeared, parents still heavily influence the choice of the spouse[4]. The upper classes in particular exert this influence through private schooling and the organization of expensive and selective social events (e.g. "rallies", in France)[5]. More alarmingly, UNICEF (2014) revealed that 700 million women alive in 2014 worldwide had been forced into child marriages, more than a third of them under 15 years old.

Yet this family dimension is basically neglected by the existing matching literature on marriage. Surprisingly, even papers studying phenomena related to arranged mar-

[1] Goody (1983), Nassiet (2000).

[2] Hakansson (1990), Luke and Munshi (2006).

[3] Hamon and Ingoldsby (2003), Anukriti and Dasgupta (2017).

[4] Kalmijn (1998) explains p.401 that "although in Western societies parental control over children's marriage decisions is limited, there are still ways in which parents can interfere. They set up meetings with potential spouses, they play the role of matchmaker, they give advice and opinions about the candidates, and they may withdraw support in the early years of the child's marriage."

[5] Arrondel and Grange (1993), Pinçon and Pinçon-Charlot (1998).

riages, such as premarital transfers or marital payments, do not take family structure into account. We seek to fill this gap here by introducing family considerations into the assignment game of Shapley and Shubik (1971). Our objective is to explore how shifting decision-making from individuals to families affects matching on the marriage market. In this paper, we study an extension of the transferable utility matching model by introducing families and considering the marriage decision to be taken at the family level. We extend the concept of stability to families and explore how the shift from individual to familial decision-making changes stable matchings. We show that stability at the family level is weaker than for individuals. In a transferable utility framework, individual stability implies aggregate surplus maximization. Moreover, this framework allows utility to be shared with family members. Consequently, an individual-stable matching must be family-stable. By contrast, family-stable matchings are not always stable for individuals. We find two main configurations in which this happens. First, family-stable matchings may be inefficient due to coordination problems between families. In this case, the loss generated by potential deviations for some members of the family is too large to be compensated for by any benefits this deviation might provide for other members. Second, even efficient matchings may not be stable for individuals. This is because families loosen constraints on the shares of the surplus: they agree on some sharings-out of surplus their children would never accept individually, because they are taking into account the family as a whole. Thus we find that the set of the shares of surplus that support efficient matchings as family-stable includes the set of the shares of surplus that support them as individual-stable. As a result, our model predicts that we should observe a larger number of stable outcomes when marriages are arranged by parents rather than by individuals. In this sense, our extension with families is less predictive than the classical matching models on marriage. We find that family-stable matchings strongly depend on the structure and composition of families. In particular, we find that when families are heterogenous in terms of size and when gender is not distributed uniformly across families, inefficient stable matchings may emerge. We also show through examples that the set of shares of surplus that support efficient matchings as stable tends to shrink as competition increases, i.e. as the number of families increases for a constant number of children. In particular, for a family partition such that each family is composed of one son and one daughter, the set of shares is minimal.

Our analysis builds on the literature of matching theory applied to the marriage market and the economics of the family, in particular Becker (1973, 1981), and recently reviewed by Browning et al. (2014). The main novelty of our model lies in shifting the decision-making process from individuals to families. To our knowledge, we are the first to introduce families into the assignment game (Shapley and Shubik 1971).[6]

There is an extensive literature on the economics of marriage examining situations related to arranged marriages under restrictive assumptions on family structure. Peters and Siow (2002), when they consider parents choosing a premarital transfer to their children and study equilibria in which children use these investments to compete for spouses, use a two-sided market setting, with families composed of one female facing families composed of one male. Actually, a family here can be modeled as an individual making an investment decision prior to the matching decision. Anderson (2003) analyzes the importance of the caste in the evolution of dowry payments with modernization, Anderson and Bidner (2015) formalize the dual role of dowry as both a premortem bequest from parents to daughters and a market clearing price, and Do et al. (2013) analyze the consequences of marital payments on consanguineous marriages when commitments are not credible. In all these papers, however, each family is composed of one child only. By contrast, we model families as arbitrary subsets in a population of males and females.

Only a few papers deal with family structure in the matching literature related to marriage. Laitner (1991) explores premarital transfers from parents to their two children, one son and one daughter, to induce their marriages in a non-transferable utility framework. He restricts attention to symmetric equilibria and focuses on the impact of assortative mating on neutrality results, but he provides a very interesting model of spouse selection by families which would be worth extending[7]. By contrast, we consider a transferable utility framework with arbitrary family structure and study the impact of family decision-making on stable matchings.

Our analysis contributes to an expanding literature on the impact of family composition on outcomes related to marriage. Botticini and Siow (2003) study how parents

[6]No theoretical paper in the matching literature explores the matching problem we address. Some papers study many-to-one markets and many-to-many markets (Roth 1985, Sotomayor 1999) applied to the marriage market. For instance, Baiou and Balinski (2000) study a matching model in which every man may have several wives and every woman several husbands and Bansal et al. (2007) study stable assignments with multiple partners. However, these models are different from ours, as we consider individuals to have one partner only. Hatfield, Kominers, Nichifor, et al. (2013) is the theoretical paper closest to ours. They model an economy in which firms can form multiple bilateral contracts with each other. The main difference with our setting is that we impose quotas on the number and the type of contracts that agents can create. I further discuss similarities and differences between our approaches in Section 2.3, and explore how our setup could fit in with their framework in Appendix 2.B.

[7]Zhang (2001) extends Laitner (1991) by introducing gender asymmetry.

decide to allocate their capital between their son and their daughter, and show that in a virilocal environment, dowry endogenously emerges. Their paper differs from ours in that they focus on one family and do not study a matching problem. Fafchamps and Quisumbing (2008) study how parents allocate their wealth among a given number of sons and daughters through transfers of assets at the time of marriage and levels of human capital. They find that children receive more when their parents are wealthier or when they have fewer siblings. They do not put any restriction on family composition and find that siblings compete for limited resources. By contrast, we show that the constraints due to being part of the same family are different when the family chooses the spouse. Vogl (2013) uses an optimal stopping model to explore how daughter competition affects the quality of the spouse and human capital outcomes in South Asia, where the norm is to marry the first-born before the younger children. Our model also stresses the constraint connected with same-gender siblings on the marriage market, but without restrictive assumptions on family structure and cultural norms. The impact of family composition is also studied for other social and economic outcomes such as education (Lafortune and Lee 2014), labor (Baland et al. 2016), migration (Bratti et al. 2016), or health (Black et al. 2017). However, all of these studies neglect the equilibrium effects of family structure. By contrast, we show that type of family partition deeply affects stable matchings.

Some papers compare the effects of parental consent versus individual consent on the marriage market. Edlund and Lagerlöf (2006) argue that a shift from parental to individual consent redistributes resources from old to young and from men to women. They show with an overlapping-generation model that such redistribution may have further consequences on growth. Huang et al. (2012) use data on urban couples in China in the early 1990s and find that parental matchmaking may distort children's spouse choice, parents being more willing to substitute money for love[8]. In this case, the parents' preferences differ from those of the children, and should be modeled with non-transferable utilities. We also compare and contrast stable matchings when marriages are arranged by families and when they are decided at the individual level in a transferable utility framework. Our results help identify which matching framework should be used to address arranged marriages in different applied contexts.

Finally, our paper establishes a new connection between the literatures on matching and on network formation. In our model, families are composed of a given number of

[8] Hortaçsu (2007) uses data on the urban Turkish family and finds that in comparison to family-initiated marriages, couple-initiated marriages are more emotionally involving.

individuals, each linked to a member of a different family through a marital relationship. In this setting, the assignment game generates a network among the families. Jackson (2010) begins his textbook on social and economic networks by discussing the example of the Renaissance Florentine marriage network. Relying on Padgett and Ansell (1993), he suggests that the central position of the Medici family in the marriage network may have allowed them to dominate the Florentine oligarchy. Our model provides a theoretical framework which may shed light on which type of marriage network emerges in different social and economic contexts.

The remainder of the paper is organized as follows. We present the model and the new concept of familial stability in Section 2.2. We explore the properties and structures of family-stable matchings in Section 2.3. Section 2.4 concludes.

2.2 The model

We consider an economy composed of marriageable sons and daughters. We assume that the population is partitioned into families by a family partition $\mathcal{F}$. A family f is a subset of agents, which can a priori contain any number of sons and daughters. Figure 2.1 illustrates different family partitions for a population of two sons i_1, i_2 and two daughters j_1, j_2.

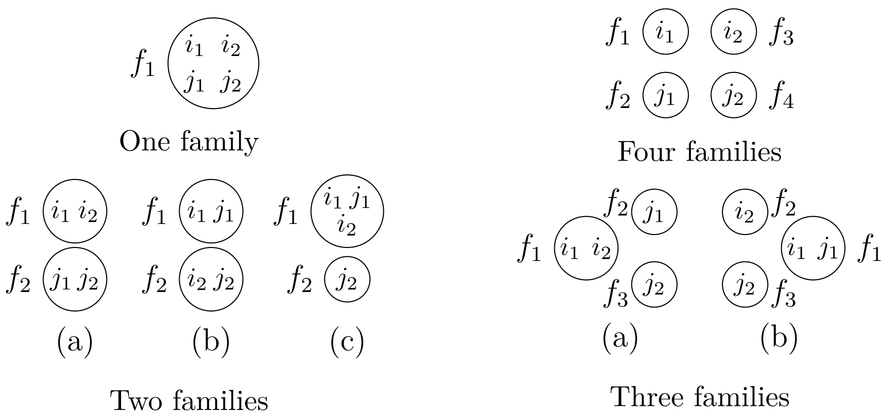

Figure 2.1 – Family Partitions

Family partitioning generates a coalition structure which is critical for the characterization of stable matchings. In Section 2.3, we study the particular case of family partitioning such that each family is composed of one son and one daughter. Parents seek to marry off their children on the marriage market in order to maximize the utility of the family u_f, which is equal to the sum of the utilities of the children. We consider a transferable utility framework, so a marriage between a son and a daughter from two different families generates a marital surplus $\pi_{ij} \geq 0$ endogenously allocated between the groom and the bride, who receive respectively $u_i \geq 0$ and $u_j \geq 0$, with $\pi_{ij} = u_i + u_j$. We assume siblings cannot marry, which is equivalent to setting $\pi_{ij} < 0$ if i and $j \in f$. Finally, we assume the normalization that being single provides no payoff, i.e. $\pi_{i0} = \pi_{0j} = 0$ for all i, j. Therefore we can state the definition of a matching (μ, u) on individuals with families formally. We consider a unique output matrix with entries π_{ij} that specify the total surplus from possible marriages. Because we assume transferable utilities, this marital surplus can be divided between the husband and the wife. Thus, by definition, if i and j from two different families form a match, i.e. if $\mu_{ij} = 1$, we have $u_i + u_j = \pi_{ij}$. Thus, a matching on individuals with families induces family utilities $u_f = \sum\limits_{k \in f} u_k$.

For instance, when each family is composed of one child only, we have the classical matching model with individuals. Introducing families shifts decision-making on the marriage market from individuals to parents. Parents consider the utility of the family, which generates some interdependence in the utilities of its members, who would otherwise act individually. They choose partners for their children in such a way as to maximize the utility of the whole family, which may mean arranging a worse marriage for one child if it enables the other children to marry better. We show in Section 2.3 that this setting changes stable matchings. It is also noteworthy that, in our framework, a matching generates a network of families. In a network analysis perspective, each node or family can be linked to one or more families through marital connections. Two families could be united through several links, as several of their children could be matched. In fact, when families are taken into account, matching can also be considered a model of strategic network formation. This is in sharp contrast with the classical one-to-one matching models on marriage. We do not specifically study the network structure that emerges from this setting, but we discuss in the Conclusion the broader economic and social implications of family links through marriage, based on this network structure.

To solve our matching problem, we introduce a new concept of *familial stability*. Classical matching models on marriage only considering individuals define a matching as stable if there are no two persons, married or unmarried, who would like to form a new union. In other words, if there are no blocking pairs. As a direct extension of this notion, we consider that a matching is *stable* if there are no two families who would like to form one or several new unions for some of their children. Thus, we say that a matching is *family-stable* if there are no blocking pairs of families. This definition is consistent with empirical evidence that families negotiate their children's mariages bilaterally. In their study on the Luo in Kenya, Luke and Munshi (2006) explain that arranged marriages are organized by a matchmaker, or *jagam*, who is usually one of the man's sisters, sisters-in-law or other extended relatives. Molho (1994) provides evidence of this practice in detailed descriptions of some arranged marriages in medieval Florence. Literally, we say that a matching is *family-stable* if there are no two families who would like to sever their existing links for one or several of their children to create new ones with the other family, such that the utilities of both families increase, one of which increasing strictly. To state the definition formally, we introduce the notation C_f, which represents a subset of children in f.

Definition 2.1. *A matching (μ, u) is not family-stable with respect to the family partition $\mathcal{F}$ if $\exists(f, f') \in \mathcal{F}^2$, $\exists(C_f, C_{f'})$ of the same size, $\exists(\mu', u')$ such that*

(1) $\forall i \in C_f\ \exists j' \in C_{f'}$ such that $\mu'_{ij'} = 1$[9].

(2) $\mu_{ij'} = \mu'_{ij'}$ if $i \notin C_f$ and $j' \notin C_{f'}$.

(3) $u'_f \geq u_f$ and $u'_{f'} \geq u_{f'}$ with at least one strict inequality.

Condition (1) says that the alternative matching (μ', u') is such that some of the children of families f and f' are married to each other, formally children in C_f and $C_{f'}$. Families f and f' may already be matched through some of their children in the initial matching (μ, u) and may decide to sever some of their existing links to create new ones. They can sever some of their links with other families to create new links between themselves, and/or swap existing marriages among their children[10]. Condition (2) states that the alternative matching only differs from the initial one for members of C_f and $C_{f'}$ and their partners in the initial matching. Condition (3) requires that the two families f and f' gain from the new matching, with at least one family gaining strictly. It is worth noting that when each family is composed of one child only, our concept of familial stability is equivalent to the classical notion of stability.

[9] In the remainder of the paper, we implicitly assume that all definitions and proofs consider the respective case of a daughter $j \in f$ being married to a son $i' \in f'$, in order to avoid heavy notations.

[10] For instance, consider families f_1 and f_2, and assume that i_1 and i_2 are part of f_1 and j_1 and j_2 are part of f_2. Assume that i_1 and j_1 are matched together, and i_2 and j_2 are matched to other families in the initial matching. f_1 and f_2 could decide to deviate together by rearranging their marriages to have i_1 married to j_2 and i_2 married to j_1.

Our definition of familial stability considers only deviations by pairs of families. In Section 2.3, we show that this concept of familial stability generates some coordination problems which may lead to inefficient social outcomes. As a consequence, we find that the set of family-stable matchings can exceed the core of the assignment game with families. We also discuss an alternative definition of familial stability that considers families as able to deviate in triples or more.

2.3 Stable Matchings with Families

In this section, we explore the properties and structures of family-stable matchings, and we compare them with individual-stable matchings. We call *individual stability* the usual concept of stability used in the Becker-Shapley-Shubik model[11]. We find in particular that familial stability is weaker than individual stability: while individual stability implies familial stability, a family-stable matching may be not stable for individuals. We find that there are two main configurations in which a matching may be stable for families but not for individuals. First, inefficient matchings, i.e. matchings that do not maximize the sum of total marital surplus, may be family-stable. This is in sharp contrast with individual-stable matchings, as the central result of the transferable utility framework is that individual stability implies aggregate surplus maximization. Second, even efficient matchings may be stable for families but not for individuals. In this case, the difference lies in the shares of surplus, not in the assignment itself: there are some shares of surplus that support efficient matchings as family-stable, but not as individual-stable. Finally, we find that family partitioning has a direct impact on the characterization of family-stable matchings. In particular, for the family partition such that each family is composed of one son and one daughter, familial stability implies individual stability.

Before proceeding, it is important to clearly characterize the core in our setup and to compare it with the core in the classical assignment game. The outcomes in the core are those that cannot be improved upon by any subset of players (Shapley and Shubik 1971). So a matching (μ, u) is *corewise-stable* if there is no coalition S of players who, by forming all their marriages only among themselves, can all obtain a higher payoff. Thus we have to distinguish between the core when the players are the individuals as in the classical assignment game, and the core when the players are the families, as in our setup. Just like corewise-stable matchings with individuals, corewise-

[11] See Shapley and Shubik (1971), Becker (1973), Browning et al. (2014).

stable matchings with families must maximize aggregate marital surplus in the economy: any inefficient matching (μ, u) is improved upon by the coalition of all families in the economy $S = \cup_{f \in \mathcal{F}} f$. However, the restrictions on the shares of surplus supporting a corewise-stable matching are more stringent when the players are the individuals than when the players are the families. So the core with families should include the core with individuals. Shapley and Shubik (1971) showed that individual-stable matchings are equivalent to corewise-stable matchings. However, we will see that family-stable matchings may be out of the core defined with families.

Our first result is that individual stability implies familial stability. This result may seem counter-intuitive, as we usually place arranged marriages and self-chosen marriages in opposition. The intuition for this result is that, as we are in a transferable utility framework, the utility generated by a marriage between a son and a daughter from different families can be transferred entirely and without friction to their respective families. It is as if the benefits the two individuals experience from a self-chosen marriage could be perfectly shared with their respective parents. Indeed, when children individually maximize their own utility on the marriage market, these utility maximizations directly benefit the family as a whole.

We now state our result formally in Theorem 2.1.

Theorem 2.1. *An individual-stable matching is always family-stable.*

Before proceeding to the proof, we introduce the notations u_{C_f} and $\bar{C}_f$. Let u_{C_f} be the sum of the utilities of the members in C_f, and $\bar{C}_f$ be such that $C_f \cup \bar{C}_f = f$.

Proof. Consider a matching (μ, u) which is stable for individuals. So (μ, u) is in the core of the game where players are the individuals. Assume this matching is not family-stable. Therefore $\exists (f, f')$, $\exists (C_f, C_{f'})$ of the same size, $\exists (\mu', u')$, which satisfy conditions 1, 2 and 3 of Definition 2.1. Indeed we have that $u'_f + u'_{f'} > u_f + u_{f'} \Leftrightarrow u'_{C_f} + u'_{\bar{C}_f} + u'_{C_{f'}} + u'_{\bar{C}_{f'}} > u_{C_f} + u_{\bar{C}_f} + u_{C_{f'}} + u_{\bar{C}_{f'}}$. But we know that $u'_{\bar{C}_f} + u'_{\bar{C}_{f'}} \leq u_{\bar{C}_f} + u_{\bar{C}_{f'}}$, because children in $\bar{C}_f$ or $\bar{C}_{f'}$ are either unaffected by the deviation or have their link severed. Therefore this implies that $u'_{C_f} + u'_{C_{f'}} > u_{C_f} + u_{C_{f'}}$. Thus there exists a coalition of individuals $S = C_f \cup C_{f'}$ for which $\sum\limits_{i,j \in S} \pi_{ij} > \sum\limits_{k \in S} u_k$. But because the matching (μ, u) is in the core, we have a contradiction. ■

Notice that this result should not hold in a non-transferable utility framework. With non-transferable utilities, the utility of the parents could be misaligned with the utilities of their children. For instance, parents could care only about the wealth or the education of their children's partners, while grown-up children could care about shared interests or affinity, as documented in urban China in Huang et al. (2012). So with non-transferable utilities, parents would have their own preferences over individual partners, which could be different from their children's own individual preferences. Furthermore, parents, contrary to children, would also have preferences over sets of partners. Preferences over sets of players in non-transferable utility frameworks have already been studied in many-to-one and many-to-many matching models (Roth 1985, Sotomayor 1999, Echenique and Oviedo 2006). But our setting differs from these models because families are decision-making entities composed of players who can be on both sides of the market. This implies that each family could have preferences over sets of partners, which could be composed of males and females.[12] An additional difference implied by this specific setup is that parents could value a set of partners differently depending on the identity of their child who is married to a specific partner. For instance, a family of two sons i_1 and i_2 could prefer the matching in which i_1 is married to j_1, and i_2 to j_2 over the matching in which i_1 is married to j_2, and i_2 to j_1. With non-transferable utilities, a matching μ would be called *family-stable* if there are no two families who, by forming new marriages only among themselves, possibly dissolving some marriages of μ and possibly keeping other ones, can obtain a preferred set of partners, with at least one family obtaining a strictly preferred set. A direct consequence of non-transferable utilities is that individual stability will not necessarily imply familial stability. So we could observe sharp differences in terms of outcomes on the marriage market depending on whether the decision-maker is the family or the individual. Another consequence of non-transferable utilities is that, unlike with transferable utilities, families cannot attract a desirable partner by giving his family a larger share of the marital surplus. So families would attract a desirable spouse by offering his family the most preferred children they have, which could differentiate even more family-stable assignments from individual-stable ones.

This first result on the relationship between individual stability and familial stability enables us to derive interesting properties of family-stable matchings. From the literature on matching, we know that individual-stable matchings always exist and that

[12]In the College Admission problem (many-to-one), each college has preferences over sets of students, while each student has preferences over individual colleges. In the firms and consultants problem (many-to-many), each firm has preferences over sets of consultants, and each consultant has preferences over sets of firms.

they always maximize the sum of total marital surplus[13]. This implies that Theorem 2.1 suffices *to prove the existence of family-stable matchings*. Moreover, thanks to the equivalence result of the transferable utility framework, we know that *there always exists a set of shares of marital surplus that satisfy familial stability for assignments that maximize aggregate surplus*. So our model predicts that if parents allowed their children to choose their own partners, the ensuing matching would be stable for families. This would argue for promoting individual choice of spouse instead of parental matchmaking in societies where arranged marriage is still prevalent, especially since individual choice should always lead to efficient social outcomes.

By contrast, our second result is that parental matchmaking may lead to inefficient matchings.

Proposition 2.1. *A matching can be family-stable and inefficient.*

Consider the two-men-two-women case and the family partition $\mathcal{F}_1$ illustrated in Figure 2.2. Family f_1 is composed of two sons i_1 and i_2, while families f_2 and f_3 are composed of one daughter each, respectively j_1 and j_2. Note that with this family partition, assignments (μ_1) $i_1 - j_1$, $i_2 - j_2$, represented by dashed lines, and (μ_2) $i_1 - j_2$, $i_2 - j_1$, represented by thick lines, are feasible. Let us assume that matching μ_1 is inefficient, while matching μ_2 is efficient.

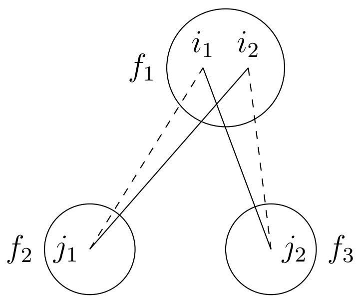

Figure 2.2 – Families versus individuals

In this configuration, if individuals chose their spouse, the outcome would be efficient matching μ_2, as theory predicts. However, when families decide who their children will marry, they may end up stuck with inefficient matching μ_1. The intuition for this is that even if both son i_1 and daughter j_2 as individuals have an incentive to sever their

[13] Shapley and Shubik (1971), Becker (1973), Browning et al. (2014).

respective links so as to marry, family f_1 would prevent a marriage between its son i_1 and j_2 if the loss generated thereby in terms of utility for its second son i_2 is too large. In this case, inefficient matching μ_1 is family-stable but not stable for individuals. If there were no families, individuals would be able to sever their links and remarry in order to reach the efficient assignment. But families forbid such deviations. Inefficient matchings emerge when potential deviations for a family are such that some of its members end up single or worse off, and the benefits its other members obtain from the new matching are not sufficient compensation. This happens when families are composed of several children of the same gender[14] and are facing smaller families or families with few children of the complementary gender. In these cases, the bigger families could oppose potential deviations, as they would be more likely to involve one of their children ending up single. In this configuration, stable matchings differ in the assignment itself, depending on whether the decision-maker is the family or the individual. We may actually observe matchings that are not predicted by the classical theory on matching, but which can be explained if we take families into account. In particular, if we assume that each son is characterized by a single characteristic x, that each daughter is characterized by a single characteristic y and that there is complementarity (substitution) in traits, i.e. that the marital surplus is a supermodular (submodular) function of the attributes of the two partners, the classical matching model predicts positive (negative) assortative mating. By contrast, with these same assumptions, matchings with no positive (negative) assortative mating can be family-stable. For instance, consider again the family partition in which family f_1 is composed of two sons i_1 and i_2, and families f_2 and f_3 are composed of one daughter each, respectively j_1 and j_2. All children k are characterized by the number of years they studied x_k. We assume that this characteristic is complementary in marriage, so we should observe positive assortative matching on education in an efficient matching, i.e. the most educated son should be married to the most educated daughter, and the least educated son should be married to the least educated daughter. Formally, we assume the marital surplus function to be supermodular in the years of education of the two spouses. Let us consider in particular the marital surplus function $\pi_{ij} = \pi(x_i, x_j) = x_i x_j$. Let us assume that $x_{i_1} = 7$, $x_{i_2} = 10$, $x_{j_1} = 6$ and $x_{j_2} = 4$, so positive assortative matching would mean that i_1 is married to j_2 and i_2

[14]This issue is also addressed by Vogl (2013): "For instance, siblings of the same gender participate in the same marriage market, sharing a pool of potential spouses. In some ways, they are like any other participants on the same side of the market, but their membership in the same family introduces special constraints on their marriages." (p.1018).

to j_1.[15] However, the matching where i_1 is married to j_1 and i_2 is married to j_2 can be family-stable. For instance, this is the case for the following shares of surplus: $u_{i_1} = 29$, $u_{i_2} = 30$, $u_{j_1} = 13$ and $u_{j_2} = 10$. In this situation, son i_2 and daughter j_1 would like to deviate individually because they currently obtain 43 collectively, whereas they would get a marital surplus of 60 if they were married to each other. However, family f_1 would prevent such a deviation, because the additional surplus of 17 generated by this marriage would not compensate the loss generated in terms of utility for its second son i_1, equal to 29. Note also that in this inefficient family-stable matching, the least-educated son receives a share of surplus that he would never have obtained if he had had to find his spouse individually in the marriage market. So in this case, the presence of family f_1 arranging the marriages of its sons helps reduce inequalities in outcomes between siblings of different qualities. Thus we do not observe positive assortative matching when marriages are arranged by families, while it would emerge if individuals chose their marriages themselves. As we will further discuss, this result is dependent on our definition of familial stability, which allows deviations for pairs of families only, and thus generates some coordination problems.

We now prove the existence of such inefficient matchings, showing that there exists a set of shares of surplus that support the inefficient matching μ_1 as family-stable in the configuration illustrated in Figure 2.2. By assumption, μ_1 ($i_1 - j_1$, $i_2 - j_2$) is the inefficient matching, and μ_2 ($i_1 - j_2$, $i_2 - j_1$) is the efficient one, which means that $\pi_{12} + \pi_{21} > \pi_{11} + \pi_{22}$. We consider possible deviations of pairs of families from the inefficient assignment. We first note that families f_2 and f_3 cannot deviate together, both being composed of one single daughter. The only two possible family deviations from the inefficient assignment are (1) the deviation involving f_1 and f_2, in which case they would form $i_2 - j_1$; and (2) the deviation involving f_1 and f_3, in which case they would form $i_1 - j_2$. Let us consider the first family deviation: f_1 and f_2 could decide to sever their existing links to marry i_2 and j_1. In particular, family f_1 would sever its link with f_3 to marry its son i_2 to j_1 from family f_2 instead of j_2 from family f_3. This threat generates an upper bound on the share u_{j_2} that f_3 can expect from f_1 in the marriage $i_2 - j_2$. f_1 and f_2 would have an incentive to deviate if $u_{f_1} + u_{f_2} < u'_{f_1} + u'_{f_2} \Leftrightarrow u_{i_1} + u_{i_2} + u_{j_1} < u'_{i_2} + u'_{j_1}$. By definition, $u_{i_2} = \pi_{22} - u_{j_2}$, therefore, the highest share that f_3 could expect from f_1 in the marriage $i_2 - j_2$ is u_{j_2} such that f_1 and f_2 are indifferent between the inefficient assignment and deviation, formally u_{j_2} such that $u_{i_1} + u_{i_2} + u_{j_1} = u'_{i_2} + u'_{j_1}$. We replace

[15] Positive assortative matching is also the efficient matching, as $\pi_{11} = 42$, $\pi_{12} = 28$, $\pi_{21} = 60$ and $\pi_{22} = 40$, so $\pi_{12} + \pi_{21} = 88$, while $\pi_{11} + \pi_{22} = 82$.

u_{i_2} by its expression in terms of u_{j_2} and find $u_{j_2} \leq \pi_{11} + \pi_{22} - \pi_{21}$ [16]. We follow the same reasoning for the second deviation involving f_1 and f_3 and find that the upper bound on u_{j_1} is: $u_{j_1} \leq \pi_{11} + \pi_{22} - \pi_{12}$. We find that all pairs (u_{j_1}, u_{j_2}) satisfying inequalities $u_{j_1} \leq \pi_{22} + \pi_{11} - \pi_{12}$ and $u_{j_2} \leq \pi_{22} + \pi_{11} - \pi_{21}$ with $0 \leq u_{j_1} \leq \pi_{11}$ and $0 \leq u_{j_2} \leq \pi_{22}$ yield imputations u_{j_1}, u_{j_2}, $u_{i_1} = \pi_{11} - u_{j_1}$ and $u_{i_2} = \pi_{22} - u_{j_2}$ that support the inefficient assignment as family-stable. To represent this set graphically in Figure 2.3, assume $\pi_{22} > \pi_{21}$, $\pi_{12} > \pi_{11}$, and $\pi_{12} = \pi_{21}$[17].

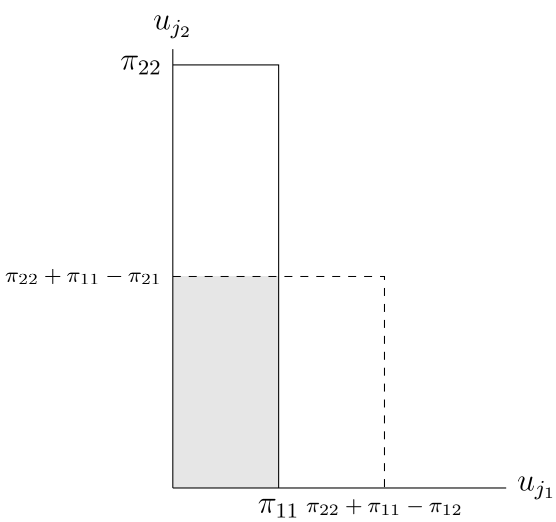

Figure 2.3 – Inefficient family-stable matching

This example shows that introducing families generates some coordination problems which may translate into inefficient outcomes. The coordination problem emerges here because deviations are only allowed for pairs of families. It is interesting to note that, in our example on positive assortative matching, if we allowed families to deviate in triples, the three families could coordinate their deviations to reach the efficient assignment. This means that the three families could obtain a higher aggregate surplus to share, and could find a sharing mode that would benefit all three. This is in sharp contrast with classical matching models on marriage in which individual-stable matchings are equivalent to the core. In our setting with families, as we have already explained above,

[16] $\pi_{22} - u_{j_2} + u_{i_1} + u_{j_1} = u'_{i_2} + u'_{j_1} \Leftrightarrow \pi_{22} - u_{j_2} + \pi_{11} = \pi_{21} \Leftrightarrow u_{j_2} = \pi_{22} + \pi_{11} - \pi_{12}$, which is the higher bound on u_{j_2}.

