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Network Externalities in Developing Economies

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Contents

Abstract

This thesis contains three essays on microeconometrics, networks and economic development. In the first two essays I focus on developing country settings (Tanzania and Nepal respectively) to study how rural villagers form their social networks, and how the existence of these informal links impacts their welfare. The third essay focuses on the international trade of arms to investigate whether the political orientation of government in power makes any difference to arms export policy. In particular:

Chapter 1
This chapter takes a network perspective to investigate how rural households form the links through which they provide and/or get economic support, and whether the connection structure of the community affects the formation of these links. I test the hypothesis that indirect contacts matter, that is, agents take into account not only potential partners' characteristics, but also their position with respect to all other agents. A network formation framework with fully heterogeneous agents is first presented, following Jackson and Wolinsky (1996), an estimation procedure is then proposed and applied to data on a village in rural Tanzania. Results show that when agents evaluate the net advantage of forming a link they also consider the relative position and the wealth of indirect partners. This chapter contributes to both network theory and the literature on risk sharing arrangements in that it proposes an innovative procedure to estimate endogenous network formation models, and provides evidence that network structure has an explanatory value disregarded by all previous studies, which are focused on direct relations only.

Chapter 2
This chapter studies how individuals exchange information with peers and how this information circulates and spreads through informal channels, focusing on the role of the community as a bridge for information flows. I concentrate on three rural villages in Nepal where an educational radio program about family planning and modern contraception methods is broadcasted. Women can access the information in different ways: they can personally listen to the radio program, they can speak with friends who listen to the radio program, or they can receive indirect in-

formation reported from third sources such as friends of their friends. I explicitly take into account the structure of the community network to show that also the information reported from third sources is a determinant of the women's adoption of modern contraception methods. I then address the issue of link formation and rule out the potential endogeneity of network, reconfirming that indirect exposure matters and personal links are an effective bridge for information flows.

Chapter 3

Since all through the XXth century arms have been not only tradable goods, but also foreign policy instruments, this chapter focuses on countries supplying major conventional weapons, and investigates whether the political orientation of government in power makes any difference to arms export policy. In particular, I concentrate on democratic exporters to check how the government's political orientation: right-wing or left-wing has an impact on the quantity of arms supplied to third countries. For this purpose, a bilateral trade equation is estimated for years 1975-2004 applying a panel TOBIT framework. Results suggest that the exporter's chief executive being right-wing has a positive and significant impact on major conventional weapons´ exports. This may reflect a general right-wing tendency to lower trade barriers, with its consequences on the deregularization of heavy industry exports, or a higher economic support toward the armament sector as a relevant part of national industry.

Chapter 1

The Network Structure of Informal Arrangements: Evidence from Rural Tanzania

1.1 Introduction

As social capital theorists have stated long ago[1] and economists have realized relatively recently, a person's network of contacts constitutes a crucial resource. This is especially the case for rural communities in developing countries where all outcomes, from weddings to money lending, are determined by informal, multi-purpose interactions (Fafchamps and Lund, 2003; Hoddinott, Dercon and Krishnan, 2005). Whenever formal economic and financial institutions lack strength, people in need are forced to rely on family, friends and associates; therefore interpersonal links also assume an economic value. The most famous example of mutual support is that of risk sharing arrangements: when households have no access to credit, either because no institutions provide it or because they cannot meet the collateral required to enter a formal transaction, private arrangements are used to stabilize consumption. Risk sharing arrangements usually take the form of gifts or credits at zero interest rate, which are used to finance primary needs in face of idiosyncratic shocks as health-related expenses, funerals and court trials. However several other forms of network-based mutual support such as work parties, sharecropping and oxen sharing have been documented (Hoddinott, Dercon and Krishnan, 2005; Krishnan and Sciubba, 2005). In all these circumstances, as Fafchamps and Gubert (2005) also point out, people do not form links specifically for the economic outcome, but the informal arrangements originate from pre-existing interpersonal relationships[2]. Accordingly, this chapter focuses on the in-

[1] See Coleman (1988) and Wilson (1987).

[2] The same perspective is adopted from a purely theoretical point of view by Bramoullé and Kranton (2005): in their model individuals first set bilateral relations and then use these relations to share income

terpersonal links that are the basis of all mutual support arrangements, rather than on the specific outcomes that may originate from them. I investigate how rural villagers in developing countries form the links through which they provide and/or get economic support, and whether the connection structure of the community affects the formation of these links. Specifically, the question to be answered is: do agents choose their partners on the base of their personal characteristics only, or also for their social position with respect to all other agents in the community? That is, do indirect contacts matter in the formation of links?

Villages are the most common economic and social structure throughout the entire developing world. Two-thirds of Sub-Saharan Africans live in rural areas, and their economic and social life is determined within the borders of their village. Villages are typically composed by a small number of households whose income is primarily derived from agriculture; within the village there are no spatial barriers and information flows are smooth. Since most villages are located far form each other or in areas where transport is difficult, relations among individuals in the same village are frequent and complex, while relations with the exterior world are rare or inexistent. All these features, together with the lack of formal economic and financial institutions and the massive presence of mutual support arrangements, make villages the ideal setting to study endogenous network formation. I base my analysis on data from a village called Nyakatoke, in the Buboka Rural District of Tanzania at the west of Lake Victoria, where the entire community (as opposed to the usual random sample of respondents) has been interviewed. In the Nyakatoke Households Survey all adult individuals were asked*"Can you give a list of people from inside or outside of Nyakatoke, who you can personally rely on for help and/or that can rely on you for help in cash, kind or labor?"*; I use this piece of information to define whether a link between two individuals exists and to trace the complete network architecture of the village. I then propose and implement a theory-based procedure to estimate whether indirect contacts matter in the process of link formation.

From the seminal research done by Jackson and Wolinsky (1996) and onwards, network theory, based on game theoretical reasoning, claims that not only direct contacts, but also the entire graph of indirect contacts is relevant for the formation or severance of links. However the flourishing economic literature on informal arrangements seems to disregard the role of the community structure. Several empirical studies on risk sharing identify which variables predict the existence of a link (Fafchamps and Lund, 2003; De Weerdt, 2004; Dekker, 2004; Udry and Conley, 2004), but none of them acknowledges that also indirect contacts may be a determinant of link formation. This chapter fills the hole between these two approaches: I use data on the village of Nyakatoke to show that not only the characteristics of direct friends, but also the characteristics of indirect contacts are taken into account

after income shocks are realized; the network is given by the pattern of existing relations where agents commit to share income, rather than by the transfers themselves.

when a link is created. In fact a new link also provides access to the larger network of partner's friends, and friends of these friends. My results suggest that the relative position and the wealth of indirect contacts do matter, that is, two potential partners with the same personal characteristics but with different endowments of friends are not worth the same.

I first proceed from theory, setting up a framework consistent with the model by Jackson and Wolinsky (1996). In the model, agents form links among themselves, and links provide benefits and involve costs. Links are created by mutual agreement and individual utility depends on the complete network structure. My framework differs from the majority of previous models in that it incorporates heterogeneity along both cost and benefit dimensions. Benefits from links increase in the wealth of potential partners and depend on the entire network structure, while costs of links are determined by the social distance between partners. From this theoretical benchmark I derive testable predictions about the importance of indirect contacts that I bring to data. Decomposing individual wealth in land and livestock, not surprisingly I find that agents are more willing to form links if partners are wealthier in terms of land and/or livestock. For what concerns indirect contacts, data suggests that externalities from indirect land are negative, while externalities from indirect livestock are positive. In other words, Nyakatoke villagers prefer partners who are well endowed with land themselves and have fewer additional contacts with other landowners, which suggests a competition mechanism. On the other hand, for livestock a positive externality prevails: good partners are well endowed in livestock and bring other indirect contacts that are also rich in terms of livestock. My results therefore show that when agents form links they also attribute importance to wealth and relative position of all other individuals. This suggests that network structure has its own importance disregarded by all previous studies, which are focused on direct relations only. I also argue that whenever indirect contacts are not taken into account the estimates of direct partners' characteristics are biased, and what determines the direction of the bias is precisely the sign of the externalities generated by indirect contacts.

This chapter contributes to both network theory and literature on risk sharing and other informal arrangements. First, it proposes an innovative procedure to estimate endogenous network formation models. The second major contribution is that it highlights the importance of indirect contacts, which is crucial for the full understanding of the forces behind the creation of links. None of the previous empirical studies explicitly recognizes a role for network architecture itself, with the only exception of Krishnan and Sciubba (2005). However, while they theoretically derive the properties of equilibrium networks and then test whether observed networks have these properties, I take a different approach, doing a structural analysis of the network formation model which, to the best of my knowledge, is entirely innovative. In fact all previous studies on applied networks take players' relative

position as given, and assess its role as determinants of the social outcome (Calvò-Armengol, Patacchini and Zenou, 2005; Conley and Topa, 2002; Conley and Udry, 2000), while I estimate the parameters of individuals' utility function consistent with a stable network. From a policy point of view, the major lesson of this chapter is that when agents choose the links they want to form they look not only at potential partners' income, but also at their social characteristics, that is, their social connections (friends, and friends of these friends). As Dasgupta (2003) points out, informal networks have effects that spill over to all areas of economic activity, and precisely for this reason it is crucial to understand the forces driving network formation. Understanding informal institutions is necessary to design policy interventions at the micro level and, without good knowledge of the unwritten rules driving informal ties, the design of social protection policies would simply result as inappropriate.

The chapter is organized as follows. Section 1.2 contains a review of the relevant literature. In Section 1.3 and 1.4 the theoretical framework and the data are respectively presented. Section 1.5 explains the estimation procedure, while section 1.6 presents empirical specifications and results. Section 1.7 proposes an interpretation of the major results, while Section 1.8 concludes summarizing the main findings. Tables and figures are presented in the Appendix A at the end of the chapter.

1.2 Literature Review

The economic literature on informal arrangements is prevalently empirical and focused on risk sharing[3]. Since in village economies insurance takes place not at the community level but among smaller groups[4] (Ravallion and Chau- duri, 1997; Udry, 1994; Fafchamps and Lund, 2003), several studies have tried to define the appropriate group for risk sharing and to shed light on the mechanisms through which these groups are created. These studies agree in pointing out kinship, friendship and neighborhood as the main determinants of risk sharing arrangements. Fafchamps and Lund (2003) investigate how households deal with shocks in rural Philippines concluding that, due to imperfect commitment and information asymmetry among villagers, mutual insurance does not take place at the village level, but in smaller groups of friends and relatives. De Weerdt (2004)

[3] Among the few theoretical contributions on risk-sharing Bloch, Genicot and Ray (2004) characterize the properties of stable insurance schemes for exogenously given network structures, and Genicot and Ray (2003) study the effect of allowing subgroup deviation in risk sharing arrangements.

[4] As Mace (1991) has pointed out, when there is no private information or liquidity constraints the optimal insurance scheme would be full income pooling. However this is not observed in reality. Different explanations for this failure have been proposed: Ligon (1998) using data from rural India concludes that information asymmetry is the main obstacle to full risk sharing, while other authors apply the theory of limited commitment to justify incomplete insurance schemes observed in reality (Coate and Ravallion, 1993; Ligon, Thomas and Worrall, 2000).

finds that the main variables predicting informal arrangements in Tanzania are kinship, distance, religion and common friends. On the same line, Dekker (2004) studies network formation in rural Zimbabwe to identify the types of social relation that are important to establish informal insurance ties. His contribution is mainly methodological in that he makes use of a dyadic model taking into account the dependence among observations[5]. A few contributions also explicitly focus on the impact of ethnicity: Grimard (1997) finds evidence of a partial consumption smoothing through ethnic lines, and Fafchamps (2003) investigates the role of ethnicity and networks in African domestic trade, finding no evidence of ethnic discriminations in agricultural markets. Along similar lines there are the descriptive assessments by Hoddinott, Dercon and Krishnan (2005), Rosenzweig (1988), and Udry and Conley (2004). Taking a slightly different perspective Goldstein, De Janvry and Sadoulet (2002) use data on Ghana to identify the characteristics of people who are more likely to fall outside mutual insurance networks and be excluded from credit.

None of these contributions explicitly recognize a role for network structure, with the only exception of Krishnan and Sciubba (2005) whose approach is by far the closest to the one I propose. They offer a bridge between the theoretical literature on endogenous network formation and the empirical work on informal arrangements, stressing the importance of both number of link and network architecture in determining the social outcome. Krishnan and Sciubba (2005) analyse labor exchange arrangements for harvesting and weeding in 15 Ethiopian villages. They modify the co-author model by Jackson and Wolinsky (1996) allowing for heterogeneity among agents: in their setting, farmers differ in productivity and decide with whom they want to form a link; *ceteris paribus*, a better-endowed farmer is more appealing for labor sharing but, on the other side, he has lower incentive to labor share. Externalities from indirect contacts are negative because a higher number of partners dilute the effort a farmer can exert in each partnership. All decentralized decisions determine the structure of equilibrium networks; since the model admits multiple equilibria, Krishnan and Sciubba identify the common features shared by any stable network architecture and then check whether labor sharing arrangements observed in rural Ethiopia are compatible with the model's predictions. My approach is analogous, with some important differences: I impose a less restrictive structure of externalities, and allow for heterogeneity both with respect to costs and benefits. And, most importantly, Krishnan and Sciubba (2005) test whether the theoretical features of stable equilibria are consistent with empirical evidence, while I start from the observation of the equilibrium network to estimate the underlining parameters of the model.

In this chapter I make an extensive use of the literature on endogenous network formation that has been flourishing in the last decade (Jackson, 2003; Jack-

[5]This is the so-called $p2$ model proposed by Duijn, Snijders and Zijlstra (2004).

son, 2005). Models of strategic network formation have originated primarily from two sources: the random graph literature by physicists[6] and the economic literature aimed to organize the empirical evidence on networks in a game theoretical framework. Some economists have approached network formation from a non-cooperative point of view (Bala and Goyal, 2000; Galeotti and Goyal, 2002). However, the majority of research papers focus on stable networks, where links are formed at the discretion of self-interested agents whose utility is given by the overall network structure. The analysis of equilibrium networks is based on both cooperative and non-cooperative considerations, and highlights the tensions between private incentives and overall efficiency. The reference model by Jackson and Wolinsky (1996) will be discussed in depth in Section 1.3.

1.3 The Theory

This section illustrates network games' basic notations, reviews the relevant passages of Jackson and Wolinsky (1996) and presents the model to be estimated.

Let $N = \{1, ..., n\}$ be a set of players connected in some network relationship. Links are the consequence of agreement between parts. A link is established and/or maintained only if there is joint consent. The network g describes which pairs of players are linked to each other: g is a list of unordered pairs of players $\{ij\}, i, j \in N; \{ij\} \in g$ indicates that players i and j are linked under the network g. For any network g, $g + ij$ defines the network obtained by adding link ij to g and, analogously, $g - ij$ defines the network obtained by deleting link ij. $N(g)$ is the set of players with at least one link in the network g. Finally, the network g^N is the set of all subsets of N of size 2, usually defined as the complete network, consequently, $G = \{g^N\}$ denotes the set of all possible networks on N.

A typical feature of network games is that the total utility generated, and the way it is allocated among players, depends on the network structure. The utility of each player not only depends on actions undertaken by his direct partners, but also on actions undertaken by all other agents. This is summarized by the value function and the allocation rule. Different network shapes generate different levels of utility, even if the set of players stays the same: the *value function* is a function $v : \{g \,|g^N\} \to R$ expressing the overall level of utility reached by the group of players for each network structure. The value function can be used to define the efficiency benchmark. A network $g \subset g^N$ is *strongly efficient* if $v(g) \geq v(g')$ for all $g' \subset g^N$. On the other hand, the so-called allocation rule defines how this overall value is divided among players. That is, if we define $Y_i(g, v)$ as the payoff player i gets from graph g under the value function V, an *allocation rule* is a function $Y : G \times V \to R^N$ such that $\sum_i Y_i(g, v) = v(g)$ for all g and v. In all that follows

[6] See Vega-Redondo (2007) and Jackson and Rogers (2006). For a direct approach to physicist literature I remand to Guimera' et al. (2003) and Boguna' et al. (2004).

the allocation rule is simply the utility that players directly receive, accounting for both costs and benefits generated by the links they form, which is the natural allocation, ruling out posterior arrangements and side payments.

In order to identify which networks are likely to arise in various contexts, a notion of network stability has to be imposed. The pairwise stability by Jackson and Wolinsky (1996) states that the formation of a link requires the consent of both parties involved, while severance can be done unilaterally; formally, a network g is *pairwise stable (PWS)* if

(i) For all $ij \in g$, $Y_i(g,v) \geq Y_i(g-ij,v)$ and $Y_j(g,v) \geq Y_j(g-ij,v)$
(ii) For all $ij \notin g$, if $Y_i(g,v) < Y_i(g+ij,v)$, then $Y_j(g,v) > Y_j(g+ij,v)$

That is, a network is pairwise stable if, given the overall network structure, links which are profitable for both parties are actually formed, and each player does not benefit in severing any existent link. Pairwise stability does not depend on the process through which the network is formed. Moreover, it is a relatively weak concept since it only admits deviations on a single link at a time. Pairwise stability frequently admits large sets of stable allocations, which may result in the impossibility of drawing policy recommendations. Several refinements to restrict the set of stable equilibria have been proposed: for instance, group deviations (instead of pairwise deviations only) may be allowed as in Jackson and Van Den Nouweland (2005); alternatively, side payments between agents may also be implicitly allowed as in Jackson and Wolinsky (1996); however, for the purpose of this chapter the pairwise stability concept will be adopted.

The connection model and the co-author model are two concrete network examples presented in Jackson and Wolinsky (1996). In the connection model, agents decide whether to form links, which represent social relationships. Relationships provide benefits but also involve costs. Players incur a cost for every link they form; on the other hand, they benefit not only from direct (and therefore costly) relationships, but also from indirect ones, which are for free. Benefits from indirect relationships deteriorate with distance: a friend is more valuable than a friend of a friend, which is more valuable than a friend of a friend of a friend and so on. Jackson and Wolinsky (1996) focus on a simplified, symmetric version of their general setting, assuming that every link has the same cost $c_{ij} = c$ and provides the same benefit normalized to 1. The payoff that player i receives from network g thus becomes

$$u_i(g) = \sum_{j \in N(g)} \delta^{t_{ij}} - \sum_{j:ij \in g} c_{ij} \tag{1.1}$$

with a depreciation rate $0 < \delta < 1$. t_{ij} is called the *geodesic distance* between i and j and is the number of links in the shortest path between i and j (setting $t_{ij} = \infty$ if there is no path between i and j). Thus, player i pays a cost c for direct connections only, but he also benefits from all indirect ones, in a way that is proportional to the proximity of these indirect partners. The value function is simply the sum of individual utilities $v(g) = \sum_{i \in N} U_i(g)$, and the allocation rule assigns to every player his own utility. As their main result, Jackson and Wolinsky (1996) illustrate the relationship between the sets of networks that are efficient and those that are stable, showing that these two sets do not generally coincide and decentralized decisions do not necessarily lead to an allocation that maximizes collective utility[7]. An analogous case is the one depicted by the co-author model, with the important difference that here indirect connections provide negative externalities. Agents are interpreted as researchers who spend time writing papers and collaborate in common project, where the outcome of the collaboration depends on the number of links partners are involved into. Since the amount of time a researcher can spend on any given project is inversely proportional to the number of projects he is involved in, in the co-author model the individual utility still depends on the full network structure, but this time indirect connections are detrimental.

In my setting I allow for a flexible structure of externalities and introduce full heterogeneity among agents, which results in differentiating benefits *and* costs. A similar setting has been analysed by Galeotti and Goyal (2002) from a non-cooperative perspective, however pairwise stable networks with such general features have not been theoretically explored yet.

In a community of $N = \{1, ..., n\}$ agents each agent $i \in N$ is endowed with an income y_i and with a vector z_i of social characteristics (religion, ethnicity, blood links, schooling, professional activity etc.). Income of both direct and indirect partners generates externalities, indirect connections are for free and become less valuable the more distant they are. The cost of linking is assumed to be increasing in the perceived social distance, which is based on the partners' social characteristics. In fact relationships between people with analogous profiles are relatively easier to form and maintain, and arrangements between partners with the same socio-cultural background have smaller enforcement and monitoring costs[8]. My objects of study are the unique pairs of agents called dyads with cardinality $l = \begin{pmatrix} n \\ 2 \end{pmatrix}$. Using the information in z let us define a social attributes matrix $Z_{m \times l}$, where m^+ are the attributes identifying the relative social position of each dyad. Finally, for s^+ let $Y_{s \times n}$ summarize each agent's wealth y_i. Individual utility function from net-

[7] In particular, for high and low costs efficient networks coincide with pairwise stable ones, while for the intermediate cases this may not be true.

[8] Karlan (2001) applies a similar argument to microfinance group-lending programs in the Andes, and concludes that more homogeneous groups have higher repayment rates due to their higher social capital and ease of monitoring.

work g is therefore defined by

$$u_i(g) = y_i + \sum_{j \in N(g)} \delta(t_{ij}) \alpha y_j + \sum_{j:ij \in g} \beta Z_{ij} \tag{1.2}$$

where:
$\delta : Z^+ \rightarrow R$ s.t. $\delta(.) \geq 0$, $\delta'(.) < 0$
t_{ij} is the geodesic distance between i and j
$\alpha \in R^s$ and $\beta \in R^m$

In this formulation, agents' utility depends on the overall network structure, and externalities from indirect contacts can be positive or negative in sign. I then proceed to empirics, and propose an estimation procedure to test whether in mutual arrangements an individual's utility is affected by indirect contacts, as theory would suggest.