[17] This is the same assumption as that made by Browning et al. (2014) in Chapter 8. We can use a numerical example to explore this result. For instance with $\pi_{22} = 8$, $\pi_{21} = \pi_{12} = 6$, $\pi_{11} = 2$ we have that the shares $u_{j_1} = 2$, $u_{j_2} = 3$, $u_{i_1} = 0$, $u_{i_2} = 5$ support the inefficient assignment as family-stable, but obviously not as individual-stable.

corewise-stable matchings must maximize aggregate marital surplus. Our result here is that family-stable matchings exceed the core, as some inefficient matchings can be family-stable.

This result comes from our definition of familial stability, which considers deviations by pairs of families. However, we could also choose an alternative definition which considers deviations by any subset of families. We could assume that families negotiate the marriage of their children multilaterally and commit through betrothal contracts. This alternative definition would resolve some situations where families are stuck in an inefficient matching. In reality, however, deviations by at most $k > 2$ families should generate coordination costs that may offset this positive result. In any case, as long as the number of families who can deviate together is bounded, i.e. $k < n$ with n the number of families in the population, inefficient outcomes are still likely to arise. In contrast, if we allowed deviations for any subset of families, i.e. $k = n$, we would obtain only efficient family-stable matchings. It is interesting to note here that if we extended our notion of familial stability to allow any subset of families to deviate, family-stable matchings would not be equivalent to corewise-stable matchings. If we allowed deviations for any subset of families, *familial stability* would rule out the possibility that any subset of families may profitably remarry some of their children among themselves while maintaining some of their prior marriages with other families. In contrast, *corewise stability with families* rules out the possibility that any subset of families may profitably remarry some or all of their children among themselves, prior marriages with other families being severed. So under corewise stability, the incentives for families to deviate shrink in comparison to the extended notion of familial stability. This implies that all *extended* family-stable matchings should be corewise-stable, but that the reverse is not true.[18] Similar findings can be found in Sotomayor (2007) and Hatfield, Kominers, Nichifor, et al. (2013), and also in the the literature of many-to-many

[18] Consider the following example borrowed from the multiple-partners assignment game of Sotomayor (2007) and adapted to our setup. There are four families: f_1, composed of i_1 and j_1; f_2, composed of i_2 and j_2; f_3, composed of i_3; and f_4, composed of j_3 and j_4. Marital surpluses are as follows: $\pi_{12} = \pi_{21} = \pi_{33} = \pi_{34} = 0$, $\pi_{13} = \pi_{14} = 2$, $\pi_{23} = \pi_{24} = \pi_{31} = \pi_{32} = 3$. There are several efficient matchings in this configuration, but let us select: $i_1 - j_3$, $i_2 - j_4$ and $i_3 - j_1$. Consider the following shares of surplus: $u_{i_1} = 1$, $u_{i_2} = 1$, $u_{i_3} = 2$, $u_{j_1} = 1$, $u_{j_3} = 1$ and $u_{j_4} = 2$. This matching is not family-stable, because families f_2 and f_3 would gain from marrying i_3 to j_2: f_2 could obtain an utility of $1 + (1 - \lambda)$ instead of 1, and f_3 could reach $2 + \lambda$ instead of 2, with $0 < \lambda < 1$. However, this matching is corewise-stable: if f_2 deviates with f_3 to form the link $i_3 - j_2$, the marriage between its son i_2 and j_4 from f_4 is severed. If f_2, f_3 and f_4 deviate together, the marriage between the other daughter of f_4, j_3 and i_1 from f_1 is severed. If all families deviate together, f_1 will be strictly worse off as its daughter j_1 ends up single.

matching models with nontransferable utilities (Roth and Sotomayor 1990, Sotomayor 1999, Echenique and Oviedo 2006). The paper of Hatfield, Kominers, Nichifor, et al. (2013), which builds on the literature of matching with contracts initiated by Hatfield and Milgrom (2005), is the closest to our approach. They consider a one-sided market with firms that can form multiple bilateral contracts with each other under transferable utilities. The main difference with our setting is that we impose a pre-existing structure on this market, which constrains agents in the number and the type of contracts they can form with each other. I explore in Appendix 2.B how our setup with families could fit in with their framework.

Interestingly, our third result is that a matching can be efficient and family-stable but not individual-stable.

Proposition 2.2. *A matching can be efficient and family-stable but not stable for individuals.*

This means that the assignment itself might be the same for families and individuals, while the shares of surplus that support it as stable differ. We find that the set of shares of surplus that support efficient assignments as family-stable includes the set of shares of surplus that support them as individual-stable. The intuition here is that when we consider families instead of individuals, constraints are less binding, and therefore families may accept a wider range of sharings-out of surplus than individuals.

Consider again the two-men-two-women case presented previously. We now study the efficient matching. For individuals, we follow Browning et al. (2014), who characterize the shares of surplus that support the efficient matching μ_2 $(i_1 - j_2, i_2 - j_1)$ as individual-stable[19]. The authors show that all pairs (u_{j_1}, u_{j_2}) satisfying the inequalities $\pi_{12} - \pi_{11} \geq u_{j_2} - u_{j_1} \geq \pi_{22} - \pi_{21}$ with $\pi_{21} \geq u_{j_1} \geq 0$ and $\pi_{12} \geq u_{j_2} \geq 0$ yield imputations u_{j_1}, u_{j_2}, $u_{i_1} = \pi_{12} - u_{j_2}$, and $u_{i_2} = \pi_{21} - u_{j_1}$, which support μ_2 as stable for individuals. Indeed we observe that when the decision-maker is the individual, the share of surplus that woman j_2 can expect to obtain is bounded and depends on the share of surplus that woman j_1 obtains[20]. For families, we first consider the family partition $\mathcal{F}_1$,

[19] See Example 1 in Section 8.1 of Browning et al. (2014).

[20] Browning et al. (2014) explain p.318 "Woman j_2, who is matched with man i_1, cannot receive in that marriage more than $\pi_{12} - \pi_{11} + u_{j_1}$ because then her husband would gain from replacing her by woman j_1. She would not accept less than $u_{j_1} + \pi_{22} - \pi_{21}$ because then she can replace her husband with man i_2, offering to replace his present wife." Notations are adapted.

already described. Remember that with $\mathcal{F}_1$, family f_1 is composed of two sons i_1 and i_2, while families f_2 and f_3 are composed of one daughter each, respectively j_1 and j_2. We characterize formally the set of the shares of surplus that support the efficient assignment μ_2 as family-stable with $\mathcal{F}_1$, and compare it with the set of surplus that supports it as individual-stable. Note that for this purpose, it is important to choose a family partition for which assignments μ_1 and μ_2 are both possible[21]. This is so that we can isolate the impact of family decision-making on the set of the shares of surplus which support the stable matching, from the impact of siblings of different sex, who cannot marry. We follow the same reasoning as before and consider possible deviations by pairs of families from the efficient assignment. We find that all pairs (u_{j_1}, u_{j_2}) satisfying inequalities $u_{j_1} \leq \pi_{12} + \pi_{21} - \pi_{22}$ and $u_{j_2} \leq \pi_{12} + \pi_{21} - \pi_{11}$ with $\pi_{21} \geq u_{j_1} \geq 0$ and $\pi_{12} \geq u_{j_2} \geq 0$ yield imputations u_{j_1}, u_{j_2}, $u_{i_1} = \pi_{12} - u_{j_2}$ and $u_{i_2} = \pi_{21} - u_{j_1}$ that support the efficient assignment as family-stable. It is worth noting that, unlike when the marriage decision is taken by individuals, there is no lower bound on u_{j_1} and u_{j_2} other than 0, and u_{j_1} and u_{j_2} are independent of each other. The reason for this is that family partition $\mathcal{F}_1$ is such that alternative husbands for j_1 and j_2 are part of the same family f_1, which makes the threat of the wife leaving her current husband for the other potential husband obsolete. The only constraint on the shares of surplus is that u_{j_1} (resp. u_{j_2}) should be such that $u_{f_1} + u_{f_3} \geq \pi_{22}$ (resp. $u_{f_1} + u_{f_2} \geq \pi_{11}$).[22] Otherwise families f_1 and f_3 (resp. f_1 and f_2) would both have an incentive to deviate, even if this means son i_1 (resp. son i_2) ending up single, because they would have more surplus to share with π_{22} (resp. π_{11}).

We represent these two sets graphically in Figure 2.4, assuming as before that $\pi_{22} > \pi_{21}$, $\pi_{12} > \pi_{11}$, and $\pi_{12} = \pi_{21}$. On the left, the shaded area represents all the pairs that satisfy the requirements for individual stability. On the right, the shaded area represents all the pairs that satisfy the requirements for familial stability with $\mathcal{F}_1$[23].

We observe that the set of the shares of surplus supporting the efficient assignment as family-stable with family partition $\mathcal{F}_1$ includes the set of the shares of surplus that support it as individual-stable[24], which is consistent with Theorem 2.1.

[21]This would not be the case for the family partition (b) in Figure 2.1 with two families, as i_1 would be the brother of j_1, and i_2 the brother of j_2.

[22]Which is equivalent to $(\pi_{12} - u_{j_2}) + (\pi_{21} - u_{j_1}) + u_{j_2} \geq \pi_{22} \Leftrightarrow u_{j_1} \leq \pi_{12} + \pi_{21} - \pi_{22}$ $((\pi_{12} - u_{j_2}) + (\pi_{21} - u_{j_1}) + u_{j_1} \geq \pi_{11} \Leftrightarrow u_{j_2} \leq \pi_{12} + \pi_{21} - \pi_{11})$.

[23]The left hand side of Figure 2.4 is the same as Figure 8.1 in Browning et al. (2014). On the right hand side, the upper bound of u_{j_2} is π_{12}, as $\pi_{12} + \pi_{21} - \pi_{11} > \pi_{12}$ with the assumptions made on the marital surpluses for this graphical representation.

[24]We can use the same numerical example as before to verify that the shares $u_{j_1} = 0$, $u_{j_2} = 0$, $u_{i_1} = 6$, $u_{i_2} = 6$ support the efficient assignment as family-stable, but not as individual-stable.

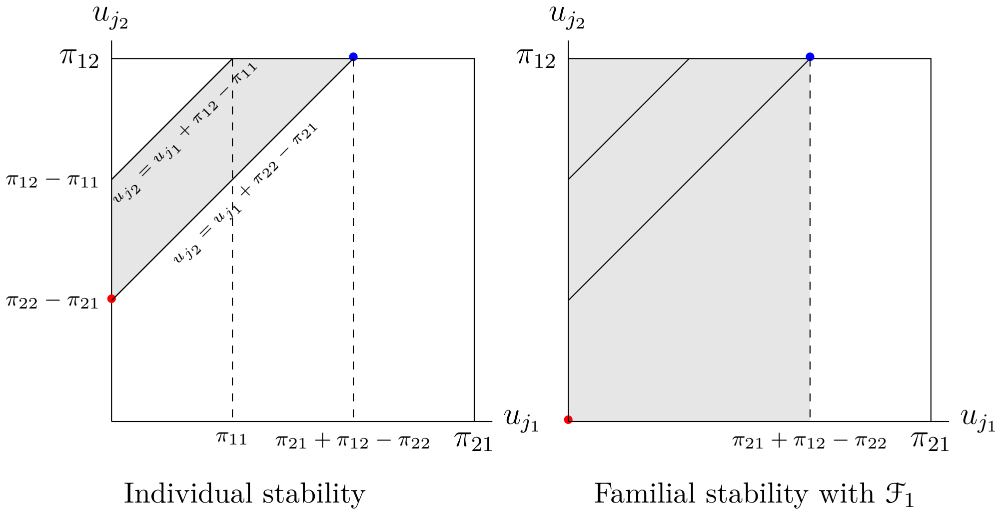

Figure 2.4 – Shares of surplus

Notice here that the fact that i_1 and i_2 belong to the same family f_1 rather than to two single-child families can make them collectively better off. The best they could obtain together if they were part of two single-child families, i.e. if they chose individually, would be to reach the red dot on the left of Figure 2.4: in this case, $u_{i_1} = \pi_{12} - (\pi_{22} - \pi_{21})$ and $u_{i_2} = \pi_{21}$, so collectively they would obtain $\pi_{12} + \pi_{21} - (\pi_{22} - \pi_{21})$. This is less than what they might obtain when they are part of the same family f_1, which is represented by the red dot on the right of Figure 2.4, and amounts to $\pi_{12} + \pi_{21}$. This example also shows that family f_1 can reach higher levels of utility when its decides on the marriages of its sons, rather than letting them decide by themselves. In addition, f_1 cannot do worse than the worst outcome i_1 and i_2 could reach if they chose individually, represented by the blue dots in Figure 2.4.

Now let us consider the family partition $\mathcal{F}_2$, such that family f_1 is composed of men i_1 and i_2 and family f_2 is composed of women j_1 and j_2. This family partition corresponds to configuration (a) in Figure 2.1 with two families, and here again, is chosen to ensure that assignments μ_1 and μ_2 are feasible. We note that in this configuration, the two possible husbands for each woman are part of the same family f_1, and the two possible wives for each man are part of the same family f_2. This familial configuration eliminates the threat of switching wives or husbands, which determines the upper and lower bounds on the shares that men and women can expect individually. It becomes straightforward that any sharing-out of the aggregate surplus will support the efficient assignment as family-stable. If this set were represented in Figure 2.4, the whole square would be shaded. Moreover, we note that with this family configuration, no inefficient matching is family-stable: the two families will obviously choose the assignment under which they would have the most to share. These results imply that we should end up with a larger number of stable outcomes when two families marry off several of their children, as they have more leeway to rearrange the aggregate surplus among them. This helps explain why the practice of *watta-satta*, a bride exchange involving the simultaneous marriage of a brother-sister pair from two households, is common in some developing countries (Jacoby and Mansuri 2010).

Thus, we find that for a given efficient assignment, families would accept some sharings-out of surplus its members would never accept if they were acting alone. As a consequence, our model predicts that arranged marriage could leave the assignment itself unaffected while greatly changing the surplus-sharing accepted by the married children. This result may have drastic implications ex ante in terms of premarital investment, in particular for the education of daughters.

So Propositions 2.1 and 2.2 state that there are two main configurations in which we can obtain family-stable matchings that are not stable for individuals. This implies that when families arrange the marriages of their children, it is likely that some children would rather leave their family to be able to deviate as they wish to. This is the case for high-valued children who could perform well in the marriage market by themselves, but can be constrained by their families. In contrast, low-valued children in the marriage market can obtain larger shares of surplus in family-stable matchings that are not individual-stable, as we observed in the example where children are characterized by the number of years they studied. So, on the one hand, the presence of families arranging marriages for their children can help reduce inequalities in outcomes between siblings of different qualities, but on the other hand it can potentially trigger tensions within families. We could assume that in societies where inequalities in the marriage market can be offset by other institutions, the cost induced by tensions generated with arranged marriages could eventually exceed their benefits, thus leading to a change in social norms towards individual-matching.

Overall, we find that family partitioning determines the properties of family-stable matchings. For some family partitions, we may observe inefficient outcomes. As explained above, this seems to be the case when the distribution of sons and daughters is not uniform across families or when there is heterogeneity in families' size. For certain other family partitions, we may observe only efficient outcomes but drastic differences in terms of the size of the set of shares supporting them. For some family partitions, any sharing-out of aggregate surplus across families supports the efficient assignment as family-stable, as we illustrated with $\mathcal{F}_2$ and more broadly for all partitions that divide the population into two families. For others, the set is smaller and even the same as that obtained under individual decision-making: this is straightforward for the family partition that partitions the population into single individuals, for instance. Less trivially, this is also the case when each family is composed of one son and one daughter. It seems that the more competition between families, the smaller the set of shares supporting the efficient outcomes, as shown in Figure 2.5. For a population of three men and three women, we observe how the family partition affects the set of shares of surplus that support the efficient assignment (μ^*) $i_1 - j_2$, $i_2 - j_3$, $i_3 - j_1$. We thus assume that $\pi_{12} + \pi_{23} + \pi_{31}$ maximizes the sum of total marital surplus over all possible assignments[25]. Shaded volumes represent the set of shares of surplus that support μ^* as family-stable. When volumes are in several colors, the set of shares of surplus supporting μ^* as family-stable is the intersection of these volumes. The construction of Figure 2.5 is detailed in Appendix 2.A.

We observe that in family partitions for which all alternative husbands for the daughters are in the same family, as in (a), (b) and (c), the shares of surplus are independent of each other. By contrast, when alternative husbands are scattered among different families (as in (d), (e) and (f)), we observe not only lower bounds for women's shares, but also a functional relationship between the shares of surplus. Moreover, we observe that the more competition (i.e. the more families for the same number of males and females), the smaller the set of shares: the set shrinks when we go from (b) to (c), and when we go from (d) to (e). Finally, the family partitions for which inefficient matchings can be family-stable, (b), (c), (d) and (e), are characterized by families having same-gender children and are also heterogenous in terms of family size, as opposed to (a) and (f).

In particular, we find that for the family partition such that each family is composed of one son and one daughter, familial stability implies individual stability. Therefore for this family partition, the only family-stable assignments are the efficient ones and the sets of the shares of surplus that support the efficient assignments as stable are the same for individuals and families. We state our result formally in Theorem 2.2.

[25]We also assume $\pi_{12} + \pi_{31} \geq \pi_{11} + \pi_{32}$, otherwise μ^* would not hold as family-stable in family partitions (b) and (d). To graphically represent the sets in Figure 2.5, we choose $\pi_{12} = \pi_{23} = \pi_{31}$.

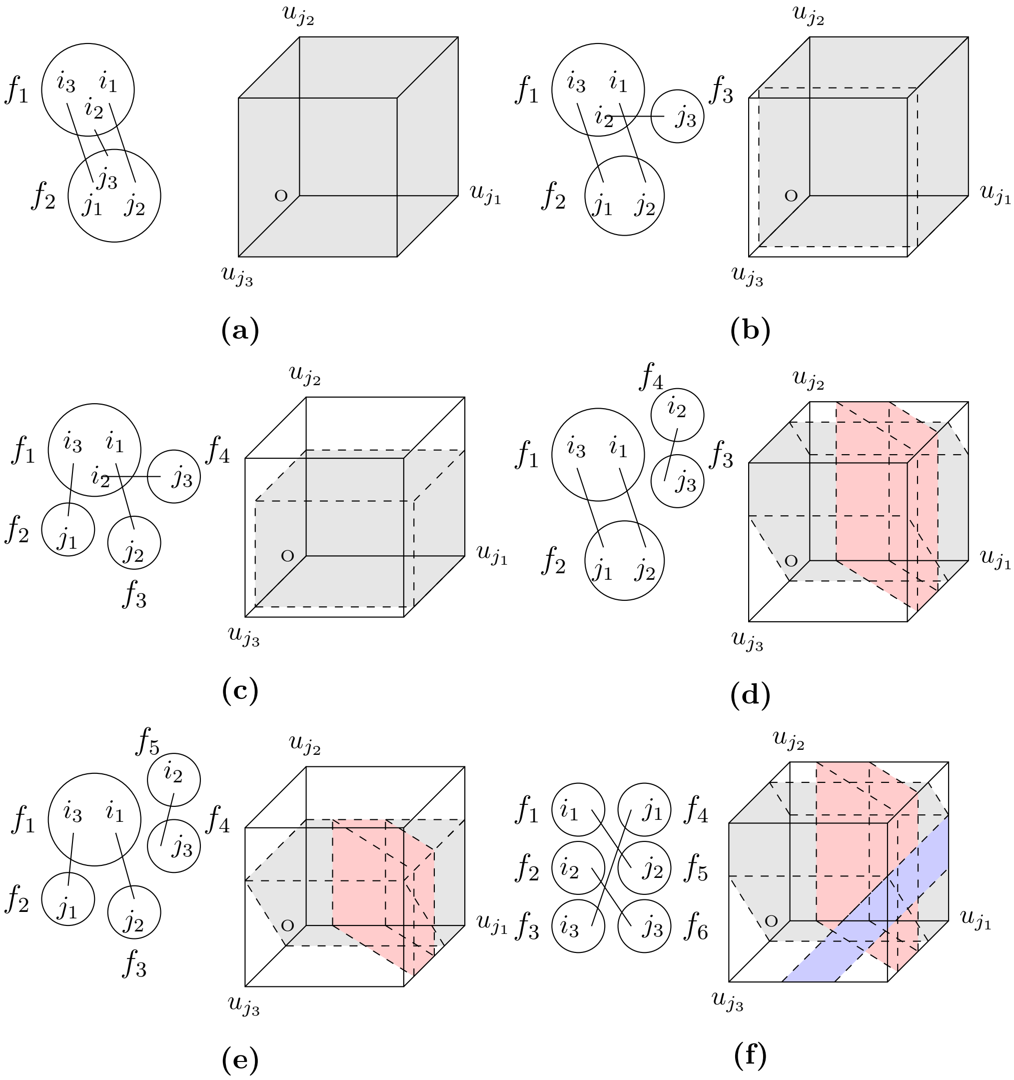

Figure 2.5 – Sets of surplus and family partitions

Theorem 2.2. *For the family partition such that each family is composed of one son and one daughter, a family-stable matching must be stable for individuals.*

Proof. Consider the family partition such that each family is composed of one son and one daughter. Consider a matching (μ^*_{ij}, u^*_{ij}). This matching is family-stable if there is no pair of families who would like to deviate from it together (see Definition 2.1). We need to consider all possible deviations from this matching, which should cover families that are linked and families that are not linked.

First consider any pair of linked families, f_k and $f_{k'}$. If these two families are already linked in terms of all four of their children, then they cannot deviate together. This is because this family partition is such that each family is composed of one son and one daughter, so two families already linked through two marriages cannot deviate by swapping the marriages of their children. If these two families are linked only in terms of their children i_k and $j_{k'}$, they could deviate together if they chose a marriage between their two other children, j_k and $i_{k'}$. Conditions on the sharing of surplus of linked families for (μ^*_{ij}, u^*_{ij}) to be a family-stable matching are: $u^*_{f_k} + u^*_{f_{k'}} > u_{f_k} + u_{f_{k'}} \Leftrightarrow \pi_{k,k'} + u^*_{i_{k'}} + u^*_{j_k} > \pi_{k,k'} + \pi_{k',k} \Leftrightarrow u^*_{i_{k'}} + u^*_{j_k} > \pi_{k',k}$, which is a condition for individual stability.

Now consider any pair of unlinked families, f_k and $f_{k'}$. These two families are not linked, so they have three options for deviation: marrying i_k to $j_{k'}$; marrying j_k to $i_{k'}$ or both these marriages. Considering only the two first deviations, we derive the conditions on surplus-sharing with unlinked families for (μ^*_{ij}, u^*_{ij}) to be a family-stable matching,[26] as follows:

$u^*_{f_k} + u^*_{f_{k'}} > u_{f_k} + u_{f_{k'}} \Leftrightarrow u^*_{i_k} + u^*_{j_k} + u^*_{i_{k'}} + u^*_{j_{k'}} > \pi_{k,k'} + u^*_{i_{k'}} + u^*_{j_k} \Leftrightarrow u^*_{i_k} + u^*_{j_{k'}} > \pi_{k,k'}$;

$u^*_{f_k} + u^*_{f_{k'}} > u_{f_k} + u_{f_{k'}} \Leftrightarrow u^*_{i_k} + u^*_{j_k} + u^*_{i_{k'}} + u^*_{j_{k'}} > \pi_{k',k} + u^*_{i_k} + u^*_{j_{k'}} \Leftrightarrow u^*_{i_{k'}} + u^*_{j_k} > \pi_{k',k}$;

which are conditions for individual stability.

Conditions for (μ^*_{ij}, u^*_{ij}) to be family-stable imply that $\pi_{k,k'} = u^*_{i_k} + u^*_{j_{k'}}$ if i_k and $j_{k'}$ are married, and $\pi_{k,k'} < u^*_{i_k} + u^*_{j_{k'}}$ if they are not, which is exactly the definition of a stable matching for individuals. Indeed, for the family partition such that each family is composed of one son and one daughter, familial stability implies individual stability. ■

This result is consistent with our previous observations: this family partition is such that there is a uniform distribution of sons and daughters across families, homogeneity of family size, and competition between families.

2.4 Conclusion

Our paper introduces families into the assignment game and extends the notion of stability to families in order to study arranged marriages. We explore how the shift from individuals to families in the decision-making process changes stable matchings in the marriage market. We find that individual-stable matchings are always family-stable. By contrast, family-stable matchings may be not stable for individuals. A matching can be both family-stable and inefficient, due to coordination problems. Moreover, a matching can be family-stable and efficient but not stable for individuals. This arises from the fact

[26]Considering the third deviation would give weaker restrictions on the shares of surplus.

that constraints are less rigid for families, as they can accept a poorer match for one of their children if this will benefit the whole family. As a consequence, our model predicts that there is a larger number of stable outcomes when marriages are arranged by parents rather than by individuals. We also find that the family partition impacts family-stable matchings. It seems that when families are heterogenous in size and when gender is not distributed uniformly across families, inefficient matchings are likely to appear. Finally, for efficient matchings we show through examples that the set of shares of surplus tends to shrink as competition increases. In particular, when families are composed of one child only or when they are composed of one son and one daughter, the set of shares is minimal. Thus, the theoretical framework we provide to capture consequences of family decision-making on stable matchings should be an aid to understanding outcomes in societies where arranged marriage is still prevalent.

In our model we consider transferable utilities, but it should be noted that we do not assume that parents can use the share of the surplus obtained from the marriage of one of their children to secure the marriage of another child. We could capture this dimension by introducing some dynamics into the model and assuming that each family marries off one child at each period. We could also see this emerging if we assumed credit-constrained families and explicit marriage payments. This would be a nice extension of our model for future research, which would enable us to capture some interesting features of arranged marriages in societies where marriage payment prevails. It has been documented that in such societies, the marriage of a child (e.g. a daughter) entails a marital transfer (e.g. a brideprice) to the wife-giving family, who can use it to finance the marriage payment of another child (e.g. the brideprice for a brother)[27].

In our paper, we find that different family partitions lead to different family-stable matchings, which restricts parents' range of decision-making. As a consequence, we support the idea that at the micro level, family composition has an impact on the way parents decide to marry off their children. For instance, Nassiet (2000) shows that in the French nobility of the Ancien Régime, good marriages for first-born sons were more important than for younger children, due to male primogeniture. Moreover, in this historical context, women without brothers were very valuable partners as they would be the only heiresses of the family, while in other social contexts, such as rural South

[27]The 2015 documentary Sonita presents an Afghan family trying to marry one of its daughters to obtain a brideprice so that her elder brother could purchase a bride. Nassiet (2000) points out that the in-coming dowry of the bride was used to compensate for the out-going dowries of the sisters of her husband in the French nobility of the Ancien Régime.

India (Kapadia 1995), women without brothers are less valuable mates. Vogl (2013) also provides evidence that in South Asia the quality of older daughters' marriages decreases as the number of their sisters increases. In future research it would be interesting to study this issue more deeply, by introducing more assumptions into our model. In particular, we could introduce birth order and asymmetry between sons and daughters, in order to more thoroughly capture the effect of family composition on marriage decisions.

In our model, family size and sex ratio are given, but we could also imagine an extension in which these two dimensions are endogenous. This would contribute to the growing literature on parents' decisions in terms of family size and sex selection in a marriage perspective (Edlund 1999, Bhaskar 2011).

Moreover, we could study the broader economic and social implications of family marriages. Marriages between families create a network of families whose structure determines the degree of segmentation of the society, which in turn has direct consequences in terms of redistribution, inequality and social mobility. As we show in our paper, the structure of families, described by the family partition, has direct impacts on family-stable matchings, and in turn on observed networks of families linked through marriage. It would be interesting to explore how family partitioning impacts this network formation.

Our intuition is that the impacts on stable matchings would be even sharper if we considered a non-transferable utility framework, in which the utility of the parents and the utilities of the children are misaligned. This would also be an interesting avenue for future research.

Finally, our model introduces pre-existing coalitions into the assignment game of Shapley and Shubik (1971). The matching problem we explore here could therefore have relevance for a wider range of topics than simply marriage.

Appendix

2.A Construction of Figure 2.5

To construct these figures, I assumed that $\pi_{12}+\pi_{23}+\pi_{31}$ was larger than $\pi_{13}+\pi_{21}+\pi_{32}$ and $\pi_{11}+\pi_{22}+\pi_{33}$, so that the efficient matching μ^* is i_1-j_2, i_2-j_3, i_3-j_1.
I also assumed that $\pi_{12}+\pi_{31}\geq\pi_{11}+\pi_{32}$, otherwise μ^* would not hold as family-stable in partitions (b) and (d).
To represent them graphically on Figure 2.5, I used the following numerical example: $\pi_{12}=\pi_{23}=\pi_{31}=6$, $\pi_{13}=2$, $\pi_{21}=7$, $\pi_{32}=2$, $\pi_{11}=8$, $\pi_{22}=4$, $\pi_{33}=3$.

Configuration (a): the population is divided into two families, so any deviation from the efficient matching would lower the aggregate surplus they share together. All sets of shares of surplus support μ^*, as any redistribution that would strictly increase the utility of one family would necessarily lowers the utility of the other. So the whole cube is shaded.

Configuration (b): family deviations are possible between families f_1 and f_2 on the one hand, and between families f_1 and f_3 on the other hand.

I. f_1 and f_2 could deviate the following ways:
1/ i_3-j_2 and i_1-j_1. But this deviation would bring them less utility collectively, as we assumed that $\pi_{12}+\pi_{31}\geq\pi_{11}+\pi_{32}$. So they will not deviate this way.
2/ i_2-j_1 and keep i_1-j_2: they will not deviate if $u^*_{f_1}+u^*_{f_2}\geq u_{f_1}+u_{f_2}\Leftrightarrow u^*_{i_1}+u^*_{i_2}+u^*_{i_3}+u^*_{j_1}+u^*_{j_2}\geq u_{i_2}+u_{j_1}+u^*_{i_1}+u^*_{j_2}\Leftrightarrow\pi_{23}-u^*_{j_3}+\pi_{31}\geq\pi_{21}\Leftrightarrow\pi_{23}+\pi_{31}-\pi_{21}\geq u^*_{j_3}$.
3/ i_2-j_2 and keep i_3-j_1: they will not deviate if $u^*_{f_1}+u^*_{f_2}\geq u_{f_1}+u_{f_2}\Leftrightarrow u^*_{i_1}+u^*_{i_2}+u^*_{i_3}+u^*_{j_1}+u^*_{j_2}\geq u_{i_2}+u_{j_2}+u^*_{i_3}+u^*_{j_1}\Leftrightarrow\pi_{23}-u^*_{j_3}+\pi_{12}\geq\pi_{22}\Leftrightarrow\pi_{23}+\pi_{12}-\pi_{22}\geq u^*_{j_3}$.
4/ i_2-j_1 and i_3-j_2: they will not deviate if $u^*_{f_1}+u^*_{f_2}\geq u_{f_1}+u_{f_2}\Leftrightarrow u^*_{i_1}+u^*_{i_2}+u^*_{i_3}+u^*_{j_1}+u^*_{j_2}\geq u_{i_2}+u_{j_1}+u_{i_3}+u_{j_2}\Leftrightarrow\pi_{12}+\pi_{31}+\pi_{23}-u^*_{j_3}\geq\pi_{21}+\pi_{32}\Leftrightarrow$

$\pi_{12} + \pi_{31} + \pi_{23} - \pi_{21} - \pi_{32} \geq u^*_{j_3}$.
5/ $i_2 - j_2$ and $i_1 - j_1$: they will not deviate if $u^*_{f_1} + u^*_{f_2} \geq u_{f_1} + u_{f_2} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_1} + u^*_{j_2} \geq u_{i_1} + u_{j_1} + u_{i_2} + u_{j_2} \Leftrightarrow \pi_{12} + \pi_{31} + \pi_{23} - u^*_{j_3} \geq \pi_{11} + \pi_{22} \Leftrightarrow \pi_{12} + \pi_{31} + \pi_{23} - \pi_{11} - \pi_{22} \geq u^*_{j_3}$.

II.f_1 and f_3 could deviate the following ways:
1/$i_1 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_3} \geq u_{i_1} + u_{j_3} + u^*_{i_3} \Leftrightarrow \pi_{12} - u^*_{j_2} + \pi_{23} \geq \pi_{13} \Leftrightarrow \pi_{12} + \pi_{23} - \pi_{13} \geq u^*_{j_2}$.
2/$i_3 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_3} \geq u_{i_3} + u_{j_3} + u^*_{i_1} \Leftrightarrow \pi_{31} - u^*_{j_1} + \pi_{23} \geq \pi_{33} \Leftrightarrow \pi_{31} + \pi_{23} - \pi_{33} \geq u^*_{j_1}$.

With the numerical example, these conditions lead to $u^*_{j_1} \leq 9$, $u^*_{j_2} \leq 10$ and $u^*_{j_3} \leq 5$. But because $u^*_{j_1}$ and $u^*_{j_2}$ cannot exceed 6, this amounts to $u^*_{j_1} \leq 6$, $u^*_{j_2} \leq 6$ and $u^*_{j_3} \leq 5$.

Configuration (c): family deviations are possible between families f_1 and f_2; f_1 and f_3; f_1 and f_4.

I. f_1 and f_2 could deviate the following ways:
1/ $i_1 - j_1$: they will not deviate if $u^*_{f_1} + u^*_{f_2} \geq u_{f_1} + u_{f_2} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_1} \geq u_{i_1} + u_{j_1} + u^*_{i_2} \Leftrightarrow \pi_{12} - u^*_{j_2} + \pi_{31} \geq \pi_{11} \Leftrightarrow \pi_{12} + \pi_{31} - \pi_{11} \geq u^*_{j_2}$.
2/ $i_2 - j_1$: they will not deviate if $u^*_{f_1} + u^*_{f_2} \geq u_{f_1} + u_{f_2} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_1} \geq u_{i_2} + u_{j_1} + u^*_{i_1} \Leftrightarrow \pi_{23} - u^*_{j_3} + \pi_{31} \geq \pi_{21} \Leftrightarrow \pi_{23} + \pi_{31} - \pi_{21} \geq u^*_{j_3}$.

II. f_1 and f_3 could deviate the following ways:
1/ $i_2 - j_2$: they will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_2} \geq u_{i_2} + u_{j_2} + u^*_{i_3} \Leftrightarrow \pi_{23} - u^*_{j_3} + \pi_{12} \geq \pi_{22} \Leftrightarrow \pi_{23} + \pi_{12} - \pi_{22} \geq u^*_{j_3}$.
2/ $i_3 - j_2$: they will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_2} \geq u_{i_3} + u_{j_2} + u^*_{i_2} \Leftrightarrow \pi_{31} - u^*_{j_1} + \pi_{12} \geq \pi_{32} \Leftrightarrow \pi_{31} + \pi_{12} - \pi_{32} \geq u^*_{j_1}$.

III. f_1 and f_4 could deviate the following ways:
1/ $i_1 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_4} \geq u_{f_1} + u_{f_4} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_3} \geq u_{i_1} + u_{j_3} + u^*_{i_3} \Leftrightarrow \pi_{12} - u^*_{j_2} + \pi_{23} \geq \pi_{13} \Leftrightarrow \pi_{12} + \pi_{23} - \pi_{13} \geq u^*_{j_2}$.
2/ $i_3 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_4} \geq u_{f_1} + u_{f_4} \Leftrightarrow u^*_{i_1} + u^*_{i_2} + u^*_{i_3} + u^*_{j_3} \geq u_{i_3} + u_{j_3} + u^*_{i_1} \Leftrightarrow \pi_{31} - u^*_{j_1} + \pi_{23} \geq \pi_{33} \Leftrightarrow \pi_{31} + \pi_{23} - \pi_{33} \geq u^*_{j_1}$.

With the numerical example, these conditions lead to $u^*_{j_1} \leq 9$, $u^*_{j_2} \leq 4$, $u^*_{j_3} \leq 5$. But because $u^*_{j_1}$ cannot exceed 6, this amounts to $u^*_{j_1} \leq 6$, $u^*_{j_2} \leq 4$ and $u^*_{j_3} \leq 5$.

Configuration (d): family deviations are possible between families f_1 and f_2; f_1 and f_3; f_4 and f_2.

I. f_1 and f_2 could deviate the following way: $i_3 - j_2$ and $i_1 - j_1$. But this deviation would bring them less utility collectively, as we assumed that $\pi_{12} + \pi_{31} \geq \pi_{11} + \pi_{32}$. So they will not deviate together.

II. f_1 and f_3 could deviate the following ways:
1/ $i_1 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_3} + u^*_{j_3} \geq u_{i_1} + u_{j_3} + u^*_{i_3} \Leftrightarrow \pi_{12} - u^*_{j_2} + u^*_{j_3} \geq \pi_{13} \Leftrightarrow u^*_{j_3} + \pi_{12} - \pi_{13} \geq u^*_{j_2}$.
2/ $i_3 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_3} + u^*_{j_3} \geq u_{i_3} + u_{j_3} + u^*_{i_1} \Leftrightarrow \pi_{31} - u^*_{j_1} + u^*_{j_3} \geq \pi_{33} \Leftrightarrow u^*_{j_3} + \pi_{31} - \pi_{33} \geq u^*_{j_1}$.

III. f_2 and f_4 could deviate the following ways:
1/ $i_2 - j_1$: they will not deviate if $u^*_{f_2} + u^*_{f_4} \geq u_{f_2} + u_{f_4} \Leftrightarrow u^*_{j_1} + u^*_{j_2} + u^*_{i_2} \geq u_{i_2} + u_{j_1} + u^*_{j_2} \Leftrightarrow \pi_{23} - u^*_{j_3} + u^*_{j_1} \geq \pi_{21} \Leftrightarrow u^*_{j_1} \geq u^*_{j_3} + \pi_{21} - \pi_{23}$.
2/ $i_2 - j_2$: they will not deviate if $u^*_{f_2} + u^*_{f_4} \geq u_{f_2} + u_{f_4} \Leftrightarrow u^*_{j_1} + u^*_{j_2} + u^*_{i_2} \geq u_{i_2} + u_{j_2} + u^*_{j_1} \Leftrightarrow \pi_{23} - u^*_{j_3} + u^*_{j_2} \geq \pi_{22} \Leftrightarrow u^*_{j_2} + \pi_{23} - \pi_{22} \geq u^*_{j_3}$.

With the numerical example, these conditions lead to $u^*_{j_3} + 3 \geq u^*_{j_1} \geq u^*_{j_3} + 1$ and $u^*_{j_3} + 4 \geq u^*_{j_2} \geq u^*_{j_3} - 2$.

Configuration (e): family deviations are possible between families f_1 and f_2; f_1 and f_3; f_1 and f_4; f_5 and f_2; f_5 and f_3.

I. f_1 and f_2 could deviate the following way: $i_1 - j_1$. They will not deviate if $u^*_{f_1} + u^*_{f_2} \geq u_{f_1} + u_{f_2} \Leftrightarrow u^*_{i_1} + u^*_{i_3} + u^*_{j_1} \geq u_{i_1} + u_{j_1} \Leftrightarrow \pi_{12} - u^*_{j_2} + \pi_{31} \geq \pi_{11} \Leftrightarrow \pi_{12} + \pi_{31} - \pi_{11} \geq u^*_{j_2}$.

II. f_1 and f_3 could deviate the following way: $i_3 - j_2$. They will not deviate if $u^*_{f_1} + u^*_{f_3} \geq u_{f_1} + u_{f_3} \Leftrightarrow u^*_{i_1} + u^*_{i_3} + u^*_{j_2} \geq u_{i_3} + u_{j_2} \Leftrightarrow \pi_{31} - u^*_{j_1} + \pi_{12} \geq \pi_{32} \Leftrightarrow \pi_{31} + \pi_{12} - \pi_{32} \geq u^*_{j_1}$.

III. f_1 and f_4 could deviate the following ways:
1/ $i_1 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_4} \geq u_{f_1} + u_{f_4} \Leftrightarrow u^*_{i_1} + u^*_{i_3} + u^*_{j_3} \geq u_{i_1} + u_{j_3} + u^*_{i_3} \Leftrightarrow \pi_{12} - u^*_{j_2} + u^*_{j_3} \geq \pi_{13} \Leftrightarrow u^*_{j_3} + \pi_{12} - \pi_{13} \geq u^*_{j_2}$.
2/ $i_3 - j_3$: they will not deviate if $u^*_{f_1} + u^*_{f_4} \geq u_{f_1} + u_{f_4} \Leftrightarrow u^*_{i_1} + u^*_{i_3} + u^*_{j_3} \geq u_{i_3} + u_{j_3} + u^*_{i_1} \Leftrightarrow \pi_{31} - u^*_{j_1} + u^*_{j_3} \geq \pi_{33} \Leftrightarrow u^*_{j_3} + \pi_{31} - \pi_{33} \geq u^*_{j_1}$.

IV. f_5 and f_2 could deviate the following way: $i_2 - j_1$. They will not deviate if $u^*_{f_5} + u^*_{f_2} \geq u_{f_5} + u_{f_2} \Leftrightarrow u^*_{i_2} + u^*_{j_1} \geq u_{i_2} + u_{j_1} \Leftrightarrow \pi_{23} - u^*_{j_3} + u^*_{j_1} \geq \pi_{21} \Leftrightarrow u^*_{j_1} \geq \pi_{21} - \pi_{23} + u^*_{j_3}$.

V. f_5 and f_3 could deviate the following way: $i_2 - j_2$. They will not deviate if $u^*_{f_5} + u^*_{f_3} \geq u_{f_5} + u_{f_3} \Leftrightarrow u^*_{i_2} + u^*_{j_2} \geq u_{i_2} + u_{j_2} \Leftrightarrow \pi_{23} - u^*_{j_3} + u^*_{j_2} \geq \pi_{22} \Leftrightarrow u^*_{j_2} + \pi_{23} - \pi_{22} \geq u^*_{j_3}$.

With the numerical example, these conditions lead to $u^*_{j_3} + 3 \geq u^*_{j_1} \geq u^*_{j_3} + 1$ and $u^*_{j_3} + 4 \geq u^*_{j_2} \geq u^*_{j_3} - 2$, $u^*_{j_2} \leq 4$ and $u^*_{j_1} \leq 10$ (so $u^*_{j_1} \leq 6$).

Configuration (f): family deviations are possible between families f_1 and f_4; f_1 and f_6; f_2 and f_4; f_2 and f_5; f_3 and f_5; f_3 and f_6.

I. f_1 and f_4 could deviate the following way: $i_1 - j_1$. They will not deviate if $u^*_{f_1} + u^*_{f_4} \geq u_{f_1} + u_{f_4} \Leftrightarrow u^*_{i_1} + u^*_{j_1} \geq u_{i_1} + u_{j_1} \Leftrightarrow \pi_{12} - u^*_{j_2} + +u^*_{j_1} \geq \pi_{11} \Leftrightarrow u^*_{j_1} \geq u^*_{j_2} + \pi_{11} - \pi_{12}$.

II. f_1 and f_6 could deviate the following way: $i_1 - j_3$. They will not deviate if $u^*_{f_1} + u^*_{f_6} \geq u_{f_1} + u_{f_6} \Leftrightarrow u^*_{i_1} + u^*_{j_3} \geq u_{i_1} + u_{j_3} \Leftrightarrow \pi_{12} - u^*_{j_2} + +u^*_{j_3} \geq \pi_{13} \Leftrightarrow u^*_{j_3} + \pi_{12} - \pi_{13} \geq u^*_{j_2}$.

III. f_2 and f_4 could deviate the following way: $i_2 - j_1$. They will not deviate if $u^*_{f_2} + u^*_{f_4} \geq u_{f_2} + u_{f_4} \Leftrightarrow u^*_{i_2} + u^*_{j_1} \geq u_{i_2} + u_{j_1} \Leftrightarrow \pi_{23} - u^*_{j_3} + +u^*_{j_1} \geq \pi_{21} \Leftrightarrow u^*_{j_1} \geq u^*_{j_3} + \pi_{21} - \pi_{23}$.

IV. f_2 and f_5 could deviate the following way: $i_2 - j_2$. They will not deviate if $u^*_{f_2} + u^*_{f_5} \geq u_{f_2} + u_{f_5} \Leftrightarrow u^*_{i_2} + u^*_{j_2} \geq u_{i_2} + u_{j_2} \Leftrightarrow \pi_{23} - u^*_{j_3} + +u^*_{j_2} \geq \pi_{22} \Leftrightarrow u^*_{j_2} + \pi_{23} - \pi_{22} \geq u^*_{j_3}$.

V. f_3 and f_5 could deviate the following way: $i_3 - j_2$. They will not deviate if $u^*_{f_3} + u^*_{f_5} \geq u_{f_3} + u_{f_5} \Leftrightarrow u^*_{i_3} + u^*_{j_2} \geq u_{i_3} + u_{j_2} \Leftrightarrow \pi_{31} - u^*_{j_1} + +u^*_{j_2} \geq \pi_{32} \Leftrightarrow u^*_{j_2} + \pi_{31} - \pi_{32} \geq u^*_{j_1}$.

VI. f_3 and f_6 could deviate the following way: $i_3 - j_3$. They will not deviate if $u^*_{f_3} + u^*_{f_6} \geq u_{f_3} + u_{f_6} \Leftrightarrow u^*_{i_3} + u^*_{j_3} \geq u_{i_3} + u_{j_3} \Leftrightarrow \pi_{31} - u^*_{j_1} + +u^*_{j_3} \geq \pi_{33} \Leftrightarrow u^*_{j_3} + \pi_{31} - \pi_{33} \geq u^*_{j_1}$.

With the numerical example, these conditions lead to $u^*_{j_3} + 3 \geq u^*_{j_1} \geq u^*_{j_3} + 1$, $u^*_{j_3} + 4 \geq u^*_{j_2} \geq u^*_{j_3} - 2$ and $u^*_{j_2} + 4 \geq u^*_{j_1} \geq u^*_{j_2} + 2$.

2.B Matching with contracts

Our setup could be cast in the framework of "matching with contracts", initiated by Hatfield and Milgrom (2005). Their seminal paper identifies and explores similarities among auction and matching mechanisms. Matching with contracts encompasses NTU and TU matching, and its basic unit of analysis is the *contract*.[28] In this general frame-

[28]For instance, to reproduce the Gale-Shapley college admissions problem, a contract is fully identified by the student and college. To reproduce the Kelso-Crawford model of firms bidding for workers, a contract is fully identified by the firm, the worker, and the wage. To reproduce

work, similarities can be found between our setup and the models developed to study trading networks, which subsume many-to-many matching with contracts (Ostrovsky 2008, Hatfield and Kominers 2012, Hatfield, Kominers, Nichifor, et al. 2013, 2018). The paper of Hatfield, Kominers, Nichifor, et al. (2013) is the closest to ours, because it considers continuously transferable utilities and does not require a "vertical" network structure, contrary to supply chain networks. But unlike our framework, they do not consider a pre-existing structure constraining the number of contracts one agent can form, nor the type of contracts that can be formed between two agents. With the concepts developed in their paper, we could interpret our model the following way.

There is a finite set F of arbitrary families in the economy, which can a priori contain any number of sons and daughters. We will say that a family $f \in F$ is composed of $n_{b,f}$ sons and $n_{g,f}$ dauhgters. These families can participate in bilateral marriages involving a son from one family and a daughter from another family. In most countries where arranged mariages are prevalent, a bride moves in to her husband's family after marriage. So we will consider the bride's family to be the selling family and we will say that this family *sells* its daughter to the buying family, i.e. to the family of the groom. Thus each marriage ω is associated with a *buyer* $b(\omega) \in F$ and a *seller* $s(\omega) \in F$, with $b(\omega) \neq s(\omega)$. The set of possible marriages Ω is finite and exogenously given by the number of boys and girls in the economy. The set Ω may contain multiple marriages that have the same buying family and the same selling family. So if one family is composed of several daughters, it may sell several of its daughters to the same buying family if the latter is composed of enough sons, with each daughter-son pair represented by a separate marriage. Furthermore, a family may be the seller in one marriage and the buyer in another marriage with the same family. That is, if one family contains one boy and one girl, it can sell its daughter to a family for one marriage ω and buy a daughter from this same family for a second marriage ψ to its son. Formally, the set Ω can contain marriages ω and ψ such that $s(\omega) = b(\psi)$ and $s(\psi) = b(\omega)$.

If a marriage ω is arranged between a son i and a daughter j, their marriage generates an exogenous non-negative marital surplus $\pi_\omega = \pi_{ij} \geq 0$ which is endogenously split between the two families. We will say that the buying family *pays* $p_\omega \leq \pi_\omega$ to the family of the bride, and thus receives a monetary utility of $\pi_\omega - p_\omega$. The complete vector of prices for all marriages in the economy is denoted by $p \in \mathbb{R}^{|\Omega|}$. Formally, a *contract* is a pair (ω, p_ω), with $\omega \in \Omega$ denoting the marriage and $p_\omega \in \mathbb{R}$ denoting the price of the

the Ausubel-Milgrom model of package bidding, a contract is fully identified by the bidder, the package of items that the bidder will acquire, and the price to be paid for that package.

bride for this marriage. The set of available contracts is $X \equiv \Omega \times \mathbb{R}$. For any set of contracts $Y \subseteq X$, we denote by $\omega(Y)$ the set of marriages involved in contracts in Y:

$$\omega(Y) \equiv \{\omega \in \Omega : (\omega, p_\omega) \in Y \text{ for some } p_\omega \in \mathbb{R}\}$$

For a contract $x = (\omega, p_\omega)$, we denote by $b(x) \equiv b(\omega)$ and $s(x) \equiv s(\omega)$ the buying family and the selling family associated with the marriage ω of contract x. Consider any set of contracts $Y \subseteq X$. We denote by $Y_{\to f}$ the set of contracts in Y in which family f is the buyer: $Y_{\to f} \equiv \{y \in Y : f = b(y)\}$. Similarly, we denote $Y_{f\to}$ the set of contracts in Y in which family f is the seller: $Y_{f\to} \equiv \{y \in Y : f = s(y)\}$. We denote Y_f the set of contracts in Y in which family f is involved as the buying family or the selling family: $Y_f \equiv Y_{\to f} \cup Y_{f\to}$. We let $f(Y) \equiv \cup_{y \in Y}\{b(y), s(y)\}$ denote the set of families involved in contracts in Y as buyers or sellers.

We say that the set of contracts Y is *feasible* if there is no marriage ω and prices p_ω and p'_ω with $p_\omega \neq p'_\omega$ such that both contracts (ω, p_ω) and (ω, p'_ω) are in Y; and if there is no marriages ω and ω', respectively involving son i married to daughter j, and son i' married to daughter j' with $i = i'$ or $j = j'$ in Y; that is, a set of contract is feasible if each marriage is associated with at most one contract in that set, and if there are no two marriages involving a same spouse. An *outcome* $A \subseteq X$ is a feasible set of contracts. Thus an outcome specifies which marriages are executed and what the associated prices are but does not specify prices for marriages that do not take place. Note that an outcome A must be such that $\forall f \in f(A)$, $|A_{\to f}| \leq n_{b,f}$ and $|A_{f\to}| \leq n_{g,f}$. This captures the fact that a feasible set of contracts must be such that each family does not exceed its quota: a family f cannot buy more than $n_{b,f}$ daughters, and cannot sell more than $n_{g,f}$ daughters.

Each family f has a linear utility function U_f over the sets of marital surpluses and the associated transfers. For any outcome Y, we say that

$$U_f(Y) \equiv \sum_{(\omega,p_\omega)\in Y_{f\to}} p_\omega + \sum_{(\omega,p_\omega)\in Y_{\to f}} (\pi_\omega - p_\omega)$$

The *choice correspondance* of family f given a set of contracts $Y \subseteq X$ is defined as the collection of sets of contracts maximizing the utility of family f:

$$C_f(Y) \equiv \underset{Z \subseteq Y_f; Z \text{ feasible}}{\arg\max}\ U_f(Z)$$

The choice correspondance C_f is *fully substitutable* if (once attention is restricted to sets for which C_f is single-valued), when the set of opportunities available to f on one side expands, f both rejects a (weakly) larger set of contracts on that side and selects a (weakly) larger set of contracts on the other side. In our case, the utility function of families is linear across contracts, so their preferences satisfy the full substitutability condition.

In this setting, our definition of *familial stability* would translate into the following way. An outcome A is *family-stable* if it is individually rational and if it is *not blocked by a pair of families*: i.e. if there is no feasible *blocking set* $Z \subseteq X$ such that

a. $|f(Z)| = 2$;

b. $Z \cap A = \varnothing$; and

c. for all $f \in f(Z)$, there exists a $Y^f \subseteq Z \cup A$ such that $Z \subseteq Y^f$ and $U_f(Y^f) \geq U_f(A)$, with at least one strict inequality.

Our definition of familial stability is closest to the definition of *strongly group stability* than to the concept of stability defined in Hatfield, Kominers, Nichifor, et al. (2013). Just like these two concepts, familial stability allows for the possibility that families may retain prior contracts. But unlike strongly group stability and stability, which allow for deviations by any subset of agents, familial stability allows only for deviations by pairs of families. Moreover, like strongly group stability, familial stability requires only that the new set of contracts for each family be an improvement. In contrast, the concept of stability defined in Hatfield, Kominers, Nichifor, et al. (2013) requires that the new set of contracts be optimal for each family.

Hatfield, Kominers, Nichifor, et al. (2013) find that when continuous transfers are allowed and agents' preferences are quasi-linear, full substitutability of preferences is sufficient and necessary for the guaranteed existence of stable outcomes. Furthermore they find that full substitutability implies that all stable outcomes are in the core and are efficient. However, the converse is not true: there may be core-wise stable matchings that are not stable.[29] Their Theorem 8 also states that any strongly group stable outcome is stable and in the core. Relying on their findings, we could extend our concept of familial stability, allowing deviations by at most k families in an economy composed of n families. In Chapter 2, we find that when $k = 2$, family-stable matchings exceed

[29]Similar findings are found for the multiple-partners assignment game in Sotomayor (2007), where the stability notion is setwise stability.

the core (due to the existence of inefficient family-stable matchings), while findings in Hatfield, Kominers, Nichifor, et al. (2013) suggest that when $k = n$, the set of family-stable matchings (which include strongly group stable matchings) is included in the core but is not equivalent to it, such that there may exist corewise-stable matchings that are not family-stable. So the set of family-stable matchings should be shrinking as $k \to n$.

Then, based on their framework, we could compare how the pre-existing structure (i.e. family partition) impact stable matchings. In particular, we could compare stable matchings when families can only form one marriage (i.e. when families are composed of only one child, thus being equivalent to individuals) to stable matchings when there is an arbitrary family partition.

We could also use their framework to study an extension of our setup in which fertility would be endogenous.

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Chapter 3

Arranged Marriages, Premarital Investments and the Family Network

3.1 Introduction

In many societies, it is parents who decide who their children marry. Arranged marriages used to be prevalent in European countries (Marcassa et al. 2018, Goni 2018), and are still the dominant form of matchmaking in Asia, Africa and the Middle East (Hamon and Ingoldsby 2003).[1] When parents have several children, they can marry them with spouses from different families who also have other children married with spouses from different families and so on... Thus arranged marriages define a network of families connected with each other through the marital connections of their children. So far, this family dimension has been largely overlooked by the existing matching literature on marriages (Browning et al. 2014, Chiappori 2017). In most models considering families in a matching framework, families are actually composed of one child, and so are equivalent to individuals. Moreover, when we consider only single-child families, the family network following from matching on the marriage market is composed of pairs of families. However, when we consider larger families, the matching generates richer network structures. This paper explores the network dimension of matching on

[1] A survey of 5 000 representative households conducted by the South India Community Health Study in Tamil Nadu in 2016 reveals that 86% of parents had their marriages arranged. For the generation of their children, 80% of sons and 88% of daughters had their marriages arranged (Border et al. 2017).

the marriage market with complex families. Its objective is to analyse the structure of the family network generated by arranged marriages, and its determinants.

The shape of the family network depends on several parameters, including social norms governing arranged marriages. In North and West Africa, the Middle East and South Asia, close-kin marriages are a widespread practice (Do et al. 2013, Hotte and Marazyan 2018). In India, children must be married within their caste, so the castes define independent marriage markets (Border et al. 2017). Using data on marriages within the German and English nobilities from the 1500s to the 1800s, Marcassa et al. (2018) find that the German nobility was much more stratified than the English nobility, because they had more stringent constraints on dowries. The structure of this family network leads to unanticipated economic, social and political consequences in turn.[2] In a well-connected network, information, opportunities, and social norms can easily circulate. In contrast, Jackson et al. (2017) explain p.51 that "in sufficiently segregated networks, different behaviors, norms, and expectations can persist in different communities which, in turn, can have consequences for human capital investments, career choice, and various other behaviors". Several aggregate characteristics of the network such as the density of links, the number and size of components, the diameter and the degree of homophily[3] strongly affect diffusion processes within the network. Local characteristics of the network, such as the neighborhood of a specific node also influences the behavior of this node. Informal insurance and transfers may be more efficient in a tightly clustered group of people. Two families who exchange favors can have stronger incentives to behave efficiently if they are linked to families in common, who could ostracize them in case of misbehavior (Jackson et al. 2017). Moreover, the position of a family in the network, captured by centrality measures, determines its importance and influence

[2]In some contexts we could consider that these consequences are anticipated when parents arrange the marriages of their children. Jackson (2010) discusses the example of the marriage network in Renaissance Florence. Drawing on Padgett and Ansell (1993), he suggests that the central position of the Medici family in the marriage network may have enabled them to dominate the Florentine oligarchy. However, this dimension is beyond the scope of this paper. Taking into account the utility the family will derive from its position in the network would be a fascinating path for future research.

[3]The density of links is measured by the *average degree* in the network, i.e. the number of links divided by the number of nodes; a *component* is a set of nodes such that all pairs have at least one path connecting them, and such that the addition of any other node breaks this connectedness property; the *distance* between two nodes is the length of the shortest path between them and the *diameter* is the largest distance between any two nodes in the network; and *homophily* is the fact that individuals are more likely to be linked to others who share similar characteristics.

in the diffusion processes, which will affect its role with respect to other families. So understanding the determinants of the family network structure is an important first step.

This paper considers a matching framework with transferable utilities in which parents choose first a premarital investment and then a spouse for their children. The focus is on efficient outcomes only, so the maximization of net aggregate marital surplus can be used to derive a simple micro-founded rule on optimal premarital investments. Premarital investment in a child varies positively with parental revenue and negatively with the number of siblings and the associated investment cost. Investment costs describe how costly it is for parents to invest in a specific child, which capture psychological costs associated with social norms. Then, under the assumption of positive assortative matching on premarital investments, the structure of the resulting family network is studied. When the sex ratio is perfectly balanced across income classes and by family size, we obtain a family network segregated by income class and by family size if there is no revenue dispersion within income classes. Thus the most segregated family network structure is characterized by positive assortative matching in terms of both family revenue and family size. Interestingly, family networks segregated by income class only require less demanding conditions in terms of family partition, but stricter ones in terms of revenue dispersion between two successive income classes. The determinants of connectivity within the family network are then explored. Differentiated investment costs or social norms are first considered. When social norms generate differentiated investment costs based on gender alone, the family network does not change. But any deviation from such social norms may strongly affect the family network. In contrast, social norms that generate differences in investment costs by birth order or family composition[4] increase the connectivity of the family network and social mix. Then imbalance in the sex ratio is considered. Introducing gender imbalance at a given point of a network segregated by income class and family size generates a downward domino effect: all families above this threshold remain segregated, while all families below are fully connected in one single component. Naturally, when a sex ratio imbalance is introduced in the richest group of the network, the whole network is fully connected. The nature of this connection depends on whichever gender is scarce: when men are scarce, the network is connected through hypogamous marital links, that is men marry up. In contrast, when women are scarce, the network is connected through hypergamous marital links: women marry up. Finally, the impact of revenue dispersion on the connectivity

[4] For instance when social norms are such that a daughter with a brother is not considered in the same way as a daughter with sisters only.

of the network is studied. Connectivity within an income-class is greater when revenue is more dispersed and when family sizes within the income class are smaller. Dispersion within income classes also triggers connectivity across income classes. In addition, the lower the degree of revenue dispersion between income classes, the more inter-income class marriages there are.