1.4 The Data

Data come from the Nyakatoke Household Survey. Nyakatoke is a small Haya[9] village in the Buboka Rural District of Tanzania, at the west of Lake Victoria. The community is composed by 600 inhabitants, 307 of which are adults, for a total of 119 households. Inhabitants have been interviewed in five regular intervals from February to December 2000. First all household heads, and a few days later, all adults were interviewed;[10] this has produced a rich dataset containing information on households' demographics (composition, age, religion, education), wealth and assets (land and livestock ownership, quality of housing and durable goods), income sources and income shocks, transfers and network relations. Even if some piece of information was collected at the individual level, the 7021 household dyads are taken as units of analysis.

Informal relationships are a crucial resource for Nyakatoke households, as they self-report risk sharing via transfers to be the most important coping strategy to deal with idiosyncratic shocks like sickness, death, crime and court cases, and ceremonies (Dercon and De Weerdt, 2006). During the survey all adult households' members were asked *"Can you give a list of people from inside or outside of Nyakatoke, who you can personally rely on for help and/or that can rely on you for help in cash, kind or labor?"*; this piece of information is used to define whether a link exists and to trace the village architecture. These links are reciprocal by definition, since people are

[9] One of the largest tribes at the west of Lake Victoria.

[10] In order to eliminate possible sources of bias, gender sensitive issues were implemented by enumerators of the same sex as respondents.

asked to mention somebody they can rely on *and/or* that can rely on them. Also, informal links are bilateral by their own nature since they rely on agreements among parties involved, and economic help is expected to be reciprocated at some point in the future. I thus assume links to be unweighted and undirected, and every time an individual mentions another one I draft a link between the two households they belong to[11]. With this procedure 490 links among the 119 households are identified. The resulting network is dense, with a mean geodesic distance of 2.5 steps and a maximum geodesic distance of 5 steps. No household is isolated, and the number of households' reported links ranges from 1 to 32. The network exhibits all the empirical regularities of large social networks (*small world properties*) that have been described in the empirical literature.[12] For a graphical representation of the Nyakatoke network see Appendix A, Figure 1.A.

Nyakatoke's village area is small, with an average distance between households of 523 meters and a maximum distance of 1738 meters. The village is relatively poor, since the consumption for adult equivalent unit is less than 2 US $ a week and average food share in consumption is about 77% (Dercon and De Weerdt, 2006). Households in Nyakatoke get most of their income from agricultural activities, especially the cultivation of coffee and banana; other sources of income are rare and off-farming activities are mostly considered supplementary to farming (Mitti and Rweyemamu, 2001). The village has no primary school (the closest one is at 2 km) and overall educational level is low, with 26 households out of 119 where no member has completed primary education.

Social interactions in Nyakatoke are frequent and complex, and the social life of the community is organized around kin groups, clans and religious associations. Previous evidence suggests that blood relations are a primal resource for village households, and this seems also to be the case in Nyakatoke, where for any wealth level households keep about 30 % of their links within their kin net (see Appendix A, Table 10.A). Adopting a broad definition of kinship[13], the average-

[11]For the sake of completeness the estimations in Section 1.4 have also been repeated under the stricter definition of a link: a link exists only if both households explicitly mention each other. Results are consistent in sign and magnitude but not always in significance, which is not surprising given the exiguous number of links (140 instead of 490).

[12]The typical features of large socially-generated networks are the following: a) The number of nodes is very large as compared to the average number of links; b) The network has an unique component or a main component covering a large share of the population; c) There are more nodes with a really low or a really high number of connections than in a network where links are formed uniformly at random; d) The number of links of connected partners tends to be positively correlated; e) The average distance between nodes is small and the maximum distance (*diameter*) is in the order of $ln(n)$, (which is precisely our case since $ln(119) = 4.77$); f) The clustering coefficient, which measures the tendency of linked nodes to have common neighbors, is larger in social networks with respect to the case where links are generated by an independent random process (for Nyakatoke the clustering coefficient is 0.23, where in an analogous randomly generated network it would be 0.03). For further details on small world properties see Jackson and Rogers (2006).

[13]Two households belong to the same kin group whenever a member of one household has a blood

size kin group in Nyakatoke counts 6.4 households. All households nowadays follow modern religions, and are either Muslim, Lutheran or Catholic[14]. Religion is a characterizing attribute in Nyakatoke also because the three main formal religious associations play an active role in the social and economic life of the village, providing help for funerals and giving support to the church or mosque in cash, kind or labor (De Weerdt, 2002). Finally, In Nyakatoke there are 26 different clans, with a variable number of households from 1 to 23. Clan belonging is another influent social tie because, as De Weerdt (2004) acknowledges, *"(. . .) the clan is still an important institution in Haya culture, for example in matters regarding land rights. The clan elders can, in effect, function as a court of law. They could easily reprimand younger clan mates when they think their behavior is bad for the clan. Everybody wants to avoid falling out with their clan"*.

It is also worth mentioning that Nyakatoke hosts more than 20 *formal* insurance groups, mostly aimed to help participants in the event of a funeral, which in Haya society is an important lump-sum expense. However, these groups follow a relatively rigid protocol in terms of acceptance, membership and contributions; therefore they cannot be compared with informal insurance arrangements and are out of the focus of analysis.

Descriptive statistics about the village are reported in the Appendix A (Table 1.A to 4.A). A detailed description of how variables have been specified in the empirical analysis will come with Section 1.6. For additional information on Nyakatoke I remand to Mitti and Rweyemamu (2001) and De Weerdt (2002).

1.5 Estimation Procedure

For each pair of agents[15] ij, the dependent binary variable x_{ij} equals one if they are linked. Recalling the linear individual utility function

$$u_i(g) = y_i + \sum_{j \in N(g)} \delta(t_{ij}) \alpha y_j + \sum_{j:ij \in g} \beta Z_{ij} + \epsilon_i \tag{1.3}$$

bond of the kind "cousin, grandparent or grandchildren" or stricter with a member of the other household.

[14]The first settlement in Nyakatoke dates around 1910: at that time most households were still adherents to traditional Bahaya religions. With time, however, the entire village was converted to modern religions. Presently the area north of the stream is predominantly Catholic; most of the Lutherans are in the south and Muslims southwest of the village. This distribution is likely to result from mutual influence between neighbors, which may in principle lead to endogeneity. However, this seems not to be a problem, because conversion to modern religions was dated much before the surveyed individuals were born, and because if we omit religious variables from the analysis all major findings stay consistent (results available upon request).

[15]Whenever agents are mentioned it should be interpreted as households, since households are the unit of analysis.

For an observed network g, α´s and β´s have to be estimated under the constraint of pairwise stability, that is, imposing

$$\begin{aligned} \forall ij \in g, u_i(g) \geq u_i(g-ij) \ \ \& \ \ u_j(g) \geq u_j(g-ij) \\ \forall ij \notin g, u_i(g) < u_i(g+ij) \Rightarrow u_j(g) > u_j(g+ij) \end{aligned} \tag{1.4}$$

Under pairwise stability no subgroup deviations or multiple simultaneous deviations are allowed, and each agent considers whether to form/sever only one link at a time. Links are formed and maintained only if both agents involved agree. In order to decide whether the link ij is profitable each agent takes the equilibrium network g as given, and he only compares his utility under the two different scenarios when link ij is formed or not. That is, under pairwise stability agent i evaluates his utility from link ij taking the structure of g as exogenous, including all other links he is involved in (ik and ki, $k \neq j$) and all other links player j is involved in (jk and kj, $k \neq i$). This *ceteris paribus* condition dramatically simplifies the estimation, since it rules out endogeneity. Therefore, for every dyad ij the model reduces to a discrete choice form

$$P(x_{ij} = 1) = P\left(u_i(g) \geq u_i(g-ij) \ \& \ u_j(g) \geq u_j(g-ij)\right) \tag{1.5}$$

Where for each ij the regressors are calculated on the equilibrium network g when only the link ij varies. The utility of agent i under the two scenarios is given by

$$u_{i_{ij}} = \underbrace{y_i + \sum_{k \in N(g_{ij})} \delta(t_{ik}) \alpha y_k + \sum_{k:ik \in g_{ij}} \beta Z_{ik}}_{\equiv Z_{i_{ij}}} + \epsilon_{i_{ij}} \tag{1.6}$$

$$\bar{u}_{i_{ij}} = \underbrace{y_i + \sum_{k \in N(g_{\bar{ij}})} \delta(t_{ik}) \alpha y_k + \sum_{k:ik \in g_{\bar{ij}}} \beta Z_{ik}}_{\equiv \bar{Z}_{i_{ij}}} + \bar{\epsilon}_{i_{ij}} \tag{1.7}$$

And the utility of agent j by

$$u_{j_{ij}} = \underbrace{y_j + \sum_{k \in N(g_{ij})} \delta(t_{jk}) \alpha y_k + \sum_{k:jk \in g_{ij}} \beta Z_{jk}}_{\equiv Z_{j_{ij}}} + \epsilon_{j_{ij}} \tag{1.8}$$

$$\bar{u}_{j_{ij}} = \underbrace{y_j + \sum_{k \in N(g_{\bar{ij}})} \delta(t_{jk}) \alpha y_k + \sum_{k:jk \in g_{\bar{ij}}} \beta Z_{jk}}_{\equiv \bar{Z}_{j_{ij}}} + \bar{\epsilon}_{j_{ij}} \tag{1.9}$$

where g_{ij} and $g_{\bar{ij}}$ are *ad hoc* networks constructed for estimation purposes. To define g_{ij} the architecture of g is taken as given for all other dyads except ij, and additionally ij is assumed to exist. Analogously, $g_{\bar{ij}}$ is constructed by taking the rest of the network g as given and artificially setting $x_{ij} = 0$.[16] Redefining

$$\begin{aligned} z_{i_{ij}} - \bar{z}_{i_{ij}} &= \varphi_{i_{ij}} \\ z_{j_{ij}} - \bar{z}_{j_{ij}} &= \varphi_{j_{ij}} \\ \epsilon_{i_{ij}} - \bar{\epsilon}_{i_{ij}} &= \eta_{i_{ij}} \\ \epsilon_{j_{ij}} - \bar{\epsilon}_{j_{ij}} &= \eta_{j_{ij}} \end{aligned} \tag{1.10}$$

The model reduces to

$$P(x_{ij} = 1) = P(\varphi_{i_{ij}} + \eta_{i_{ij}} \geq 0 \ \& \ \varphi_{j_{ij}} + \eta_{j_{ij}} \geq 0) \tag{1.11}$$

Since $\eta_{i_{ij}}$ and $\eta_{j_{ij}}$ represent omitted factors[17] affecting the utility that individuals i and j respectively get if link ij is formed, a joint distribution $[\eta_{i_{ij}}, \eta_{j_{ij}}] \sim$ bivariate normal $[0, 0, 1, 1, \rho]$ is assumed. The model is thus estimated as a bivariate probit with partial observability. In the bivariate probit, two binary response variables vary jointly; partial observability occurs when a positive outcome is observed only if both response variables are positive. To proceed to the estimation, the problem is reformulated in the following way. Let's define

$$u_{i_{ij}} = \begin{cases} 1 \ if \ \varphi_{i_{ij}} + \eta_{i_{ij}} \geq 0 \\ 0 \ otherwise \end{cases} \tag{1.12}$$

[16] This is a slight abuse of notation, since g_{ij} should be defined as $g + ij$ if $x_{ij} = 0$ and $g - ij$ if $x_{ij} = 1$, and analogously $g_{\bar{ij}}$ should be defined as $g - ij$ if $x_{ij} = 1$ and g if $x_{ij} = 0$. In everything that follows g_{ij} and $g_{\bar{ij}}$ will refer to the artificial networks created from g setting a particular link ij to 1 or to 0 (regardless of the link being 1 or 0 in reality).

[17] For instance I do not control for formal associations belongings and trade partnerships.

$$u_{j_{ij}} = \begin{cases} 1 \; if \; \varphi_{j_{ij}} + \eta_{j_{ij}} \geq 0 \\ 0 \; otherwise \end{cases} \tag{1.13}$$

Each of these dichotomous variables take value one when the corresponding agent, given the equilibrium network architecture, benefits from forming the link ij. What is observed is a binary variable x_{ij} which is the product of these variables for both agent i and agent j:

$$x_{ij} = u_{i_{ij}} u_{j_{ij}} = \begin{cases} 1 \; if \; u_{i_{ij}} = 0 \; \& \; u_{j_{ij}} = 0 \\ 0 \; otherwise \end{cases} \tag{1.14}$$

Now the problem reduces to a two-equations system where the dependent variables are $u_{i_{ij}}$ and $u_{j_{ij}}$, errors are correlated, the observed outcome is $u_{i_{ij}} u_{j_{ij}}$ and linear restrictions are imposed such that the individual coefficients $\alpha,\ \beta$ and γ in $\varphi_{i_{ij}}$ and $\varphi_{j_{ij}}$ are the same for the two equations. This model is analogous to the one proposed by Poirier (1980) (see also Maddala, 1983; Abowd and Farber, 1982; Farber, 1983).

For each dyad ij, benefits from linking are given by the additional utility that each agent respectively gets if the link ij is formed, compared to the case where the link is not formed. $u_{i_{ij}} = 1$ if *ceteris paribus* player i finds it profitable to form link ij, that is, if

$$u_{i_{ij}} - \bar{u}_{i_{ij}} = \left[\sum_{k \in N(g_{ij})} \delta(t_{ik}) \alpha y_k - \sum_{k \in N(g_{\bar{ij}})} \delta(t_{ik}) \alpha y_k \right] + \beta Z_{ij} + \eta_{i_{ij}} \geq 0 \tag{1.15}$$

and analogously $u_{j_{ij}} = 1$ if

$$u_{j_{ij}} - \bar{u}_{j_{ij}} = \left[\sum_{k \in N(g_{ij})} \delta(t_{jk}) \alpha y_k - \sum_{k \in N(g_{\bar{ij}})} \delta(t_{jk}) \alpha y_k \right] + \beta Z_{ij} + \eta_{j_{ij}} \geq 0 \tag{1.16}$$

The terms in brackets represent the overall net gain in terms of direct and indirect partners' discounted income that agent i and j respectively get if link ij is formed,

and can be decomposed by geodesic distance:

$$\sum_{k\in N(g_{ij})} \delta(t_{ik})\alpha y_k - \sum_{k\in N(g_{\bar{ij}})} \delta(t_{ik})\alpha y_k =$$
$$\underbrace{\alpha\delta(1)}_{\equiv a_{i1}} y_j + \underbrace{\alpha\delta(2)}_{\equiv a_{i2}} \underbrace{\left[\begin{smallmatrix} y_{k\in N(g_{ij})} & - & y_{k\in N(g_{\bar{ij}})} \\ \delta(t_{ik})=2 & & \delta(t_{ik})=2 \end{smallmatrix}\right]}_{\equiv 2steps\ gain_{i_{ij}}} + \underbrace{\alpha\delta(3)}_{\equiv a_{i3}} \underbrace{\left[\begin{smallmatrix} y_{k\in N(g_{ij})} & - & y_{k\in N(g_{\bar{ij}})} \\ \delta(t_{ik})=3 & & \delta(t_{ik})=3 \end{smallmatrix}\right]}_{\equiv 3steps\ gain_{i_{ij}}} + ... \tag{1.17}$$

and, for the agent j,

$$\sum_{k\in N(g_{ij})} \delta(t_{jk})\alpha y_k - \sum_{k\in N(g_{\bar{ij}})} \delta(t_{jk})\alpha y_k =$$
$$\underbrace{\alpha\delta(1)}_{\equiv a_{j1}} y_i + \underbrace{\alpha\delta(2)}_{\equiv a_{j2}} \underbrace{\left[\begin{smallmatrix} y_{k\in N(g_{ij})} & - & y_{k\in N(g_{\bar{ij}})} \\ \delta(t_{jk})=2 & & \delta(t_{jk})=2 \end{smallmatrix}\right]}_{\equiv 2steps\ gain_{j_{ij}}} + \underbrace{\alpha\delta(3)}_{\equiv a_{j3}} \underbrace{\left[\begin{smallmatrix} y_{k\in N(g_{ij})} & - & y_{k\in N(g_{\bar{ij}})} \\ \delta(t_{jk})=3 & & \delta(t_{jk})=3 \end{smallmatrix}\right]}_{\equiv 3steps\ gain_{j_{ij}}} + ... \tag{1.18}$$

In this way we can explicitly separate the net utility gains deriving from indirect contacts according to their distance. For instance, $2steps\ gain_{i_{ij}}$ expresses the net gain in terms of income of agents 2-steps-away that i gets if the link ij is formed. This term may be positive or negative[18] and can be computed from data. This decomposition provides a straightforward test of my hypothesis: if the α coefficients turn out to be significant it suggests that agents form arrangements taking also into account the relative position and the wealth of indirect partners.

Keeping in mind that wealth is given by $y_i = (land_i,\ livestock_i)$, and setting $\delta(t_{ij}) = 0$ for $t_{ij} \geq 4$ for technical reasons[19] my final specification is therefore a bivariate probit with partial observability given by:

[18] It is negative for instance if agent i sets a link with a partner who used to be reachable in 2 steps, because the direct gain is reflected in a 2-steps-distance loss.

[19] First note that the maximum geodesic distance in the network is 5 and therefore the sum of regressors accounting for direct and indirect gains up to the 5th step equals zero. This is rather intuitive: from i's point of view, any potential partner j is reachable in a maximum of 5 steps, therefore if the link ij is formed the asset of j simply gets closer. In other words, any change in the network structure results in a readjustment of players' relative position. This is true for all dyads except for three specific cases (namely, dyads that are connected by a link where one of the partners only has this link, such that in the alternative scenario the household is not reachable anymore). Also note that, since the network is rather dense (with an average geodesic distance of 2.5), structural adjustments are "reabsorbed" in a few steps; therefore in most cases several-steps-away-gains are null. For instance, the variable $5steps\ livestock\ gain$ equal zero in 6908 out of 7021 observations. Therefore regressors accounting for direct and indirect gains up to the 4th step are (almost perfectly) collinear, and I omit $4steps\ land\ gain$ and $4steps\ livestock\ gain$ for i and j taking them as a reference category.

$$\begin{cases} a_{i_{11}} land_j + a_{i_{12}} 2steps\ land\ gain_{i_{ij}} + a_{i_{13}} 3steps\ land\ gain_{i_{ij}} + \\ a_{i_{21}} livestock_j + a_{i_{22}} 2steps\ livestock\ gain_{i_{ij}} + \\ a_{i_{23}} 3steps\ livestock\ gain_{i_{ij}} + \beta_i Z_{ij} + \eta_{i_{ij}} \geq 0 \end{cases} \tag{1.19}$$

$$\begin{cases} a_{j_{11}} land_i + a_{j_{12}} 2steps\ land\ gain_{j_{ij}} + a_{j_{13}} 3steps\ land\ gain_{j_{ij}} + \\ a_{j_{21}} livestock_i + a_{j_{22}} 2steps\ livestock\ gain_{j_{ij}} + \\ a_{j_{23}} 3steps\ livestock\ gain_{j_{ij}} + \beta_j Z_{ij} + \eta_{j_{ij}} \geq 0 \end{cases} \tag{1.20}$$

Where I constrain the coefficients to be the same for Equation 1 and 2:

$$\begin{aligned} a_{i11} &= a_{j11} \\ a_{i12} &= a_{j12} \\ a_{i13} &= a_{j13} \\ a_{i21} &= a_{j21} \\ a_{i22} &= a_{j22} \\ a_{i23} &= a_{j23} \\ \beta_i &= \beta_j \end{aligned} \tag{1.21}$$

In order to compute the regressors *all* shortest paths among *all* players for *all* possible scenarios have been calculated. That is, for each dyad ij, the networks g_{ij} and $g_{\bar{i}j}$ are constructed, a matrix of geodesic distances is assigned to g_{ij} and $g_{\bar{i}j}$ respectively, and finally *all* $t_{ik}, t_{jk},\ \forall k : k \in N(g_{ij})$ and $t_{ik}, t_{jk}, \forall k : k \in N(g_{\bar{i}j})$ are calculated and multiplied for agents' land and livestock assets. This has been done with Dikstra's algorithm, a procedure to solve the single-source shortest path problem in graphs.[20]

1.6 Specifications and Results

In this section I first describe the variables in use (as summarized in Table 1.1), I then present results from the baseline model, and I finally relax the assumption of symmetric benefits between network partners.

1.6.1 Variable Definition

In all following specifications, the units of observation are the households' dyads, and the dichotomous dependent variable equals one if the two households in the

[20]This algorithm, proposed by Dijkstra (1959), was originally programmed for directed, weighted graphs. For a given pair of vertices of a graph, the algorithm finds the shortest path.

dyad are connected with a link of mutual help (see Section 1.4). As the theory suggests, benefits are given by direct and indirect partners' wealth while costs of linking are determined by the social distance between the two households who form the dyad. The estimates of social distance are based on geographical distance, kinship levels, clan membership, education, religion, households' income sources and covariance in portfolios.

Households' wealth is bi-dimensional and is given by the monetary value of land and livestock assets (bulls, cows, calves, goats, sheep, pigs, chickens, and ducks), in Tanzanian shillings.[21]

Geographical distance (in meters) is included to account for the fact that frequent interactions between neighbors can broaden their information and facilitate trust relations.

I record a kinship tie between two households whenever a member of one household has a blood bond up with a member of the other one, so that each dyad falls into one of the four categories: "parents, children and siblings", "Nephews, nieces, uncles, aunts, cousins, grandparents and grandchildren", "other blood bond", and the default is "no blood bond". Clan membership is instead a dummy taking the value of one is the two households belong to the same clan.