The present analysis builds on the literature of matching theory applied to the marriage market and the economics of the family, in particular Becker (1973, 1981), and recently reviewed by Browning et al. (2014) and Chiappori (2017). The main novelty of the present paper is that it introduces complex family structures into the matching framework and then provides an analysis of the resulting network of connected families. Laitner (1991) models families composed of one son and one daughter in a matching framework to study the impact of assortative mating on neutrality results. In Chapter 2, arbitrary families were included in the assignment game of Shapley and Shubik (1971) to study how parental matchmaking affected stable matchings. To the best of my knowledge, this paper is the first to study the family network stemming from matching with families on the marriage market.

This paper connects the literatures on matching and on network formation. Matching with families generates a network of families. In this setting, families are nodes whose degree is exactly the number of their children. Exploring how the structure of the family network changes depending on different parameters enables us to better understand the process of family network formation. A better knowledge of the determinants of the family network structure is also important, because this structure can in turn affect the diffusion processes within society and the efficiency of informal insurance and transfers that individuals can expect from their altruistic extended family (Jackson et al. 2017, Bourlès et al. 2017).

This analysis also contributes to the literature on the impact of family composition on outcomes related to marriages. Botticini and Siow (2003) study how parents decide to allocate their capital among their offspring, and show that a virilocal environment dowry endogenously emerges. Vogl (2013) uses an optimal stopping model to explore how sister competition affects the quality of the spouse and human capital outcomes in South Asia, where the norm is to marry the first-born before the younger children. The paper also studies how different social norms on gender and birth order impact marriages, but differs from theirs in that it studies a market-wide phenomenon and not a single family. Fafchamps and Quisumbing (2008) study how parents allocate their wealth among a given number of sons and daughters through transfers of assets at the time of marriage and levels of human capital. They find that children receive more when their parents are wealthier or when they have fewer siblings. Similar findings are reported here, except that the impact of different investment costs for siblings is also considered. Overall, the main contribution to the literature here is the study of how family composition and social norms affect the resulting family network.

The paper also adds to the literature on the impact of the sex ratio on marital outcomes. A robust prediction of marriage models is that the standing of men (women) in the marriage market improves (worsens) with a reduction in the sex ratio (Becker 1973, Bloch and Ryder 2000, Chiappori et al. 2002). Abramitzky et al. (2011) study the impact of male scarcity on marital assortative matching using the large demographic shock of WWI in France. In agreement with the theoretical literature, they find that men were less likely to marry women of lower social classes in regions with higher mortality rates. Iyigun and Walsh (2007) study the impact of imbalance in the sex ratio on premarital investments in a transferable utility framework. They find that when men are in short supply in the marriage market, women can invest more than men even when the returns on investment are lower or the costs are higher for women. In a more applied framework Bhaskar, Li, et al. (2017) find that a male-biased sex ratio induces families with a son to increase total investments and to shift the composition towards physical capital and away from human capital. Then they find empirical evidence from the China Family Panel Studies survey which supports their predictions. The present analysis shows that a slight imbalance in the sex ratio fully connects an otherwise perfectly segregated family network. Furthermore, the nature of the connection depends on whichever gender is scarce.

Finally, the paper also addresses the literature on premarital investment games. Premarital investment games raise a host of issues in terms of the existence, uniqueness and efficiency of the equilibrium in both transferable utility (TU) (Cole et al. 2001, Iyigun and Walsh 2007, Nöldeke and Samuelson 2015) and non transferable utility (NTU) frameworks (Peters and Siow 2002, Peters 2007, Bhaskar and Hopkins 2016). In NTU contexts, we may obtain only mixed-strategy equilibria, or inefficient equilibria. However, in a TU framework, although inefficient equilibria may exist due to coordination failures, there exists an equilibrium in which investment decisions are made at the efficient level (Cole et al. 2001, Nöldeke and Samuelson 2015, Chiappori 2017). This analysis abstracts from the difficulties inherent in premarital investment games. It introduces a family structure which influences premarital investments, and it is the first analysis of the family network stemming from matching with families on the marriage market.

The remainder of the paper is organized as follows. The model is presented in Section 3.2. The sufficient conditions under which segregated family networks are obtained are studied in Section 3.3. Section 3.4 explores the connectivity of the network, focusing on the effects of different investment costs and the unbalanced sex ratio. Section 3.5 investigates the impact of revenue dispersion within income classes and between successive income classes on the resulting family network. Section 3.6 concludes.

3.2 The model

I consider an economy composed of marriageable sons i and daughters j. I assume that the population is partitioned into families by a family partition $\mathcal{F}$. A family f is a subset of agents, which can a priori contain any number of sons and daughters. Families are characterized by a revenue y_f, which parents allocate between consumption and premarital investments ω in their children. The premarital investment ω_k received by a child k determines their quality on the marriage market. It encompasses education, marital payment, such as dowry or brideprice, or expected bequest. The cost to family f of providing one unit of premarital investment with its child k is denoted $c_k > 0$. Investment costs may reflect psychological costs associated with social norms or altruism. They may also represent actual technological costs. For instance, it may be materially more difficult for parents to educate their daughters in places where schools are only for boys. These investment costs may be the same for all siblings, or vary depending on gender, birth order or family composition.[5] The total cost to family f of its premarital investments is denoted $C_f(\omega_f)$, with $\omega_f = \sum\limits_{k \in f} c_k \omega_k$. A marriage between a son and a daughter from two different families generates a marital surplus $\pi(\omega_i, \omega_j)$. I consider a transferable utility framework, so this marital surplus is endogenously allocated between the groom and the bride, who receive respectively $u_i \geq 0$ and $u_j \geq 0$, with

[5] For instance, male primogeniture, a succession rule that prevailed among the French nobility during the Ancien Régime in order to preserve the lineage down the generations, recommended that the first-born son inherited the property and most of the wealth of the family. Other sons received only a small bequest, while daughters received a dowry if they married. But if a noble family had no male heir, a daughter could become an heiress and consequently her dowry was significantly higher, as explained in Nassiet (2000). In contrast, Kapadia (1995) explains that in rural southern India, women without brothers are less valuable mates, because traditionally men are supposed to support the children of their sisters in the event of need.

$\pi(\omega_i, \omega_j) = u_i + u_j$. The utility of the family f is the sum of the utilities of its children minus the total cost of premarital investments, so $u_f = \sum\limits_{k \in f} u_k - C_f(\omega_f)$. So in this setting families only differ from each other by their composition and their revenue,[6] and parents choose premarital investments and spouses for their children such that the family utility is maximized.

The focus here is on the efficient outcome, which is the result of an efficient matching and efficient premarital investments. The objective is to derive a micro-founded rule on premarital investments to study the structure of the family network resulting from this efficient outcome. When agents first sink investments and then enter the matching market, the literature on premarital investment games finds that equilibria may exhibit inefficiencies (Peters and Siow 2002, Peters 2007, Nöldeke and Samuelson 2015, Bhaskar and Hopkins 2016, Mailath et al. 2017). But, in a transferable utility framework, there exists an equilibrium in which investment decisions are made at the efficient level (Cole et al. 2001, Nöldeke and Samuelson 2015, Chiappori 2017). In particular, Nöldeke and Samuelson (2015) show that this equilibrium is exactly that stemming from the fictitious game in which agents simultaneously negotiate investments and matches under the standard stability notion. Moreover, we know that in a transferable utility framework, individual stability implies familial stability, and thus that efficient matching will be stable for families, as proved in Chapter 2.[7]

The efficient outcome maximizes the net aggregate marital surplus. So it involves a match μ and premarital investments ω such that

$$\max_{\mu,\omega} \sum_{i,j} \mu_{ij} \pi(\omega_i, \omega_j) - \sum_f C_f(\omega_f) \tag{3.1}$$

We can decompose this problem in the following way

$$\begin{aligned} &\max_{\mu} [(\max_{\omega} \sum_{i,j} \mu_{ij} \pi(\omega_i, \omega_j)) - \sum_f C_f(\omega_f)] \\ &= \max_{\omega} \sum_{i,j} \mu^*_{ij} \pi(\omega_i, \omega_j) - \sum_f C_f(\omega_f) \end{aligned} \tag{3.2}$$

Here we solve for the optimal investment conditional on a matching μ. Then we have to solve for the optimal matching knowing that the optimal conditional investment is

[6] Introducing a third characteristic, such as inherited status, capturing caste, ethnicity or social rank could be an interesting path for future research.

[7] Exploring how the family network changes when we consider inefficient outcomes due to inefficiencies in the investment game could be an interesting path for future research.

chosen. In order to derive a simple rule on premarital investments, it is assumed that the marital surplus function is $\pi(\omega_i, \omega_j) = \ln(\omega_i \omega_j)$. The total cost to family f is $C_f(\omega_f) = -\ln(y_f - \omega_f)$. Thus the maximization problem becomes

$$\max_{\omega} \sum_{i,j} \mu_{ij}^* \ln(\omega_i \omega_j) + \sum_f \ln(y_f - \omega_f) \tag{3.3}$$

Due to the separability property of the marital surplus function, we can solve this problem by considering one given family f composed of m children. First order conditions lead to the following optimal premarital investments

$$\forall k \in f \quad \omega_k^* = \frac{y_f}{c_k(m+1)} \tag{3.4}$$

This micro-founded rule predicts that the optimal premarital investment received by a child k increases with the revenue of their family y_f and decreases with the number of their siblings m and the investment cost c_k.[8] Note that with this rule on premarital investments, the only reason why siblings may receive different premarital investments is differentiated investment costs. When investment costs are the same for all siblings, parents divide their investment among their children evenly. This rule is consistent with documented features of budget allocation within a family: children tend to receive more when their parents are wealthier and when they have fewer siblings, as already highlighted in Fafchamps and Quisumbing (2008). The additional intuitive dimension that I put forward is investment costs, which can be different between siblings. Thus this micro-founded rule on premarital investment is tractable and captures important documented forces of budget allocation within a family.

The next step is to solve for the optimal family-stable matching knowing that investments follow the rule described in (3.4). Chapter 2 showed that there always exists a set of shares of surplus that support the efficient matching as stable for families, so we will restrict ourselves to the efficient matching.[9] Note that due to the separability property of the marital surplus function, all matchings are equivalent conditional on everyone

[8] I chose a marital surplus function such that the rule on premarital investments is independent of the characteristics of the potential spouse. This allows me to simplify the analysis and to concentrate on the study of the structure of the resulting family network.

[9] Chapter 2 also emphasized than when families choose the partners of their children, inefficient matchings may be stable due to coordination problems. Studying how the family network changes when families choose an inefficient matching is beyond the scope of this paper, but would be an interesting path for future research.

being matched.[10] However positive assortative matching on premarital investments[11] is documented in societies where marriages are arranged. In societies where dowries exist, Anderson (2007) explains that "dowry becomes a means to maintain social status by attracting a husband of at least equal standing for one's daughter". Relying on the study of Guzzetti (2002) on fourteenth-century Venice, she adds that average dowry increased with social class, with dowries of nobles almost four times those of commoners. Similar patterns are observed in contemporary India (Border et al. 2017). Using data on Indonesia and Zambia, Ashraf et al. (2018) find that the value of brideprice payments that the parents receive tends to increase with their daughter's education. A slight change in the payoff function helps us select the matching that exhibits positive assortative matching (PAM) on investments with a similar rule on investments. It is enough to assume that $\pi(\omega_i, \omega_j) = \ln(\omega_i \omega_j) + \epsilon f(\omega_i, \omega_j)$ with f a supermodular function and ϵ very small to obtain premarital investments defined in (3.4) and PAM in equilibrium. With families, we also have to take into account the non-incest constraint, that is a brother and a sister cannot marry. Thus the matching takes place in the following way: boys are ranked with respect to their premarital investment, and they marry the daughters with the highest premarital investment who are not their sisters; and similarly for daughters.[12]

So a matching here defines a mapping from the set of families to itself. With complex family structures, marriages define the network of connected families. Families are connected with each other through the marriages of their children. The structure of the network of families will depend on the ordering of premarital investments and thus on the parameters emphasized in the rule defined in (3.4). In this setting, the nodes of the network are the families and the degree of each family is exactly the number of its children. A component is a subset of families linked together through marriages

[10] With families, there are combinatorial effects in the matching process due to the non-incest constraint. Consider a supermodular marital surplus function. Then the standard matching will be positive assortative on investments and everyone will be matched if the sex ratio is balanced. With families, unmarried siblings may remain at the bottom of the investment distribution. Here we consider only configurations where this does not happen, leading to everyone being married.

[11] Remember that in our setting, premarital investments include education, marital payment or expected bequest.

[12] Note that we could consider an alternative justification leading to this same matching. In a non-transferable utility framework, we take this rule on premarital investment as a given social norm. So each child obtains the premarital investment predicted by this exogenous rule, depending on the characteristics of their family and their investment cost. Then each child ranks potential spouses according to their premarital investment, discarding their siblings of the opposite gender, and then matches individually on the marriage market. The way parents influence the marriage of their children in this setting is through the given premarital investment. We would obtain exactly the same matching as the one described.

and isolated from the rest of the population. In the standard matching literature on marriages, the population is composed of single-child families only. So the associated standard network is composed of pairs or families. Note that a pair of families is the minimal component in this setting. But when we consider a population composed of families of different sizes, the average degree of the network increases, and so does its connectivity. Thus, matching on the marriage market generates richer and more complex family network structures, as illustrated in Figure 3.1.

Figure 3.1 shows the equilibrium network emerging from a population of 348 individuals distributed into families composed of at most five children. Circles represent boys and triangles girls. The sex ratio is balanced along income class and family size. Investment costs are equal to one for all children. The color of the node reflects the income class of the family: red families are in the richest income class, orange families in the middle-income class, and yellow families in the poorest one. There is revenue dispersion within income classes.[13] Thick lines represent family links, and thin ones are the marital links.

The objective of this paper is to explore the structure of the family network and its determinants. In my setting, families share the same social norms[14] but differ in two main respects: their revenue and their size. I thus distinguish between three main network structures depending on their degree of segregation in these respects. I say that a family network is *segregated by income class and family size* if all marriages are within the same income class and family size. I will consider this structure to be the most segregated one. Then, I say that a family network is *segregated by income class* if all marriages are within the same income class but can connect families of different sizes. Finally, I say that a family network is *fully connected* if it forms one single component, that is when all families are connected.

Understanding better the way families are connected through marital links is important because this structure in turn impacts diffusion processes in the whole society. It also affects the organization and the efficiency of informal insurance, transfers and mutual help that individuals can expect from their extended family network. For instance, De Weerdt et al. (2019) study a sample of 3 173 households from 712 extended family networks in the Kagera Region in Tanzania. They show that out of all private transfers

[13] Rich families' revenues range from $152 - \sigma_1$ to $152 + \sigma_1$. These of middle-class families range from $101 - \sigma_2$ to $101 + \sigma_2$. They range from $50 - \sigma_3$ to $50 + \sigma_3$ for poor families. For all income classes y_k, $\sigma_k = 20$.

[14] Studying a society in which social norms change along income classes or along an additional characteristic capturing subgroups in society could be an interesting path for future research.

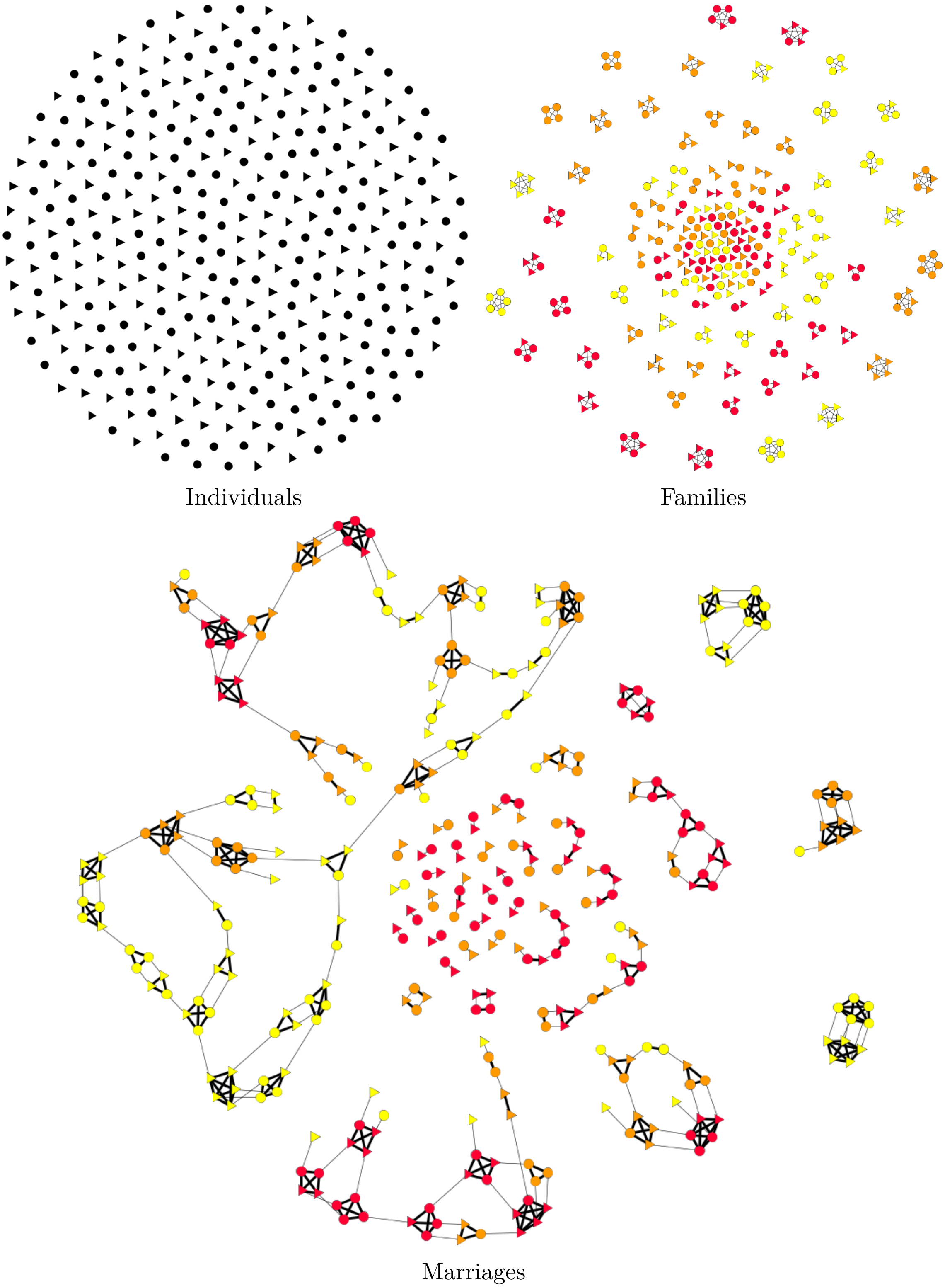


Figure 3.1 – A Family Network

among these households, 59% goes to recipients within the extended family network. All these dimensions contribute to shape inequalities, social cohesiveness and political organizations in a given society. Greenwood et al. (2014) show that the rise in positive assortative mating in the United States in the last fifty years triggered a rise in income inequality. Jackson et al. (2017) explain that persistent inequality between social classes relates to segregation patterns, "as segregation in network structures affects how information flows, what access individuals have to various opportunities, and how decisions are made" (p.51). Exploring the determinants of the connectivity of a society, through the study of the marital network formation is thus an important step. In particular, I will study how differentiated investment costs, the sex ratio and the degree of revenue dispersion affect the connectivity of the family network.

But first, I will present sufficient conditions under which we obtain segregated family networks in the following section.

3.3 Segregation

In this section, I study sufficient conditions under which we obtain family networks segregated by income class and family size, and family networks segregated by income class only. For the rule on premarital investments to generate such segregated networks, I identify three main sufficient conditions on the family partition, the revenue dispersion and differentiated investment costs. In Sections 3.4 and 3.5, I will relax one by one these conditions to explore how connectivity emerges in the network.

I will first define some concepts to clarify the presentation. I say that a family with m children is *of size m*. The set of families of size m is denoted F_m, while the set of families in the income class y_k is denoted F_{y_k}. Then, $F_m \cap F_{y_k}$ is the set of families of size m in the income class k, and is denoted F_{m,y_k}. Let r denote the measure of boys relative to girls in the population. If there are as many boys as girls in the population, then the sex ratio is balanced and $r = 1$. Otherwise, the sex ratio is unbalanced: if $r < 1$ there are more girls than boys, while $r > 1$ when boys are more numerous.

Definition 3.1. *Consider a population with $r = 1$. A family partition is gender-balanced by size if there are as many boys as girls in F_m $\forall m$.*

Figure 3.2 depicts a population composed of 15 boys and 15 girls and two family partitions. The family partition on the right is gender-balanced by size, while the one on the left is not.

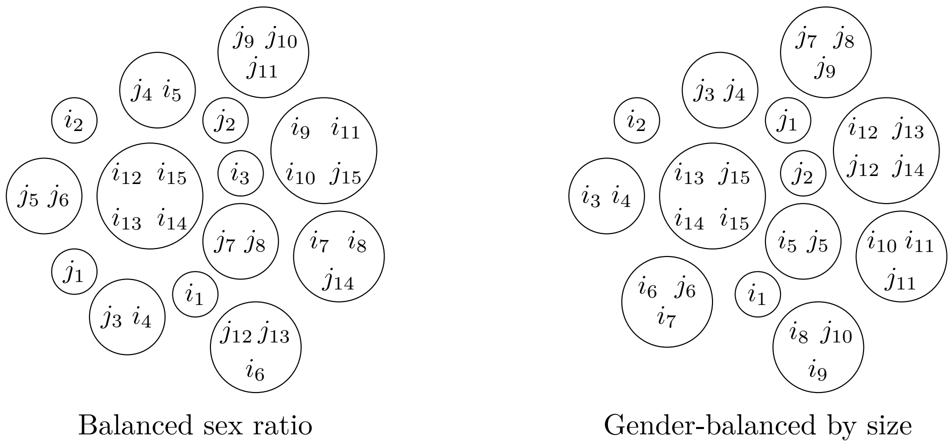


Figure 3.2 – Family partitions

Individuals are distributed into families, which are characterized by a revenue y_f. Families are in turn distributed into income classes y_k, $k \in [1, n]$, with $y_1 > \cdots > y_n$. I say that there is *no revenue dispersion within income classes* when $\forall f \in F_{y_k}$, $y_f = y_k$, $\forall y_k$.

Definition 3.2. *An income class y_k is gender-balanced if there are as many boys as girls in F_{y_k}. An income class y_k is gender-balanced by size if there are as many boys as girls in F_{m,y_k} $\forall m$.*

From these definitions, Corollary 3.1 follows.

Corollary 3.1. *When all income classes are gender-balanced, then the sex ratio is necessarily balanced. When all income classes are gender-balanced by size, then the family partition is necessarily gender-balanced by size.*

These concepts being defined, we may now state in Proposition 3.1 sufficient conditions under which the family network will be segregated by income class and family size.

Proposition 3.1. ***Segregation by income class and family size***
If all income classes are gender-balanced by size with at least two families in F_{m,y_k} $\forall m$ $\forall y_k$, if there is no revenue dispersion within income classes, and if investment costs are the same for all children, the rule on premarital investments generically generates a family network segregated by income class and family size.

Proof. In the population described in Proposition 3.1, consider the set of families of size m and income class y_k, F_{m,y_k}. There is no revenue dispersion within income classes and investment costs are equal to c for all children, so all children in F_{m,y_k} receive a premarital investment of $\frac{y_k}{c(m+1)}$ and thus have the same quality on the marriage market. There are $N \geq 2$ families in F_{m,y_k}, so there are Nm children in the set. N may be any integer if m is even, but must be an even number if m is odd. Income classes are gender-balanced by size, so there are $Nm/2$ boys and $Nm/2$ girls in F_{m,y_k}. Assume that there is no mate with a premarital investment larger than $\frac{y_k}{c(m+1)}$ available in the population. Consider family $f \in F_{m,y_k}$, with b boys and g girls such that $b + g = m$. So there are $\frac{Nm-2m}{2} + g$ boys in other families of the set, which is weakly larger than g as $N \geq 2$. Similarly, there are $\frac{Nm-2m}{2} + b$ girls in other families than f in F_{m,y_k}. So $\forall f \in F_{m,y_k}$ there exist potential partners for all their children in F_{m,y_k}. So if some siblings remained unmatched, there would always exist a family deviation in F_{m,y_k} that would strictly increase the utility of at least one family without diminishing the utilities of the others, and lead to everyone being matched. So all children in F_{m,y_k} are matched together. This applies to all sets F_{m,y_k}, $\forall m, y_k$, starting from the set with the highest premarital investment down to the bottom, leading to a network segregated by income class and family size. This result is generic: it holds for all sets of revenues, except for those such that $\exists(y_k, y_{k'})$ such that $\frac{y_k}{c(m+1)} = \frac{y_{k'}}{c(m'+1)}$ for some $m \neq m'$. ■

Figure 3.3 depicts the equilibrium outcome of Proposition 3.1 with a numerical example. Income classes are gender-balanced by size.[15] There are 348 children divided into 62 families.[16] There is no revenue dispersion within income classes, and investment costs are 1 for all children. As predicted by Proposition 3.1, the rule on premarital investments generates a family network segregated by income class and family size. Note that when there is no revenue dispersion within income classes, there is some indeterminacy in the marriages of the children in F_{m,y_k}, as they all receive the same premarital investment. We can either obtain that all families in F_{m,y_k} are linked in one single component, or segregated into several components.

So under some sufficient conditions, we obtain the most segregated and endogamous structure of family network, characterized by perfect positive assortative matching on the revenue and the size of the family. So a prediction of the model is that if the sex ratio were balanced within income classes by family size, if investment costs were the

[15] In red, $y_1 = 152$, $y_2 = 101$ in orange and $y_3 = 50$ in yellow.

[16] 24 single-child families, 12 two-children families, 8 three-children families, 6 four-children families and 4 five-children families.

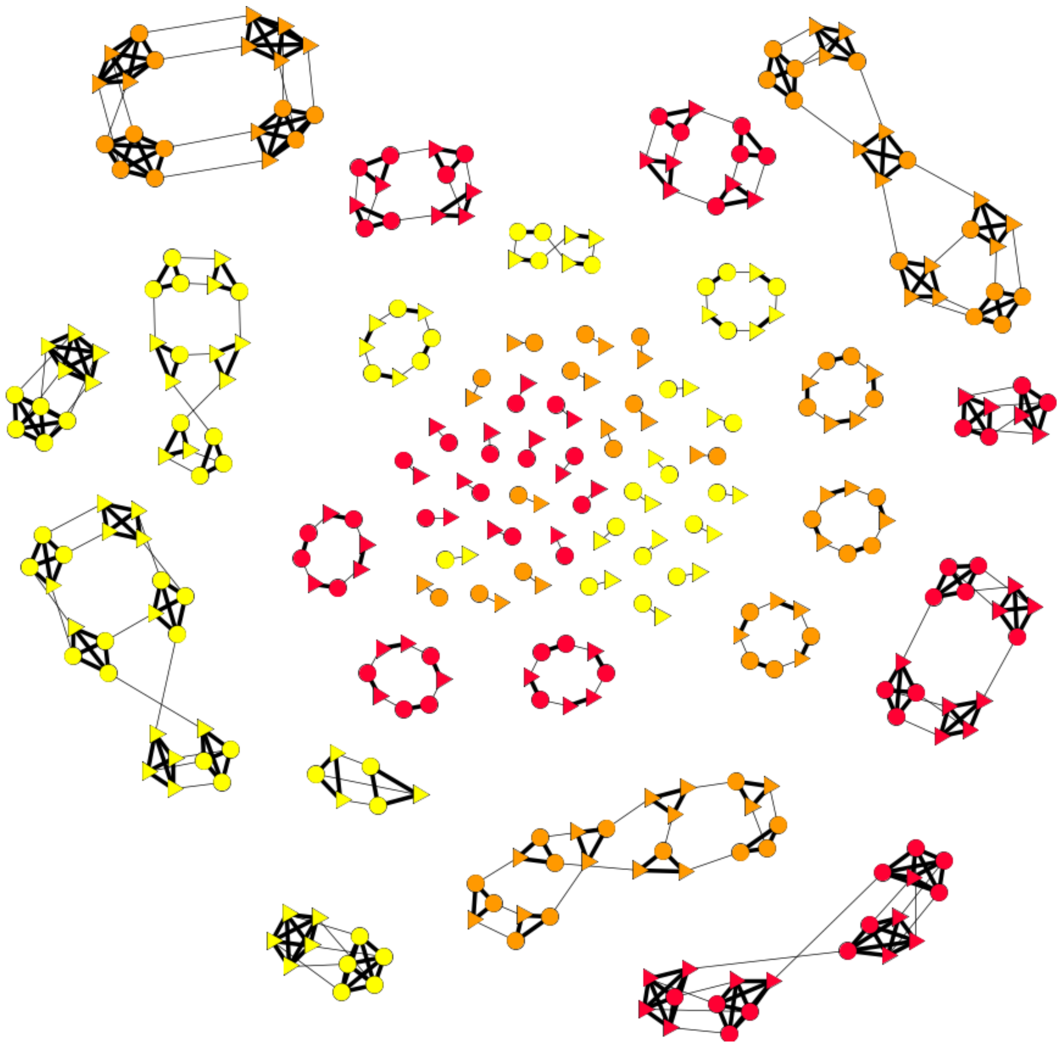


Figure 3.3 – Segregation by income class and family size

same for all children and if there were nearly no revenue dispersion within income classes, then we would observe not only positive assortative matching on the revenue of families, but also on their size. The intuition here is that children who grow up in families with few siblings compete less for limited resources than children who are raised in families with the same revenue but with more siblings. As a consequence, when the investment cost is not differentiated, children in small families should obtain a higher premarital investment than children in large families in a given income class. This higher premarital investment includes more time and attention given by the parents to their children, more resources to finance their education, more belongings and money for their marriage payment or their expected bequest. Thus, children match assortatively on their family size within an income class. So there are two main forces that drive segregation in the family network: income class and family size.

I now consider the sufficient conditions under which we obtain a family network segregated by income class only. Interestingly, these conditions are less demanding in terms of distribution of families across income classes than in Proposition 3.1, but stricter in terms of revenue dispersion between income classes. They are described in Proposition 3.2.

Proposition 3.2. ***Segregation by income class***
Let m_k denote the biggest family size in income class y_k. If all income classes are gender-balanced with at least two families in F_{m_k,y_k} $\forall y_k$, if there is no revenue dispersion within income classes and if investment costs are the same for all children, then the rule on premarital investments generates a family network segregated by income classes if children of the families of the biggest size in an income class are strictly wealthier than children of single-child families of the income class just below.

Proof. In this configuration, there are as many boys as girls in F_{y_k} who receive a premarital investment in $[\frac{y_k}{m_k+1}; \frac{y_k}{2}]$. Conditions on revenue dispersion between income classes are such that $\frac{y_k}{m_k+1} > \frac{y_{k+1}}{2}$ and $\frac{y_{k-1}}{m_{k-1}+1} > \frac{y_k}{2}$. Thus no children of other income classes compete for spouses with children of class y_k. Then we only have to make sure that there are no unmarried siblings in $f \in F_{m_k,y_k}$, because otherwise they would match with children of the class below and so would break segregation by income class. A sufficient condition to avoid this situation is to assume that there are at least two families in F_{m_k,y_k}. Two configurations could emerge. First, if there are as many boys as girls in families F_{1,y_k} to F_{m_k-1,y_k} this implies that there are as many boys as girls in F_{m_k,y_k}. If children in F_{1,y_k} to F_{m_k-1,y_k} are all matched together, then the fact that there are at least two families in F_{m_k,y_k} is enough to make sure that there will remain no unmarried siblings (see the proof of Proposition 3.1). If there remain unmarried siblings in $f \in F_{m_k-1,y_k}$, they match with children in F_{m_k,y_k} and the remaining children in F_{m_k,y_k} match together. Second, if there are not as many boys as girls in F_{1,y_k} to F_{m_k-1,y_k}, then the sex ratio is necessarily balanced when we add families in F_{m_k,y_k}. If there is an excess of boys in smaller families, unmarried boys marry girls in F_{m_k,y_k}, and the remaining unmarried children in F_{m_k,y_k} marry together. In all configurations, there are always family deviations that lead to a situation in which all children in F_{y_k} are married together, thus implying segregation by income class. ■

Figure 3.4 shows the equilibrium outcome of Proposition 3.2 with a numerical example. The population is composed of 150 individuals, distributed into three gender-balanced income classes, and then into families of at most 5 children.[17] There is no revenue dispersion within income classes, and the dispersion between income classes is large enough.[18] Investment costs are equal to 1 for all children. As predicted by Proposition 3.2, the rule on premarital investments generates a family network segregated by income class. Note that segregation by income class does not imply that all families in F_{y_k} are connected, but that marriages are only between children of the same income class.

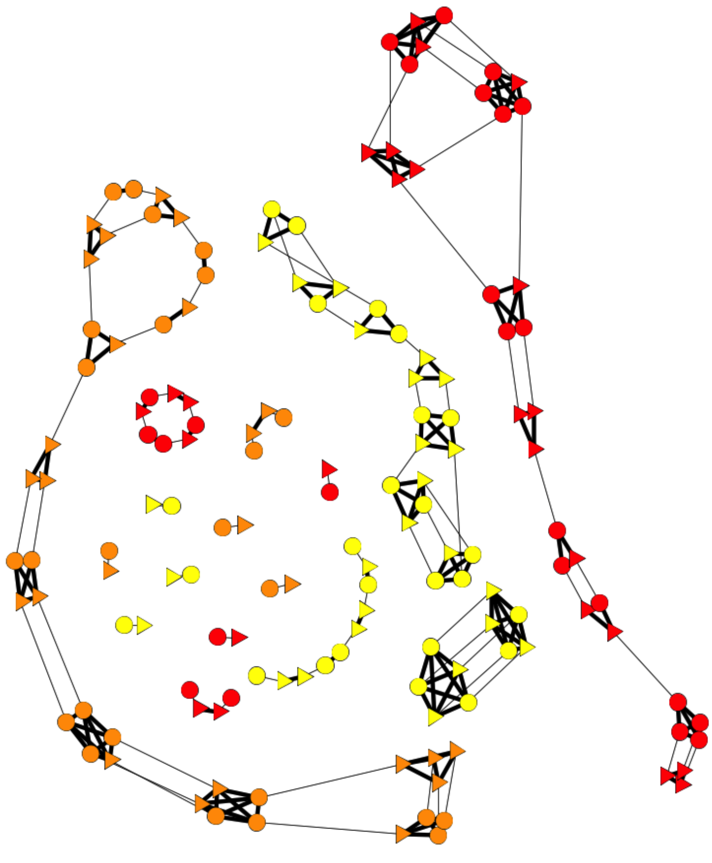


Figure 3.4 – Segregation by income class

[17]Income classes are not gender balanced by size here, for instance, note that in the set of single-child families in the rich group, there are 4 boys and only 2 girls.

[18]$y_r/3 > y_m$ and $y_m/3 > y_p$, in particular, the rich in red get 152, the middle-class in orange get 50 and the poor in yellow get 16.

Proposition 3.1 states that a sufficient condition to obtain a family network segregated by income class and family is that all income classes should be gender-balanced by size. This condition seems extreme for small societies but for large societies, we could ask ourselves whether approximate gender-balance will hold by income class and family size if it holds for society in general. To answer this question, I have simulated 11 100 populations whose sizes range from 500 to 55 500 individuals. For a population of size T, the sex of individuals was drawn from the binomial distribution with parameters $N = T$ and a probability of success for each trial $p = 0.5$. I have then randomly distributed individuals in families of at most five children, and then families in three different income classes. For each simulated population, I have computed the sex ratio in the whole society, the sex ratio by income class and the sex ratio by family size for each income class. Results of these simulations are shown in Figures 3.5 and 3.6.

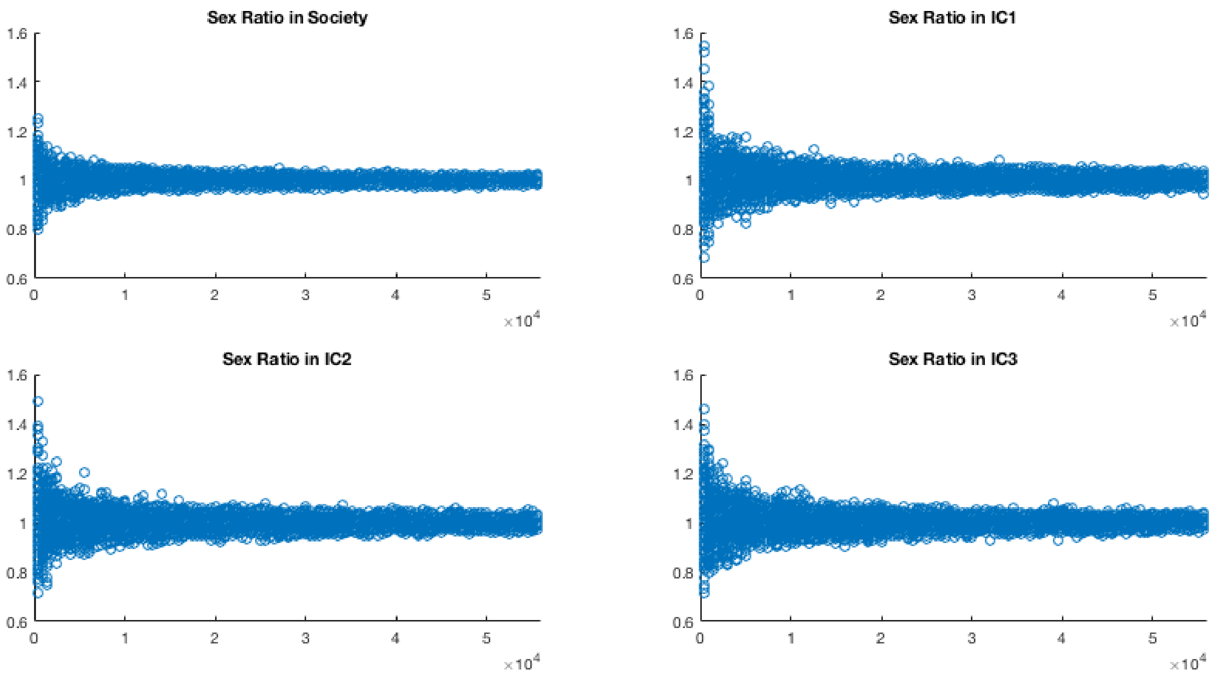


Figure 3.5 – Sex Ratio by Income Class

Figures 3.5 shows how the sex ratio by income class varies when the size of the population increases. For small populations with less than 1 000 individuals the sex ratio by income class varies approximately from 0.7 to 1.6, while sex ratio for the whole society varies from 0.8 to 1.3. As soon as population get to 10 000 individuals, sex ratio in society ranges between 0.95 and 1.05, while it is only when population reaches

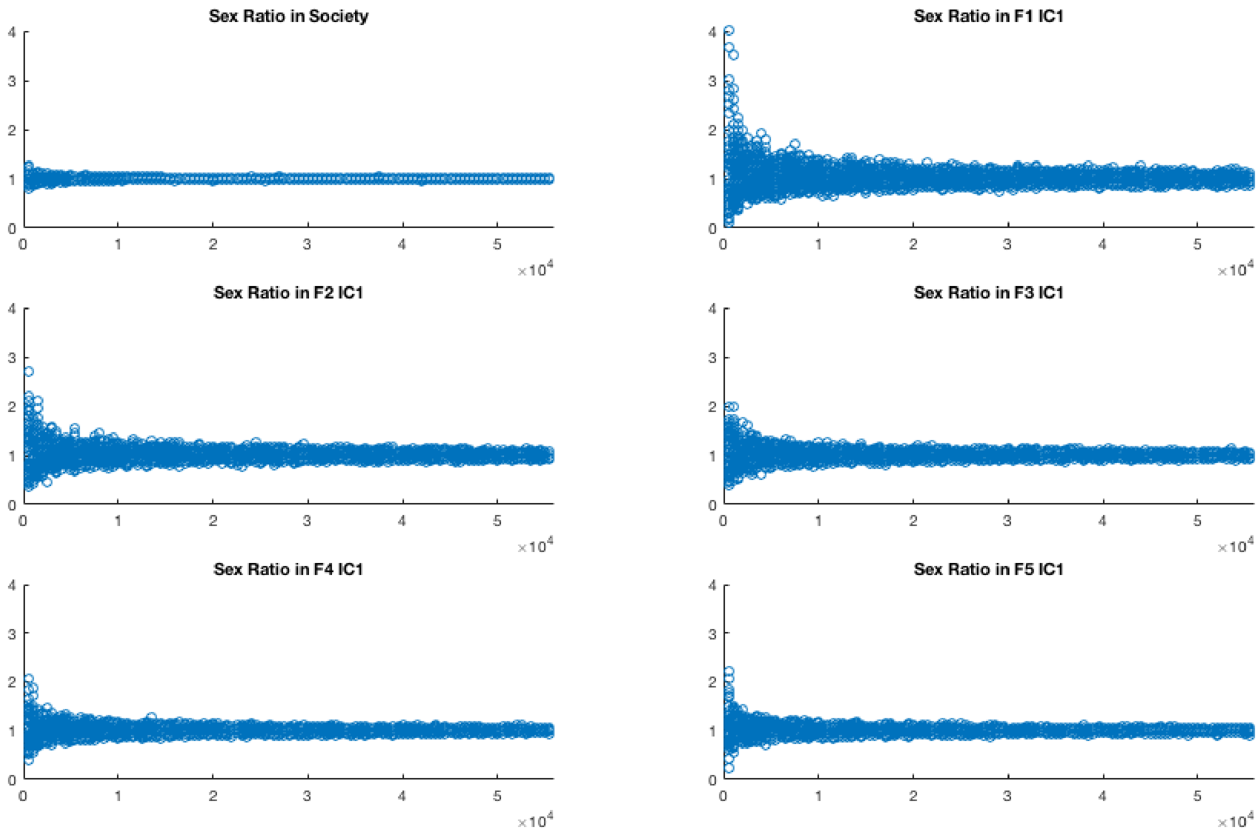


Figure 3.6 – Sex Ratio by Family Size in Income Class 1

approximately the size of 20 000 individuals that sex ratio by income class start varying from 0.95 to 1.05. I find similar patterns for sex ratio by income class and family size. Figure 3.6 shows how the sex ratio by family size varies in the first income class with the size of the population.[19] Sex ratio by family size in the first income class varies from 0.5 up to 4 for single-child families in populations with less than 1 000 individuals. But then its dispersion around 1 shrinks as the size of the population increases. Sex ratio by family type approximately varies from 0.8 to 1.2 when the number of individuals in the population reaches 20 000, and dispersion keeps shrinking slowly around 1 for larger populations. Figure 3.7 shows the box plots for the sex ratio by family size in each income class, together with the sex ratio for the whole society and for each income

[19] Figures showing the sex ratio by family type for the second and third income classes can be found in the Appendix 3.A.

class for 100 populations of 55 500 individuals.[20] For this population size, the sex ratio for the whole society ranges from 0.98 to 1.02, and the sex ratios by income class from approximately 0.97 to 1.04. The sex ratio by family type and income class varies from 0.85 to 1.15 with most of the values ranging between 0.95 and 1.05 or even in a smaller interval for some family sizes.

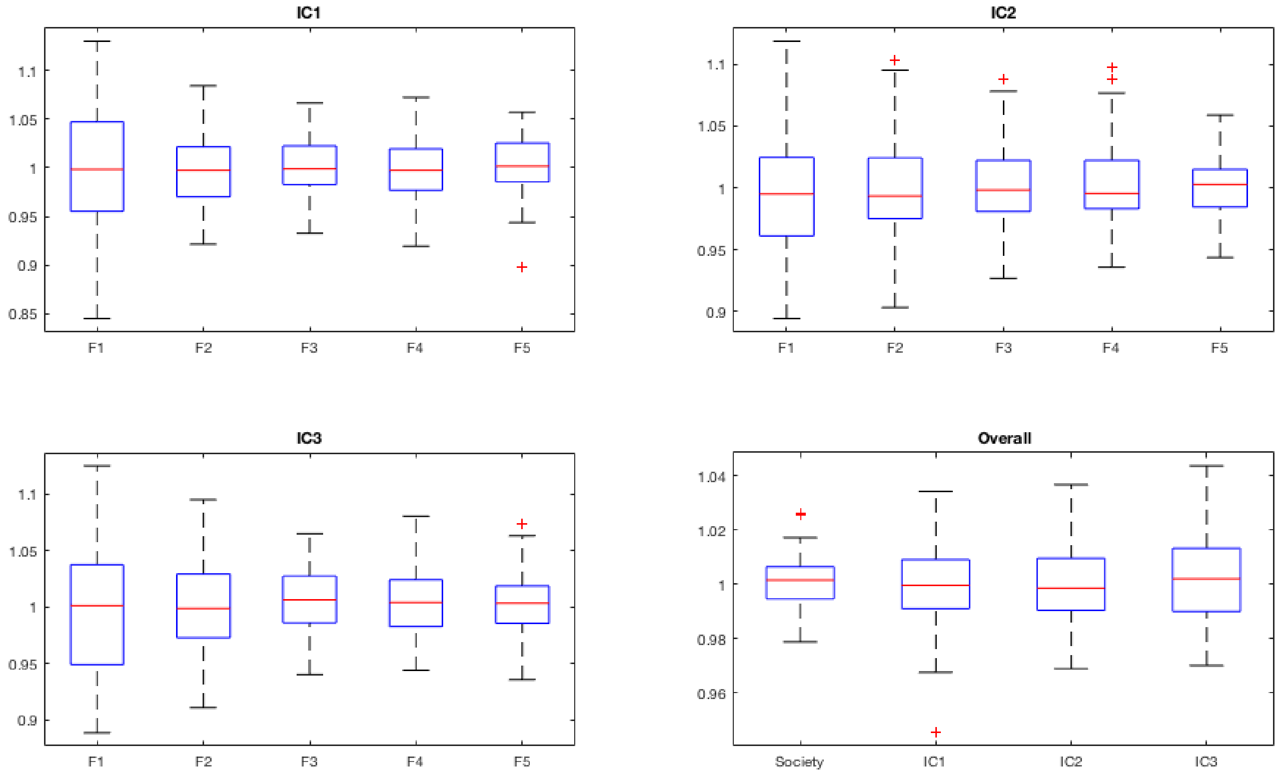


Figure 3.7 – Sex Ratio for Populations of 55500 individuals

It is likely that the sex ratio by family type and income class will keep converging towards 1 for populations with more than 55 500 individuals. So for large societies, we can assume that income classes will be approximately gender-balanced by size, if balanced sex ratio holds for society in general. This implies that the family network will be approximately segregated by income class and family size for large societies, if there is no revenue dispersion nor differentiated investment costs in children.[21]

[20]The whiskers extend to the most extreme data points not considered outliers.
[21]Preliminary results on this topic can be found in the Appendix 3.B for populations ranging from 500 to 11 000 individuals.

Moreover, let us note here that the condition on investment costs used in Proposition 3.1 and Proposition 3.2 can be partially relaxed. Assuming that there are different investment costs based on gender only, that is investment costs equal to c_i for all boys and to $c_j \neq c_i$ for all girls, would not change the family network. This result is stated more generally in Proposition 3.3.

Proposition 3.3. *Introducing different investment costs based on gender only in any population does not affect the resulting family network.*

The proof of Proposition 3.3 is straightforward. Consider a population with a family partition, a distribution of revenues and investment costs equal to 1 for all children in the population. Then the rule on premarital investments generates a ranking of premarital investment for boys, $\omega_{i_1} > \cdots > \omega_{i_n}$, and for girls $\omega_{j_1} > \cdots > \omega_{i_{n'}}$, with n and n' not necessarily equal. Then introduce different investment costs based on gender only, such that investment costs are equal to $c_i > 0$ for all boys and to $c_j > 0$ with $c_j \neq c_i$ for all girls. Then all premarital investments for boys are divided by c_i, and all premarital investments for girls are divided by c_j, so the two rankings are unaffected, and the family network unchanged. ■

Proposition 3.3 holds due to the separability assumption on familial utilities. Under this assumption, the optimal premarital investment received by a child does not depend on the premarital investments received by his siblings. So if investment costs increase for girls, parents simply reduce the levels of premarital investments given to their daughters accordingly, but this has no impact on the levels of the premarital investments they give to their sons. So different investment costs based on gender only affect similarly all boys on the one hand, and similarly all girls on the other hand, without reorganizing their respective rankings.[22] Of course, it is most likely that different investment costs based on gender affect many social and economic outcomes, such as intrahousehold allocation, bargaining power and property rights, but they will not change the resulting

[22]In further research, it would be interesting to use a different familial utility function to study how parents reallocate premarital investments among their children when the investment cost increases for one of them. This would depend on the degree of substitutability between premarital investments. In this paper, I use strong assumptions both on the marital surplus function and on familial utilities to abstract from the difficulties inherent to this problem, and to simplify the study of the structure of the marriage network generated by matching with families.

family network. However, as we will see in Section 3.4 , it is enough for a single family to deviate from the social norms on gender for the entire network of families to be affected.

Finally, in Proposition 3.1 and Proposition 3.2, we studied sufficient conditions under which the rule on premarital investments leads to segregated family networks. One of these conditions is that there should be no revenue dispersion within income classes. As we will see in Section 3.5, the higher the degree of revenue dispersion within an income class the higher will be proportion of marriages between children from families of different sizes and/or different income classes. But when families are all of the same size, revenue dispersion within an income class may accentuate segregation, if families are complementary two by two[23] in the revenue distribution. In this case, even a slight degree of revenue dispersion within an income class will generate a family network composed of pairs of families. Figure 3.8 shows two equilibrium networks with a numerical example considering a population of 50 two-children families, all composed of one boy and one girl. All families belong to the same income class. On the left, there is no revenue dispersion: all families have a revenue of 100, so there is indeterminacy in the matching. On the right, the revenues are drawn from an uniform distribution ranging from 85.5 to 110:[24] revenue dispersion generates an even more segregated network. The two networks of Figure 3.8 are segregated by income class and family size, but the one on the left is made of 4 big components, while the one on the right is made of 25 small components. In Section 3.5, I will study further the impact of revenue dispersion on the number of components in populations with different family sizes and several income classes.

So I find that in a population composed of families with one boy and one girl, and with continuous revenues, the rule on premarital investment generates perfect *watta satta*: the two richest families exchange their daughters, and so on and so forth down to the two poorest families. The practice of *watta satta* has been studied by Jacoby and Mansuri (2010) as a strategic game between two sets of parents with exactly one married girl and one married boy. In my setting, I show that this practice can emerge as an equilibrium phenomenon in a matching framework.

In the next sections, I study the forces which overcome segregation.

[23] Two families are said to be *complementary* if they are of the same size, and the number of girls in one family is equal to the number of boys in the other family.

[24] The richest third of families are in red, and the poorest in yellow.

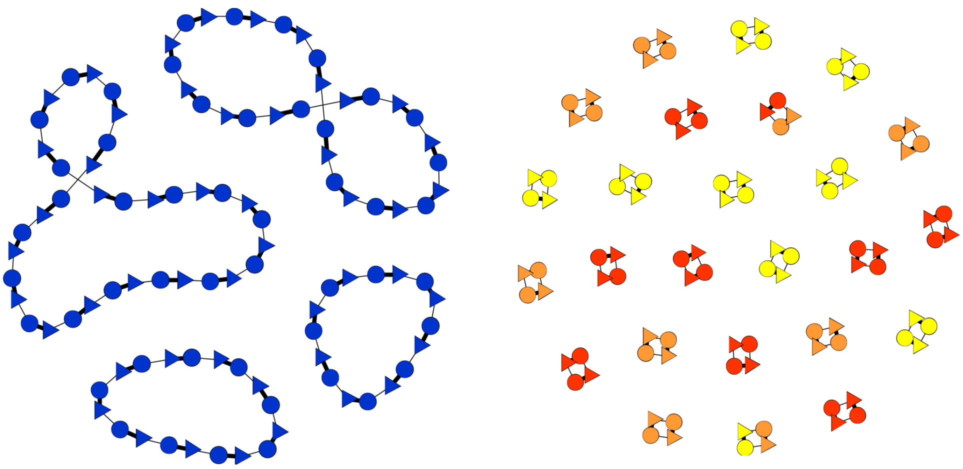


Figure 3.8 – Revenue dispersion and complementary families

3.4 Connectivity

I focus here on two main forces which may engender connectivity: differentiated investment costs and imbalanced sex ratio.

Let us consider the society illustrated in the right panel of Figure 3.8. In this case, the rule on premarital investments generates perfect *watta satta* when investment costs are equal to one or when there are different investment costs based on gender only, as pointed out in Proposition 3.3 . But we note that it only needs one family to deviate from this social norm for the *watta satta* structure to break down, as illustrated in Figure 3.9.

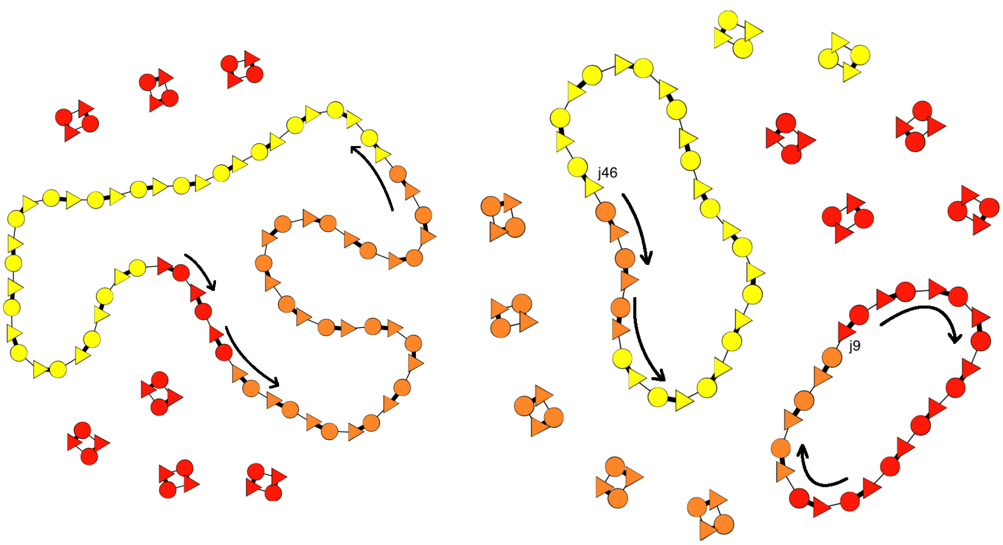


Figure 3.9 – Differentiated investment costs

Figure 3.9 shows two equilibrium network resulting from the same society as in the right panel of Figure 3.8, except for the presence of deviating families. There are 50 families composed of one son and one daughter, and revenues range from 85.5 to 110, with $y_{f_1} > \cdots > y_{f_{50}}$. I assume that investment costs are equal to 1 for all children, except for some deviating families. On the left, I consider that family f_{15} invests less than predicted by the social norm in its daughter. In particular, I assume that $c_{j_{15}} > \frac{y_{15}}{y_{50}}$, so $c_{j_{15}} = 1.21$, such that daughter j_{15} receives the lowest premarital investment. This deviant attitude of one family for only one of its children strongly affects the family network: we still observe *watta satta* for families richer than f_{15}, but now families f_{15} to f_{50} are fully connected in one single component. Furthermore, we observe that this deviation is such that there are now fewer girls with high premarital investments than boys, so this generates an artificial imbalance in the sex ratio at some point of the income ladder. This artificial imbalance in the sex ratio mechanically generates hypergamy: families are vertically connected through marriages between grooms from families slightly wealthier than the families of the brides. At the bottom of the income ladder, the poorest family f_{50} marries off its son to the daughter of family f_{15}, which is a richer family. So such deviations not only generate connection between families, but also social mixing. Note that deviations by more than two families can generate more complex structures, as illustrated on the right of Figure 3.9. This shows two deviating families: family f_9 invests less in its daughter than the social norm predicts, so that daughter j_9 is ranked in 21^{st} position, while family f_{46} invests more in its daughter, so that daughter j_{46} is ranked in 31^{st} position.[25] As a consequence, families with a revenue larger than y_9 are married in pairs, while families f_9 to f_{20} are fully connected through hypergamic links. Then families f_{21} to f_{30} are matched in pairs, and families f_{31} to f_{46} are fully connected through hypogamic links, that is vertical connections through marriages between brides from families slightly wealthier than the families of the grooms.[26] Finally, families f_{47} to f_{50} are matched in pairs.

An interesting feature of these family networks is that connectivity trickles down the income ladder. When the sex ratio is balanced, a sufficient condition to obtain a fully connected family network is to artificially generate sex ratio imbalance through differentiated investment costs at the top of the income ladder that ripples down to the bottom. Thus investment costs should be such that the richest family invests far less in

[25] $c_{j_9} = 1.055 > \frac{y_9}{y_{20}}$ and $c_{j_{46}} = 0.916 < \frac{y_{46}}{y_{31}}$.

[26] We obtain hypogamous links here because the deviation of f_{46} generates a relative surplus of daughters with high premarital investments at some point on the income ladder.

its daughter such that she receives the lowest premarital investment in the population, or alternatively, that the poorest family invests much more in its daughter such that she receives the highest premarital investment.[27] This extreme situation is quite unlikely in reality, but as we will see below, an actual sex ratio imbalance at the top of the income ladder will fully connect an otherwise segregated society.

This result on different investment costs shows that *watta satta* or other forms of segregated and endogamous family networks are not robust to deviations from social norms, or public policies that would impact investment costs. In particular, this model predicts that a policy that would subsidize education for daughters in the poorest families, would help generate a more connected and mixed family network.

This result also shows that different investment costs within and between families should increase connectivity and social mixing. This implies that if we consider social norms that generate such differentiated investment costs, the rule on premarital investments should generate some connectivity in the family network. For instance, in South Asia, one social norm is to marry off the eldest sister before the younger ones. Vogl (2013) finds that this social norm has negative impacts on the education of the eldest sister and the quality of her spouse. In our setting, this implies that the oldest daughter receives less education, thus obtains a lower premarital investment, and then marries a spouse from a poorer family than her younger sisters will. This social norm is such that two sisters, although from the same family, will marry partners of different quality, thus linking their family with families of different revenues or sizes.

Social norms that differentiate children according to birth order and family composition in populations composed of families of different sizes thus generate connectivity and social mix. Figure 3.10 depicts the equilibrium network resulting from the same society as in Figure 3.3, but with a social norm similar to male primogeniture. I assume that first-born boys are characterized by an investment cost of 0.5, while daughters and other boys are characterized by an investment cost of 1.5. In families with no boys, I assume that the first-born girl is characterized by an investment cost of 0.5. First-born boys are represented by pentagons, while first-born girls in families without boys are represented by squares. When I apply this social norm, we shift from a family network segregated by income class and family size, as illustrated in Figure 3.3, to a much more complex and richer network, as illustrated in Figure 3.10.

[27] $c_{j_1} > \frac{y_1}{y_{50}}$, or alternatively $c_{j_{50}} < \frac{y_{50}}{y_1}$.