Education may impact link formation through several channels. On the one hand, it can be a dimension of similarity if households share the same educational attainments. On the other hand, as De Weerdt (2004) suggests, education is a scarce and useful resource and households without literate members may find it interesting to befriend households with literate members. A household is considered educated if at least one member has completed primary school, and not educated otherwise. Taking as reference the case of different educational levels, the two dummies take the value one if both households have an educated member and take the value of zero if no members are educated.

For what concerns religious belonging, perceived distance between the three religious groups may not always be the same: since Catholics and Lutheran are both Christians, they are supposed to be ideologically closer between themselves than with Muslims. Therefore, taking as reference the case where both households are Lutheran, dummies for every religious combination are included in order to capture each group's willingness to form links within its own religion and with other religions.

[21] Data on land were originally in acres, but in order to allow comparisons they have been transformed in monetary equivalent. I use a conversion rate of 300000 tzs for 1 acre, which reflects average local prices in 2000. For international comparisons, the exchange rate in 2000 was 1 US dollar for 800 tzs.

Table 1.1: Variables Definition

land$_j$	Monetary value of land owned by household j (1 unit=100000 tzs)
livestock$_j$	Monetary value of livestock owned by household j (1 unit=100000 tzs)
2steps land gain $_{i_{ij}}$	Net gain for i in term of land of 2 steps away agents if link ij is formed (1 unit=100000 tzs)
3steps land gain $_{i_{ij}}$	Net gain for i in term of land of 3 steps away agents if link ij is formed (1 unit=100000 tzs)
2steps livestock gain $_{i_{ij}}$	Net gain for i in term of livestock of 2 steps away agents if link ij is formed (1 unit=100000 tzs)
3steps livestock gain $_{i_{ij}}$	Net gain for i in term of livestock of 3 steps away agents if link ij is formed (1 unit=100000 tzs)
distance(mts) $_{ij}$	Distance between the households' houses (mts)
strict kinship $_{ij}$	Dummy variable, equals 1 if adults in the two households are respectively parents, children or siblings
broad kinship $_{ij}$	Dummy variable, equals 1 if adults in the two households are respectively nephews, nieces, uncles, aunts, cousins, grandparents or grandchildren
other blood links $_{ij}$	Dummy variable, equals 1 for blood bonds other than the ones above
same clan $_{ij}$	Dummy variable, equals 1 if the two households belong to the same clan
both Muslim $_{ij}$	Dummy variable, equals 1 if both households are Muslim
both Catholic $_{ij}$	Dummy variable, equals 1 if both households are Catholic
Lutheran + Catholic $_{ij}$	Dummy variable, equals 1 if households are Catholic and Lutheran respectively
Catholic+ Muslim $_{ij}$	Dummy variable, equals 1 if households are Catholic and Muslim respectively
Lutheran + Muslim $_{ij}$	Dummy variable, equals 1 if households are Lutheran and Muslim respectively

Table 1.1: Variables Definition (Continued)

both low education $_{ij}$	Dummy variable, equals 1 if in neither of the two households a member has completed primary school
both high education $_{ij}$	Dummy variable, equals 1 if in both households at least one member has completed primary school
income share from off-farm $_{j}$	Share of total income originated from off-farm labor in household j
income share from casual labor $_{j}$	Share of total income originated from casual labor in household j
income share from trade $_{j}$	Share of total income originated from trade in household j
income share from cropping $_{j}$	Share of total income originated from cropping in household j
income share from livestock $_{j}$	Share of total income originated from livestock rearing in household j
income share from assets $_{j}$	Share of total income originated from assets in household j
income share from processing $_{j}$	Share of total income originated from processing in household j
covariance off-farm $_{ij}$	(income share from off-farm)$_i$ $\times$ (income share from off-farm)$_j$
covariance casual labor $_{ij}$	(income share from casual labor)$_i$ $\times$ (income share from casual labor)$_j$
covariance trade $_{ij}$	(income share from trade)$_i$ $\times$ (income share from trade)$_j$
covariance cropping $_{ij}$	(income share from cropping)$_i$ $\times$ (income share from cropping)$_j$
covariance livestock $_{ij}$	(income share from livestock)$_i$ $\times$ (income share from livestock)$_j$
covariance assets $_{ij}$	(income share from assets)$_i$ $\times$ (income share from assets)$_j$
covariance processing$_{ij}$	(income share from processing)$_i$ $\times$ (income share from processing) $_j$
difference land $_{ij}$	$\lvert$land$_i$ - land$_j$ $\rvert$
difference livestock $_{ij}$	$\lvert$livestock$_i$ - livestock$_j\rvert$
moreland $_{ij}$	Dummy variable, equals 1 if land$_i$ $>$land$_j$
morelivestock $_{ij}$	Dummy variable, equals 1 if livestock$_i$ $>$livestock$_j$

The information about productive activities was collected at the individual level. Each active adult has listed the one or more productive activities he is engaged into, and then these activities were coded in seven categories: casual labor, trade, crops, livestock rearing, assets, processing of agricultural products and other off-farm work. Here I introduce two sets of regressors to account for different mechanisms. On one side income from a particular activity may be considered more valuable an asset. That is, potential partners' source of income may also be relevant and not only the income itself. Therefore, a proxy for the share of total income originated by each productive activity in the partner household is included among the regressors.[22] On the other side, people engaged in similar activities are facilitated in forming links, thus covariance terms for households' productive activities portfolios are also included.[23] As several authors have already pointed out (De Weerdt, 2004; Fafchamps and Gubert, 2005), people engaged in similar activities are also subject to similar income fluctuations, which make insurance arrangements less efficient. However in Nyakatoke the large majority of loans and gifts take place in the event of idiosyncratic shocks and not community-correlated events.[24] Table 1.1 summarizes the variables' definition.

1.6.2 The Baseline Model

Column (1) in Table 1.2 refers to the benchmark case where agents only take into account land and livestock assets for direct partners, and the network structure is disregarded. Column (2) includes land and livestock gains from the entire network structure according to the model presented in Section 1.5. For both columns, marginal effects are reported.

Direct partners' assets $land_j$ and $livestock_j$ are positive and significant, even when these traditional variables are the only ones included as in (1). As expected, the richer a potential partner, the more desirable is a link with him.

$2steps\,livestock\,gain_{i_{ij}}$ and $3steps\,livestock\,gain_{i_{ij}}$, which represent the net gains

[22] This term is calculated as follows: in the survey each adult individual mentions the one or more productive activities he is involved into. Since individuals do not mention the relative importance of each activity, all activities they mention are assumed to contribute to their income in the same measure. Therefore, for each household the share of total income generated by each productive activity is calculated on the base of the number of active members and their activities. In case an individual does not earn any income, the information is coded as a zero (note that 5 households have no member earning any income).

[23] For each dyad and for each productive activity, the product the two households' income shares is used as measure of overlapping by sector.

[24] In the fifth survey round (December 2000) all adults individuals were asked to enumerate the two worst shocks their household has experienced in the past 10 years. As Dercon and De Weerdt (2006) report, the respondents listed a total of 296 shocks: illness is the most frequently mentioned shock, followed by death/funeral, ceremony, and crime and court cases. Community-correlated events (as bad agricultural prices or weather shocks) are mentioned only 12 times, which supports the hypothesis of idiosyncratic shocks.

in term of livestock of 2 and 3-steps-away partners that the agent receives if the link is formed, are significant and positive in sign. The analogous variables for land ($2steps\,land\,gain_{i_{ij}}$ and $3steps\,land\,gain_{i_{ij}}$) are also significant, and their sign is negative. That is, agents actually take into account the wealth characteristics and the relative position of all other individuals in the community when deciding whether to form a link. However, indirect livestock benefits seem to be favorably perceived, while for land the opposite holds; Section 1.7 will be devoted to the interpretation of this evidence. Interestingly, results from (1) appear biased. The direction of the bias is precisely determined by the fact that network externalities are omitted, and therefore their effect is absorbed by the direct partners' coefficients. That is, when wealth externalities (negative in case of land and positive in case of livestock) are omitted the coefficient for direct partners' land is overestimated, while the coefficient for direct partners' livestock is underestimated.

All other variables have the expected sign, and reconfirm what has been documented by previous studies on risk sharing networks (Fafchamps and Lund, 2003; De Weerdt, 2004; Dekker, 2004). Geographical proximity between two households is significantly correlated with the existence of a link. The same holds for kinship ties; the stricter the blood tie the stronger the effect. In fact the likelihood of observing a link is greater when household components are respectively parents and children than in the case where they are grandparents and grandchildren. On the other side, clan belonging and educational attainment do not seem to be relevant for link formation. Looking at religious belonging, Muslim households seem to be much more willing to form links with people of their same religion than Catholic and Lutherans respectively, which can be interpreted in the light of their ideological distance from the two Christian groups. Also this can result from a minority effect since Muslims are the smallest of the three religious groups. Additionally, the likelihood of observing a link between Catholics and Muslims is significantly smaller than for any other religious combination. Regarding income sources, data suggest that only assets and processing have significant coefficients, that is, are considered more valuable for mutual help purposes, while no variable accounting for income generating activity overlapping seems to strikingly impact the process of link formation.

Finally, it is worth mentioning that major findings are robust to the elimination of livestock outliers, and also if we control for the impact of family belonging on wealth.[25] These results have been omitted for the sake of brevity but they are available upon request.

[25]Since agents may evaluate potential partners' wealth differently whenever they all belong to the same family, I re-estimate the model interacting partners' assets with a dummy $same\,family_{ij}$ which equals one whenever there is any blood link between i and j.

Table 1.2: Bivariate Probit Marginal Effects[26]

Dependent variable: $u_{i_{ij}}$		
	(1)	(2)
land$_j$	.0034934	.0020332
	(0.000)	(0.003)
livestock$_j$	.0087746	.0125078
	(0.034)	(0.000)
2 steps land gain$_{i_{ij}}$		-.0012536
		(0.000)
3 steps land gain$_{i_{ij}}$		-.0004188
		(0.058)
2 steps livestock gain$_{i_{ij}}$		.0062917
		(0.002)
3 steps livestock gain$_{i_{ij}}$		.0057006
		(0.005)
distance (mts)$_{ij}$	-.000062	-.0000631
	(0.000)	(0.000)
strict kinship$_{ij}$	.0506058	.2131954
	(0.041)	(0.002)
broad kinship$_{ij}$	.040352	.0798821
	(0.004)	(0.001)
other blood links$_{ij}$	.0301029	.0480781
	(0.000)	(0.001)
same clan$_{ij}$	.0014884	.0002623
	(0.730)	(0.957)
both Muslim$_{ij}$	.0205308	.0219675
	(0.002)	(0.019)
both Catholic$_{ij}$	-.0050362	-.0085584
	(0.268)	(0.071)
Lutheran + Catholic$_{ij}$	-.0035143	-.0057569
	(0.376)	(0.179)
Catholic+Muslim$_{ij}$	-.0218936	-.0228431
	(0.000)	(0.000)
Lutheran + Muslim$_{ij}$	-.0050575	-.0069864
	(0.277)	(0.140)

Table 1.2: Bivariate Probit Marginal Effects (Continued)

	(1)	(2)
Catholic+Muslim$_{ij}$	-.0218936	-.0228431
	(0.000)	(0.000)
Lutheran + Muslim$_{ij}$	-.0050575	-.0069864
	(0.277)	(0.140)
both low education$_{ij}$	-.0009396	-.0033343
	(0.897)	(0.648)
both high education$_{ij}$	.001516	.0041251
	(0.624)	(0.203)
income share from off-farm$_j$	.0199957	.0378192
	(0.220)	(0.071)
income share from casual labor$_j$	.0152096	.0280453
	(0.225)	(0.122)
income share from trade$_j$	-.0128758	.0010232
	(0.359)	(0.957)
income share from cropping$_j$	.0293193	.0271912
	(0.086)	(0.260)
income share from livestock$_j$	.0103609	.0181362
	(0.575)	(0.427)
income share from assets$_j$	.1065404	.1889668
	(0.160)	(0.011)
income share from processing$_j$	.0598164	.0635219
	(0.002)	(0.003)
covariance off-farm$_{ij}$	.040869	.0317597
	(0.305)	(0.504)
covariance casual labor$_{ij}$	-.0388885	-.0499187
	(0.093)	(0.083)
covariance trade$_{ij}$	.0060595	.0001152
	(0.867)	(0.998)
covariance cropping$_{ij}$	-.032385	-.0217649
	(0.118)	(0.388)
covariance livestock$_{ij}$	-.1029424	-.1220129
	(0.237)	(0.229)
covariance assets$_{ij}$	1758	1925
	(0.137)	(0.197)
covariance processing$_{ij}$	-.0209847	.0065028
	(0.617)	(0.882)
observations	6670	6670

dy/dx is for discrete change of dummy variable from 0 to 1

p value in parenthesis

[26]For $land_j$, $livestock_j$ and income shares: means are calculated on the original sample of 119

1.6.3 A Model with Asymmetric Exchanges

In this subsection I estimate an extended version of the model that allows for heterogeneity in the impact of partner's wealth. That is, now the agents' utility function becomes

$$u_i(g) = y_i + \sum_{j \in N(g)} \delta(t_{ij}) \alpha y_j + \sum_{j:ij \in g} [\psi + \xi more\, y_{ij}] \, |y_i - y_j| \sum_{j:ij \in g} \beta Z_{ij} + \sum_{j:ij \in g} \gamma E_{ij} \tag{1.22}$$

where the dummy $more\, y_{ij}$ equals one whenever $y_i > y_j$. This way the overall effect of partner's assets may also depend on the absolute difference in wealth and on the relative position of the two agents. This is motivated by the fact that in Nyakatoke the links between wealthy and poor agents are frequent and from the point of view of the rich they cannot be interpreted in terms of economic incentives only.[27] The specifications in Table 1.3 therefore allow agents to attribute different weights to economic incentives. Again, (3) reports the results of a model where agents only care about direct partners' characteristics and indirect contacts are omitted, and this is confronted with the full model of (4), which also takes into account indirect partners' assets.

As we can see from Table 1.3, results are consistent with the ones obtained from the less sophisticated model, and all relevant variables behave in the expected way for sign and significance, including indirect contacts whose relevance is reconfirmed. Again, direct partners' assets from (3) appear biased, overestimated in the case of land and underestimated in the case of livestock. Additionally, it is worth noticing that allowing for asymmetric economic incentives, the estimated coefficients for direct partners' assets $land_j$ and $livestock_j$ are bigger. Overall, this confirms that the basic model is able to describe satisfactorily the phenomena, and its simplicity does affect the major results.

For what concerns the new variables, assets' differences are as expected significantly negative, confirming that the wealth gap is a negative factor for link formation. Interactions $moreland_{ij} \times difference\, land_{ij}$ and $morelivestock_{ij} \times difference$

households. For $2steps\ \ land\ \ gain_{i_{ij}}$, $3steps\ \ land\ \ gain_{i_{ij}}$, $2steps\ \ livestock\ \ gain_{i_{ij}}$, and $3steps\ \ livestock\ \ gain_{i_{ij}}$: means are calculated on all households in the dyads (7021+7021 observations). All other variables' means are calculated on the sample of 7021 dyads. Marginal effects for household i are reported.

[27] At first glance we could think that these unbalanced links simply come from the definition of the variable. Since links are assumed to be reciprocal (see Section 1.4), it might be argued that poor partners always declare links with rich ones, and therefore these links are not really reciprocal as it is assumed. However this is not the case since when the link is not reciprocal, the partner who declares the link is indeed more often the poorer out of the two, but the difference is not as striking as we could have expected (see Appendix A, Table 11). Moreover, in the survey individuals could list as many contacts as they want and, since on average wealthy people also have more links, they are likely to quote only the most important ones. Therefore this difference alone cannot explain why we observe so many unbalanced links in terms of wealth.

Table 1.3: Marginal Effects under Asymmetry

Dependent variable: $u_{i_{ij}}$		
	(3)	(4)
land$_j$	.0076215	.0047065
	(0.001)	(0.003)
livestock$_j$	.0317126	.0367085
	(0.004)	(0.001)
2steps land gain$_{i_{ij}}$		-.0015526
		(0.000)
3steps land gain$_{i_{ij}}$		-.000613
		(0.048)
2steps livestock gain$_{i_{ij}}$		.0078039
		(0.007)
3steps livestock gain$_{i_{ij}}$		.0068213
		(0.017)
difference land$_{ij}$	-.0079918	-.006384
	(0.000)	(0.000)
moreland$_{ij}$ $\times$ difference land$_{ij}$	.0111502	.009408
	(0.000)	(0.000)
difference livestock$_{ij}$	-.0274673	-.0232054
	(0.015)	(0.036)
morelivestock$_{ij}$ $\times$ difference livestock$_{ij}$	.0287672	.0233399
	(0.013)	(0.045)
distance (mts)$_{ij}$	-.0001138	-.0000885
	(0.000)	(0.000)
strict kinship$_{ij}$	.4874882	.4238081
	(0.000)	(0.001)
broad kinship$_{ij}$	.1946591	.1486708
	(0.007)	(0.012)
other blood links$_{ij}$	.1090885	.0845001
	(0.006)	(0.009)
same clan$_{ij}$	.0025018	.0005
	(0.776)	(0.944)
both Muslim$_{ij}$	.0561747	.0381908
	(0.028)	(0.028)
both Catholic$_{ij}$	-.0114761	-.0107467
	(0.171)	(0.105)
Lutheran+Catholic$_{ij}$	-.0087999	-.0078651
	(0.252)	(0.201)

Table 1.3: Marginal Effects under Asymmetry (Continued)

Catholic+Muslim$_{ij}$	-.0357431	-.0301752
	(0.000)	(0.000)
Lutheran+Muslim$_{ij}$	-.0097081	-.0090277
	(0.251)	(0.182)
both low education$_{ij}$	-.0039103	-.0020934
	(0.765)	(0.843)
both high education$_{ij}$	.0039548	.0030891
	(0.500)	(0.512)
income share from off-farm$_j$	.0581153	.0640093
	(0.022)	(0.014)
income share from casual labor$_j$	.0455959	.0452254
	(0.033)	(0.029)
income share from trade$_j$	-.027862	-.0180362
	(0.240)	(0.429)
income share from cropping$_j$	.0357799	.0300155
	(0.129)	(0.231)
income share from livestock$_j$	.0329305	.0254715
	(0.251)	(0.343)
income share from assets$_j$	.2327595	.2172934
	(0.007)	(0.011)
income share from processing$_j$	.0610097	.0811598
	(0.018)	(0.003)
covariance off-farm$_{ij}$	.034764	.0098725
	(0.661)	(0.883)
covariance casual labor$_{ij}$	-.1088319	-.0900709
	(0.020)	(0.019)
covariance trade$_{ij}$	.0042729	.0215645
	(0.952)	(0.705)
covariance cropping$_{ij}$	-.0401871	-.0253034
	(0.180)	(0.383)
covariance livestock$_{ij}$	-.226248	-.1940877
	(0.178)	(0.183)
covariance assets$_{ij}$	3885347	3083
	(0.130)	(0.178)
covariance processing$_{ij}$	.0900104	.0392718
	(0.230)	(0.516)
observations	6670	6670

dy/dx is for discrete change of dummy variable from 0 to 1

p value in parenthesis

$livestock_{ij}$ are both significant and positive, that is, the richest the agent the less concerned about partner's assets. This suggests that rich individuals may have non-economic motivations to form links, which is in line with the theory of asymmetric exchanges. In asymmetric exchanges, income is traded against symbolic attributes such as homage, respect, social esteem or political power. Several previous economists have indeed interpreted gift transactions as exchange rather than altruism, and have recognized asymmetric exchanges as the base of village-level patronage relationships in developing countries (Breman, 1974; Scott, 1976; Fafchamps, 1992; Platteau, 1995).

1.7 An Interpretation of the Results

The results on direct contacts presented in Section 1.6 suggest that, in line with intuition, the richer a potential partner, the higher the willingness to form a link with him. On the other hand, the results on indirect contacts for land and livestock differ in sign, that is, coefficients for livestock are positive, while for land the direction of the effect is the opposite. An interpretation of these findings based on anthropological and distributional considerations is proposed in what follows.

Land is the traditional status symbol in Haya society and the primary asset for most households in Nyakatoke. As Mitti Rweyamamu (2001) remark, *"Almost every family in Nyakatoke owns the land it lives on and cultivates"*. On the other hand, almost all livestock is in the hands of a few households, while 38% of the population owns no livestock at all. These features result in a Gini coefficient for livestock that is almost twice the one for land (0.79 vs. 0.44). For the distributions of assets by quintile I remand to the Appendix A, Table 4.A.
Land and livestock for the same household are not necessarily correlated, but it may be the case that a household is in the 1^{st} quintile for an asset and in the 5^{th} quintile for the other. However, some features of the top quintile are common to both land and livestock distributions. Households in the 5^{th} quintile have more links than the rest of the population and are relatively more connected among themselves than with less wealthy income groups (see Appendix A, Table 5.A and 6.A for links by quintile and Table 7.A for outliers in the number of links). If we consider instead the very upper part of the distribution (95^{th} centile), the behavior of land and livestock owners differs. Landowners in the 95^{th} centile have an average number of links that is close to the sample mean, while livestock owners in the 95^{th} centile have more than twice the average number of contacts (see Appendix A, Table 8.A). Also, if we abstract from the number of links and only consider how these links are distributed across wealth groups, we notice that the 95^{th} centile for livestock has a much stronger tendency to link with other wealthy individuals in terms of livestock (See Appendix A, Table 9.A). Therefore not only are the outliers in terms of livestock very few and also hubs for their number of contacts, but they are also strictly interconnected among themselves (in fact among them the

network is complete, that is, all possible links exist). A justification of this strict interconnection comes from the consuetudinary rules of Nyakatoke, where *"[...] indigenous cattle are grazed in a common herd (buyo). Cattle from several households are pooled each day and herded in turn"* (Mitti and Rweyamamu, 2001).

As network theory acknowledges from its very first steps (Jackson and Wolinsky, 1996) externalities from indirect contacts may be positive or negative. That is, the friends of my friends can be beneficial in that they broaden my range of social interactions, but they can also be detrimental if there is competition because the social and/or economic resources of direct friends are scarce. This seems to be the case for Nyakatoke, where both forces are present and drive results in opposite directions. In mutual support arrangements, friends' friends may indeed be beneficial in terms of social status or in that small gifts in nature can be expected from them in case of need. However, they may also be detrimental since most households in Nyakatoke live at the subsistence level (with an average food share on consumption of 77%) and not much is left to help people in need, and therefore a partner with several contacts is not very likely to be a big support in case of necessity. In the case of land, externalities from indirect contacts are negative. In other words, Nyakatoke villagers prefer rich partners, but with fewer and/or poorer contacts. Since the distribution of land is relatively egalitarian, it can be generalized as a condition on the number of contacts: the fewer additional friends other than myself my partner has, the more valuable he is ceteris paribus. For land assets the competition mechanism prevails because the benefits that can be extracted from friends are connected to the use of their land, and therefore exclusive by their own nature. As descriptive evidence about Nyakatoke points out, *"free gift of land for cultivation of seasonal crops among friends and neighbours is quite common. A little of the produce may be given to the landowner as a gesture of appreciation for the use of his land"*, and also *"some villagers (especially women) perform vigodi* [a term used in the locality to mean casual labor, especially farm work] *or working on other households farms for cash"* (Mitti and Rweyamamu, 2001). The vast majority of households can devote a small portion of their land assets to help partners in time of need, which exacerbates the competition for these scarce resources. This, as is explained in what follows, is not the case for livestock. In Nyakatoke a large stock of livestock is in the hands of a really few households. Livestock is therefore a real wealth dimension, more valuable than land in that it is less subject to economic fluctuations than agricultural harvests, which is reflected by the magnitude of the coefficients (see Table 1.2 and Appendix A, Table 5.A), where in terms of risk sharing a unit of livestock is considered more valuable than an analogous monetary unit of land. In the case of livestock indirect contacts are positive in sign: good partners bring many and/or rich indirect contacts and, given the distribution, "rich" is the natural interpretation. Here the positive externality prevails on the competition mechanism for several reasons. First, a relation based on livestock exchanges is by nature less exclusive than a relation based on the temporary use of

land. Second, small gifts in nature (for example a chicken for a funeral party) are very common practice in Nyakatoke, and the likelihood of receiving some kind of indirect support via a partner who has rich contacts instead of many contacts is higher. Third, the few rich livestock owners are wealthy enough to support several people in need at the same time, which decreases competition for resources, and they are really interconnected among themselves, which facilitates the externality flow. These considerations altogether explain why in the case of land the competition may reasonably dominate, while for livestock the positive externality of indirect contacts prevails as results in Section 1.6 suggest.

1.8 Conclusions

This chapter approaches mutual support arrangements in rural villages from a network perspective, investigating how links are formed and whether indirect contacts are relevant in the process of network formation. When agents form a link not only do they establish a new contact, but they also gain access to the larger network of the partner's friends and friends of these friends. In this chapter I test the hypothesis that indirect contacts matter, that is, when forming links agents also consider the wealth and the relative position of indirect partners. A network formation model with full heterogeneity among agents is first presented following Jackson and Wolinsky (1996); an estimation protocol is then proposed and applied to data on a village in rural Tanzania. Results show that agents actually take into account the net advantage of potential links, evaluating also indirect benefits deriving from changes in their position with respect to all other agents. This chapter contributes to both network theory and the empirical literature on informal economic arrangements, in that it proposes an innovative procedure to estimate endogenous network formation models, and also provides evidence that indirect contacts have an explanatory value disregarded by all previous studies, which are focused on direct relations only.

1.9 Appendix A

Figure 1.A: Links among Nyakatoke Households

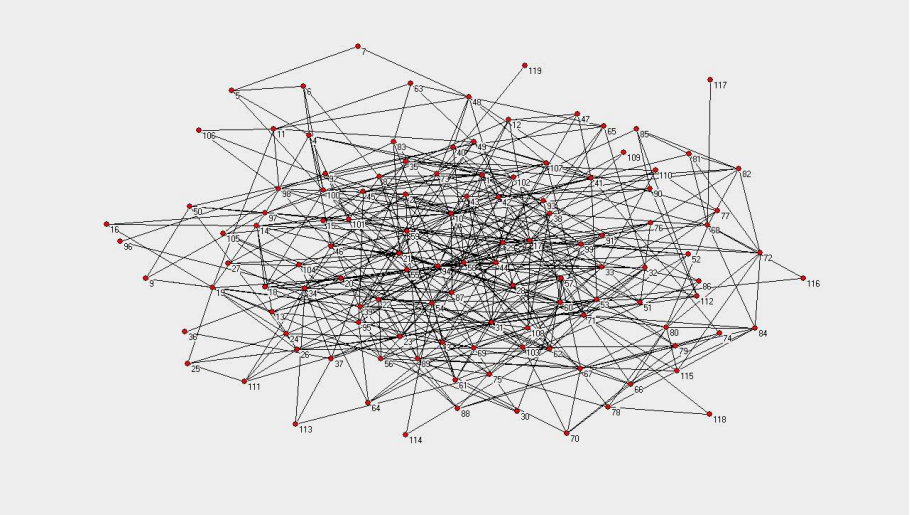

Figure 2.A: Land Quantiles

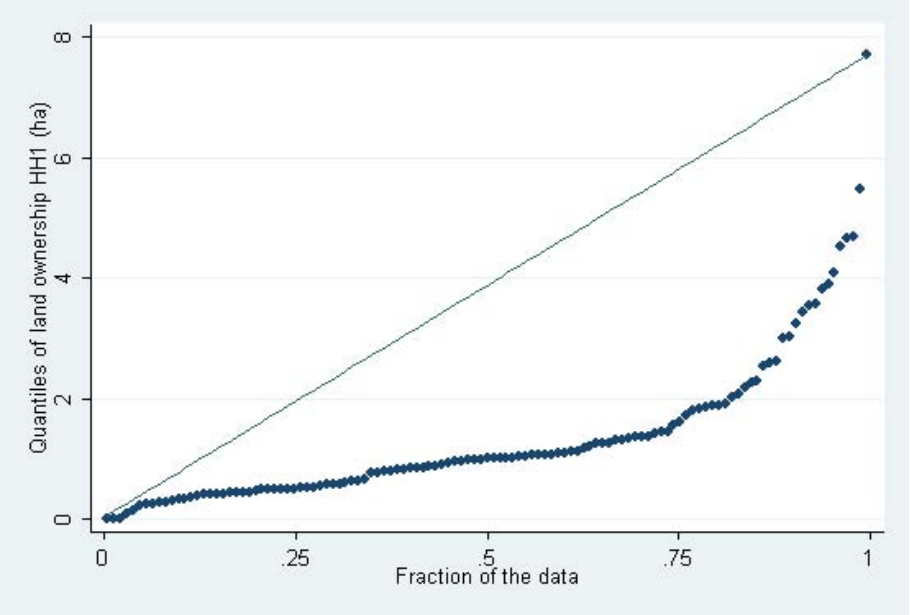

Figure 3.A: Livestock Quantiles

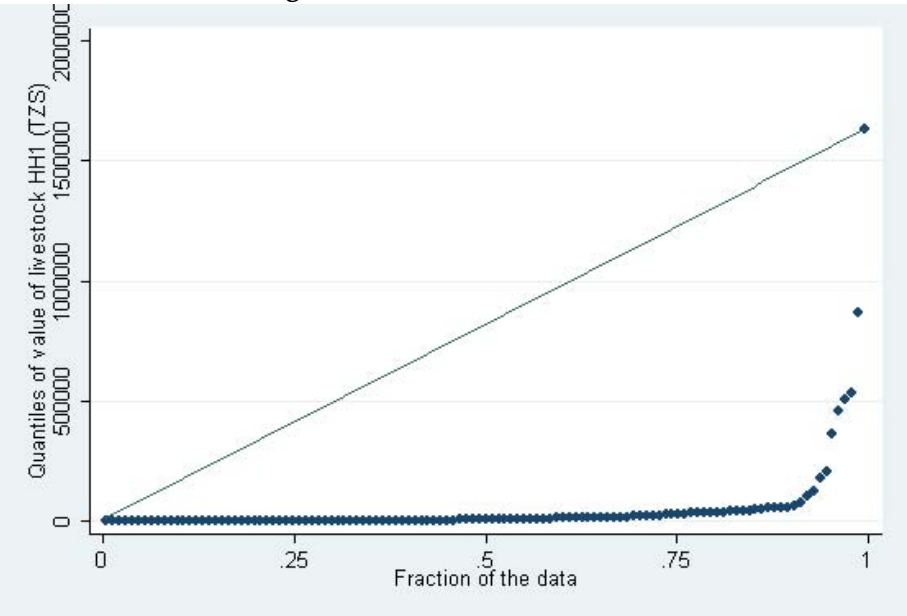

Table 1.A: Nyakatoke Age Structure

Age category	Male	Female	Total
younger than 10	93	104	197
10 to 20	75	74	149
20 to 30	38	50	88
30 to 40	29	29	58
40 to 50	22	23	45
50 to 60	14	14	28
60 to 70	9	7	16
70 to 80	3	8	11
older than 80	3	5	8
TOTAL	286	314	600

Source: De Weerdt (2004)

Table 2.A: Distribution of Dyadic Variables

Variable	Definition	Dyads (tot. 7021)
Link	No link	6531
	Unilateral or reciprocal link	490
Geodesic distance	1 step	490
	2 steps	1996
	3 steps	2900
	4 steps	1275
	5 steps	360
Kinship	Child, siblings, parents	109
	Nephew, niece, uncle, aunt, cousins, grandparents, grandchildren	102
	Other blood links	172
	No blood link	6638
Education	Both households have at least one member who completed primary education	4278
	Only one household has at least one member who completed primary education	2418
	None of the two households have any member who completed primary education	325

Table 3.A: Distribution of Attribute Variables among Households

Religion	Muslim	24	n=119
	Lutheran	46	
	Catholic	49	
Clan	1 household	11	n=119
	2 households	5	
	3 households	2	
	4 to 10 households	5	
	12 to 23 households	3	
Households engaged in	Casual labor	57	n=116
	Trade	41	
	Crops	108	
	Livestock	31	
	Assets	8	
	Processing	45	
	Other off-farm	40	

Table 4.A.1: Land Assets by Quintile

Quintile	Average land(ha)
Quintile 1	0.29
Quintile 2	0.62
Quintile 3	0.98
Quintile 4	1.43
Quintile 5	3.37

Table 4.A.2: Livestock Assets by Quintile[28]

Quintile	n. of households	Average livestock (tzs)
No livestock	42	0
Quintile 1	16	3000
Quintile 2	16	9512.5
Quintile 3	14	19042.9
Quintile 4	16	38012.5
Quintile 5	15	353613.3

Table 5.A.1: Links by Land Quintile, Absolute Values

	Quintile1	Quintile2	Quintile3	Quintile4	Quintile5
Quintile1	11	24	27	26	29
Quintile2	24	16	47	42	40
Quintile3	27	47	21	35	51
Quintile4	26	42	35	21	56
Quintile5	29	40	51	56	44

[28]Households with no livestock are considered a group on its own, and livestock quintiles are based only on the share of population that actually owns livestock.

Table 5.A.2: Links by Land Quintile, Percentages

	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5	Total
Quintile1	9	21	23	22	25	100
Quintile2	14	9	28	25	24	100
Quintile3	15	26	12	19	28	100
Quintile4	14	23	19	12	31	100
Quintile5	13	18	23	25	20	100

Table 6.A.1: Links by Livestock Quintile, Absolute Values

	No livestock	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5
No livestock	46	27	32	49	41	41
Quintile1	27	6	10	26	10	14
Quintile2	32	10	11	25	18	18
Quintile3	49	26	25	17	25	18
Quintile4	41	10	18	25	7	28
uintile5	41	14	18	18	28	21

Table 6.A.2: Links by Livestock Quintile, Percentage

	No livestock	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5	Total
No livestock	19	11	14	21	17	17	100
Quintile1	29	6	11	28	11	15	100
Quintile2	28	9	10	22	16	16	100
Quintile3	31	16	16	11	16	11	100
Quintile4	32	8	14	19	5	22	100
Quintile5	29	10	13	13	20	15	100

Table 7.A: The Most Connected Households in Nyakatoke
(95th Centile for Number of Links, 6 obs.)

Number of Links	Quintile land	Quintile livestock
20	2	2
22	5	4
23	5	5
24	5	5
24	5	5
32	3	2

Table 8.A: Average Number of Links by Centile

		n. observations	average links
full sample		119	8.2
Land	Quintile 1	24	5.3
	Quintile 2	24	7.7
	Quintile 3	24	8.4
	Quintile 4	23	8.3
	Quintile 5	24	11.4
	90th centile	12	12.3
	95th centile	6	10.2
Livestock	No livestock	42	6.7
	Quintile 1	16	7.1
	Quintile 2	16	10.2
	Quintile 3	14	8.9
	Quintile 4	16	8.5
	Quintile 5	15	10.7
	90th centile	7	15.1
	95th centile	3	19.3

Table 9.A: Links from the 95 Centile towards the Other Quintiles.

Asset	Centile	Contribution of this centile to the total population	Percentage of links from the 95 centile towards this centile
land	Quintile 1	20	15.3
	Quintile 2	20	16.9
	Quintile 3	20	20.3
	Quintile 4	20	22
	Quintile 5	20	25
livestock	No livestock	35	21.8
	Quintile 1	13	7.30
	Quintile 2	13	10.9
	Quintile 3	13	12.7
	Quintile 4	13	20
	Quintile 5	13	27

Table 10.A.1: Links and Kin Group by Land Quintiles

quintile	% of links outside the kin group	% of links within the kin group
Quintile 1	70.9	29.1
Quintile 2	69.8	30.2
Quintile 3	68	32
Quintile 4	69.4	30.6
Quintile 5	75.9	24.1

Table 10.A.2: Links and Kin Group by Livestock Quintiles[29]

quintile	% of links outside the kin group	% of links within the kin group
No livestock	72.9	27.1
Quintile 1	72	28
Quintile 2	60.5	39.5
Quintile 3	73.1	26.9
Quintile 4	67.4	32.6
Quintile 5	75	25

Table 11.A: Wealth in Non-reciprocal Links (% cases)

Land	The poorer declares the link	56.57
	The richer declares the link	43.43
Livestock	The poorer declares the link	52.57
	The richer declares the link	36.86
	They both have same livestock	9.35
	They both have no livestock	1.22

[29]Kinship groups include all blood links (broad kinship, strict kinship and other blood links).

Chapter 2

Educational Programs in Rural Nepal: Peer Communication and Information Spillovers

2.1 Introduction

Although interpersonal communication is universally seen as a powerful multi-purpose social resource, its economic effects have not yet been quantified. In the attempt to fill the hole, this chapter studies how individuals exchange information with peers, how this information circulates and spreads through informal channels, and how it impacts individual behavior.

I focus on three Nepalese villages where an educational radio program about family planning and modern contraception methods (FPC henceforth) is weekly broadcasted. Women in the villages listen to the radio program and discuss FPC issues with friends of the same gender, so that the information about the new techniques is available to them either through personal exposure or through their network of contacts. I focus on the role of the community as a bridge for information flow and study how information is spread among peers, with the goal of estimating the magnitude of information spillovers. When a woman discusses FPC issues with her friends she also indirectly accesses the information held by other women than her direct friends. That is, as information circulates throughout the community two women who are not directly connected but have a friend in common are likely to end up exchanging the information that becomes eventually available to one of them. I claim and empirically demonstrate that not only direct exposure to the radio program, but also this indirect information component, that I call information spillovers, explains woman behavior, and in particular their adoption of modern FPC methods.

My study relates to the literature on peer effects, where several empirical studies have attempted to measure the extent to which individual behavior is influenced by one's social environment (Glaeser, Sacerdote and Scheinkman, 1996; Gaviria and Raphael, 2001; Duflo and Saez, 2006). In the majority of cases detailed information is not available, and thus the reference group is defined on the basis of personal characteristics, for example all individuals in the same geographical area or in the same high school dorm (Aizer and Curries, 2002; Sacerdote, 2001; Conley and Topa, forthcoming). While data allow determining the precise structure of the network, the reference group is defined as the circle of self-reported peers (Udry and Conley, 2005), and this is also the case for this chapter. However, all these studies only take into account the characteristics of direct friends, and doing so they disregard the so-called network effect: in my setting for instance, even if women exchange information with their direct friends only, there is still an indirect diffusion of information at the community level that I attempt to quantify.

My analysis is different from all previous peer effect studies in that I explicitly take into account the structure of the community network. The educational radio drama conveys information about modern FPC techniques, and I estimate how women's likelihood of adopting modern contraception methods depends on the fact that they have been exposed to the FPC program allowing for different levels of exposure. In my setting, a woman is considered *directly exposed* to information if she declared she has personally listened to the FPC radio drama. The second level of exposure relates to the circle of friends she is in direct contact to. A woman's *peer exposure* is calculated as the number of her direct friends who declare that they have listened to the FPC radio drama. The third level of exposure to the radio drama is the *indirect exposure*: since direct links are bridges for information flows, the information held by women who are not direct peers can still be received through friends. I thus draw the complete map of the communication between women in the village, in order to compute the relative distance between women in the community network. If two women are not directly connected but have a friend in common, they are considered two steps apart. A woman's indirect exposure is calculated as the number of women who are not among her communication partners but are two steps apart from her and declare that they have listened to the FPC radio drama. The specifications that I bring to data incorporate these three levels of exposure, encompassing the standard models of peer effect.

My empirical analysis is articulated in two parts. In the first part I investigate whether and to which extent the adoption of modern contraception methods depend on the three levels of exposure as defined above. Results confirm that not only direct and peer exposure but also indirect exposure has an impact on individual behavior. In the second part of my analysis, I address the problem of the potential endogeneity of the network. One can in fact argue that two women discuss FPC issues because they have *a priori* the same opinion. If this was the case, this

so-called assortative matching among discussion partners would lead to an overestimation of previous results. In order to convince on the contrary, I run a dyadic analysis that explores the determinants of link formation and, using an instrumental variable approach, I show that women get together to discuss FPC issues on the basis of individual and social characteristics other than their *ex ante* opinion. This rules out the endogeneity of network links and reconfirms the validity of previous findings.

While traditional peer-effect literature evaluates the impact of direct partner characteristics only, I take a wider approach and evaluate how individual behavior is affected by actions undertaken by all other agents in the community. In order to do that I do not simply incorporate variables which may proxy for information spillovers at the community level, but I explicitly take into account the structure of the network emerging from women's communication patterns. This is in line with the main lesson on network theory (from Jackson and Wolinsky, 1996, onwards) that stresses the importance not only of direct partners, but also of the entire structure of the network in affecting individual behavior.

The chapter is organized as follows. Section 2.2 contains a review of the relevant literature, while in Section 2.3 the data are presented. The empirical strategy is presented in Section 2.4 and 2.5: Section 2.4 investigates whether the adoption of modern contraception methods depend on the exposure to the FPC program, while Section 2.5 is aimed to rule out the endogeneity of network links. Section 2.6 concludes summarizing the main findings. Tables and figures are presented in the Appendix B at the end of the chapter.

2.2 Literature Review

My study is at the crossroad of three literatures: the literature on natural experiments, the literature on peer effect, and the economic theory of networks. Natural experiments and treatment evaluation techniques have been extensively applied to different fields, from schooling (Krueger, 1999; Evans and Schwab, 1995) to income smoothing behavior (Grueber, 1996) passing through a wide range of applications (see Meyer, 1995, for an overview). Natural experiments are particularly useful in development economics, where household-level program evaluations have been flourishing in recent years (Duflo, 2001; Duflo, 2003; Kremer, 2003; Kremer and Miguel, 2004; Glewwe, Kremer, Moulin and Zitzewith, 2004; Angrist, Bettinger and Kremer, forthcoming). Although natural experiments and peer effect literature do not generally coincide, they are somehow complementary and in some case overlap. In the last two decades several studies on peer effects have attempted to measure the extent to which individual behavior is influenced by one's social environment, mainly for what concerns education (Evans, Oates and Schwab, 1992; Sacerdote, 2001; Gaviria and Raphael, 2001; Zimmermann, 2003; Angrist and Lang,

2004) but also in other fields (Glaeser, Sacerdote and Scheinkman, 1996; Duflo and Saez, 2006). The majority of these studies take a linear-in-means approach, that is, they assume that the individual behavior is a linear function of the mean behavior of the reference group. In most cases detailed information about social interactions is not available, and thus the reference group is defined on the base of personal characteristics, for example all individuals in the same geographical area (Aizer and Curries, 2002; Conley and Topa, forthcoming) or in the same school grade or high school dorm (Sacerdote, 2001). When instead data allow determining the precise structure of the network, the reference group is defined as the circle of self-reported peers (Udry and Conley, 2005). My study adopts this latter approach, since I construct the social network directly from the self-reported declarations of respondents.