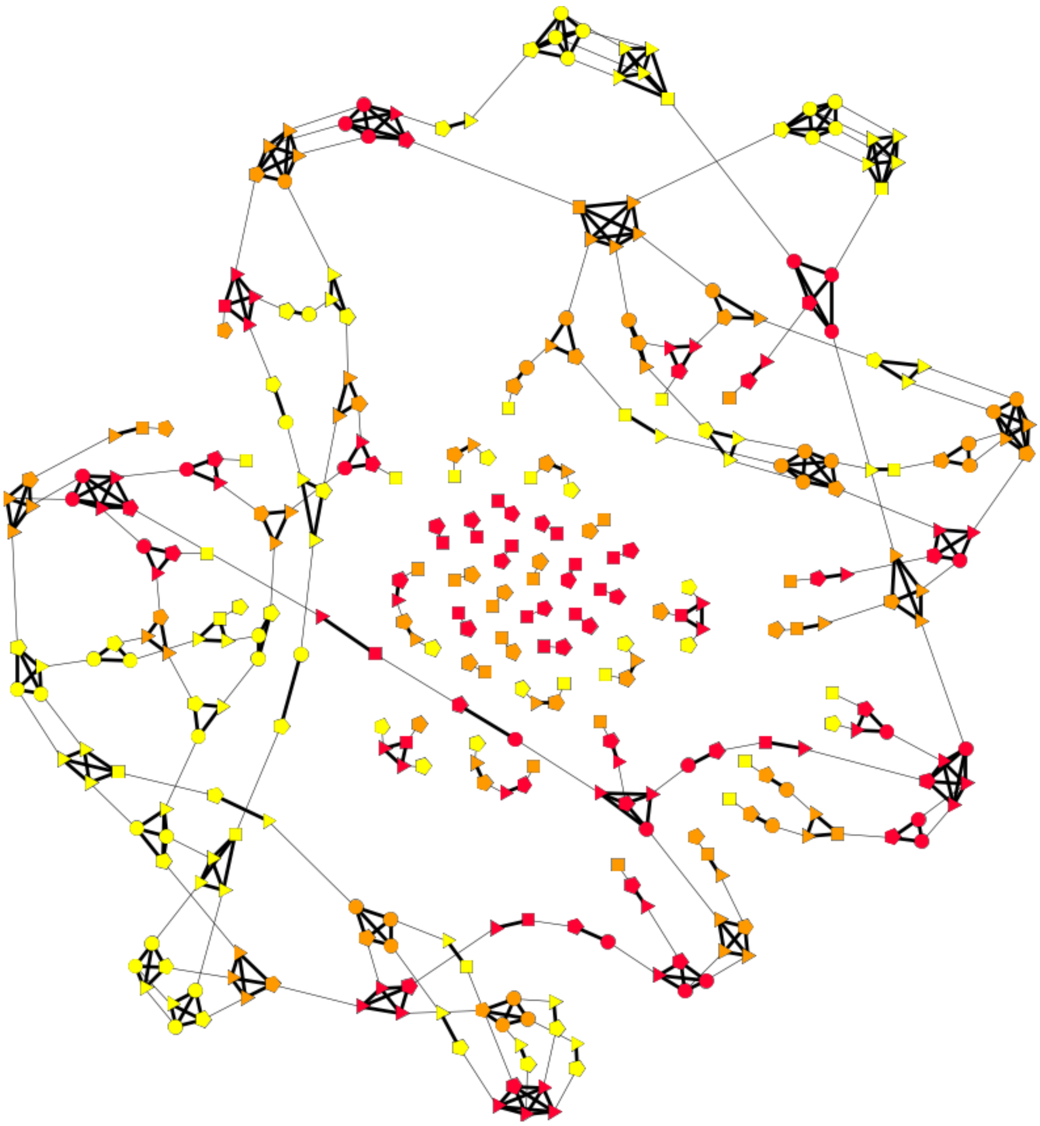


Figure 3.10 – Male primogeniture

I now consider the impact of actual sex ratio imbalance on the connectivity of the family network. Let us consider again the society illustrated in the right panel of Figure 3.8, but let us replace one family composed of one boy and one girl by a family with two boys. This substitution generates a slight imbalance in the sex ratio, with more boys than girls ($r = 1.041$). Figure 3.11 shows the equilibrium network with this imbalance in the sex ratio. On the left, I introduce an unbalanced sex ratio at the top of the income distribution: the richest family f_1 is now composed of two boys. We observe that we shift from a *watta satta* society to a fully connected society, with hypergamous vertical links symmetrically organized around the two brothers in f_1.[28]

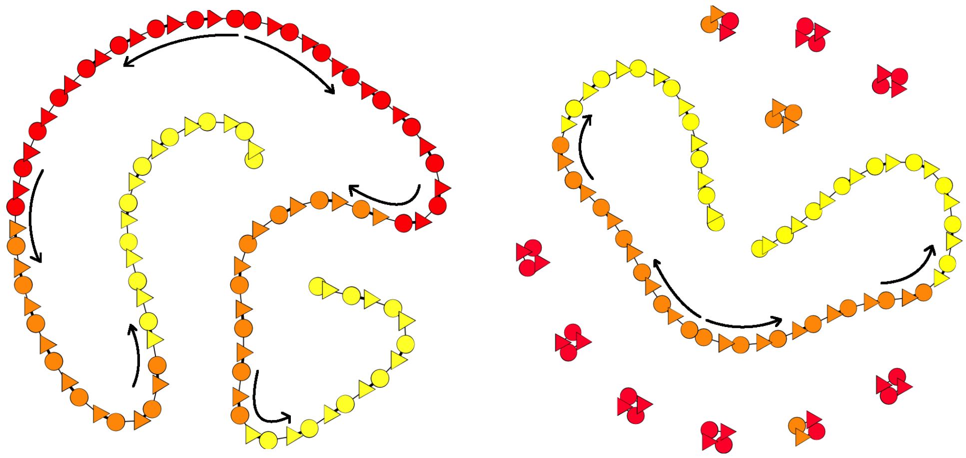


Figure 3.11 – Unbalanced sex ratio

As said earlier, the sex ratio imbalance ripples down the income ladder. On the right, I introduce an unbalanced sex ratio in the middle of the income ladder: family f_{21} is now the one composed of two boys. We now observe that families wealthier than f_{21} are married in a *watta satta* structure, while families f_{21} to f_{50} are fully connected in one single component through hypergamic marital links, once again symmetrically organized around the two brothers in f_{21}. This downward domino effect would be stopped only if the sex ratio imbalance were offset at some point of the income ladder, for instance if there were a family composed of two daughters below f_{21}.

Interestingly, if in addition we assumed differentiated investment costs between the two brothers such that, for instance, the younger one received a smaller premarital investment than his elder brother, we would observe asymmetry between the two brothers, as illustrated in Figure 3.12.[29]

Families linked through marital connections to the first-born son of family f_{21} are more numerous and on average wealthier than families linked through marital connections to the younger son of the same family. This result casts a new light on another effect of male primogeniture: its impact on the quality of the "parentèle" or the extended family. This dimension was of major political importance in dynastic states,

[28] We would have obtained hypogamous links if we had replaced the family by a family composed of two daughters, thus generating a slight imbalance in the sex ratio with more girls than boys ($r < 1$). The relationship between scarcity of men and hypogamous marital links has been empirically explored by Abramitzky et al. (2011).

[29] I replace f_{21} by a family of two boys, and I assume that $c_{i_{21}} = 1$ and $c_{i_{22}} = 1.3$.

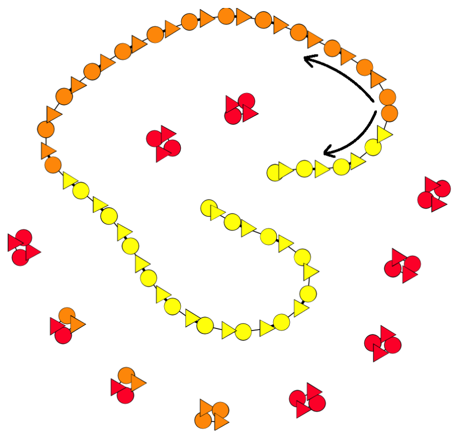


Figure 3.12 – Unbalanced sex ratio and differentiated investment costs

as explained by Nassiet (2000). The numerical strength of the extended family of regional leaders helped them quickly mobilize a large army in the event of conflict with a neighbouring leader. In a setup in which families would derive utility from the network structure, we could see male promogeniture endogenously emerging as a social norm in some societies.

It is possible to generalize the downward domino effect to populations with families of different sizes. Let us consider again a population as described in Proposition 3.1, with no single-child families.[30]

Theorem 3.1. ***The downward domino effect***
In a population with l different family sizes with a minimum of two children, and n income classes which are gender-balanced by size, with at least two families in F_{m,y_k} $\forall m \geq 2$, $\forall y_k$, no revenue dispersion within income classes, and investment costs equal to 1 for all children, consider the most connected equilibrium network.[31]
This network is segregated by income class and family size (Proposition 3.1).
Replace one boy in F_{m^*,y_k^*} by one girl (or one girl by one boy) to generate a sex ratio imbalance. Denote $\omega^* = \frac{y_k^*}{m^*+1}$.

1. *The equilibrium network is such that families making a premarital investment $\omega > \omega^*$ are segregated by income class and family size; while families making a premarital investment $\omega \leq \omega^*$ are fully connected.*

[30]Single-child families would mechanically "break" the downward domino effect, because they can only have one marital link, by definition.
[31]That is, the family network composed of exactly nl components of fully connected families of the same size and income class.

2. *When, $m^* = 2$ and $y_k^* = y_1$, the whole family network is fully connected.*

3. *When we replace one boy by one girl, i.e. r<1, the connection is through hypogamous links. When we replace one girl by one boy, i.e. r>1, the connection is through hypergamous links.*

Proof. We assume in the proof that we replace one boy by one girl.

1. In a family $f \in F_{m^*,y_k^*}$, we replace one boy by one girl. So all the children in the population are married, except the previous spouse of the deleted boy, and the new girl introduced in the population. These two girls have a premarital investment ω^*. Boys with $\omega \geq \omega^*$ gain nothing from changing spouses because by construction they have a premarital investment equal or higher than ω^*. However, all boys with $\omega < \omega^*$ are married to girls with $\omega < \omega^*$, and would rather marry the two single girls with a premarital investment equal to ω^*. The two single girls will marry the boys with the highest premarital investment below ω^*, denoted ω^*_{-1}. Thus two girls with premarital investment ω^*_{-1} end up single. And so on down to the bottom of the society, i.e. the group of the largest families in the poorest income class, F_{m_n,y_n}.

2. If $m^* = 2$ and $y_k^* = y_1$, then $\omega^* = \frac{y_1}{2}$, which is the highest premarital investment in the society. According to 1., all families with premarital investment $\omega \leq \omega^*$ are fully connected, and ω^* being the highest premarital investment, the whole population is fully connected.

3. The phenomenon described in 1. is such that marriages which connect components are between brides with a higher premarital investment than the grooms', which is the definition of hypogamous marital links. If we had assumed an imbalance in the sex ratio such that $r > 1$, we would have obtained the opposite phenomenon, that is marriages connecting components including grooms with a higher premarital investment than the brides', and so hypergamous marital links.

■

Let us consider the society illustrated in Figure 3.3, for which the rule on premarital investments generates a family network segregated by income class and family size. Let us delete single-child families and consider the most connected equilibrium network.

This is a family network composed of 12 components connecting families of the same size and income classes, as illustrated on the left of Figure 3.13.[32] Then I replace one girl by one boy in the top group, which is the group of families of the smallest size, that is with two children only, in the wealthiest income class, F_{2,y_r}. This generates a fully connected family network as illustrated in the right panel of Figure 3.13.

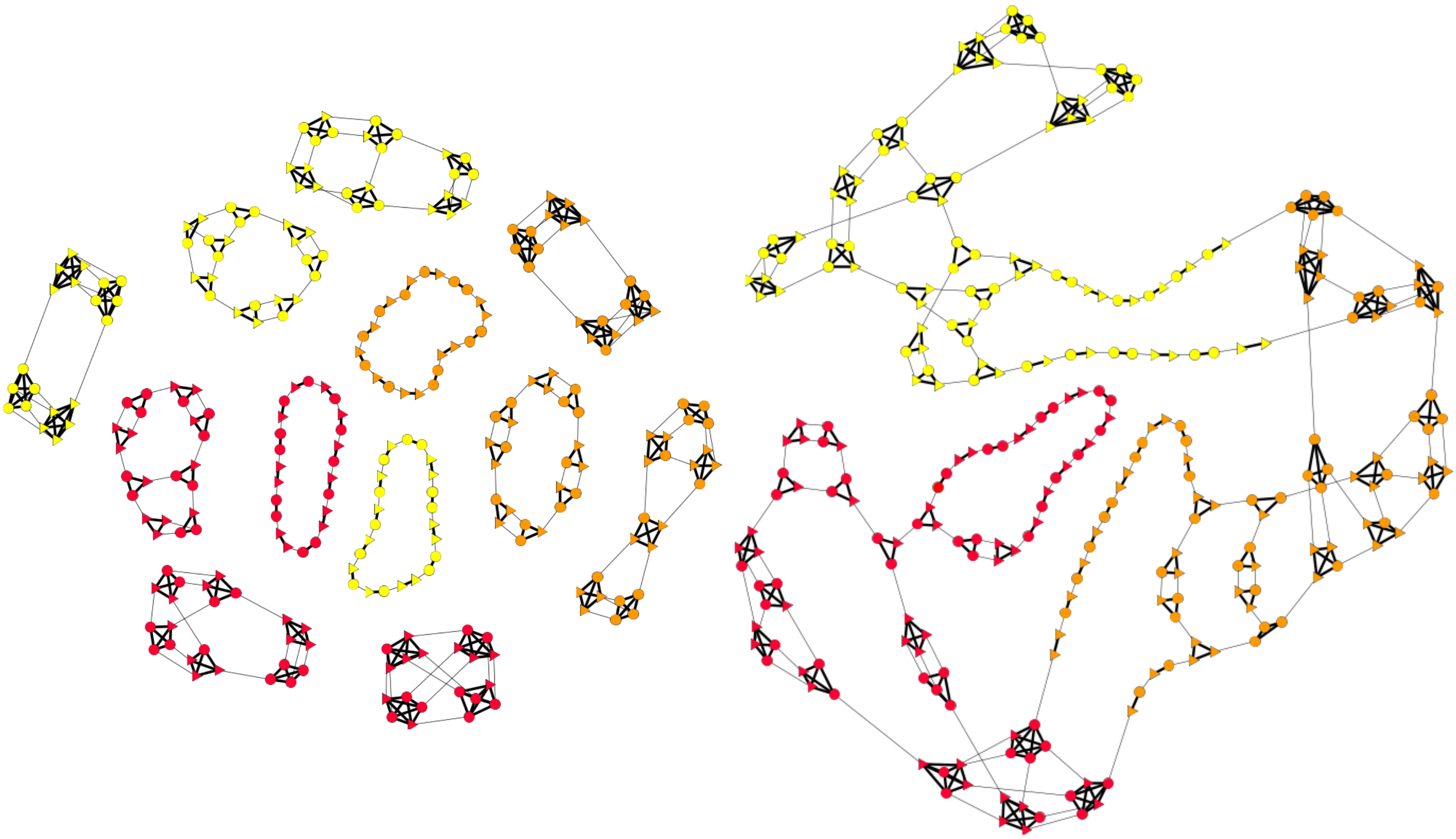


Figure 3.13 – Downward domino effect

As predicted by Theorem 3.1, we observe that marriages connecting two previously separated components are between a groom with a higher premarital investment than the bride's, thus the connection is through hypergamous links.

In the left panel of Figure 3.14, I replace one girl by one boy in a middle-income group instead of the top one. I replace one girl by one boy in a family in F_{3,y_m}, that is in a family with three children in the middle-income class. As predicted by Theorem 3.1, we observe that children in families above F_{3,y_m} are still segregated by income class and

[32] I withdraw single-child families, so there are four different family sizes and three income classes.

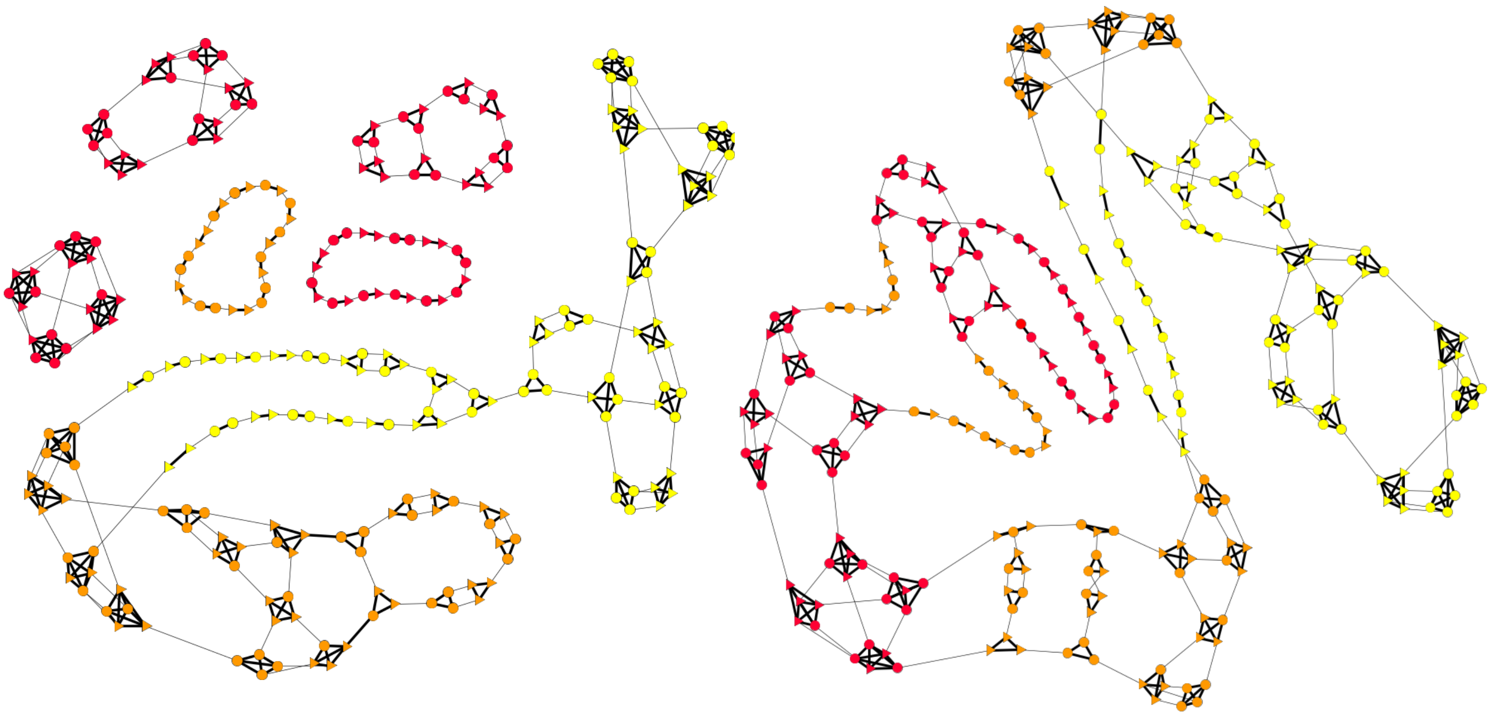


Figure 3.14 – Downward domino effect

family size. Children in families in F_{3,y_m} and in families below, down to the bottom family group F_{5,y_p}, which is the group of families with five children in the poorest income-class, are fully connected through hypergamous links. Whether the connection is hypergamous or hypogamous can have substantial impacts on outcomes within the household and beyond: the bargaining power within a household may be different depending on whether the husband's parents-in-law are wealthier or poorer than his own parents. Moreover, it impacts the direction of patron-client relationships between generations, which can affect outcomes such as social mobility. For instance, in a hypogamous network, the father-in-law of the husband has a higher status, so he can co-opt his step-son in exchange for services.[33] In a hypergamous network, the direction of the relationship is reversed.

Notice that the structure of the connection depends on the revenue dispersion between income classes. On the right of Figure 3.13 and on the left of Figure 3.14, I assume that the dispersion between income classes is large: children of the most numerous families of an income class obtain larger premarital investments than children in the

[33] Co-optation of sons-in-law in the Parisian law court by fathers-in-law was a common practice among the French nobility in the eighteenth century (Bluche 1960).

smallest families on the income class below.[34] But if we assumed a smaller dispersion between income classes, we would obtain a more mixed network, that is a network with more inter-income class marriages, as illustrated on the right of Figure 3.14.[35]

In order to give a quantification of the effect of sex ratio imbalance on equilibrium networks I have run some numerical simulations. I have simulated 10 100 populations characterized by gender balanced by family size and income class, with families of at most five children and three income classes with no revenue dispersion within income classes and revenue dispersion between income classes set to 25%.[36] Then, I have randomly replaced some girls by boys in the populations, to introduce sex ratio imbalance ranging from 1 to 2. Assuming no differentiated investment costs on children, I have generated the associated 10 100 family networks. Figure 3.15 shows how sex ratio imbalance affects segregation patterns in equilibrium family networks. On the left I have represented how the proportion of links connecting two families of same income class varies the sex ratio. On the right I have represented the proportion of links connecting two families of same size.

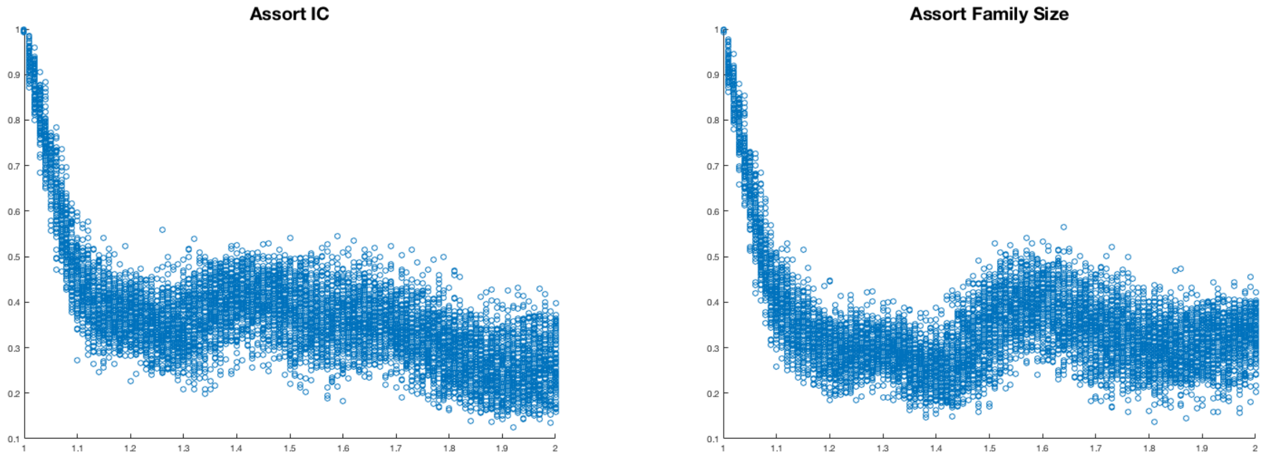


Figure 3.15 – Impact of Sex Ratio on Segregation Patterns

As predicted by Proposition 3.1, we observe segregation by income class and family size when the sex ratio is perfectly balanced: 100% of the links are between families of same income class and family size. This proportion steadily diminishes as soon as

[34] $y_r/3 > y_m$ and $y_m/3 > y_p$
[35] I assume here that $y_r/4 > y_m/3 > y_r/5 > y_r/6 > y_m/4 > y_m/5 > y_p/3 > y_m/6 > y_p/4$.
[36] So for two successive income classes y_k and y_{k+1}, $(y_k - y_{k+1})/y_k = 0.25$.

we introduce sex ratio imbalance in the population: the proportion of links connecting families of same income class decreases by 5.58 percentage points when the sex ratio increases by 0.01 unit between 1 and 1.1. When the sex ratio reaches 1.1, the proportion of links connecting families of same income class is on average equal to 44.95%. The decrease is even steeper for the proportion of links connecting families of same size: it decreases by 6.11 percentage points when the sex ratio increases by 0.01 unit between 1 and 1.1, and reaches on average 40.18% when sex ratio is equal to 1.1. For sex ratios larger than 1.1, these proportions remain relatively constant but are more dispersed. The proportion of marriages between families of same income class is on average equal to 34.41%, with a standard deviation of 7.48 percentage points. Concerning the proportion of marriages between families of same size, it is on average equal to 32.05% with a standard deviation of 6.39 percentage points.

I then study the impact of sex ratio imbalance of some characteristics of the network structure. I focus in particular on four main characteristics, as illustrated in Figure 3.16.

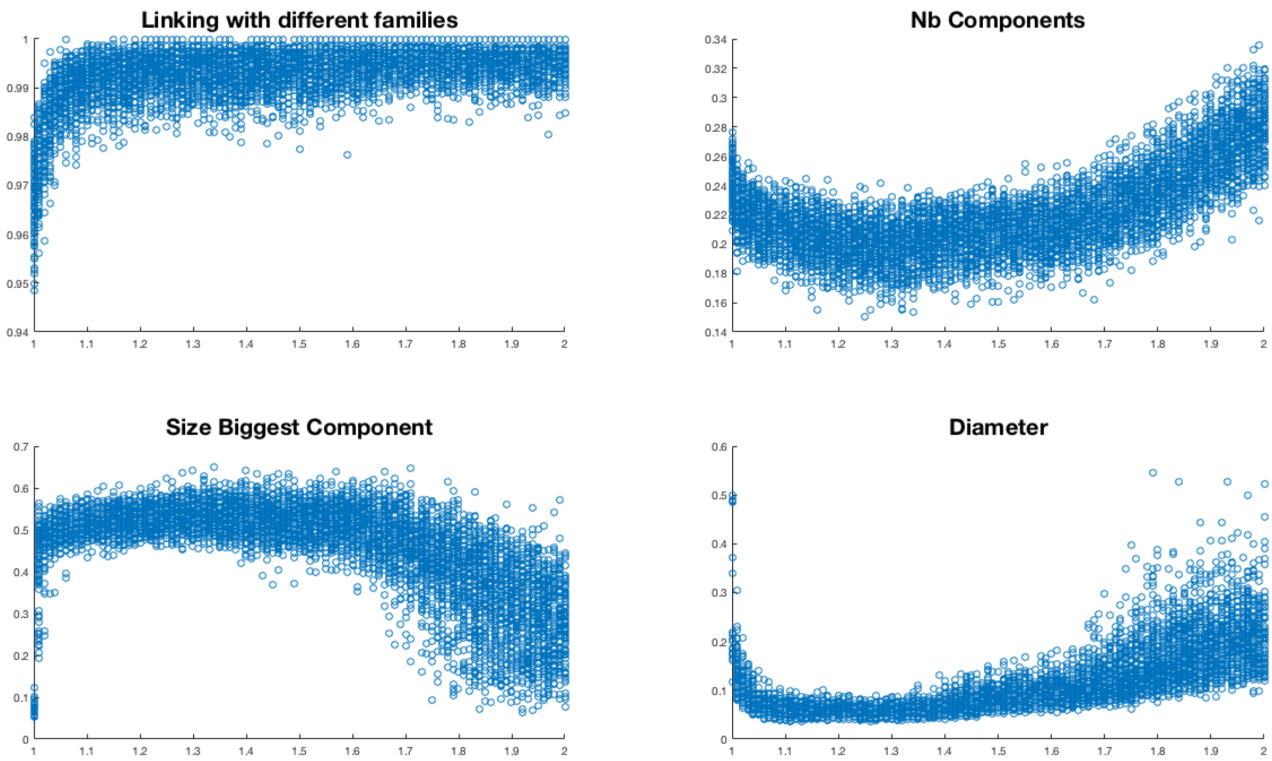


Figure 3.16 – Impact of Sex Ratio on the Network Structure

The first one captures the tendency for families to have simple links with different families rather than multiple links with the same family. I have measured this by computing the ratio of the number of pairs of connected families to the total number of connections in the network.[37] So, the lower this ratio, the more families tend to marry their children to spouses from a same family. In contrast, the higher this ratio, the more families tend to marry their children to spouses from different families. We observe a sharp increase of this ratio when we start introducing sex ratio imbalance in the population. This increase shows that the family network is more connected and denser when there is imbalance in sex ratio. Then this ratio stays high and constant for sex ratios larger than 1.1. The second characteristic of the network we study is the number of its components. In order to compare this characteristics for the 10 100 networks simulated, I have divided the number of components by the number of nodes in each network. We observe a decrease in the number of components when the sex ratio increases from 1 to 1.3. This also indicates that the network is more connected when there is sex ratio imbalance in the population. The increase we observe in the number of components for sex ratios larger than 1.3 only captures the fact that there is an increasing number of families disconnected from others because they cannot marry their sons due to the scarcity of daughters in the population. Then I study how the size of the biggest component in the network varies when the sex ratio increases. I have also divided the size of the biggest component by the number of families in each network in order to be able to compare them. We observe an increase in the size of the biggest component when the sex ratio increases from 1 to 1.2. It remains constant when the sex ratio varies from 1.2 to 1.5, and then falls certainly because more and more families remain disconnected from the rest of the network due to the celibacy of their sons. Finally, the fourth characteristic we explore is the ratio of the diameter in the biggest component to the size of the biggest component. We observe a decrease of this ratio, when the sex ratio varies from 1 to 1.1. When the sex ratio is equal to 1, the diameter of the biggest component is equal to 44.07% of its size on average, while it drops to 5.78% of its size on average for a sex ratio equal to 1.1. The lower the diameter, the shorter the largest distance between any two families in the biggest component. Thus our results indicate that the biggest component tends to be more connected when we increase the sex ratio. For sex ratios ranging

[37] The total number of connections in the network is the number of marriages. The number of pairs of connected families simply indicates whether there is a link between two families, whatever the number of links between these two families. For instance, if two families are linked through two marital connections, we will count only one connection between these two families.

from 1.1 to 1.4, this ratio remains constant and on average equal to 5.72%. Overall, results indicate that introducing sex ratio imbalance in the population leads to a more connected network: families tend to marry more their children to spouses from different families, the number of components in the networks decreases while the size of the biggest components increases, and the diameter in the biggest components decreases.

Finally, in this setting, I assume that the sex ratio is given. But it has been widely documented that the sex ratio is often the result of strategic decisions of sex selection by parents. Nearly thirty years ago, Sen (1990) revealed that 100 million women were missing in Asia because of sex selection. Since then, preference for boys has been studied by economists (Edlund 1999, Bhaskar 2011). More recently Border et al. (2017) show in a matching framework that relatively wealthy households within castes will be more likely to practice sex selection. My framework suggests other reasons why parents could strategically play on the sex ratio, not necessarily through the dramatic practice of sex selection, but through the way they arrange marriages of their children. If network benefits were included in the utility functions of families, parents could strategically decide on the number of their daughters they would marry in order to make a trade-off between the quantity of links for quality. Nassiet (1995, 2000) explains that in the fifteenth and sixteenth centuries, noble families usually married off all their daughters, which tended to generate hypogamous marital links due to the unbalanced sex ratio.[38] Hypogamous marital links were valuable, because they helped create clientelistic relationships between the father of the brides and his sons-in-law, of a relatively lower status. But during the seventeenth century, with the rise of a wealthy bourgeoisie who could offer large dowries to their daughters, noble families rather married off one daughter only with a groom from a family of equivalent wealth, and kept the other single, most of them being sent to a convent. This change in practice could be interpreted as a way for noble families to rebalance the sex ratio, in order to improve the position of noble daughters on the marriage market, and thus obtain fewer marital links but homogamous ones.

In the next section, I explore the effects of revenue dispersion on the connectivity of the family network.

[38]There were more women than men ($r < 1$), because the way of life of the nobility at the time (wars, duels, tournaments, hunting) led to high male adult mortality.

3.5 Revenue dispersion

I now study how the connectivity of the family network changes with revenue dispersion. I make a distinction between revenue dispersion within a given income class, and revenue dispersion between two different income classes.