The present chapter refers to both natural experiment and peer effect literature, in that I study the effect of the direct exposure to an educational FPC program and the peer transmission of the information that the program conveys. Two former studies have dealt with the same topic: Rogers et al. (1999) and Boulay (2002) evaluate the effect of a FPC educational radio program in Tanzania and Nepal respectively. However, my approach differs from both of them. Rogers et al. (1999) concentrate on the direct exposure to the radio program, without taking into account peer effects and indirect transmission of information. Boulay (2002) uses the same dataset I use, and starts from an analogous research question since he evaluates how women's contraception adoption is affected not only by direct exposure to the FPC program but also by their group of peers. However, he proxies the peer effect with the share of women's discussion partners who declare to have listened to the FPC radio program. In this chapter I instead depart from the theory of networks and propose an innovative procedure to calculate peer effects.

The literature on economic networks has been flourishing in the last decade (Jackson, 2003; Jackson, 2005). From the path-breaking contribution of Jackson and Wolinsky (1996) and onwards, network theory, based on game theoretical reasoning, claims that not only direct contacts, but also the entire graph of indirect contacts matter. In the most simple network game setting, the players are agents who form link among them. Links provide benefits, involve costs, and are created by mutual agreements. A typical feature of network games is that the utility of each individual not only depends on actions undertaken by his direct partners, but also on actions undertaken by all other agents. While the theoretical contributions in the field are numerous, the studies on applied networks are few. The quasi-totality of them does not study the mechanisms through which individuals form links, but they rather take agents' relative position as given to assess the role of the network structure of the community as determinant of the social outcome (Calvò-Armengol, Patacchini and Zenou, 2005; Conley and Topa, 2002; Udry and Conley, 2005). My study incorporates this network approach into the peer effect

estimation. I claim that since information spills over the community, women's adoption of modern contraception methods not only depend on the information held by their direct partners, but also on the information held by all other women in the community. This leads to the estimation procedure presented in Section 2.4.

2.3 The Nepal Social Network Survey

In 1991 a national survey carried on by the Nepalese Ministry of Health revealed a high unmet need of information and services about modern contraception and family planning. At that time, more than 28% of married women of reproductive age claimed that they want to delay or limit childbirth but they were not using contraception. This lack of contraception use was due to various factors, among them poor information about the effects of contraception, traditional social norms and culturally defined gender roles limiting women's decisional power. In 1993, research conducted by the Nepalese Ministry of Health suggested that, due to the nature of the country's terrain, radio was the most effective way to reach the Nepalese population to improve their family planning service use. In order to fulfil this unmet need of information, in 1995 the Nepalese Ministry of Health, with technical assistance from The Johns Hopkins University of Baltimore, started broadcasting a radio drama serial at the national level called *Cut your Coat according to your Cloth*. The drama was designed to educate and entertain at the same time, and was organized in weekly episodes where residents of fictional villages model communication regarding FPC and its beneficial effects. The series was broadcasted once a week in the Nepali language, in three phases: the first phase went on air from December 1995 to December 1996, the second from December 1997 to December 1998, and the third from January 1999 onwards. The scrupulous evaluations that have followed the project suggest a high exposure rate and a significant effect of the program on the population. In particular, women exposed to the FPC campaign after the exposure ameliorated their attitude towards FPC, initiated spousal communication regarding FPC issues, and adopted modern family planning techniques. For further details I remand to Storey and Boulay (2001).

In this chapter I use data from the Nepal Social Network Survey collected by the Population Communication Service of Johns Hopkins University. This survey refers to three villages named Gobardia, Tulsipur and Urahari located in the mid western district of Dang, which have been reached by the FPC radio campaign. Data were collected in two rounds: a baseline round in November 1997 and a follow-up survey in March 1999. In this chapter I mainly use the information from the 1999 follow-up round. In the Nepal Social Network Survey all married women aged 15-45 were interviewed. The survey provides information on personal characteristics, contraception habits and exposure to the FPC radio drama. Women were asked whether they had listened to the FPC radio drama in the past six months. This allows me to identify which women were treated, that is, reached

by the educational program. Additionally, the survey contains detailed information on interpersonal communication among women. Respondents were asked to name all women living in the same village with whom they had discussed FPC issues during the past six months. The identity of discussion partners was then traced and linked with their identity in the survey to produce a complete map of the village communication.

Each woman could mention up to 5 discussion partners, and overall 376 discussion partners were mentioned in the baseline round, and 420 in the follow-up round. A few mentioned partners (14% in the follow-up round) could not be matched to a survey respondent because they were living outside of the village, or they were living in the village but were ineligible for the survey due to their age, and therefore they have been dropped.

2.4 Evaluating the Transmission of Information

This section is devoted to clarify whether personal links are an effective bridge for information flows. In order to do that, I investigate whether, apart from direct exposure and peer exposure to the FPC radio drama, information spillovers from indirect exposure has an impact on individual contraception adoption.

2.4.1 Direct, Peer Level and Indirect Exposure

In the 1999 follow-up round of the Nepal Social Network Survey, respondents were asked to *"list the full names of those women in your village with whom you have discussed family planning in the last six months"*. This piece of information is used to define whether a link exists and to trace the network architecture for each of the three villages. The links are assumed to be reciprocal for two reasons: first, given the high specificity of the question posed to respondents, and given that interaction among women in the village is frequent and complex, women are more likely to forget about having discussed FPC issues with one of their friends rather than misreporting to have had discussions if this was not the case. Second, women could mention no more than 5 partners, therefore some well-connected women may have been forced to mention only their principal discussion partners rather than all of them. I thus assume links to be unweighted and undirected, and every time a woman mentions another one I draft a communication link between them.[1] With this procedure 310 links among the 337 women are identified overall. The resulting network is rather sparse, with 71 isolated women out of 337, an average

[1]The complete analysis has been also repeated under a stricter definition of network, where women are considered connected if each of them mentions the other as a FPC discussion partner. Results are similar in sign and magnitude but a few variables lose their significance, which is not surprising since under this definition the 310 links among 337 women reduce to 51 links only.

number of links equal to 1.8. The geodesic distance (that is, the number of steps in the shortest path between two women) has a mean value of 4.45 and a maximum value of 11 steps. For a graphical representation of the three villages' networks see Figure 1.B, Appendix B.

Once I have drawn the complete map of the communication networks in the three villages, I estimate how the likelihood of adopting modern contraception methods depends on the fact that the woman has been reached by the FPC radio drama directly and/or indirectly. Women in the sample are classified as contraception users if they reported using one of the following methods: oral contraceptives, IUDs, injectable methods, condoms, Norplant, female sterilization, or male sterilization. I concentrate my analysis on the six months period of time prior to the follow-up survey (October 1998-March 1999). I select the 151 women who at the beginning of the six months period were not pregnant and were not using a modern contraception method. Out of them, 129 were still not using a modern contraception method at the end of the six months period, while another 22 had adopted one by the end of the period.[2] In the empirical analysis, the sample will be reduced to 107 women still not using any contraceptive method and 20 women who adopted one in the six months prior to the survey, and this due to missing data.

I allow for three levels of exposure: a woman i is considered directly exposed to FPC information if she declared to have listened to the FPC radio drama in the reference period (October 1998-March 1999). In this case, the dummy variable $direct\,exposure_i$ equals one.

The second level of exposure relates to the group of peers, that is, the women in the village with whom i has a direct link (either because she declares to have discussed FPC issues with them or because they declare so). The variable $peer\,exposure_i$ is equal to the number of i's peers who self-report to have listened to the FPC radio drama in the six months prior to the survey (October 1998-March 1999). Since I am interested in the mechanism of information transmission, I use the fact that these friends have listened to the radio educational program rather than the fact that they use modern FPC methods themselves.

[2]All the information is recovered from the 1999 follow-up round in the following way: the women who did not adopt modern contraception are the ones who in the survey have declared that they have never used any contraception method. The women who have adopted modern contraception are the ones who in the survey declare that they have been using a modern contraception method for less than six months. One can criticize that a woman may have used a different contraception method in the past, and then switched to the current one, and this is still considered a contraception adoption. If this was the case it would still be compatible with the idea that exposure to FPC radio drama can help women to choose a better contraception method, which is *grossomodo* the effect to be isolated. However this seems not to be the case, since 20 women out of 22 have never used any method other than the one they have recently adopted.

The third level of exposure to the FPC radio drama is the indirect exposure accounting for community-level information spillovers, and refers to women with whom there is no direct communication. In order to define the concept of indirect exposure I take the women in the village who are not directly linked to a generic woman i, but are two steps away from her in that they are directly connected to one of her peers. Accordingly, the variable $indirect\,exposure_i$ corresponds to the number of women who have listened to the FPC radio drama in the six months prior to the survey out of all the women who are two steps away from i.

Even though it would be interesting to also estimate the effect of indirect exposure from women who are three or more steps away in terms on network distance, these variables are highly correlated with the other variables in use, and therefore are omitted.[3]

2.4.2 Basic Specifications and Results

I apply a probit model where the dichotomous dependent variable y_i equals one if the respondent had adopted a modern contraceptive method in the six months prior to the 1999 follow-up survey. Formally, for a generic woman i let us define the dummy $TREAT_i$ which equals one if i has listened to the FPC radio drama in the reference period. Thus for a set of covariates x_i, and defining the so-called geodesic distance t_{ij} as the number of links in the shortest path between i and j,[4] we obtain the following equations:

$$y_i = \beta x_i + \delta_0 \underbrace{TREAT_i}_{\equiv direct\ exposure_i} + \epsilon_i \tag{2.1}$$

$$y_i = \beta x_i + \delta_0 \underbrace{TREAT_i}_{\equiv direct\ exposure_i} + \delta_1 \sum_{t_{ij}=1}^{i \neq j} \underbrace{TREAT_j}_{\equiv peer\ exposure_i} + \epsilon_i \tag{2.2}$$

$$y_i = \beta x_i + \delta_0 \underbrace{TREAT_i}_{\equiv direct\ exposure_i} + \delta_1 \sum_{t_{ij}=1}^{i \neq j} \underbrace{TREAT_j}_{\equiv peer\ exposure_i} + \delta_2 \sum_{t_{ij}=2}^{i \neq j} \underbrace{TREAT_j}_{\equiv indirect exposure_i} + \epsilon_i \tag{2.3}$$

These three equations correspond to the three columns of Table 2.1. Equation (2.1) corresponds to column (1) in the Table 2.1 and represents the traditional strategy of program evaluation, where the individual outcome depends on whether the individual himself was reached by the educational program. The second equation (2.2) corresponds to column (2) in the Table 2.1 and can be seen as a case of peer-effect estimation, where self-reported information about the social relationships are used to construct the community network. Finally, equation (2.3) corresponds

[3] Let us define $3steps\,indirect\,exposure_i$ and $4steps\,indirect\,exposure_i$ as the number of women who have listened to the FPC radio program and are respectively 3 or 4 steps away from i. In the selected sample, the correlation between $indirect\,exposure_i$ and $3steps\,indirect\,exposure_i$ is 0.72, and the correlation between $3steps\,indirect\,exposure_i$ and $4steps\,indirect\,exposure_i$ is 0.86.

[4] By definition the geodesic distance is equal to ∞ if there is no path between i and j, which is by default the case if the two women do not belong to the same village.

to column (3) in the Table 2.1 and incorporates not only direct exposure and peer exposure, but also a variable for indirect exposure defined as in the previous subsection.

For what concerns the covariates, in Table 2.1 I include women's socio-economic characteristics and maternal background. Socio economic characteristics are: the age (coded with two dummies for 18-25 and 26-35 years respectively, while 36-45 years is omitted), the village (dummies for Tulsipur and Urahari, while Gobardia is omitted), the caste (coded with two dummies: Tharu, and Brahmins and Chhetris[5] while Others is omitted), and monthly household expenditure[6] (in quintiles). The education is expressed by a dummy that equals one if the woman has at least one year of schooling. The controls related to the maternal story of the respondent are: the number of previous pregnancies, and a variable called $desired\ children_i$ corresponding to the number of sons and daughters she still should give birth to in order to reach the number she consider the ideal one, if not reached yet.[7] Descriptive statistics for all the variables are reported in the Appendix B, Table 1.B (the table also report the t-test for *ex ante* differences between the women who adopted FPC methods at the end of the period and the one who did not). The estimation results are reported in Table 2.1 (also, marginal effects for the most complete specification in column (3) can be found in Appendix B, Table 2.B).

These results confirm that not only direct and peer exposure, but also indirect exposure to the FPC radio program effect women's behavior. The direct exposure to the program is always positive and significant, even when we introduce the other levels of exposure. Also the coefficients for peer exposure are positively significant in both (2) and (3), and similar in magnitude to the direct exposure ones.[8] For what concerns the indirect exposure, the magnitude of its effect in smaller but still positive and significant, which is consistent with the idea of community spillovers in the diffusion of information. The interpretation is straightforward: if we define i as the average respondent, one additional woman two-steps-away from i who has listened to the FPC radio drama increases i's likelihood of adopting a modern contraception method by the corresponding marginal effect. This evidence suggests that the three effects are complementary, and all contribute to determine the individual behavior.

[5]Brahmins and Chhetris are considered to have similar cultural systems and therefore they are grouped in a single category (See Boulay et al., 2002).

[6]Women who reported not knowing their monthly expenditure were coded at the midpoint of the distribution.

[7]Respondents were asked *"if you could choose exactly the number of sons and daughters to have in your whole life, how many would that be?"*. Women answered separately for boys and girls. For each gender I calculated the difference between the ideal number of children and the number of children born and currently alive; if this difference is negative I set it to zero. The final variable is the sum of the two differences calculated by gender.

[8]The magnitude is likely to depend on the endogeneity of direct exposure (see subsection 2.4.3).

Table 2.1: Estimated Probit Coefficients, Basic Specifications

Dependent variable: FPC adoption			
	(1)	(2)	(3)
direct exposure	0.341	0.644	0.522
	(0.008)**	(0.000)**	(0.016)*
peer exposure		0.722	0.647
		(0.000)**	(0.000)**
indirect exposure			0.157
			(0.024)*
18-25	1273	0.951	0.916
	(0.001)**	(0.001)**	(0.000)**
26-35	1118	0.798	0.760
	(0.000)**	(0.000)**	(0.000)**
village Tulsipur	1182	2202	2325
	(0.000)**	(0.000)**	(0.000)**
village Urahari	1375	2479	2572
	(0.000)**	(0.000)**	(0.000)**
Brahmins or Chhetris	-0.488	-0.916	-0.930
	(0.424)	(0.068)	(0.095)
Tharu	-0.359	-0.804	-0.935
	(0.572)	(0.120)	(0.097)
attended school	-0.237	-0.576	-0.491
	(0.375)	(0.017)*	(0.053)
household expenditure	-0.124	-0.290	-0.337
	(0.002)**	(0.000)**	(0.000)**
desired children	-0.943	-1219	-1319
	(0.000)**	(0.000)**	(0.000)**
previous pregnancies	0.192	0.192	0.190
	(0.014)*	(0.037)*	(0.039)*
constant	-2764	-3325	-3227
	(0.014)*	(0.006)**	(0.007)**
Observations	127	127	127

robust p-values in parenthesis

$*$significant at 5%; $**$ significant at 1%

The estimated coefficients for the remaining controls go in the expected direction. Age variables are positively significant, and suggest that *ceteris paribus* younger women are more likely to adopt modern contraception (perhaps because they are more fertile or sexually more active, or simply because younger cohorts are more open to non-traditional behavior). Village effects are significant, while caste dummies seem not to be. Having at least one year of education is not significant in two out of three specifications presented, and negative in sign. This negative sign seems to suggest that when women who are somehow educated do

not use contraception, they are less incline to change this behavior afterward. In other words, women with no education are more likely to choose their contraception habits because of external reasons like a lack of information, and therefore are more easily impacted by the educational program. However, education in highly correlated with caste belonging, which may explain part of the result.[9] Household monthly expenditure is significant and negative in sign, which suggests that FPC is mostly used by those households who are financially constrained. As expected, an unmet desire for children as proxied by the variable $desired\ children_i$ discourages contraception adoption, while a higher number of pregnancies encourages it.

2.4.3 Instrumental Variables Approach

In this subsection I extend my basic model correcting for the endogeneity in the direct exposure to the FPC radio drama, and finally I introduce a few more controls to check the robustness of my results.

In my current framework, there are two kinds of endogeneity to be concerned about, both related to the fact that some unobserved characteristics, for instance *a priori* attitude toward FPC, might be correlated with both the direct and indirect exposure to the FPC radio drama and the contraception adoption. The current subsection treats the endogeneity of the direct exposure lead by the fact that women may decide to listen or not to the FPC radio drama depending on their *a priori* attitude. The second source of endogeneity, which relates to peer exposure and indirect exposure, works indirectly through the choice of discussion partners. In fact women may be more likely to exchange information with other women who share their *a priori* attitude toward FPC. This second source of endogeneity will be discussed in Section 2.5.

Running a Rivers and Vuong (1988) test, the exogeneity of direct exposure is rejected with a p-value smaller than 1%. Therefore I make use of two instruments: a dummy which equals one if the respondent reports to listen to the radio everyday or almost everyday ($radio\ daily_i$) and a dummy which equals one if anybody in her household owns a radio that works ($radio\ owned_i$) . Following Heckman (1978) and Evans and Schwab (1995), I thus estimate the bivariate probit system

$$\begin{aligned} \underbrace{TREAT_i}_{\equiv direct\ exposure_i} &= \gamma_1 radio\,daily_i + \gamma_2 radio\,owned_i + \beta_1 x_i + \\ &\delta_1 \sum_{\substack{i\neq j \\ t_{ij}=1}} \underbrace{TREAT_j}_{\equiv peer\ exposure_i} + \delta_2 \sum_{\substack{i\neq j \\ t_{ij}=2}} \underbrace{TREAT_j}_{\equiv indirect\ exposure_i} + \epsilon_{1i} \end{aligned} \tag{2.4}$$

[9] Brahmins and Chhetris are the most educated: out of the 32 women in my sample, 15 have at least one year of schooling, which account for 71% of total educate woman in the sample. On the other side, out of the 82 Tharu women, only 2 of them have at least one year of schooling.

$$\begin{aligned} y_i = & \beta_2 x_i + \delta_0 \underbrace{TREAT_i}_{\equiv direct\ exposure_i} + \delta_1 \sum_{\substack{i \neq j \\ t_{ij}=1}} \underbrace{TREAT_j}_{\equiv peer\ exposure_i} + \\ & \delta_2 \sum_{\substack{i \neq j \\ t_{ij}=2}} \underbrace{TREAT_j}_{\equiv indirect\ exposure_i} + \epsilon_{2i} \end{aligned} \tag{2.5}$$

where y_i^* is the respondent unobserved propensity of using FPC, $TREAT_i^*$ is her unobserved propensity of listening to the FPC radio drama,

$$y_i = \begin{cases} 1\ if\ \ y_i^* > 0 \\ 0\ otherwise \end{cases} \tag{2.6}$$

$$TREAT_i = \begin{cases} 1\ if\ \ TREAT_i^* > 0 \\ 0\ otherwise \end{cases} \tag{2.7}$$

and (ϵ_1, ϵ_2) are bivariate normal disturbances.

Table 2.2 presents the results from the bivariate probit estimation. The two columns of (4) refer to the bivariate probit system estimated with the same set of regressors as in Table 2.1. In the first column the results from ancillary equation are reported while the second column refers to the main equation. All previous findings are reconfirmed: not only $direct\,exposure_i$, but also $peer\,exposure_i$ and $indirect\,exposure_i$ are positive and significant. Interestingly, after its instrumentation the coefficient of $direct\,exposure_i$ has a significant increase in magnitude with respect to the standard probit coefficients of Table 2.1. For what regards the other variables, results are consistent with previous findings, with the only exception that caste is now significant.

Finally, in the two columns of specification (5) I report an additional robustness check adding a few additional regressors to the bivariate probit. Among these additional regressors: a dummy $young\,child_i$ that equals one if the youn- gest child has less than 18 months, and a dummy $group\,belonging_i$ that equal one if the woman participates to a community group. Aside I also control for the percentage of couple in the village that the respondent believes to use FPC methods. In fact, the more people use FPC, the higher the individual probability of FPC adoption is, because both uncertainty of the technology and social sanction decrease. However, since this variable is likely to be endogenous (that is, women who use FPC methods may state that most people do so) I proxy this effect using this same piece of information as it is in the 1997 baseline data. Therefore, the dichotomous variable $perceived\,FPC\,use_i$ equals one if in 1997 survey the respondent believed that

Table 2.2: Bivariate Probit Results

	(4)		(5)	
Dependent variable:	Direct Exposure	Adoption	Direct Exposure	Adoption
direct exposure		1.878		1.867
		(0.000)**		(0.000)**
peer exposure	-0.200	0.613	-0.257	0.633
	(0.050)*	(0.000)**	(0.211)	(0.001)**
indirect exposure	0.027	0.097	0.036	0.149
	(0.849)	(0.000)**	(0.673)	(0.008)**
18-25	0.457	0.907	0.463	1.335
	(0.321)	(0.008)**	(0.513)	(0.005)**
26-35	0.534	1.086	0.523	1.292
	(0.159)	(0.000)**	(0.199)	(0.000)**
village Tulsipur	-0.856	2.537	-0.607	2.707
	(0.001)**	(0.000)**	(0.310)	(0.000)**
village Urahari	-0.425	2.495	0.015	2.374
	(0.081)	(0.000)**	(0.980)	(0.001)**
Brahmins or Chhetris	0.925	-1.255	1.122	-1.277
	(0.000)**	(0.023)*	(0.010)**	(0.000)**
Tharu	0.880	-1.038	0.977	-1.594
	(0.133)	(0.014)*	(0.000)**	(0.003)**
attended school	0.535	-0.863	0.613	-0.844
	(0.530)	(0.000)**	(0.388)	(0.000)**
household expenditure	0.124	-0.331	0.078	-0.378
	(0.008)**	(0.000)**	(0.270)	(0.000)**
desired children	-0.176	-0.963	-0.199	-0.991
	(0.707)	(0.000)**	(0.626)	(0.000)**
previous pregnancies	-0.036	0.217	-0.025	0.331
	(0.834)	(0.093)	(0.879)	(0.017)*

Table 2.2: Bivariate Probit Results (Continued)

	(4)		(5)	
young child			-0.272	0.269
			(0.261)	(0.371)
group belonging			-0.584	0.853
			(0.008)**	(0.031)*
perceived FPC use			0.377	0.455
			(0.559)	(0.422)
declared friends			0.156	-0.065
			(0.609)	(0.781)
constant	-1.802	-3.775	-2.122	-4.499
	(0.035)*	(0.000)**	(0.048)*	(0.000)**
radio owned	1.172		1.233	
	(0.000)**		(0.005)**	
radio daily	0.852		0.810	
	(0.000)**		(0.017)*	
observations	127	127	127	127

robust p-values in parenthesis

$*$ significant at 5%; $**$ significant at 1%

more than half of the couples in their village were using a contraceptive method. Finally, according to my definition, links are undirected, that is, two women are considered connected if at least one of them mentions the other, but this does not reflect the disparities between woman who mention several discussion partners, and women who are mainly mentioned. In fact, women who mention several discussion partners may be more accurate in recalling their names because they are more sensitive to the issue of FPC, and/or because at the time of the conversation they were explicitly looking for information on the topic. In order to control for this effect, the variable $declared\,friends_i$ which expresses the number of friends the woman has mentioned (rather than the total number of links, which is identified by her declarations as well as other women responses) is included among the controls.

Results from (5) are comparable with the previous findings, and the importance of indirect exposure is preserved. Additionally, $group\,belonging_i$ seems to positively affect contraception adoption, while the other three variables $young\,child_i$, $perceived\,FPC\,use_i$ and $declared\,friends_i$ are not significant.

2.5 Dealing with the Endogeneity of Networks

The endogeneity of network is the oldest argument, and still the most important threat to the validity of any study dealing with peer effects. One can in fact argue

that two women discuss FPC issues because they have *a priori* the same opinion. If this was the case, this so-called assortative matching among discussion partners would introduce a component of endogeneity in the variables accounting for peer and indirect exposure, and bias the results presented in Section 2.4. Let us assume that women with a good *a priori* opinion toward FPC are more likely to listen to the radio drama, and that women select discussion partners with similar *a priori* opinion toward FPC: in this case the coefficients for peer exposure and indirect exposure would absorb the effect of unobserved individual characteristics (good *a priori* opinion toward FPC) and the impact of these variables would be overestimated. This source of endogeneity is non-standard, and it cannot simply be corrected with traditional techniques since the variables expressing peer exposure and indirect exposure incorporate two pieces of information (namely the link among women and the treatment status of all women in the community) that cannot be disentangled. In what follows, an instrumental variable approach is used to shed light on this point.

My goal is to estimate whether women in my sample choose FPC discussion partners with their same *a priori* opinion. In the estimates reported in Table 2.3 the units of observation are the dyads, that is, the unique pairs of women within the same village who may or may not have discussed FPC among them. Dyads' number goes from 19530 to 13330, depending on the specification. For each dyad ij, the dichotomous dependent variable $link_{ij}$ equals one if (at least) one of them mentions the other among her FPC discussion partners.

In both 1997 baseline survey and 1999 follow-up survey respondents were asked in details about their attitude toward FPC. This was assessed by asking them to indicate their level of agreement on a four-point Likert scale to a battery of statements. The statements were based on prior qualitative studies assessing the attitudes that influence contraceptive use in Nepal (see Boulay et al., 2002). Individual items were then recoded with higher responses indicating a more favorable attitude toward family planning and with "Don't know" responses coded at the midpoint. With this piece of information for each respondent two variables were calculated: $FPC\ attitude_i$ (referring to the 1999 follow-up survey) and $FPC\ attitude\,1997_i$ (referring to the 1997 baseline survey).[10] In the entire sample,

[10]For each statement, the respondent stated one of the following: "strongly agree", "agree", "don't know", "disagree", "strongly disagree"; these answers were coded in order from 1 to 5. The final variables are the average score calculated on the following 18 statements: "Each child is born because of LUCK", "Children are a gift from God; we should accept them as they come along", "I would rather have a boy than a girl", "It is necessary to keep having children until a boy is born", "If a wife has only girls, the husband should marry another woman", "Child care is not a father's responsibility", "People who use condoms are promiscuous", "Family planning causes promiscuity", "People who use family planning lose the respect of their family and friends", "When a woman uses a contraceptive method her husband becomes angry", "If a woman uses a temporary contraceptive method, she may become sterile", "Religion is against a woman using family planning methods", "Contraceptives have dangerous side-effects", "The majority of people who use family planning are rich", "Wives should get

the correlation between $FPC\ attitude_i$ and $FPC\ attitude\ 1997_i$ is 0.19.

The network declared in 1997 survey is almost totally different from the one declared in 1999: the percentage of 1997 ties that were dropped in 1999 survey is 71%, 74% and 85% for the three villages respectively, and the percentage of new ties that were added in 1999 is 92%, 78% and 80% (Boulay et al., 2002). Therefore I can estimate whether the existence of a link is connected to the same *a priori* opinion about FPC, instrumenting the current attitude with the past one: when a link ij exists in the 1999 follow-up data, opinion of agent i in 1997 is by construction correlated to her own opinion in 1999 but not to the opinion of agent j in 1999.

My variables of interests are: the current difference in FPC attitude between the two partners $gap\ FPC\ attitude_{ij} = |FP\ attitude_i - FP\ attitude_j|$, and the analogous variable $gap\ FPC\ attitude\ 1997_{ij}$ calculated on the 1997 baseline survey data. The specification (6) in Table 2.3 reports the results from a standard probit model with link ij as dependent variable and $gap\ FPC\ attitude_{ij}$ among the regressors. In (7) the variable $gap\ FPC\ attitude\ 1997_{ij}$ is used instead. Finally, (8) I report results from a probit model with endogenous regressors, where $gap\ FPC\ attitude_{ij}$ is instrumented with $gap\ FPC\ attitude\ 1997_{ij}$.

The remaining dyadic covariates are common to all three specifications. Among them, I include: the age difference between i and j, two dummies equal to one if both women or none of them has ever attended school respectively, a dummy equal to one if the women belong to the same caste, and their difference in household monthly expenditure (in rupees, rescaled). I also include control dummies which are respectively equal to one if both women have already been pregnant, both have a child less than 1.5 years old, both belong to a community group, and they have a language in common. Village fix effects are also included.

When in (6) only the current difference in FPC attitude is taken into account, this not surprisingly turns out to be significant and negative in sign, that is, ex post FPC attitudes of discussion partners is likely to converge as a result of reciprocal influence. However, when in (7) I use the 1997 gap in attitude to proxy for the a priori divergence instead, its coefficient is not significant anymore. As a final step, in (8) the current $gap\ FPC\ attitude_{ij}$ is instrumented with $gap\ FPC\ attitude\ 1997_{ij}$, and results also reconfirm that the a priori gap in attitude does not affect link formation. Taken altogether this evidence suggests that, even if discussion naturally leads to ex post convergence in opinion, women seem not to choose their discussion partners on the basis of their *ex ante* opinion about FPC issues.

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their husband's permission before taking any contraceptives", "Sterilization makes you weak", "Pills make you weak", "Sterilization gives you a backache".

Table 2.3: Dyadic Analysis, Probit and IV Probit Coefficients

Dependent variable: link_{ij}			
	(6)	(7)	(8)
	Probit	Probit	Biprobit
gap FPC attitude	-0.066		-0.100
	(0.013)*		(0.956)
gap FPC attitude 1997		-0.004	
		(0.957)	
age difference	-0.020	-0.028	-0.027
	(0.001)**	(0.000)**	(0.000)**
both schooling	0.220	0.189	0.195
	(0.034)*	(0.006)**	(0.013)*
none schooling	-0.285	-0.369	-0.384
	(0.057)	(0.004)**	(0.299)
same caste	0.785	0.830	0.823
	(0.000)**	(0.000)**	(0.000)**
difference in expenditure	-0.012	-0.017	-0.017
	(0.000)**	(0.004)**	(0.003)**
both already pregnant	0.280	-0.027	-0.031
	(0.000)**	(0.523)	(0.292)
both have a child <1.5 years	-0.016	0.015	0.018
	(0.885)	(0.886)	(0.801)
both in a community group	0.561	0.636	0.623
	(0.000)**	(0.000)**	(0.004)**
language in common	0.515	0.464	0.469
	(0.000)**	(0.000)**	(0.000)**
village Tulsipur	0.223	0.248	0.246
	(0.000)**	(0.000)**	(0.012)*
village Urahari	-0.221	-0.197	-0.214
	(0.000)**	(0.000)**	(0.558)
constant	-2.992	-2.572	-2.493
	(0.000)**	(0.000)**	(0.128)
observations	19530	13330	13330

robust p-values in parenthesis

$*$ significant at 5%; $**$ significant at 1%

According to my dyadic analysis, several variables other than ex ante opinion are determinants of link formation. In particular, my results suggest that women are more likely to discuss FPC issues if they are close in age, they both had some schooling, they belong to the same caste, they have a similar economic status proxied by their household monthly expenditure, they both belong to a community group or they share a common language. These variables altogether define the social group for the women in these villages, and it is within the border of this

reference group that women communicate and exchange information.

To conclude, since it seems to be the case that women get together to discuss FPC issues on the basis of individual and social characteristics other than their *ex ante* opinion, results from the dyadic analysis are against the hypothesis of overestimation of indirect treatment effects. Findings from Section 2.4 suggest that peer exposure and indirect exposure to the FPC radio drama increase the probability of adopting a modern contraception method. The dyadic results presented in the current section rule out endogeneity of network links to reconfirm the validity of previous findings.

2.6 Conclusions

This chapter focuses on three villages in rural Nepal where an educational radio program about family planning and contraception methods is weekly broadcasted, and women share this new information during their informal discussions with friends. I study how information is spread among peers, focusing on the role of the community as a bridge for information flows. My goal is to estimate the magnitude of information spillovers from indirect contacts, and evaluate whether indirect information affect women's decision of adopting a modern contraception method. This chapter contributes to the literatures of networks and peer-effects. Previous studies on peer-effects consider the individual outcome as a function of his characteristics, and the characteristics of his neighborhood of friends. However in doing so, they disregard the network effects. Even if women exchange information with their direct friends only, through them they have access to the information spread by thirds. I therefore take a wider perspective, considering not only direct peers, but also indirect contacts as determinants of individual outcome. In order to do that, I explicitly take into account the social structure of the community that emerges from the self-reported links among women. That is, following network theory I claim and demonstrate than in equilibrium not only direct friends matter, but also the friends of these friends, and all other agents in the community can impact individual outcome through network spillovers.

2.7 Appendix B

Figure 1.B.1: The Network in the Village of Gobardia

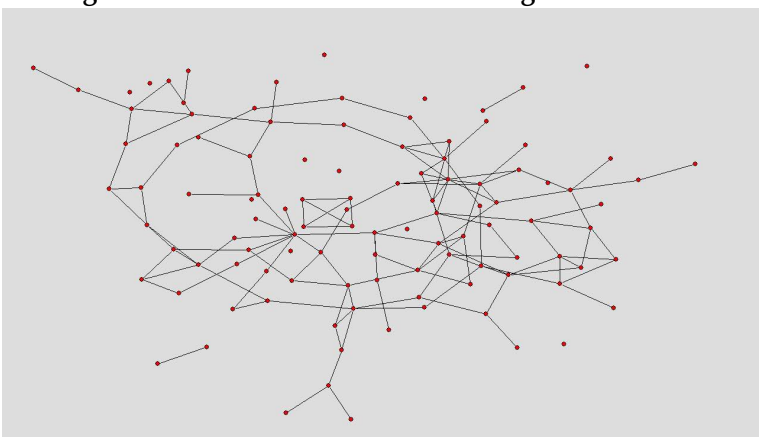

Figure 1.B.2: The Network in the Village of Tulsipur

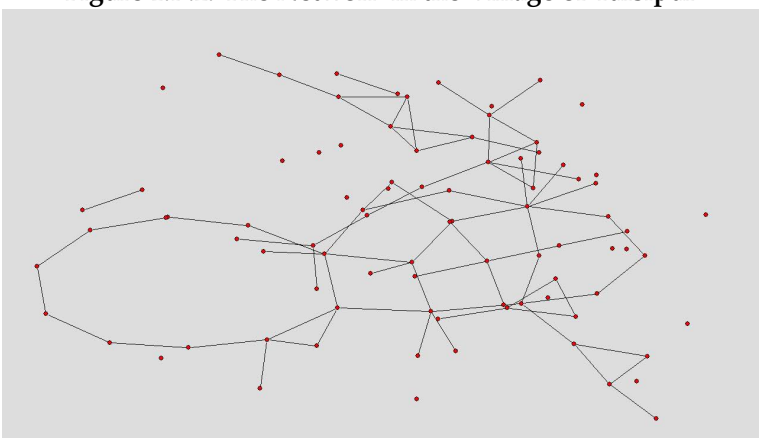

Figure 1.B.3: The Network in the Village of Urahari

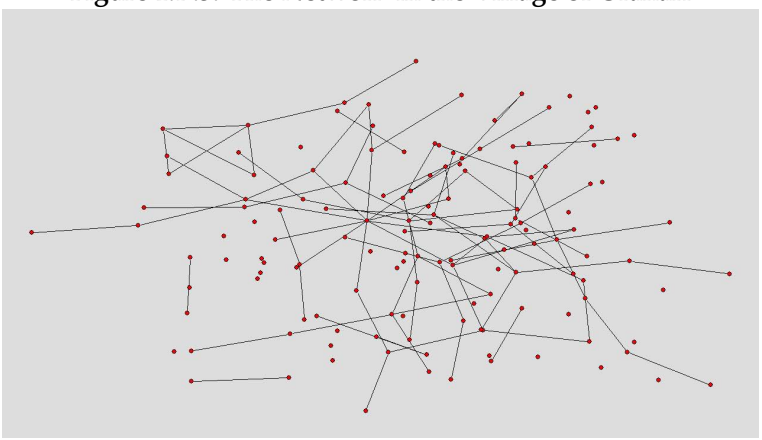

Table 1.B: Descriptive Statistics (n=127)

Variable	Mean	s.d.	P value[11]
direct exposure	0.496	0.502	0.657
peer exposure	0.906	1.123	0.087
indirect exposure	1.528	2.096	0.867
18-25	0.504	0.502	0.136
26-35	0.370	0.485	0.070
village Tulsipur	0.260	0.440	0.320
village Urahari	0.457	0.500	0.164
Brahmins or Chhetris	0.252	0.436	0.983
Tharu	0.646	0.480	0.645
attended school	0.165	0.373	0.395
household expenditure	2.449	1.367	0.481
desired children	0.772	0.632	0.000
previous pregnancies	3.110	2.063	0.010
young child	0.606	0.491	0.354
group belonging	0.110	0.314	0.030
perceived FPC use	0.354	0.480	0.292
declared friends	0.945	1.157	0.660
radio owned	0.512	0.502	0.394
radio daily	0.496	0.502	0.315

[11]P-value for the t-test on the women who adopted FPC methods and the one who did not (n=20 and n=107, respectively), for the H0 of no statistically significant difference among the two groups.

Table 2.B: Marginal Effects of (3), Table 2.1

Dependent variable: FPC adoption	
direct exposure	0 .0431
	(0.004)**
peer exposure	0 .0519
	(0.000)***
indirect exposure	0 .0126
	(0.090)*
18-25	0 .0786
	(0.002)**
26-35	0 .0756
	(0.000)***
village Tulsipur	0 .4638
	(0.000)***
village Urahari	0 .3456
	(0.000)***
Brahmins or Chhetris	-0 .0534
	(0.027)**
Tharu	-0 .1007
	(0.183)
ever attended school	-0 .0298
	(0.042)**
household expenditure	-0 .0270
	(0.000)***
desired children	-0 .1059
	(0.000)***
previous pregnancies	0 .0153
	(0.032)**
observations	127

robust p-values in parenthesis

$*$ significant at 10%; $**$ significant at 5%, $***$ significant at 1%

Chapter 3

Democracies, Politics and Arms Supply: A Bilateral Trade Equation

3.1 Introduction

The trade in arms, especially when it involves developing countries, has crucial economic and ethic implications: the latest report estimates that the last 15 years of conflicts have cost Africa around 300$ billions (a sum that is equivalent to international aid from major donors in the same period), and that at least 95% of Africa's most commonly used conflict weapons come from outside the continent.[1] However, even though during the past decades the public concern on the market for arms has increased exponentially, it has not received equal attention by economists and political science scholars. As a better understanding of the arms market functioning is the first step toward efficient policy measures, this study wants to be a contribution in this direction.

The economic papers focused on arms trade are not very numerous. All these contributions either are theoretical (Peleg, 1977; Levine and Smith, 1995; Levine and Smith, 1997; Levine and Smith, 2000) or relate to the demand side of arms trade (Smith and Tasiran, 2005; Pearson, 1989; Kollias and Sirakoulis, 2002) while the determinants of arms supply haven't been investigated yet. My empirical analysis focuses on the supply side of arms market to answer a question that relates to economics and politics: whether the government's political orientation in the exporting country influences the amount of arms actually supplied to third countries. To answer this question, a gravity-type bilateral equation with a TOBIT framework is estimated for the years 1975-2004. Gravity-type equations have never been applied to arms trade, while they are commonly used in trade literature (Bergstrand,

[1] IANSA, Oxfam, and Safeworld (2007).

1985; Egger, 2000). In particular I refer to Summary (1989) who uses a gravity framework to check whether international political factors affect US trade.

Since the market of arms shows different features for different products, I restrict the attention to major conventional weapons (henceforth MCW), a technologically advanced share of the arms production sector. MCW include aircrafts, armored vehicles, artillery, radar systems, missiles, and ships; it does not include small arms.[2] All along the XXth century the MCW industry has been highly concentrated: my studies focuses on the 20 major MCW exporting countries, which alone account for 97% of total worldwide exports for the period 1975-2004. Only five out of these twenty countries have ever experienced an autocratic regime. Most of the following analysis focuses on the remaining democracies, which account for more than 65% of total MCW exports for the period 1975-2004.

The trade in arms is not just business but also a foreign policy issue, involving strategic and political interests together with economic ones (Krause, 1991; Smith, Humm and Fontanel, 1985; Skons, 2000). International relations during the Cold War have alimented the general perception of arms trade being a political affair, which is far from being *naïve* since governments can influence the arms export process through several channels. The market for arms lacks an international regulation, being therefore subject to each country's sovereignty. Arms export licenses are exclusively granted by governmental agencies (mostly inter-ministerial committees)[3], and can be easily revoked by them. Even if nowadays licenses for some destinations are automatically granted, the armament industry is still under national control: in virtually all exporting countries a relevant share of the arms industry is state property.[4] Moreover, arms orders are political tools in that they may be used to boost the employment of industrial regions.[5] In fact the armament sector attracts subsidies and other measures in defense of national industry. A well-documented case is the export credits granted by the UK Export Credit Governmental Department. Martin (1999) concludes that in the UK each job generated by arms export is subsidized by just under 2000 pounds per annum and that a one-third reduction in UK defense exports would save the taxpayer 76 million pounds per annum at 1995 prices. For an overview of the national export controls system

[2]For what concerns small arms the share of black market is greater, and therefore no reliable and an exhaustive dataset of transfers is available. Moreover, the industry is less concentrated and nowadays most countries, even among developing ones, produces some amounts of small arms.

[3]Few countries have made their arms licensing regulation more transparent through secondary legislation, while the majority of them leave all details to inter-ministerial committees. The license decisions pass through the inter-ministerial committee responsible for them; defense, economic, security ministries and parliament are normally represented. Regulated systems are flexible and subject to varied interpretation and enforcement by the government. For an essay on the topic, see Miller and Brooks (2001).

[4]The list of Top 100 arms-producing companies (containing information on sales, profit, employment and ownership) is provided by SIPRI and on line on its website.

[5]Martin, Hartley and Stafford (1999) estimate the potential effect of a reduction of UK arms exports on national employment.

of major MCW see Appendix D, which reports for each exporter detailed information on legislation of reference, licensing authority and consultation procedures, end-user requirements, types of licenses and procedures for license negotiation, exemption and revocation.

Thus, assuming that arms trade is both an economic and a foreign policy issue, and that governments control arms exports through different channels, it is worth to test whether the government's political orientation affects arms export decisions. In Section 3.5, I first provide evidence that arms export trends from democratic and autocratic regimes differ, and then exclude from the sample major non-democratic MCW producers to concentrate on democracies only. My aim is to assess eventual differences between right, center or left wing democratic executives in arms export policy.

In the empirical specification adopted, the amount of conventional arms transferred among countries is the dependent variable of a bilateral trade equation that develops along three dimensions: importer, exporter and time. The sample of exporter is restricted to the twenty major arms producers, while importers are all independent countries recognized by UN. The equation is estimated for years 1975-2004, that is, the core of Cold War and the years right after. The strategy followed is rather innovative because I estimate a panel TOBIT; why this choice is consistent with the nature of data and the scope of the analysis will be discussed in Section 3.3.