I say that there is revenue dispersion within an income class, when $\forall f \in F_{y_k}$, $y_f \in [y_k - \sigma_k; y_k + \sigma_k]$. The higher σ_k, the higher the degree of revenue dispersion within the income class. By definition, different income classes should never overlap, this means that we should always have $y_k - \sigma_k \geq y_{k+1} + \sigma_{k+1}$, $\forall y_k$. The degree of revenue dispersion between income classes is measured by the distance between the means of two successive income classes y_k and y_{k+1}. The smaller $y_k - y_{k+1}$, the smaller the revenue dispersion between these two income classes. If there are n income classes, then the smaller $\frac{1}{n-1}(\sum\limits_{k=1}^{n-1} y_k - y_{k+1})$, the smaller between revenue dispersion in the whole society.

We start from a configuration that satisfies the conditions described in Proposition 3.1. In particular, the society is composed of gender-balanced by size income classes with no revenue dispersion within income classes. Thus we obtain a family network segregated by income class and family size, like the one represented in Figure 3.3. We first consider how revenue dispersion impacts connectivity within a given income class y_k, and then how it impacts connectivity between two successive income classes.

In order to obtain a family network in which families of different sizes within the same income class intermarry, the degree of revenue dispersion within the income class must be such that

$$\frac{y_k + \sigma_k}{m+2} \geq \frac{y_k - \sigma_k}{m+1} \Leftrightarrow \sigma_k \geq \frac{y_k}{2m+3} \tag{3.5}$$

This means that the revenue dispersion within the income class must be such that a family with $m+1$ children at the top of the income distribution must be able to make a higher premarital investment in its children than a family with m children at the bottom of the income distribution. We observe that the lower m, the higher the degree of dispersion σ_k should be. So in order to obtain a family network in which all families, from F_{1,y_k} to F_{m_k,y_k},[39] are connected, a necessary condition is that $\sigma_k \geq y_k/5$. If σ_k is lower than this threshold, then we will have connections between the largest families, while the smallest ones will remain segregated by size. For instance if $\sigma_k < y_k/7$, then single-child families and families with two children will be segregated by size, while

[39] With m_k being the biggest family size in the income class y_k

families with three or more children will be connected. Also, we note that the higher y_k, the higher the revenue dispersion σ_k must be in order to generate a connected income class.

We now study the conditions on revenue dispersion under which we have connections between two successive income classes. This is the case when

$$\frac{y_{k+1} + \sigma_{k+1}}{2} \geq \frac{y_k - \sigma_k}{m_k + 1} \tag{3.6}$$

with $y_k > y_{k+1}$. This condition says that a single-child family with the highest income in y_{k+1} must be able to make a higher premarital investment in its child than a family with m_k children and the lowest income in y_k. Rearranging (3.6), we find

$$y_k - y_{k+1} \leq \frac{(m_k - 1)y_{k+1}}{2} + \frac{(m_k + 1)\sigma_{k+1}}{2} + \sigma_k \tag{3.7}$$

Thus in order to obtain a family network with connections between two successive income classes, the revenue dispersion between these two income classes should be small enough. We observe that the smaller the most numerous family in y_k, the smaller should be the degree of between dispersion to connect the two income classes. This is because the smaller the more numerous family in y_k, the higher the gap between the lowest premarital investment in y_k and the highest one in y_{k+1}, which must be compensated by a smaller degree of between revenue dispersion. Moreover, the higher the degree of revenue dispersion within an income class, the looser the conditions on the degree of between dispersion to connect two different income classes. So more connectivity within an income class due to a larger degree of revenue dispersion σ_k should also generate more connectivity between two successive income classes. As a consequence, the degree of between dispersion should be large enough if we want to obtain a family network fully connected within income classes, but still segregated by income classes. In particular, if we choose $\sigma_k = y_k/5$ and $\sigma_{k+1} = y_{k+1}/5$, the condition on in-between dispersion to generate a network segregated by income classes is

$$y_k - y_{k+1} \geq \frac{(3m_k - 1)y_{k+1}}{4} \tag{3.8}$$

Figures 3.17 and 3.18 show the equilibrium networks resulting from the same population as in Figure 3.3, but with different degrees of within and between revenue dispersion. In Figure 3.17 , the between revenue dispersion is the same for the three depicted family networks, but the degree of within revenue dispersion changes. I assume that the

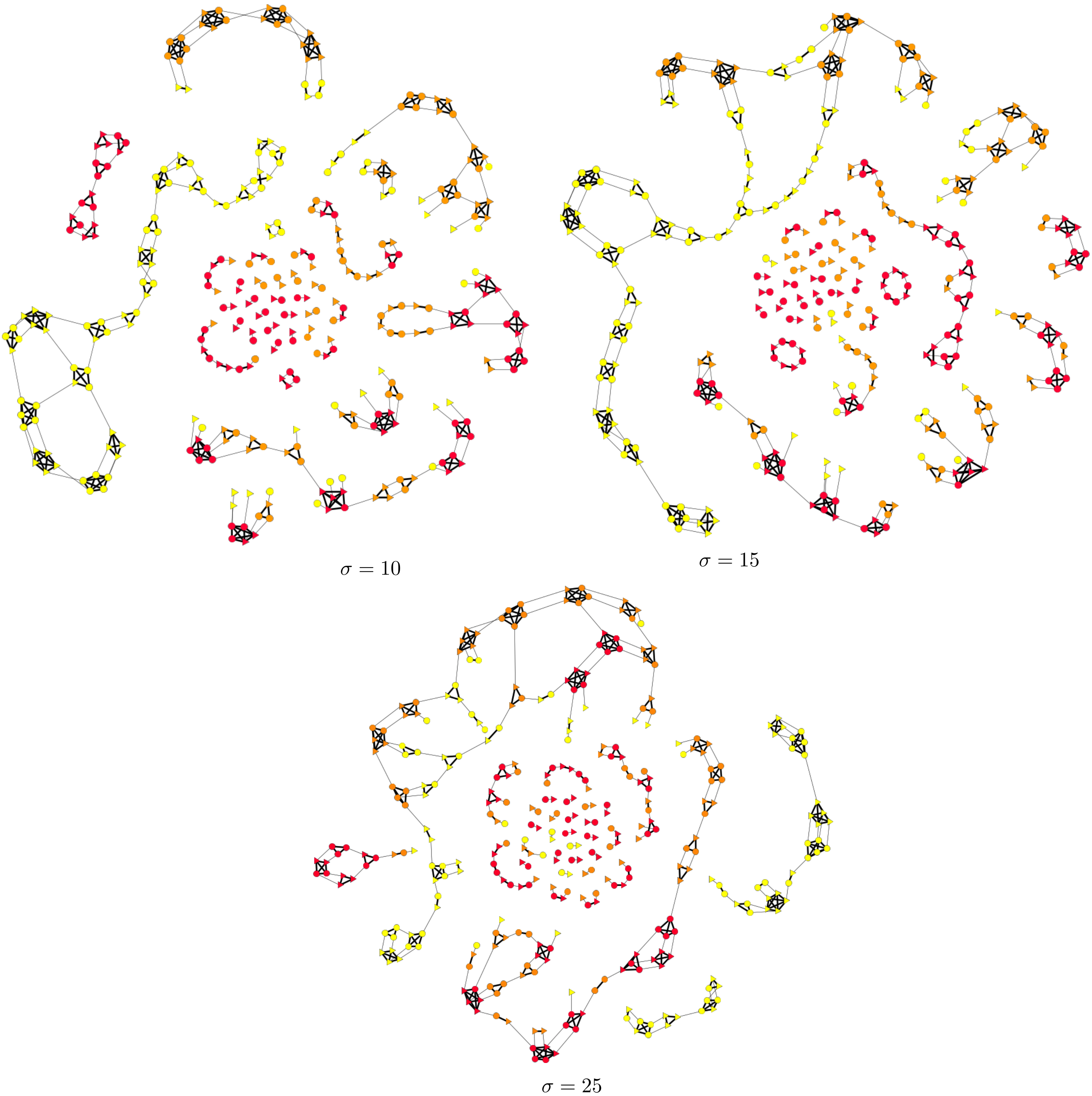


Figure 3.17 – Different within revenue dispersions

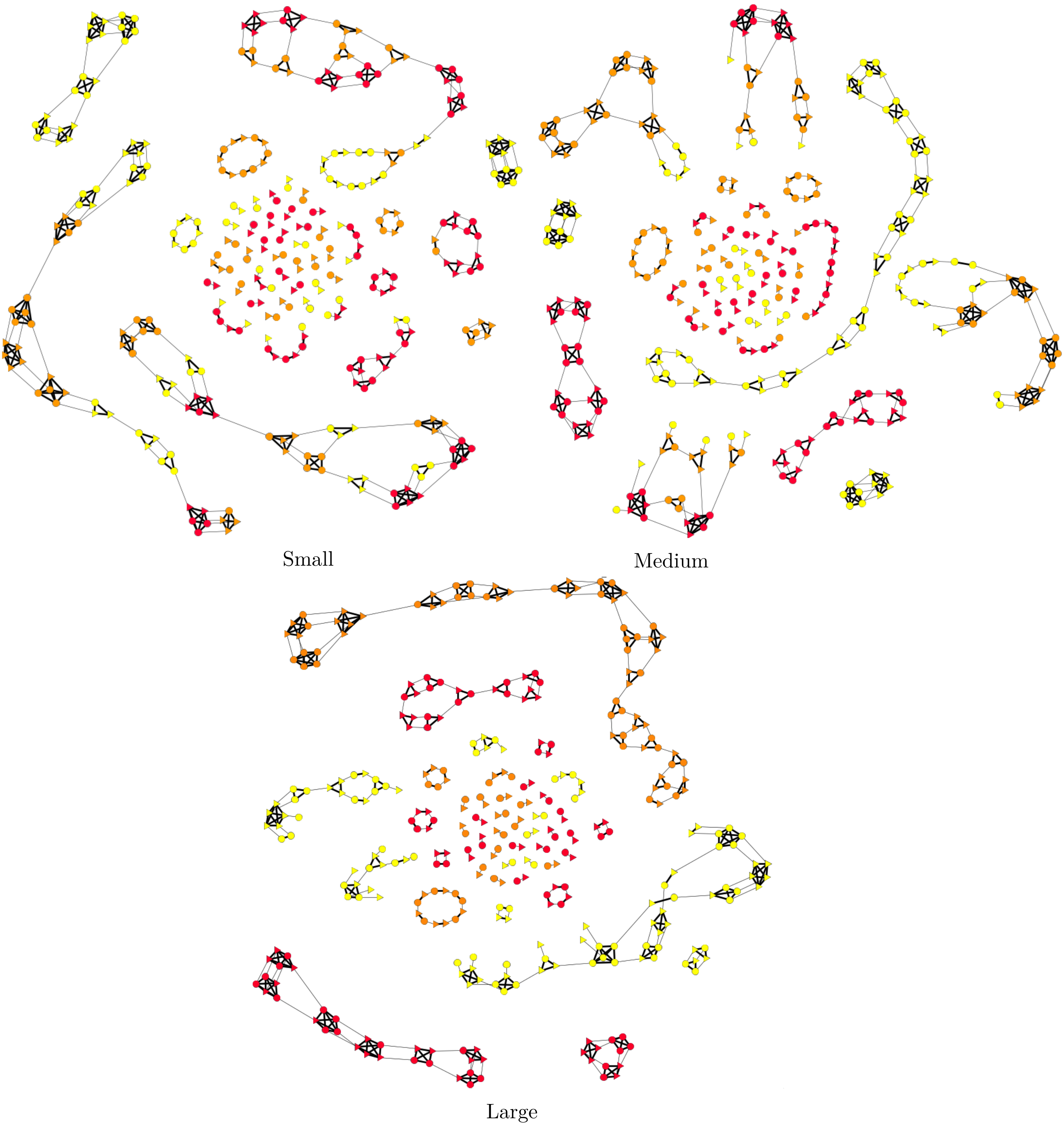


Figure 3.18 – Different between revenue dispersions

degree of within revenue dispersion is the same for the three income classes. We observe that the higher σ, the more connected the family network within and between income classes, as predicted by conditions (3.6) and (3.7). However, in this configuration, σ is not large enough to fully connect families inside an income class, as most single-child families remain segregated.

In Figure 3.18, the within revenue dispersion is the same for the three depicted family networks, but the degree of between revenue dispersion changes.[40] We observe that the smaller the degree of between dispersion, the stronger the connectivity of the family network. We also note that a smaller degree of between revenue dispersion generates components characterized by a greater social mix. In particular, in the family network characterized by a medium degree of between revenue dispersion, the component which is the more mixed links wealthy five-children families with poor single-child families. In contrast, in the family network characterized by a small degree of between revenue dispersion, the component which is the more mixed links wealthy five-children families with poor four-children families. In the family network characterized by a large degree of between revenue dispersion, the degree of between revenue dispersion is large enough to generate a family network segregated by income class.

I complement this analysis with numerical simulations. To study the impact of revenue dispersion within income classes, I have simulated 7 200 populations characterized by gender balance by family size and income class, with families of at most five children and three income classes. Revenue dispersion between income classes is set to 25%. Revenue dispersion within income classes varies from 0% to 14.2% of the center of the income class.[41] Above this threshold, income classes start overlapping. Assuming no differentiated investment costs on children, I have generated the associated 7 200 family networks. To study the impact of revenue dispersion between income classes, I have simulated 6 500 populations characterized by gender balance by family size and income class, with families of at most five children and three income classes and a revenue dispersion set at 14.3%. Revenue dispersion between income classes varies from

[40] For all family networks, $\sigma = 5$. On the top left, $y_r = 152$, $y_m = 126$ and $y_p = 100$. On the top right, $y_r = 152$, $y_m = 101$ and $y_p = 500$. At the bottom, $y_r = 152$, $y_m = 43$ and $y_p = 7$.

[41] To analyze simultaneously the impacts of increased revenue dispersion within income class for the three different income classes, I measure revenue dispersion within income class σ as follows: revenues of the income class y_k are drawn from the uniform distribution ranging from $[y_k(1 - \sigma/100); y_k(1 + \sigma/100)]$.

25.5%[42] to 90.5%.[43] Assuming no differentiated investment costs on children, I have generated the associated 6 500 family networks.

Figure 3.19 shows how revenue dispersion within income classes affects segregation pattern in equilibrium networks.

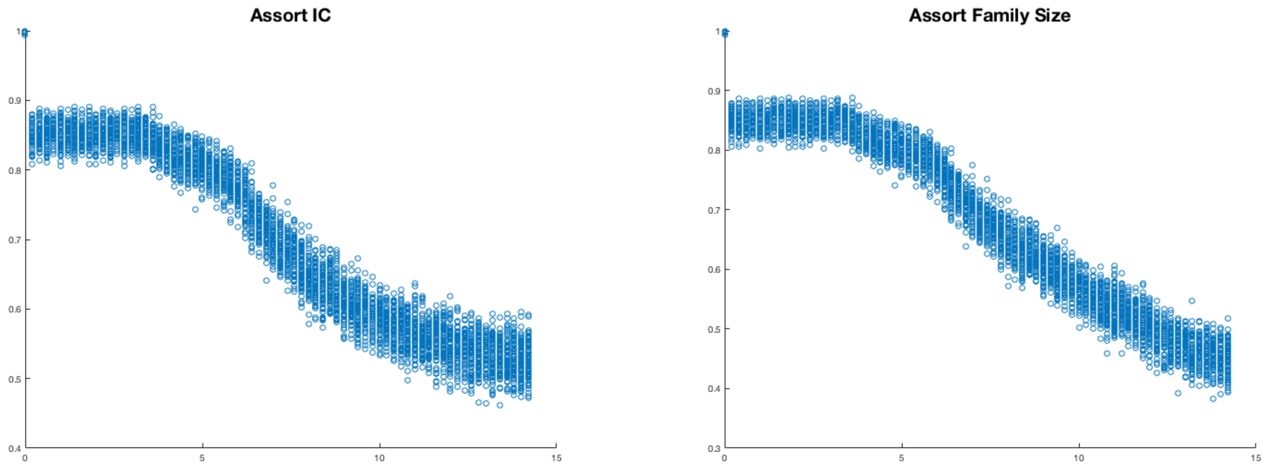


Figure 3.19 – Impact of Within Revenue Dispersion on Segregation Patterns

As predicted by Proposition 3.1, when there is no dispersion within income classes, the family networks are segregated by income class and family size: 100% of the links connect families of same size and income class. This proportion discontinuously drops when we introduce revenue dispersion: for a revenue dispersion of 0.2%, only 85.27% of the links on average connect families of the same income class; while 84.94% of the links connect families of the same size on average. These proportions keep decreasing as revenue dispersion within income classes increases, but not linearly: when the revenue dispersion varies from 0.2% to 4%, they remain quite constant, around 85% for income classes and 84.65% for family size, but then sharply decrease when revenue dispersion exceeds 4%. For values of the revenue dispersion between 4% and 14.2%, the proportion of links connecting families of the same income class decreases by 3.29 percentage points when revenue dispersion increases by 1 percentage point. When revenue dispersion reaches 14.2%, the proportion of links connecting families of same income class is on average equal to 52.62%. The effect of revenue dispersion is even larger for the proportion of links connecting families of same size: it decreases by 4.06 percent-

[42] Below this threshold, income classes overlap.

[43] Revenue dispersion between two successive income classes y_k and y_{k+1} is measured as follows: $y_{k+1} = y_k(1 - \sigma/100)$.

age points when revenue dispersion increases by 1 percentage point, from 4% to 14.2%. When revenue dispersion is equal to 14.2%, the proportion of links connecting families of different family size is equal to 44.83% on average. This stronger effect is due to the fact that families are now linked with families of different sizes not only from their own income class, but also from other income classes.

It is interesting to compare these results with the ones obtained on the impact of revenue dispersion between income classes on segregation patterns, illustrated in Figure 3.20

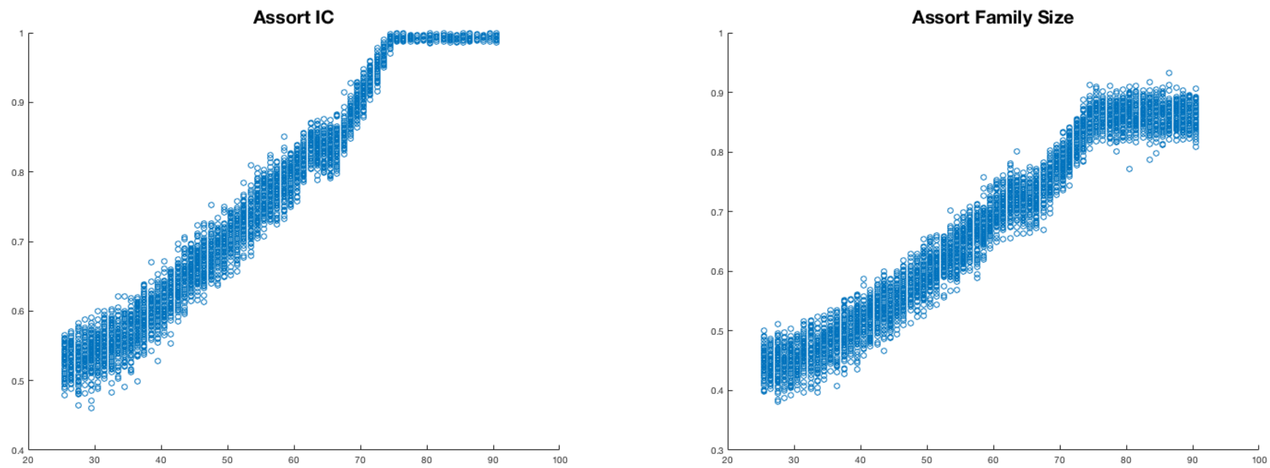


Figure 3.20 – Impact of Between Revenue Dispersion on Segregation Patterns

The two proportions steadily increase when revenue dispersion between income classes increases starting, on average, at 52.70% for income classes, and at 44.63% for family sizes. The proportion of links connecting families of same income class increases by 0.90 percentage point when between revenue dispersion increases by 1 percentage point, from 25.5% to 73.5%. Concerning the proportion of links connecting families of same size, it increases by 0.81 percentage point for each increase of between revenue dispersion of 1 percentage point between 25.5% to 73.5%. The lower impact on the proportion of links connecting families of different size comes from the fact that families from the same income class but of different sizes continue intermarrying. But as Figure 3.20 shows, when the revenue dispersion between income classes is small, most marriages linking families of different sizes are between families from different income classes. Then, when revenue dispersion between income classes is large enough, i.e. when even the child of the richest single-child family in an income class is poorer than the children of the poorest five-children family of the income class just above, the family network is segregated by income classes: for values of the between revenue dispersion larger than 73.5%, the proportion of links connecting families of same income class is on average equal to 99.18%. But there still remain some mixed marriages in terms of family size, due to the effect of the 14.2% within revenue dispersion: for values of the between revenue dispersion larger than 73.5%, the proportion of marriages connecting families of same size in on average equal to 85.97%, with a standard deviation of 1.94 percentage points.

Finally, I study the effects of within revenue dispersion and between revenue dispersion on the four characteristics of the equilibrium network structure introduced in Section 3.4. Figure 3.21 shows the results for the impact of revenue dispersion within income classes.

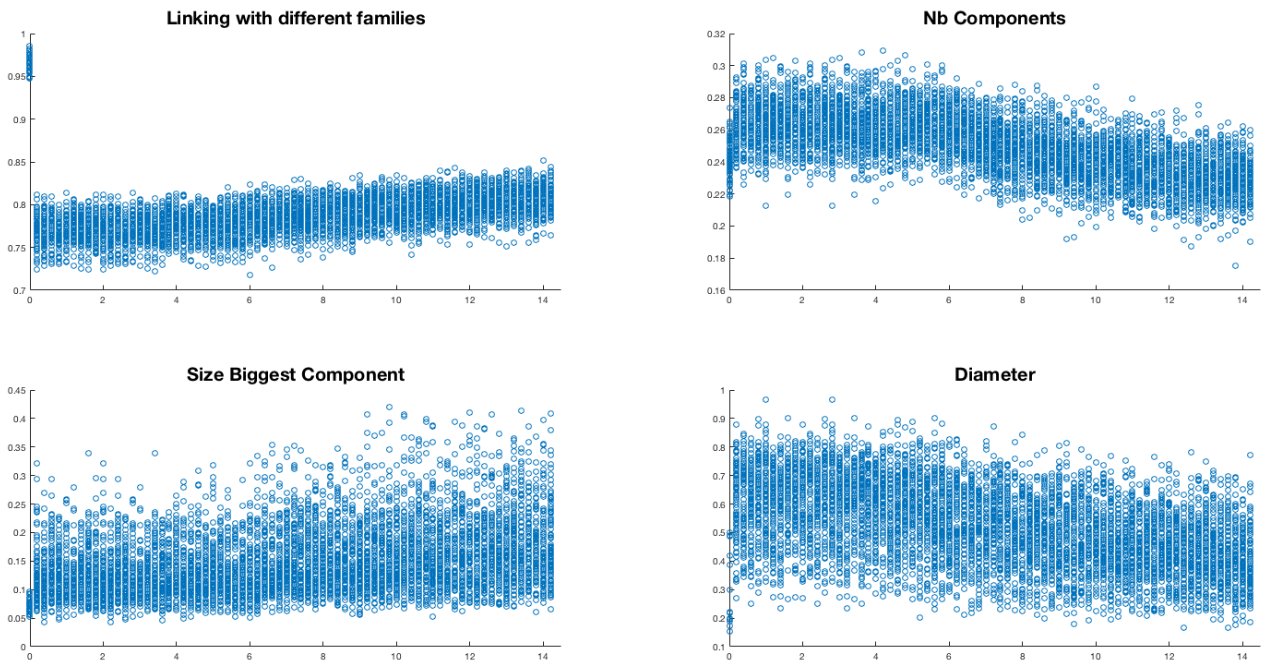


Figure 3.21 – Impact of Within Revenue Dispersion on the Network Structure

First, we notice the sharp discontinuous drop in the ratio of the number of pairs of connected families to the total number of links: dropping from an average of 0.97 when there is no revenue dispersion, to an average of 0.77 when revenue dispersion is equal to 0.2%. This illustrates the fact that families tend to marry more their children to spouses from a same family, rather than to spouses from different families when revenue dispersion within income classes is introduced. This is exactly the same phenomenon we observed in Figure 3.8. This effect contributes to lower the connectivity of the family network. But this phenomenon is countervailed by the other effects within revenue dispersion has on the network structure. The number of components first increases due to families tending to marry their children with spouses from the same families, but then steadily decreases when within revenue dispersion exceeds 5%. The effect on the size of the biggest component is less clear, but it seems that it can reach larger values when the within revenue dispersion is high. As for the diameter of the biggest component, although very dispersed, it decreases from 61.20% to 41.60% of the size of the biggest component when within dispersion increases from 0.2% to 14.2%. The high dispersion in the number of components, in the size of the biggest components and in the diameter observed in the figures is related to the presence of single-child families which can mechanically break connectivity in the network. Studying populations without single-child families would help overcome this effect.

Increasing revenue dispersion between income classes leads to opposite effects, as Figure 3.22 illustrates.

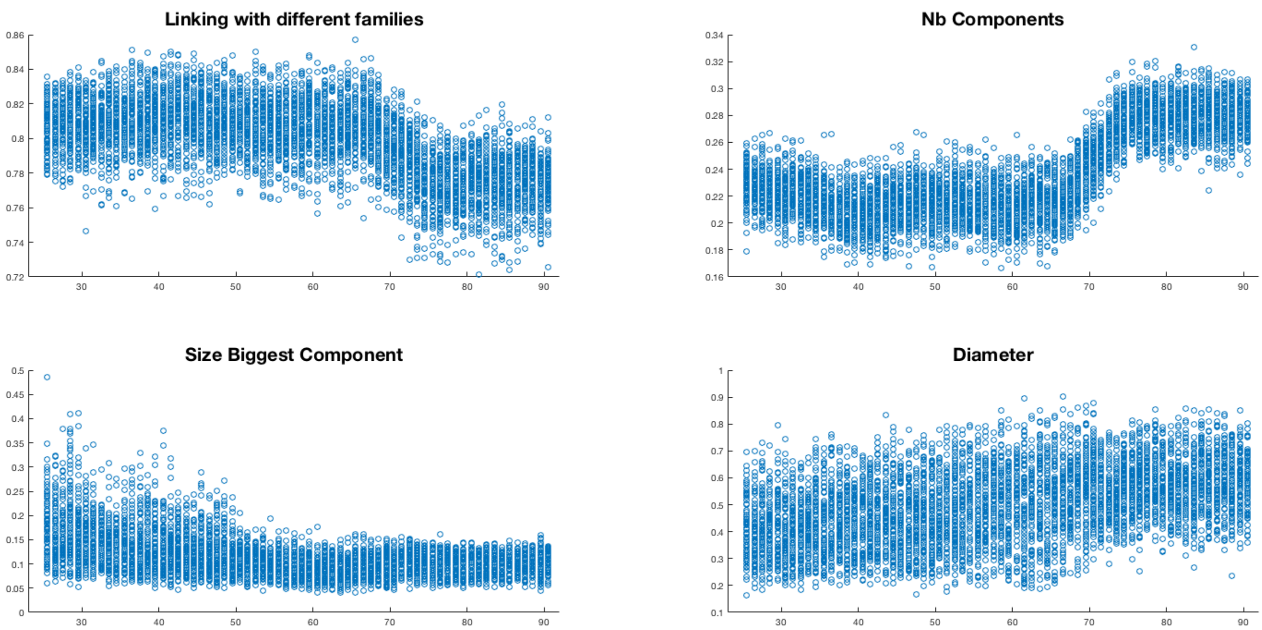


Figure 3.22 – Impact of Between Revenue Dispersion on the Network Structure

The number of components first remains approximately constant and then increases when revenue dispersion exceeds 65%. The size of the biggest component tends to decrease with increasing revenue dispersion, while the diameter of the biggest component increases from 41.23% of the size of the biggest component on average when between revenue dispersion is equal to 25.5%, to 59.04% on average when revenue dispersion reaches 90.2%. All of these effects decrease connectivity in the family network.

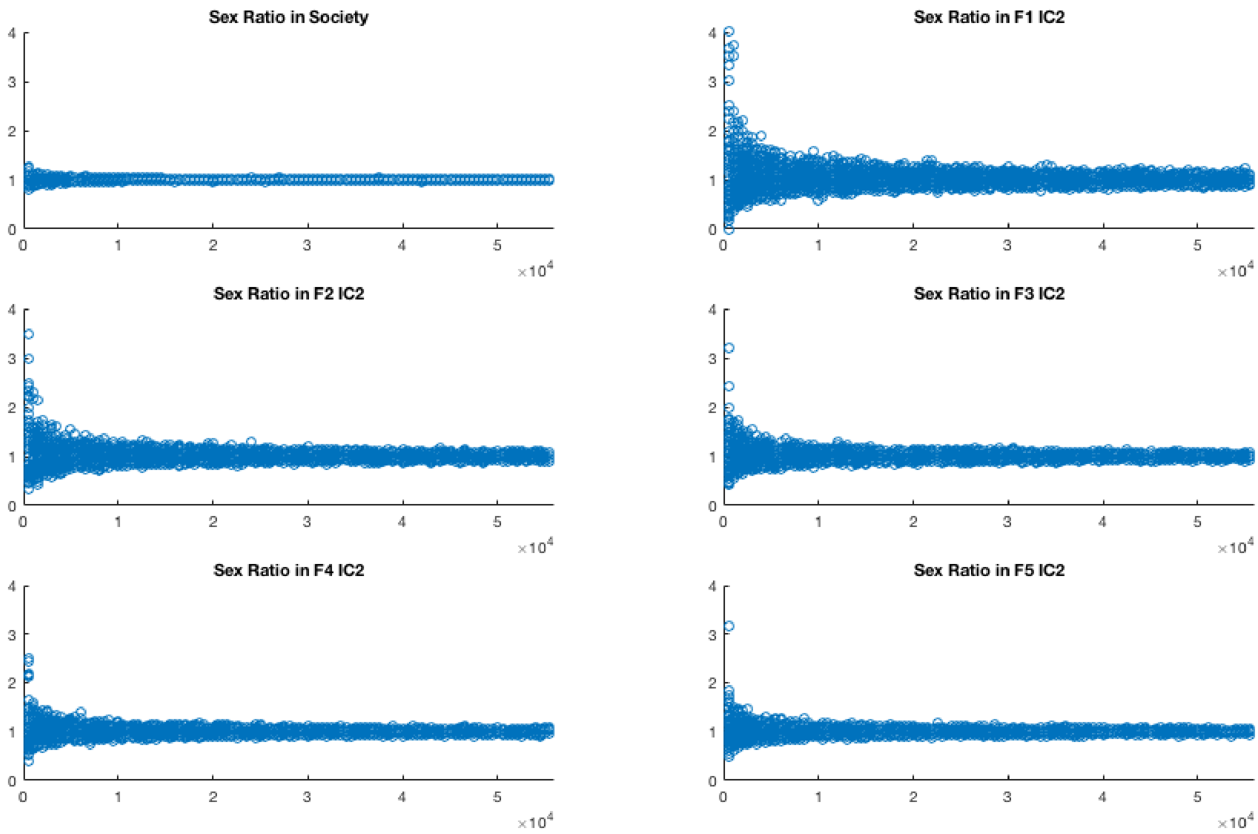
3.6 Conclusion

This paper seeks to explore the structure of the family network resulting from matching on the marriage market with families. I find that, under conditions with respect to the family partition and the distribution of revenues, we obtain not only positive assortative matching in terms of the revenue of families, but also in terms of their size. While different investment costs based on gender only do not affect the network's structure, social norms that generate differentiation between children according to birth order and the gender of their other siblings strongly increase the connectivity of the network. Thus it seems that the more complex the familial structures, the stronger the connectivity within the family network. Imbalance in the sex ratio and the degree of dispersion of revenues also impact the connections of families of different sizes within an income class, and across income classes.