The results give original insights into the phenomenon of arms trade, suggesting that in democratic countries the government in power being right wing significantly increases the quantity of arms exported. This may reflect a general right-wing tendency to lower trade barriers, with its consequences on deregularization of heavy industry exports, or a greater importance of national industry in political agenda, resulting in a higher economic support toward the armament sector.

The rest of the chapter is organized as follows: Section 3.2 reviews the relevant literature, while in Section 3.3 the model is described. Section 3.4 goes over data and variables in use. In Section 3.5 results are presented, and Section 3.6 concludes. Tables and figures are presented in Appendix C. Appendix D contains an overview of arms national export control systems for the exporter countries.

3.2 Literature Review

As previous contributions point out (Krause, 1991; Smith, Humm and Fontanel, 1985; Skons, 2000), trade in arms is not just business but also a foreign policy issue, involving strategic and political interests together with economic ones. This chapter departs from this evidence to investigate whether the political orientation

of the arms exporter's government has an impact on the quantity of arms supplied to third countries.

As Hartley and Sandler (1995) point out, there is surprisingly little theoretical and empirical development of the economics of arms trade, and the few contributions face the central problem of going beyond the proliferation of (albeit useful) policy position articles, to a more solid base of theoretical and empirical models.

Most studies on arms market follow the theoretical approach initiated by Peleg (1977). Among them, Levine and Smith (1995) propose a dynamic model of arms trade where there are a small number of profit-oriented suppliers and a large number of buyers, and they use the model to evaluate the potential effectiveness of arms control regimes. On an analogous line, Levine and Smith (2000) develop a partial equilibrium model of the international arms market to compare different regimes, from *laissez-faire* to a common defense policy. Levine and Smith (1997) model a game between two hostile countries getting involved in arms races; this framework will be later extended to birth-death stochastic processes by Kollias and Sirakoulis (2002).

The empirical contributions on arms market are not numerous and mostly relate to the demand side. Pearson (1989) identifies clusters of variables correlated with arms imports levels, while Smith and Tasiran (2005) estimate the determinants of arms imports for a panel of 52 countries. On the supply side, Blanton (2000) focuses on US arms export policy checking whether human rights and democratic governance are determinants of arms transfers. On a different line, Brauer (2000) compares potential and actual levels of production in arms producer countries.

To the best of my knowledge, no previous empirical study has simultaneously taken into account demand and supply side of the arms market. Gravity-type equations have been extensively used in economics of trade (Frankel and Romer, 1999; Egger, 2000; Anderson and Wincoop, 2003), while I am the first one applying the gravity model to explain the equilibrium level of arms traded. In particular I refer to Summary (1989) who develops a gravity-type bilateral equation to check whether, apart from traditional economic variables, also international political factors affect US generic trade.

3.3 The Model

The econometric specification in use departs from previous gravity equation literature, since a panel TOBIT model is adopted. A TOBIT specification seems the most appropriate because the amount of arms traded between two countries for a given year equals zero for an important proportion of observations (around 90% in the basic specification). The abstract model estimated is thus

$$Y_{ijt} = \begin{cases} Y^*_{ijt} \; if \;\; Y^*_{ijt} > 0 \\ 0 \quad if \;\; Y^*_{ijt} \leq 0 \end{cases}$$

given

$$Y^*_{ijt} = x^{'}_{ijt}\beta + c_{ij} + u_{ijt}$$
$$u_{ijt}|x_{ij}, c_{ij} \sim N(0, \sigma^2_u)$$

where $c_{ij} \sim N(0, \sigma^2_u)$ describes the unobserved random effect and the set of variables $x^{'}_{ijt}$ explain both the latent variable Y^*_{ijt} and the observed outcome.

The panel is unbalanced and evolves along three dimensions: exporter, importer and time; the year and the pair $exporter \times importer$ identify each dependent observation. The period under analysis is 1975-2004, where all data are available. I take into account the twenty major MCW producer countries from the overall 1950-2006 rank by the Stockholm International Peace Research Institute (SIPRI). These exporters -in order of importance- are: the USA, the USSR, the UK, France, Russia, China, West Germany (FRG), Czechoslovakia, Italy, Unified Germany (GMY), Netherlands, Sweden, Canada, Poland, Israel, Spain, Ukraine, Switzerland, Brazil, Norway. These twenty countries alone account for 97% of total MCW exports for the period 1975-2004; adding more exporters would results in a computationally intractable dataset.[6] Out of the twenty countries in the sample, the non-democratic ones are: the USSR, China, Czechoslovakia, Poland 1975-1988, Brazil 1975-1984. Taking away these cases, the remaining democracies still account for more than 65% of total MCW exports for the period 1975-2004. On the import side, all 200 independent countries recognized by UN and existing in the period under analysis are included in the sample of potential importers, subject to data availability.[7]

[6] MCW trade is not frequent. Even reducing the sample of the exporters to twenty producers, in 90% of the observations the quantity of arms traded is zero. If we build a squared dataset where all existing countries are potential exporters, the dataset becomes computationally intractable.

[7] Importing and exporting countries are classified as in the Correlated of War Project 2005 State System Membership List, v2004.1. The only exception is Russia and the USSR which I code separately (USSR data goes until 1991 included, and Russia from 1992 onwards). For the sake of completeness I have also included among potential arms importers the countries that have never imported nor exported arms (Andorra, Antigua and Barbuda, Dominica, East Timor, Liechtenstein, Monaco, Nauru, San Marino, Sao Tome e Principe, Santa Lucia, Nauru).

The equation to be estimated is thus

$$arms_{ijt} = \beta_0 + x_{ijt} + \delta_{ij} + u_{ijt} \tag{3.0}$$

Where the dependent variable is the MCW flow from country i to country j at time t, and the covariates x_{ijt} vary along one or more dimensions. The random effect terms δ_{ij} refer to bilateral interactions between countries and are therefore supposed to describe time-invariant geographical-political-historical-cultural relations like long run government friendship and colonialism, and trade impediment measures as distance, common language, and border dummies. By construction δ_{ij} also account for individual exporter effects.

A last issue to be mentioned is the time delay in the delivery of arms. Since many different categories of arms are grouped under the MCW label, no theory can help us assess the amount of time between the signature of the contract and the delivery of the good. Procedures vary from country to country, as reported in the Appendix D. Despite this, it seems reasonable to assume that responses to political changes are relatively fast. Even if the production of some arms can take up to a few years, licenses are usually required not for the negotiation of the contract but for the delivery.[8] When licenses to delivery arms are granted, they expire in a relatively short time (within one year for France and Italy). Moreover, licenses can be discretionally revoked by the governmental agency at any time, or at least under a wide range of circumstances. Therefore, although specifications with lags have been run as well, it seems reasonable to test the model in the structure presented above.

3.4 Data and Variables Description

This section is devoted to present the main features of the data and the variables in use. Different specifications make use of different subsets of variables, which are all described here for the sake of simplicity. The subscripts following each variable name (i for exporter, j for importer, t for time) are there to remind along which dimensions the variable varies. Unless differently specified, the data are available for the years 1975-2004, which is the time span of the basic specification, that is,

[8] A license is required also to open negotiations in few specific cases, enumerated in what follows. In Germany an authorization to negotiate is necessary only if intermediaries located in foreign territory are involved. In Italy, companies must be in the national register of arms exporting companies to be able to contract for exports of military items. In the USA negotiation is free, except if technical information relevant for national security is revealed in the course of contract. In France licenses are required both for negotiating and delivering arms; in any case, the two procedures are independently conducted and both licenses expire within one year, which is a reasonably short time length.

the smaller period for which all data are available.

Data on MCW trade come from the Arms Transfers Database by the Stockholm International Peace Research Institute (SIPRI).[9] MCW consist in aircrafts, armored vehicles, artillery, radar systems, missiles, and ships; they do not include small arms and light weapons.[10] SIPRI data register MCW transfers to sovereign countries (as well as international organizations, rebel groups, factions and non-governmental armed forces, as they appear under a recipients´ heading different from the country's central government). In order to be registered in the SIPRI dataset weapons must be transferred voluntarily by the supplier and must have a military purpose; time of transfer refers to the moment when delivery is registered. Units of arms are computed according to a trend indicator value system developed specifically by SIPRI for this purpose: instead of economic price, it reflects amounts transferred. The SIPRI trend indicator measures military resources by including an evaluation of the technical parameters of the weapon: similar weapons have similar values. Thus the concept of military resources reflects both the quantity and the quality of the weapons transferred.[11] The quantity measure by SIPRI is a trend indicator that registers the changes in flows of military resources; this feature improves the quality of the information in several ways. First, in many cases no reliable data on the economic value of a transfer are available. Second, even if the value of a transfer is known, it is in almost every case the total value of a deal, which may include not only the weapons themselves but also other related items (e.g., spare parts, armament or ammunition, specialized vehicles, software changes to existing systems, or training). Third, even if the value of a transfer is known, important details about the financial arrangements of the transfer (e.g., credit/loan conditions and discounts) are usually not known. On the other side, the SIPRI trend indicator not only registers arms sales, but every form of weapons supply including aid and gifts (even if along the chapter I mention arms trade, it would be more appropriate to only refer to arms transfers). The SIPRI data thus describe the volume of arms transfers, not the actual financial value of these transfers or the price dynamics. However, the political focus of my analysis is consistent with the measure adopted: MCW are both economic goods and foreign policy instruments, and in any case, price would not convey all information on MCW transfers, as their flows follow bilateral agreements and do not respond uniquely

[9] On line at http://armstrade.sipri.org

[10] Focusing on MCW only ensures consistency of the estimates, since the market for small arms has different features than the MCW market. Notably, the share of black market is greater and therefore no reliable and exhaustive dataset of small arms transfers is available. Moreover, the industry is less concentrated and nowadays most countries, even among developing ones, produce some amounts of small arms.

[11] For a number of weapon types it is possible to find the actual average unit acquisition price in open sources. Those weapons with a real price are used as reference points, and all other weapons for which a price is not known are assigned a value in an index, reflecting their military resources in relation to core weapons. Therefore, SIPRI data cannot be compared with other trade data. For a deeper description of the methodology see Hagelin and Wezeman (2005).

to market laws. On the other hand, a quantity measure incorporates not only arms sold for profit but also weapons that have been transferred as political aid at a zero price and would not show up in financial statistics. For all these reasons, the SIPRI trend measure is preferred over available alternatives.[12] In all specifications presented in what follows, the dependent variable $arms_{ijt}$ describes MCW flow from country i to country j at time t as from the SIPRI trend indicator. Only sovereign countries are taken into account, while other entities such as international organizations and non-governmental armed forces are omitted. The SIPRI data are also used to construct two variables accounting for country-specific and worldwide trends in arms flows. $total\ exports_{ijt}$ is calculated as the total arms flow out of the exporter country at time t minus the term $arms_{ijt}$, and expressed in thousands of units. It is aimed to capture MCW sector fluctuations in the exporter country. $worldwide\ exports_{ijt}$ is calculated as the total world exports at time t minus the term $arms_{ijt}$, and expressed in thousands of units. Analogously to a single-year dummy, it captures business cycle in worldwide arms flow.

Data on democracy come from the Polity IV Project by the Center for Global Policy of George Mason University. I use the composite polity indicator that ranges from -10 (strongly autocratic regime) to +10 (strong democracy);[13] for further clarifications I remand to Marshall and Jaggers (2005). I make use of two variables, referring to democracy level of importer and exporter respectively. $democratic\ exporter_{it}$ is a dummy that equals one if the exporter's polity indicator takes a value greater than zero. I adopt this dichotomous classification for the sake of simplicity, but it does not affect the quality of results since the distribution of the polity indicator is almost bimodal: in 96% of the cases where $democratic\ exporter_{it}$ equals zero the polity indicator is equal to or smaller than -4, and similarly for 96% of the cases where the dummy $democratic\ exporter_{it}$ equals one the polity indicator is equal to or greater than +6. Additionally, in some specification I include the variable $polity\ importer_{jt}$ for the level of democracy/autocracy of the importer country, which takes discrete value from -10 to +10.

Variables reflecting political orientations come from the World Bank Develop-

[12]The only alternative source of data on arms trade is the World Military Expenditure and Arms Transfers (WMEAT) published by the US Department of State, Bureau of Verification and Compliance. The WMEAT measure covers not only conventional arms, but also small weapons. Unlike the SIPRI index, WMEAT is an economic value measure, and it registers arms bundles sold on the commercial market. As Brzoska (1982) points out, the WMEAT measure has several major problems. First, coverage is worse than in the SIPRI measure. Second, in the many cases where prices are not available, a cost model estimated for US arms industry has been applied to other countries including the USSR, which leads to serious biases as long as the industrial and employment structure of the two countries are not comparable. Third, the WMEAT measure underestimates the role of western suppliers other than the USA and the USSR. Moreover, WMEAT data are not based on open sources of information but on statistics from US intelligence service. Given these reliability problems and the focus of my analysis, consistently with other existing literature the SIPRI index has been preferred.

[13]The indicator converts special cases (as interruption, interregnum, anarchy or transition) to traditional scores in the range from -10 to +10.

ment Research Group's Database of Political Institutions, DPI2004. I make use of the orientation of chief executive instead of the orientation of the main party in power, since the former is also applicable to regimes different from representative democracy. The variable I adopt classifies the political orientation of the chief executive with respect to economic policy. The executives are classified as one of the followings: Right (conservative, Christian democratic, or right-wing), Left (communist, socialist, social democratic, or left-wing), Center (for parties that are defined as centrist or when party position can best be described as centrist, e.g. party advocates strengthening private enterprise in a social-liberal context).[14] All those cases that do not fit into the above-mentioned category (i.e. party's platform does not focus on economic issues, or there are competing wings), or for whom there is no information, or there is no executive, are coded as missing. Just to mention a few examples: all USSR executives are classified as left, while for what regards the USA, Carter (1977-1981) and Clinton (1993-2001) are classified as left, Regan (1981-1989), G.H.W. Bush (1989-1993) and G.W. Bush (2001-present) as right. For the United Kingdom, Margaret Thatcher (1979-1990) is classified as right, while Tony Blair (1998-2007) as left. Italian leaders belonging to the Christian Democratic party (*Democrazia Cristiana*) are classified as centrist for the period 1975-1983 and 1988-1992. For further information on DPI2004 I remand to Beck et. al. (2001). In the empirical specifications, the variables in use are the following: two dummies $center\ exporter_{it}$ and $left\ exporter_{it}$ describe the political orientation of the chief executive in the MCW exporter country, while the omitted category is $right\ exporter_{it}$. In some specifications I also include a dummy $same\ orientation_{ijt}$ that equals one if the chief executives in exporter and importer countries are both left, both center, or both right.

Common sense suggests that armed conflicts in act in the importing country may proxy for the demand side of MCW market. Data on conflict come from the Armed Conflict Database 2007, provided by the International Peace Research Institute of Oslo (PRIO) and the Uppsala Conflict Data Program (UC- DP). This dataset provides detailed information on the type and the severity of conflicts that took place between independent states and/or political factions from 1946 onwards. Conflicts are classified in four categories: interstate armed conflict (which occurs between two or more states), internationalized internal armed conflict (which occurs between the government of a state and one or more internal opposition groups with intervention from other states), internal armed conflict (which occurs between the government of a state and one or more internal opposition groups without intervention from other states), and extra-systemic armed conflict (which occurs between a state and a non-state group outside its own territory). When a sovereign country has two or more conflicts in the same year, I take the most severe one, according to the following decreasing order of severity: interstate, internationalized

[14]Parties where competing factions average out to a centrist position (e.g. a party of "right-wing Muslims and Beijing-oriented Marxists") are NOT defined as centrist.

internal, internal and extra-systemic armed conflict. In some specification I use a dummy $conflict\ importer_{jt}$ which equals one if the importing country is involved in an armed conflict of any of the types above. In other specifications I put separate dummies for different types of conflicts: $interstate\ conflict_{jt}$, $internal\ conflict_{jt}$ and $internationalized\ conflict_{jt}$ equal one if a conflict of the correspondent type is in act in the importer country. The reference category is a situation in which there is no ongoing conflict, and the extrasystemic conflict category is dropped from the estimates for the exiguous number of observation in the period spanned by data.

Data for per capita GDP and population, which proxy for countries' supply and demand potentials, come from the Penn World Table Version 6.2 (2007) provided by the Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. The variables $pgdp\ exporter_{it}$ and $pgdp\ importer_{jt}$ refer to the countries' per capita GDP expressed in thousands of US$, while $population\ exporter_{it}$ and $population\ importer_{jt}$ refer to the countries' population in millions of inhabitants.

In the international market for arms, a formal obstacle to trade is represented by the international embargoes, which are relatively frequent and whose effectiveness is highly controversial. There are several types of embargo: international organizations such as the UN, the OECD or the EU impose mandatory or non-mandatory embargoes, and some countries also initiate unilateral export restrictions (such as the United Kingdom which has done this thirty-two times in recent years). I restrict my attention to mandatory arms embargoes imposed by the UN and retrieve my information combining UN secretariat sources[15] and the SIPRI dataset on international arms embargoes.[16] This leads to the dummy $embargo_{jt}$ equal to one if the importer country is under a UN mandatory arms embargo regime.

Geographical and cultural factors may correlate with trade. I thus include the variable $distance_{ij}$ which refers to the average distance between the two countries in thousands of kilometers as from the Gledistch and Ward minimum distance data (see Gledistch and Ward, 2001). Trade exchanges between two countries also lead to a diplomatic familiarity and an economic interdependence that may facilitate MCW trade, and thus I add a variable $total\ trade_{ijt}$ representing trade flows between the two countries expressed in billions of US$. These data come from the Expanded Trade and GDP Dataset described by Gledistch (2002) which cover the period 1948-2000.

All democratic MCW exporters proclaim an ideological concern for human rights and a firm rejection of their abuse. Therefore I also explicitly control for the

[15] "The Experience of the United Nations in Administering Arms Embargoes and Travel Sanctions", background paper by UN Secretariat prepared for the Second Experts Seminar, Berlin, December 2000.

[16] On line at http://www.sipri.org/contents/armstrad/embargoes.html

level of human right violations in the importer country, as it may be a deterrent for MCW trade. Data come from the Political Terror Scale dataset that measures states' human rights record for the period 1980-2005 translating human right reports from Amnesty International and the US State Department. I choose the score derived from Amnesty International reports. The variable $human\ right\ violations_{jt}$ thus represent the human rights violations in act in the importer country at time t expressed in a five-point interval scale, where a higher score indicates more severe violations.

Finally, in most specifications a dummy variable $post\ Cold\ War_t$ taking value one for years 1990 onwards is included. This variable is interesting by itself, as long as it could capture a shock in international arms trade due to worldwide demilitarization, and it is interacted with several other variables.

Variables' descriptive statistics can be found in Appendix C, Table 2.C.

3.5 Results

3.5.1 Democracies vs. Autocracies

Given the political focus of this analysis, it is straightforward to set a first distinction based on the nature of the political regime: whether it is democratic of autocratic. Since MCW not only are tradable goods, but also policy instruments, democracies and autocracies may follow different rules and may weigh purely economic or political incentives to trade differently. Moreover, since the idea of trade liberalization does not apply to autocratic rules, there is no a priori reason why left and right autocratic regimes should differ with respect to arms exporting policy. In order to give substance to these intuitive arguments, in what follows I provide evidence that democracies and autocracies differ with respect to their MCW exporting behavior.

The results presented in Appendix C, Table 3.C are based on the full sample of twenty exporters, where democracies account for about 65% and autocracies for about 35% of total MCW exports (See Section 3.3). All results refer to a gravity-type TOBIT that develops along the three dimensions exporter-importer-time, where the dependent variable is the amount of MCW transferred.

In column (1) the dummy $democratic\ exporter_{it}$ captures disparities in overall arms exporting behavior. In addition the typical controls from trade literature are included: per capita gdp and population of both exporter and importer, whether there is an embargo or a generic conflict in act in the importer country, geographical distance and total trade flows between the two countries.

Column (2) refers to a model analogous to the previous one with an additional feature: each control is interacted with the dummy $democratic\ exporter_{it}$. This is a straightforward test to capture different behaviors of democracies and autocracies with respect of any of the previous dimensions.

Finally, column (3) is the same as (2) with an additional control for the political orientation of the exporter expressed by the two dummies $center\ exporter_{it}$ and $left\ exporter_{it}$.

Since most of the interaction terms are significant, results from Table 3.C suggest that democratic and autocratic regimes show different determinants of MCW exporting behavior. It is worth noticing that the interaction terms for $population\ exporter_{it}$ and $pgdp\ \ importer_{jt}$ are positive and significant, which may be interpreted as democratic exporters being more sensitive to pure economic incentives and less constrained by ideological motivations, in that only populous countries have a sufficient industrial diversification to produce MCW and that the importer's GDP proxies for his willingness to pay.

Turning to (3), the exporter's executive being center or left oriented seems to decrease the quantity of MCW exported with respect to the omitted category of right executive in power, but the disparities of behavior between democracies and autocracies remain. Regardless of their political orientation democracies export less MCW, and their exporting behavior follows different rules. Therefore, the next section will focus on democracies to explore in depth how the political orientations impact their arms export policies.

3.5.2 The Political Orientation of Democratic Exporters

The previous subsection has shown that democratic and autocratic regimes differ with respect to their arms exporting behavior. I now restrict my attention to the sub sample of democratic MCW exporters (eliminating USSR, Czechoslovakia, China, Poland 1950-1988, Brazil 1964-1984).

Results in Appendix C, Table 4.C still refer to a gravity-type equation in a panel TOBIT framework where the dependent variable is the amount of MCW transferred in a given year. The various columns (4) to (10) start with an exiguous number of controls and progressively add more covariates.