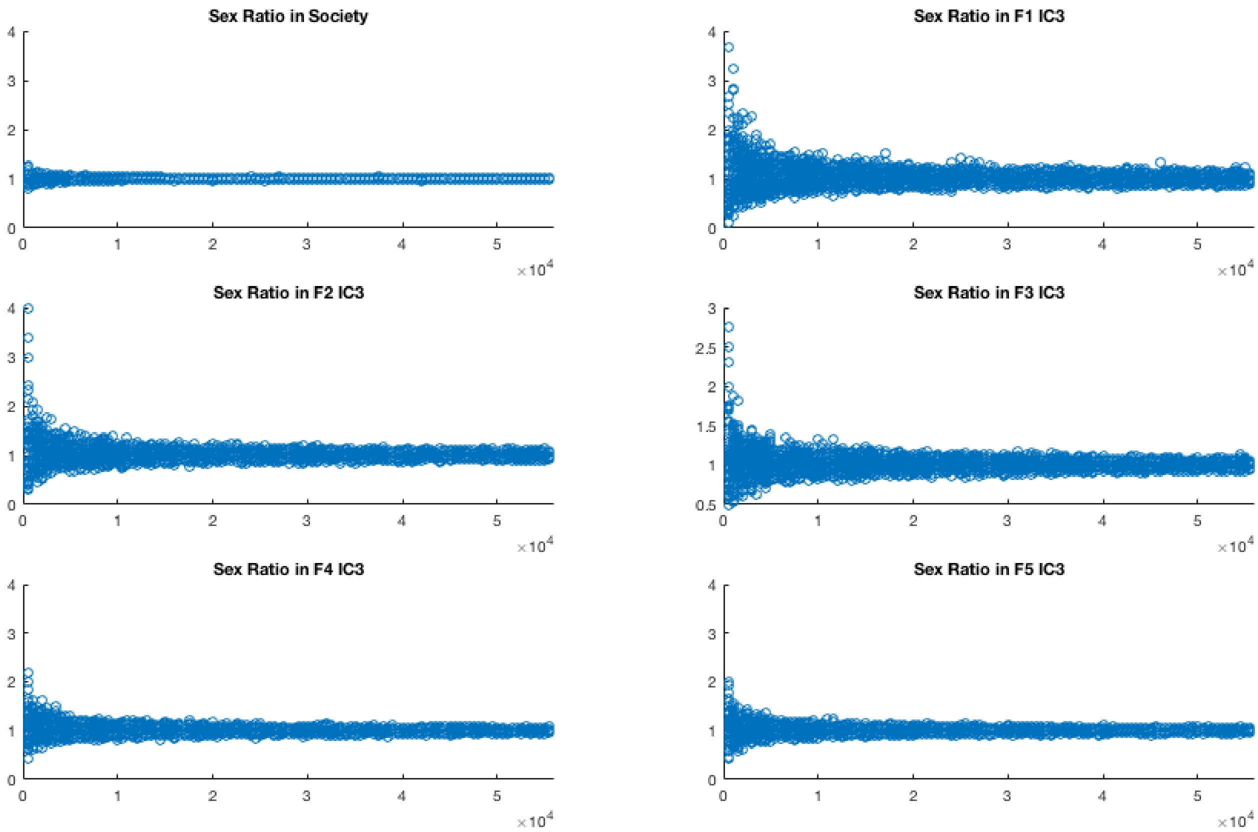
This opens paths for future research. First, introducing families in an actual premarital investment game would be an interesting and challenging road. Second, we could extend the analysis to a non-transferable utility framework and study differences with the transferable utility setting. Third, we could build a strategic model of network formation, in which families would internalize network benefits and take their matching decisions accordingly. Fourth, we could study family networks following from marriages in individualistic societies, and compare their structures with the ones following from arranged marriages. Lastly, applying the model to data on family marriages would be a natural and fascinating path for future research.

Appendix

3.A Sex ratio by income class and family size



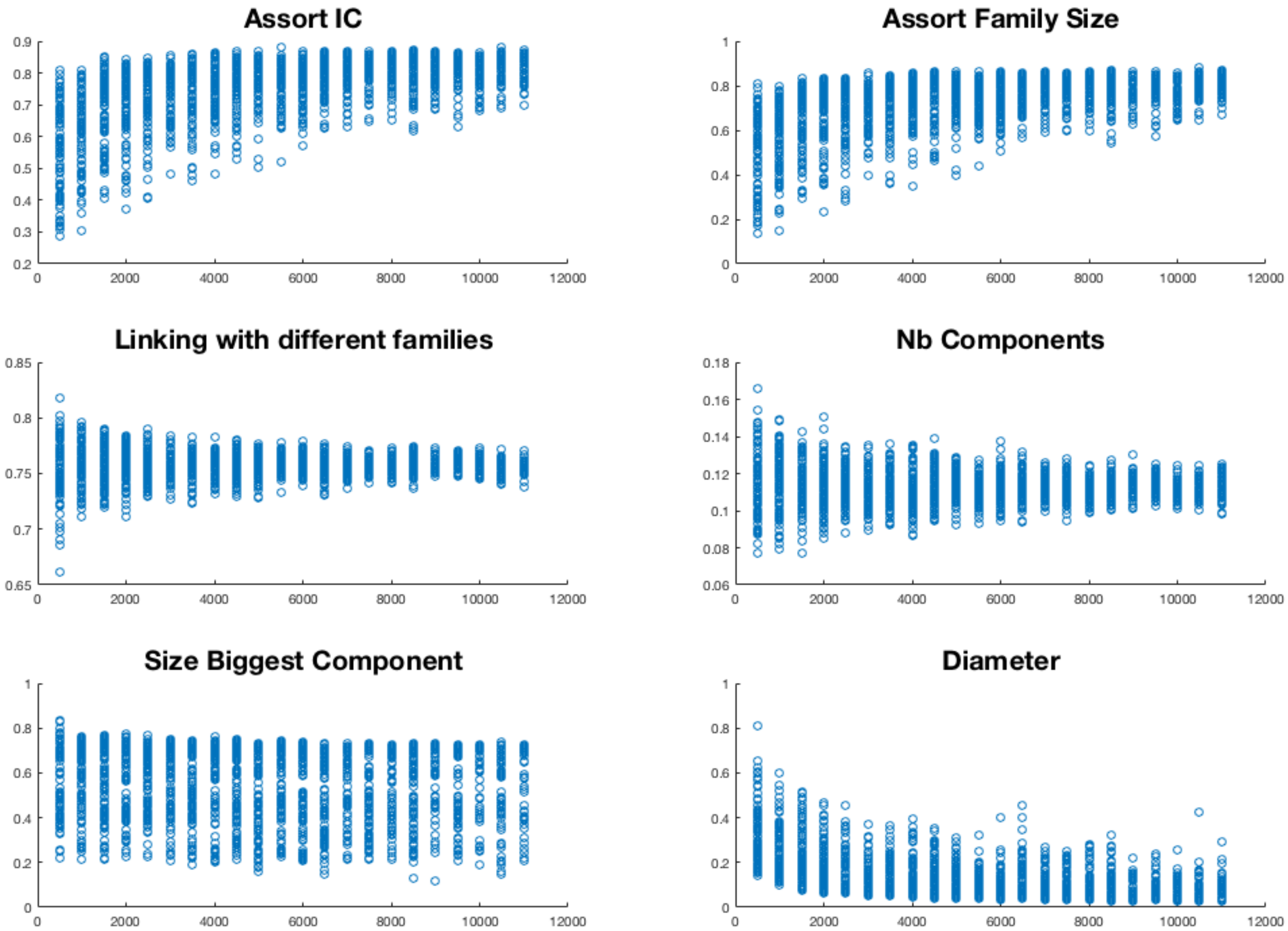
Sex Ratio by Family Size in Income Class 2



Sex Ratio by Family Size in Income Class 3

3.B Segregation patterns for large societies

I generated 2 200 family networks from populations ranging from 500 to 11 000 individuals to study how approximate gender balance by family size and income class in large societies affect segregation patterns. I consider families of at most 5 children in three income classes with no revenue dispersion. Investment costs are equal to 1 for all children.



Large Societies and Network Structure

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General Conclusion

Overall, this Ph.D. thesis studies how matrimonial decisions, taken in a given social structure, can shape the network of families interconnected through the marriages of their children. The structure of this family network impacts several economic, social and political outcomes which reach individuals, their families and the whole society in turn. From a theoretical perspective, this thesis provides the first study that adresses arranged marriages in a matching framework. For the first time, arbitrary families are explicitly introduced in a classical matching model applied to marriages. Moreover, this thesis provides the first analysis of the family network stemming from matching with families on the marriage market.

This Ph.D. thesis opens up several paths for future research.

Chapter 1 considers a framework in which the proportion of mixed marriages between the political elite and the rich ethnic minority is given. An interesting extension would be to endogenize the proportion of mixed marriages between the elite who own the political assets and the elite who owns the economic assets, in order to understand the evolution of the elite group. This extension would help explain why, in certain situations, the two elites fail to escape the "scapegoating trap" in which they remain segregated, while in other contexts, the two elites merge through mixed marriages.

Chapter 2 could be studied under the assumption of non-transferable utilities. In this framework, the preferences of the parents and the children could be misaligned, which would likely generate new situations under which family-stable matchings differ from individual-stable matchings. The setup presented in this chapter could also be studied in the framework of matching with contracts.

Chapter 3 could be extended in several directions. First, introducing families in an actual premarital investment game would be a challenging road. Second, we could build a strategic model of network formation, in which families would internalize network benefits and take their matrimonial decisions accordingly. Third, studying family networks following from marriages in individualistic societies, and comparing their structures with the ones following from arranged marriages would be a natural and interesting path. Lastly, applying the model to data on family marriages would be a fascinating road for future research.

Introduction Générale

Le fil directeur de cette thèse de doctorat est la structure sociale et son importance pour expliquer certains phénomènes économiques, sociaux et politiques. Tous les jours, les individus font des choix tout en étant encastrés dans une structure sociale donnée. Ces décisions peuvent à leur tour faire évoluer la structure sociale. Enfin, cette même structure sociale détermine les informations et les opportunités que reçoivent les individus, et qui sont à la base de leurs prises de décision. Ces sujets sont étudiés depuis la seconde moitié du $20^{ème}$ siècle par les anthropologues et les sociologues (POLANYI 1944, GRANOVETTER 1985, 2005) et plus récemment par les économistes, en particulier avec le développement de la littérature portant sur les réseaux économiques et sociaux (JACKSON 2010, BRAMOULLÉ et al. 2016, JACKSON et al. 2017).

Cette thèse aborde ces questions à travers l'étude de l'importance des choix matrimoniaux dans la formation de la structure sociale. Quand deux individus décident de se marier, ils créent non seulement un nouveau lien entre eux, mais également entre deux familles composées d'un certain nombre d'individus, eux-mêmes reliés par des relations maritales avec d'autres familles. Ce réseau de familles connectées entre elles par les mariages de leurs enfants est une trame sous-jacente essentielle de la structure sociale. Ainsi, à partir d'une structure sociale pré-existante composée de familles, les individus prennent des décisions matrimoniales, ce qui crée de nouvelles connexions entre familles, et fait donc évoluer la structure sociale. En retour, ce nouveau réseau familial entraîne des conséquences pour les individus et leurs familles. Par exemple, DE WEERDT et al. (2019) étudient un échantillon de 3 173 ménages faisant parti de 712 réseaux de famille étendue dans la région de Kagera en Tanzanie, et montrent que 59% des transfers privés au sein de ces ménages sont destinés aux membres de la famille étendue. Par ailleurs, aux États-Unis, GREENWOOD et al. (2014) trouvent que depuis une cinquantaine d'années, les individus ont de plus en plus tendance à choisir des conjoints ayant atteint le même niveau d'études. Ils montrent ensuite que ces choix matrimoniaux ont contribué à fortement augmenter les inégalités de revenus dans le pays. En répliquant les schémas matrimoniaux de 1960 avec les données de 2005 sur la distribution des revenus, ils trouvent ainsi que le coefficient de Gini baisse de 0.43 à 0.35.

Pourtant, il n'existe encore aucune recherche en sciences économiques étudiant spécifiquement la genèse et la structure du réseau familial. L'étude des choix matrimoniaux et de leurs impacts sur l'ensemble de la société a jusqu'à présent été réalisée à travers l'utilisation de modèles d'appariement, appelés modèles de matching, développés à partir des travaux fondateurs de BECKER (1973, 1981). Or dans leur forme classique, les modèles de matching appliqués aux mariages (BROWNING et al. 2014, CHIAPPORI 2017) ne permettent pas d'analyser la structure du réseau familial induit par les décisions matrimoniales. Cela est du au fait que cette approche modélise un marché du mariage scindé en deux, avec d'un côté des hommes et de l'autre des femmes, dénués de toute structure familiale pré-existante. Ainsi, quand deux individus se marient, cela n'engage qu'eux-mêmes. A l'équilibre, les modèles classiques de matching génèrent donc un réseau simple, constitué de couples d'individus déconnectés les uns des autres. En revanche, si l'on rétablit le fait que chaque individu fait parti d'une famille nucléaire, composée potentiellement de plusieurs frères et sœurs, les modèles de matching ainsi étendus génèrent des réseaux complexes de familles reliées entre elles par les mariages de leurs enfants.

Cette dimension familiale est particulièrement importante dans les sociétés où les mariages sont arrangés, c'est-à-dire où ce sont les parents qui choisissent les conjoints de leurs enfants. Cette pratique matrimoniale est dominante dans les pays d'Asie, d'Afrique et du Moyen Orient (HAMON et INGOLDSBY 2003). Par exemple, une enquête menée dans le sud de l'Inde auprès de 5 000 ménages en 2016 révèle que pour 86% personnes interrogées, le mariage avait été arrangé (BORDER et al. 2017). Comparativement aux sociétés où les individus sont libres de choisir leurs conjoints, les sociétés où les mariages sont arrangés possèdent de strictes normes sociales informelles sur les mariages, qui contraignent et façonnent la structure du réseau familial. En Afrique du Nord et de l'Ouest, au Moyen-Orient et en Asie du Sud, les mariages entre cousins sont toujours largement pratiqués (DO et al. 2013, HOTTE et MARAZYAN 2018). En Inde, les enfants doivent être mariés au sein de leur caste, ce qui génère un réseau familial ségrégué selon la caste (BORDER et al. 2017). MARCASSA et al. (2018) expliquent que les normes sur les dots, plus strictes en Allemagne qu'en Angleterre sous l'Ancien Régime, ont contribué a rendre la structure sociale de la noblesse allemande plus stratifiée que celle de la noblesse anglaise. Ainsi, quand les familles arrangent les mariages de leurs enfants, elles doivent non seulement prendre en compte leur composition familiale, mais aussi les normes sociales prévalent dans la société. Dans certaines populations, en particulier chez les élites, les parents tiennent également compte du positionnement que la famille aura dans le réseau familial une fois les mariages arrangés. Celui-ci dépendra des choix de conjoints qu'ils feront pour leurs enfants. Ainsi, prennent-ils leurs décisions matrimoniales de manière stratégique au réseau formé. JACKSON (2010) évoque l'exemple du réseau matrimonial chez les élites à Florence sous la Renaissance. En s'appuyant sur les données de PADGETT et ANSELL (1993), il suggère que la position centrale de la famille Medici dans ce réseau matrimonial lui a permis de dominer l'oligarchie florentine. Qu'elles soient anticipées ou non, la structure du réseau familial entraîne à son tour des conséquences économiques, sociales et politiques, aussi bien au sein de chaque famille que pour la société dans son ensemble. Si le réseau est bien connecté, l'information, les opportunités et les normes sociales peuvent facilement circuler. En revanche, JACKSON et al. (2017) expliquent p.51 que si le réseau est suffisamment ségrégué, différents comportements, normes ou attentes peuvent persister dans différentes communautés, ce qui à son tour a des conséquences sur les choix d'investissement en capital humain, de carrière et bien d'autres comportements.

Ainsi, le sujet de cette thèse est cet aller-retour permanent entre structure sociale et décisions individuelles, étudié à travers trois articles de recherche théoriques. Le premier chapitre analyse les conséquences économiques, sociales et politiques de la structure matrimoniale, dans un cadre appliqué. Le deuxième chapitre explore comment la structure et la composition familiale modifient les schémas matrimoniaux quand les familles arrangent les mariages de leurs enfants. Le troisième chapitre étudie la structure du réseau des familles issu des mariages arrangés. D'un point de vue théorique, cette thèse propose une extension des modèles de matching pour étudier les mariages arrangés. Jusqu'à présent, ces considérations familiales n'ont jamais été prises en compte dans les modèles de matching appliqués au mariage. Elle introduit explicitement pour la première fois des familles arbitraires dans l'*assignement game* de SHAPLEY et SHUBIK (1971) et étudie le jeu où les joueurs sont les familles et non plus les individus. Elle propose également une nouvelle connexion entre la littérature du matching et celle de la formation de réseaux sociaux. Il s'agit en particulier de la première étude de la structure du réseau familial généré par un modèle de matching appliqué aux mariages arrangés.

Le Chapitre 1 est une analyse d'économie politique appliquée aux pays en développement dans lesquels l'élite politique est issue du groupe ethnique majoritaire, tandis que l'économie est dominée par une minorité ethnique d'origine étrangère. C'est par exemple le cas de la minorité chinoise dans les pays d'Asie du Sud-Est, de la minorité indienne dans les pays d'Afrique de l'Est, et de la minorité libanaise dans les pays d'Afrique de l'Ouest. Régulièrement, ces minorités ethniques riches subissent des actes de violence de la part de la population, parfois alimentés par les élites politiques locales, qui pourtant bénéficient financièrement de leur présence (BIERWIRTH 1999, CHUA 2004, ADAM 2010, BEZEMER et JONG-A-PIN 2013). L'objectif de ce chapitre est d'explorer l'impact de la structure du réseau matrimonial des élites politique et économique sur l'allocation des ressources, l'utilisation stratégique de la minorité ethnique comme bouc-émissaire et l'émergence de la violence dans ces pays. Pour cela, nous étendons le cadre d'analyse développé par ACEMOGLU et ROBINSON (2006) dans lequel une élite politique captatrice de rentes interagit avec le peuple, en introduisant une élite économique composée d'une minorité ethnique. Nous étudions d'abord le cas où les deux élites sont parfaitement ségréguées du fait de normes endogames strictes. Nous montrons alors que la présence d'une minorité ethnique riche modifie les interactions entre l'élite politique et le peuple. Quand le risque de violence populaire envers l'élite politique est élevé du fait d'instabilité politique ou de crise économique, le gouvernement change stratégiquement ses politiques économiques afin de dévier le ressentiment du peuple sur la minorité ethnique riche. Nous disons alors que le gouvernement met en place une stratégie d'instrumentalisation de la minorité ethnique comme bouc émissaire. En revanche, quand une certaine proportion de mariages mixtes lient les deux élites, alors le gouvernement peut apporter une protection altruiste à la minorité, et réduit significativement son recours à la stratégie du bouc émissaire. Dans l'ensemble, la perspective de violence diminue. Ce chapitre montre que la structure du réseau matrimonial des élites, selon qu'elle soit strictement endogame ou mixte, modifie fortement les politiques économiques du gouvernement, son attitude par rapport à la minorité ethnique riche et l'émergence de la violence dans la société.

Le Chapitre 2 étudie l'impact de la prise de décision au niveau familial et de la structure familiale sur les schémas de mariages dans les sociétés où les mariages sont arrangés. C'est la première étude qui introduit des familles complexes dans le modèle de matching classique appliqué aux mariages pour étudier les mariages arrangés (SHAPLEY et SHUBIK 1971, BECKER 1973, BROWNING et al. 2014, CHIAPPORI 2017). Il définit un nouveau concept de stabilité familiale, qui étend naturellement celui de stabilité individuelle ou *pairwise stability*. Dans les modèles classiques, un matching est stable s'il n'existe pas deux individus qui ont intérêt à couper leurs mariages respectifs pour se marier ensemble. Dans notre extension, un matching est stable pour les familles s'il n'existe pas deux familles qui ont intérêt à réarranger les mariages de certains de leurs enfants entre elles. Sous l'hypothèse que les utilités sont transférables entre époux et au sein des familles, ce chapitre montre que les matchings stables pour les individus sont toujours stables pour les familles. En revanche, il existe des matchings qui sont stables pour les familles mais qui ne le sont pas pour les individus. Cela implique que les mariages arrangés génèrent potentiellement de fortes tensions au sein des familles. L'introduction de familles sur le marché du mariage génère des problèmes de coordination qui peuvent modifier à la fois l'appariement des époux et la manière dont le surplus marital est partagé entre eux. Le modèle prédit ainsi qu'il existe un plus grand nombre de configurations stables quand les mariages sont arrangés par les parents plutôt que choisis par les individus. Mais, contrairement aux matchings stables pour les individus, les matchings stables pour les familles peuvent être inefficaces. L'étude montre également que les caractéristiques des matchings stables dépendent de la structure familiale. Quand la structure familiale présente une forte hétérogénéité en termes de tailles et de répartition des genres, il est plus probable d'observer des matchings inefficaces. Par ailleurs, plus la compétition est forte, c'est-à-dire plus le nombre de familles est élevé pour un nombre donné d'enfants dans la population, plus l'ensemble des répartitions des surplus maritaux soutenant le matching efficace comme stable pour les familles est petit. En particulier, quand chaque famille est composée d'un fils et d'une fille, les concepts de stabilité familiale et de stabilité individuelle sont équivalents.

Le Chapitre 3 analyse la structure du réseau familial issu des mariages arrangés, ainsi que ses déterminants. Il constitue la première étude des caractéristiques d'un réseau généré par un modèle de matching. Comme dans le Chapitre 2, ce chapitre propose un modèle de matching appliqué au mariage dans lequel des familles arbitraires sont introduites. Mais à la différence du Chapitre 2, dans le Chapitre 3 les parents allouent dans un premier temps un investissement prémarital à leurs enfants avant d'arranger leurs mariages. L'investissement reçu par un enfant détermine sa qualité sur le marché du mariage. Ce chapitre propose un modèle simple pour générer une règle d'investissement prémarital micro-fondée. Ainsi, l'investissement optimal reçu par un enfant dépend positivement du revenu de sa famille et négativement du nombre de ses frères et soeurs. Il dépend également des normes sociales informelles régulant la société. Ce chapitre explore ensuite les conditions suffisantes sur la démographie, les normes sociales et la dispersion des revenus pour obtenir un réseau familial parfaitement ségrégué selon la taille de la famille et la classe de revenu. Les forces qui brisent cette ségrégation sont ensuite étudiées. Si les normes sociales qui différencient les enfants selon le genre ne modifient pas la structure du réseau, celles qui les différencient selon l'ordre de naissance et la composition de leur fratrie accroissent la connectivité. Un déséquilibre dans le sexe-ratio, même très faible, permet également de connecter le réseau, et la nature de cette connexion dépend du genre le moins fréquent. Quand les filles sont plus nombreuses que les garçons, le réseau familial est connecté verticalement par des mariages hypogamiques, c'est-à-dire des mariages où la famille de l'époux est plus pauvre que la famille de l'épouse. Quand les garçons sont plus nombreux que les filles, les connexions sont hypergamiques. Enfin, le degré de dispersion des revenus affecte également la connectivité du réseau. Plus la dispersion est élevée au sein des classes de revenus, plus le réseau familial présente de la mixité sociale : la proportion de liens maritaux entre familles de tailles différentes et de classes de revenus différentes augmente. Par ailleurs, il semble que la structure du réseau soit plus connectée : le nombre de composants diminue, la taille du plus gros composant augmente, et le diamètre du plus gros composant diminue. En revanche, plus la dispersion est élevée entre les classes de revenus, plus il est probable d'observer un réseau parfaitement ségrégué par classe de revenus. La structure de ce réseau familial peut à son tour avoir des effets économiques, sociaux et politiques, sur les individus, leurs familles et donc l'ensemble de la société, comme le montre le Chapitre 1.

Résumé

Cette thèse de doctorat met en avant l'importance de la structure sociale pour comprendre certains faits économiques, sociaux et politiques. Le premier chapitre est une analyse d'économie politique explorant l'impact de la structure sociale des élites sur l'allocation des ressources, l'utilisation stratégique de bouc-émissaires et la violence dans les pays en développement. Il étend le cadre d'analyse développé par Acemoglu et Robinson (2006) en faisant une distinction entre une élite politique et une élite économique composée d'une minorité ethnique riche. Il propose d'abord un modèle de référence dans lequel ces deux élites sont ségréguées du fait de normes endogames. Il montre que la présence d'une minorité ethnique riche modifie les interactions entre l'élite politique captatrice et la majorité pauvre sous la menace de violence. Quand cette menace est élevée, le gouvernement peut changer stratégiquement ses politiques afin d'exposer la minorité au ressentiment populaire. En revanche, quand des mariages mixtes lient les deux élites, le gouvernement peut protéger la minorité de la violence populaire et réduire son recours à l'instrumentalisation de bouc-émissaires.

Le deuxième chapitre étudie l'impact de la prise de décision au niveau familial et de la structure familiale sur les schémas de mariages dans les sociétés où les mariages sont arrangés. Il introduit des familles complexes dans le modèle de matching appliqué aux mariages à la Becker-Shapley-Shubik (1971, 1973) et définit un nouveau concept de stabilité familiale. L'introduction de familles dans le marché du mariage génère des problèmes de coordination qui peuvent modifier à la fois l'appariement des époux et la manière dont le surplus marital est partagé entre eux. Le modèle prédit qu'on devrait observer un plus grand nombre de situations stables quand les mariages sont arrangés par les parents plutôt que choisis par les individus. Mais, contrairement aux matchings stables pour les individus, les matchings stables pour les familles peuvent être inefficaces. L'étude montre aussi que les matchings stables dépendent du type de partition familiale. En particulier, quand chaque famille est composée d'un fils et d'une fille, les concepts de stabilité familiale et de stabilité individuelle sont équivalents.

Le troisième chapitre analyse la structure du réseau des familles issu des mariages arrangés, ainsi que ses déterminants. Quand les parents arrangent le mariage de leurs enfants avec des époux de différentes familles, cela crée des connexions maritales entre les familles. Cette étude considère un modèle de matching dans lequel les parents allouent d'abord un investissement prémarital à leurs enfants, puis arrangent leurs mariages. Dans ce cadre, la structure de réseau la plus ségréguée est caractérisée par de l'homogamie selon le revenu et la taille de la famille. Mais il y a des forces qui brisent cette ségrégation. Si les normes sociales qui différencient les enfants selon le genre ne modifient pas la structure du réseau, celles qui les différencient selon l'ordre de naissance et la composition de leur fratrie accroissent sa connectivité. Un déséquilibre dans le sexe-ratio permet également de connecter le réseau, et la nature de cette connexion dépend du genre le moins fréquent. Enfin, le degré de dispersion des revenus affecte également la connectivité du réseau. La structure de ce réseau peut à son tour avoir des effets économiques, sociaux et politiques (Chapitre 1).

Abstract

This Ph.D. thesis emphasizes the importance of social structure to understand some economic, social and political outcomes. The first chapter is a political economy piece exploring the impact of the social structure of the elite on resource allocation, scapegoating strategies and violence in developing countries. It extends the framework of Acemoglu and Robinson (2006) by distinguishing between a political elite and an economic elite composed of a rich ethnic minority. It first offers a benchmark where these two elites are segregated due to endogamy. It shows that the presence of a rich ethnic minority changes the interactions between the rent-seeking political elite and the poor majority under the threat of violence. When this threat is high, the government may change its policies strategically to sacrifice the minority to popular resentment. In contrast, when some mixed marriages connect the two elites, the government may altruistically protect the minority from popular violence and reduce its use of instrumental scapegoating.

The second chapter studies how familial decision-making and familial structure impact marriage patterns in societies where arranged marriages are a dominant form of matchmaking. It introduces complex families in the Becker-Shapley-Shubik (1971,1973) matching model on marriages and defines a new concept of familial stability. The introduction of families into the marriage market generates coordination problems which can affect both the assignment and how the marital surplus is shared-out between spouses. The model predicts that we should observe a larger number of stable outcomes when marriages are arranged by parents rather than chosen by individuals. However, unlike individual-stable matchings, family-stable matchings may be inefficient. The study also shows that stable matchings depend on the type of family partitioning. Notably, when each family contains one son and one daughter, familial and individual stability are equivalent.

The third chapter analyzes the structure of the family network resulting from arranged marriages, and its determinants. When parents arrange the marriages of their children with spouses from different families, this creates marital connections between families. The study considers a matching model in which parents first allocate a premarital investment to their children and then arrange their marriages. In this setting, the most segregated network structure is characterized by positive assortative matching with respect to family revenue and family size. But there are forces that overcome segregation. Differentiated social norms relating to gender only do not change the network structure, but those differentiating between children according to birth order or the gender of their siblings increase its connectivity. Imbalance in the sex ratio also helps connect the network, and the nature of the connection depends on which gender is scarce. Finally, the degree of revenue dispersion also impacts network connectivity. The structure of this network can in turn impact economic, social and political outcomes (Chapter 1).