In (4) only basic controls are used, that is, the political orientation of the exporter and per capita GDP and population of both exporter and importer. (5) also controls for embargoes and ongoing conflicts in the importer country, with separate dummies for internationalized, external and extra-systemic conflict. In (6) the dummies $post\ Cold\ War_t$ and $same\ orientation_{ijt}$ are included and interacted, in

order to take into account the changes in the international scenario at the end of the Cold War. In fact during the Cold War the political orientation also reflected block division, while after 1990 a major political break and a simultaneous MCW market restructuring took place.[17] (7) adds controls for exporter-specific and worldwide trends in arms flows, specified as in Section 3.4. In (8) I include geographical distance and the value of trade flows between exporter and importer. In line with previous studies[18] (9) control for the democracy and human rights violations in the importing country, since all exporters formally share an ideological concern for these issues. Finally, in (10) $polity\ importer_{jt}$ and $post\ Cold\ War_t$ are interacted. During Cold War the countries in communist block were in fact classified as non-democratic and thus in principle before 1990 democracies' reluctance to export to non-democratic countries might have been just due to the fact that many non-democratic countries were part of the communist block.

Results from Appendix C, Table 4.C show a robust pattern: exporter's chief executive being right wing has a positive and significant impact on MCW exports. This may reflect a general right-wing tendency to lower trade barriers, with its consequences on deregularization of heavy industry exports, or a greater importance of national industry in political agenda, resulting in a higher economic support toward heavy armament sector.

All other results go in the expected direction: the exporter country being more populous increases the quantity of MCW traded, which is not surprising given that MCW are highly specialized goods. On the other side, the per capita GDP of the exporter does not show any clear pattern. For what regards the importer country, both population and per capita GDP are positively significant, as they may proxy for exporter's likelihood to pay in the MCW open market. UN embargo pending on importer country is negative, but only occasionally significant, in line with the high rate of non-compliance reported by anecdotic and official sources.[19] For what regards the conflicts in act in importer country, only internal conflicts (that is, conflicts between the government of a state and one or more internal opposition group) are significant. The dummy $post\ Cold\ War_t$ is significant itself, consistently with the general crisis in arms production industry that led to a general reduction of 40% in military expenditure and international arms transfers.[20] From (4) to (9), the dummy $same\ orientation_{ijt}$ and its interaction with

[17] The end of Cold War brought a general reduction of 40% in military expenditure and international arms transfers. For a deeper discussion see Skons (2000) and Dunne, Garcia Alonso, Levine and Smith (2003).

[18] Blanton (2000) tested whether respect human rights and democratic governance are relevant for US arms export policy. Applying a two-stage Heckman model, she concludes that in the initial decision-making stage, human rights and democracy are important determinants of the eligibility of countries to receive arms, in the second stage democracy is still significant while human rights no longer affect the quantity of arms to be transferred.

[19] See Amnesty International, IANSA, and Oxfam International (2006).

[20] Skons (2000) and Dunne, Garcia Alonso, Levine and Smith (2003).

the $post\ Cold\ War_t$ dummy are significantly positive and negative respectively. That is, exporter and importer having the same political orientation used to play a role in MCW trade, but the magnitude of the bias dropped after the end of the Cold War. However, it is interesting to notice that when in (10) the interaction $polity\ importer_{jt} \times post\ Cold\ War_t$ is added, the effect of $same\ orientation_{ijt} \times post\ Cold\ War_t$ vanishes. Again, not surprisingly, worldwide market trend and exporter's market trend are significant and positive in most specifications. The geographical distance seems not significant, while the value of yearly overall bilateral trade proxying for commercial friendship is significant indeed. The level of importer's human rights violations seems not to affect MCW trade, while the importer's democracy index $polity\ importer_{jt}$ is indeed significant. However, while the main coefficient for $polity\ importer_{jt}$ is significantly positive, its interaction term with $post\ Cold\ War_t$ is also significant but negative in sign. This is consistent with the fact that before 1990 democracy reflected block division, and also with the ongoing worldwide democratization patterns. In fact the transition out of Cold War coincided with the so-called Third Wave of Democratization (Huntington, 1991): between 1987 and 1997, 54 countries went through a process of (full or partial) democratization (Papaioannou and Siourounis, 2007). This is also reflected in the Polity IV data I use: on the total sample of 168 countries, the median polity score for period 1975-2004 is 0, while the median polity score for period 1990-2004 is 5.

3.6 Conclusions

All through the XXth century arms have been not only tradable goods, but also foreign policy instruments. Arms are traded for either strategic or economic benefits: in any case, politics can influence the trade, and it actually does. The channels are several: arms trade regulation in country's sovereignty, export licenses exclusively granted by governmental agencies, a relevant share of armament industry is state property, and the arms production sector attracts subsidies and other measures in defense of national industry. This chapter focuses on countries supplying arms and investigates whether the exporter's government being right-wing or left-wing impacts the quantity of arms supplied to third countries. For this purpose, a bilateral trade equation is estimated for years 1975-2004 using a TOBIT framework. Results suggest that exporter's chief executive being right-wing has a positive and significant impact on arms exports. This may reflect a general right-wing tendency to lower trade barriers, with its consequences on deregularization of heavy industry exports, or a higher economic support toward armament sector as an important part of national industry.

3.7 Appendix C

Figure 1.C: Trends in MCW flows, 1975-2004

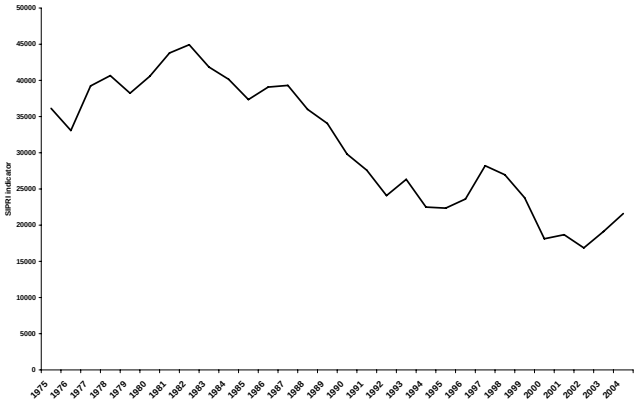

Table 2.C: Descriptive Statistics

	All exporters			Only democratic exporters		
	N	mean	sd	N	mean	s.d.
arms	139831	10 .79	97 .35	110721	8 .79	79 .15
polity exporter	133337	5 .85	6 .84	104227	9 .40	1 .36
polity importer	119343	-0 .15	7 .51	92504	0 .10	7 .48
same orientation	44673	0 .44	0 .50	36447	0 .41	0 .49
pgdp exporter	118443	10 .90	9 .12	101652	12 .35	9 .03
population exporter	133337	110 .77	234 .07	104227	54 .44	64 .56
pgdp importer	113757	4 .71	6 .41	89567	5 .11	6 .73
population importer	129415	28 .92	101 .89	101103	29 .66	105 .75
embargo	139831	0 .01	0 .11	110721	0 .02	0 .12
worldwide exports	139831	28 .07	8 .42	110721	27 .59	8 .20
total exports	139831	1 .59	3 .26	110721	1 .34	2 .73
distance	139277	6 .69	3 .92	110217	6 .56	3 .87
total trade	119724	0 .81	6 .30	91491	0 .98	7 .09
human right violations	58239	2 .73	1 .10	50926	2 .73	1 .10

Table 3.C: Panel TOBIT Results, Full Sample

Dependent variable: MCW trade			
	(1)	(2)	(3)
democratic exporter	-0.722	-2921	-5064
	(0.001)***	(0.000)***	(0.000)***
pgdp exporter	-0.030	0.796	1046
	(0.001)***	(0.000)***	(0.000)***
pgdp exporter×		-0.843	-1298
democratic exporter		(0.000)***	(0.000)***
population exporter	0.005	-0.000	-0.006
	(0.000)***	(0.479)	(0.000)***
population exporter×		0.080	0.086
democratic exporter		(0.000)***	(0.000)***
pgdp importer	0.076	-0.085	-0.041
	(0.000)***	(0.061)*	(0.558)
pgdp importer×		0.138	0.251
democratic exporter		(0.002)***	(0.000)***
population importer	0.029	0.031	0.031
	(0.000)***	(0.000)***	(0.000)***
population importer×		-0.005	-0.008
democratic exporter		(0.022)**	(0.067)*
embargo	-1166	0.091	-4886
	(0.018)**	(0.962)	(0.049)**
embargo×		-2003	3300
democratic exporter		(0.316)	(0.208)
conflict importer	0.839	0.512	0.366
	(0.000)***	(0.247)	(0.644)
conflict importer×		0.154	-0.017
democratic exporter		(0.744)	(0.984)

Table 3.C: Panel TOBIT Results, Full Sample (continued)

	(1)	(2)	(3)
distance	-0.212	-0.171	-0.244
	(0.000)***	(0.010)**	(0.017)**
distance×		-0.120	0.012
democratic exporter		(0.040)**	(0.909)
total trade	0.183	0.029	0.044
	(0.000)***	(0.558)	(0.536)
total trade×		0.079	0.119
democratic exporter		(0.124)	(0.112)
center exporter			-1840
			(0.000)***
left exporter			-0.885
			(0.000)***
constant	4382	6327	10998
	(0.000)***	(0.000)***	(0.000)***
observations	91450	91450	56683
n. groups	3580	3580	3204
exporter×importer			

robust p-values in parenthesis

$*$ significant at 10%; $**$ significant at 5%, $***$ significant at 1%

Table 4.C: Panel TOBIT Results, Democratic Exporters

	Dependent variable: MCW trade						
	(4)	(5)	(6)	(7)	(8)	(9)	(10)
center exporter	-1.383	-1.365	-1.705	-1.204	-2.390	-2.513	-2.809
	(0.000)***	(0.000)***	(0.002)***	(0.033)**	(0.000)***	(0.002)***	(0.004)***
left exporter	-0.441	-0.474	-0.751	-0.705	-1.229	-1.487	-1.913
	(0.014)**	(0.004)***	(0.006)***	(0.011)**	(0.000)***	(0.000)***	(0.000)***
pgdp exporter	-0.238	-0.210	-0.124	-0.025	-0.118	0.058	0.064
	(0.000)***	(0.000)***	(0.000)***	(0.393)	(0.001)***	(0.279)	(0.293)
population exporter	0.0848	0.081	0.097	0.068	0.126	0.123	0.134
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
pgdp importer	0.253	0.240	0.236	0.228	0.235	0.698	0.901
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
population importer	0.014	0.014	0.015	0.016	0.017	0.019	0.018
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
embargo		-0.498	-2.148	-2.090	-3.828	0.807	0.266
		(0.462)	(0.231)	(0.249)	(0.043)**	(0.696)	(0.911)
internationalized conflict		-0.707	0.441	0.333	-1.031	-2.547	-1.873
		(0.286)	(0.684)	(0.759)	(0.370)	(0.075)*	(0.272)
internal conflict		0.542	3.001	3.151	2.737	2.238	2.271
		(0.060)*	(0.000)***	(0.000)***	(0.000)***	(0.001)***	(0.005)***
extrasistemic conflict		0.600	0.739	0.451	-0.060	0.082	0.300
		(0.331)	(0.439)	(0.639)	(0.953)	(0.949)	(0.843)
same orientation			1.089	1.161	1.068	1.831	1.263
			(0.008)***	(0.005)***	(0.009)***	(0.006)***	(0.114)
post Cold War			-1.160	-1.999	-1.893	-2.874	-3.060
			(0.007)***	(0.001)***	(0.006)***	(0.003)***	(0.010)***

Table 4.C: Panel TOBIT Results, Democratic Exporters (continued)

	(4)	(5)	(6)	(7)	(8)	(9)	(10)
same orientation×			-1.170	-1.254	-1.246	-2.089	-1.260
post Cold War			(0.024)**	(0.016)**	(0.023)**	(0.010)***	(0.193)
worldwide exports				-0.021	-0.010	0.171	0.196
				(0.565)	(0.818)	(0.009)***	(0.012)**
total exports				0.835	0.049	0.376	0.519
				(0.000)***	(0.704)	(0.058)*	(0.023)**
distance					-0.155	-0.049	0.021
					(0.022)**	(0.535)	(0.810)
total trade					0.155	0.116	0.089
					(0.000)***	(0.000)***	(0.000)***
polity importer						0.520	0.714
						(0.000)***	(0.000)***
human rights						-0.007	-0.317
violations						(0.978)	(0.318)
polity importer×							-0.351
post Cold War							(0.000)***
constant	2.776	2.050	1.109	0.822	1.155	-11.323	-12.791
	(0.000)***	(0.000)***	(0.044)**	(0.621)	(0.544)	(0.000)***	(0.001)***
observations	57597	57597	33236	33236	28388	17057	17057
n.groups exporter×importer	2985	2985	2135	2135	2036	1760	1760

p-values in parenthesis;

$*$ significant at 10%; $**$ significant at 5%, $***$ significant at 1%

3.8 Appendix D

National Export Control Systems [21]

CANADA

Legislation: Export and Import Permits Act (EIPA) as amended. **Licensing Authority:** Export Controls Division, Department of Foreign Affairs and International Trade (DFAIT). **Consultation Procedures:** different branches within DFAIT, the Department of National Defense, Industry Canada and other agencies (such as the Canadian Security Intelligence Service and the Royal Canadian Mounted Police) are asked for specialist advice. **End User Requirements:**
in most cases one of the following will be required: International Import Certificate; End-use Certificate or Import license; Delivery Verification Certificate; End-use Statement. **Types of Licenses:** most exports of military goods require a single shipment/single consignee individual license. Some exports of military goods may take place under a multiple shipment/single consignee individual license.

CHINA

Legislation: Decree of the State Council and the Central Military Commission of the People's Republic of China No. 234, 22 October 1997; Regulations of the People's Republic of China on the Administration of Arms Export, 1 January 1998. **Licensing Authority:** State Administration of Arms Trade of the People's Republic of China. **Consultation Procedures:** items of arms export shall be examined and approved by the State Administration of Arms Trade or by the State Administration of Arms Trade jointly with the relevant departments under the State Council and the Central Military Commission.

CZECH REPUBLIC

Legislation: Act No. 38/1994 of the Legal Code of 15 February 1994. **Licensing Authority:** Ministry of Industry and Trade. **Consultation Procedures:** State Security Office in the Ministry of Justice, Ministry of Foreign Affairs can request information. **End User Requirements:** an end user certificate and non-reexport clause should be submitted as part of the license request. **Licensing Negotiations:** licenses should be applied for after an applicant has received written intent from the buyer to conclude a contract or an invitation to participate in a tender. **Revocation Licenses:** possible under conditions described in Act No. 38/1994. **Types of Licenses:** only an individual license is used.

[21] Source: Sipri

FRANCE

Legislation: Decree-law of 18 April 1939 creating a regime governing war material, arms, and munitions; Decree no. 55-965 of 16 July 1955 reorganising the Interministerial Committee for the S; Law no. 98-564 of 8 July 1998 with the intent of eliminating antipersonnel mines. **Licensing Authority:** Interministerial Commission for the Study of Export of War Material (CIEEMG). In the case of dual-use goods: the Service des Titres du Commerce Extérieur (SETICE). **Consultation Procedures:** Autorization for the Exportation of War Material (AEMG) delivered by the Customs general directorate. Possible inspection by the CIEEMG, composed, amongst others, of representatives from the Minister of Defense, the Minister of Economy and Finance, and the Minister of Foreign Affairs. **End User Requirements:** not directly required. License can be subject to a signed agreement undertaking not to reexport the controlled item. License can also be subject to the proof that the controlled goods are delivered to the authorized recipients. French authorities can request that the controlled item not be reexported in the state in which it was purchased. This is usually relevant in the sale of controlled components or sub-units. **Licensing Negotiations:** all stages of the contract are controlled, as well as pre-shipment activities. Prospecting, negotiation, and sale require an authorization. Authorizations, when granted, last for one year and can be extended to three years if agreed to by the CIEEMG . **Licensing Exemptions:** certain exemptions exist for transfer of certain classes of weapons within the European Community and some material depending on its nature and destination e.g. temporary exports, exports made by the Minister of National Defense. **Revocation Licenses:** possible at any time. **Types of Licenses:** licenses are usually individual and apply to one exporter for one group of goods and toward one destination. Licenses last for one year.

GERMANY

Legislation: War Weapons Control Act, implementing Article 26(2) of the Basic Law; War Weapons Reporting Ordinance of 24 January 1995 (as amended); Foreign Trade and Payments Act of 28 April 1961 (as amended); Foreign Trade and Payments Ordinance of 18 December 1986 (as amended). **Licensing Authority:** Federal Ministry for Economics in cases of war weapons. In cases of export of other military equipment, the Federal Export Office (an agency of the Federal Ministry of Economics). **Consultation Procedures:** Federal Foreign Ministry, Ministry of Defence and with other Ministries if appropriate. **End User Requirements:** an end user document must normally be submitted with the application. There are three types of end user certificate: an official EUC (for government end users); a private EUC (for company or private end users) and an International Import Certificate (IIC). **Licensing Negotiations:** no authorization required for negotiating a contract; a special license is required for deals by intermediaries regarding the

procurement of war weapons which are located abroad and are to be delivered to the foreign customer without encountering German territory. **Licensing Exemptions:** in certain cases, such as insignificant parts of firearms, military equipment can be exported under a general license. **Revocation Licenses:** possible only under narrow legal conditions such as a false statement in a license application. **Types of Licenses:** there is no distinction between licenses based on destination; exports within the framework of an intergovernmental cooperation project are covered by a general license.

ITALY

Legislation: Law No. 185/90, 9 July 1990 (New Rules for the Control of Export, Import and Transit of Conventional Weapons). **Licensing Authority:** Ministry for Foreign Affairs. **Consultation Procedures:** Ministry of Defence, Ministry of Industry, Ministry of Foreign Trade, Ministry of Finance (Customs), Treasury. **End User Requirements:** an end-user certificate is required for all destinations. However, the certificate can take different forms depending on the destination. Import certificates and delivery verification certificates are not verified if provided by the governmental authorities of the importing countries. The end-user certificate also includes a no re-export statement regarded as a contractual obligation between Italy and the importing country. **Licensing Negotiations:** license applications are examined on a case by case basis. Prior authorisation is required before a contract is signed. **Licensing Exemptions:** the 1990 Law No. 185/90 does not apply to the following: a) temporary exports directly effected by, or on behalf of the Central Government, to implement its own arms and equipment programmes for the armed forces and police; b) exports or concessions between governments for the purposes of military aid, under the terms of international agreements; c) the transit of armaments and equipment to meet the needs of allied countries, as defined in the Convention on the Status of NATO Forces, provided that waivers to Articles VI, XI, XII, XIII and XIV of the Convention between the States signatories to the North Atlantic Treaty are not invoked for any reason whatsoever. **Revocation Licenses:** licenses can be revoked at any time. **Types of Licenses:** a national register of companies operating in the field of planning, manufacture, import, export, maintenance and servicing of military products is maintained. Only companies in the register may receive permission to negotiate contracts for exports of military list items. Only individual licenses are used. Special conditions can be attached to an individual license (normally valid for 1 year) on a case-by-case basis.

NETHERLANDS

Legislation: Import and Export Law (1962); Decree on the Export of Strategic Goods (1963). Related laws and decrees: the Decree on the Delivery of Declaration

of Strategic Goods forms the basis for International Import Certificates (IIC's) and Delivery Verification Certificates; the Decree on Financial Transactions for Strategic Goods demands that a license is required in each case a Dutch legal or natural person is financially involved in the trade of strategic goods that are in transit or otherwise outside the European Union; the Law Governing Economic Violations provides for the possibility of sanctions in cases of breaches of the aforementioned regulations and sets the framework for control and enforceability; the Sanctions Law provides for the possibility to implement recommendations, resolutions or agreements of international organizations (such as the UN) on international trade sanctions for military or other goods. **Licensing Authority:** applications for export licenses are submitted to the Import and Export Licensing Branch of the Ministry of Finance. Export licenses are issued by the Ministry of Economic Affairs on the basis of information contained in the contract, in the International Import Certificate, and/or in the end-user statement. **Consultation Procedures:** if the application involves *inter alia* military equipment which is also in use by or specially developed and designed for the Dutch armed forces, the Ministry of Foreign Affairs consults with the Ministry of Defense on the possible classification aspects. Subsequently, the Minister for Foreign Affairs submits his advice, which plays an essential role in the decision making process. If there are no objections with regard to the proposed export, the export license is issued by the Ministry of Economic Affairs. **End User Requirements:** in principle, all military shipments require an International Import Certificate or an end-user certificate. **Licensing Negotiations:** the formal application procedure requires the submission of a signed contract. There is no official government authority required to enter into contract negotiations or to sign contracts with foreign customers. **Licensing Exemptions:** no license is required for exports to Belgium and Luxembourg. **Revocation Licenses:** the Import and Export Law provides for two possibilities to revoke export licenses: if the information provided by the licensee in order to receive the license appears to be inaccurate or incomplete; or if there is a very urgent or serious reason, for example war or the threat of war. **Types of Licenses:** there are two types of license: an individual license for a shipment to an end-user in one country only, for one or for different kinds of goods (value and quantity of the shipment have to be indicated at the time of application); a global license, which is a more flexible means of licensing and allows multiple shipments of a range of goods to several destinations (e.g. issued in case of a project in one or more countries).

NORWAY

Legislation: Law of 18 December 1987 no. 93 on Control over the Export of Strategic Goods, Services and Technology; Ministry for Foreign Affairs Decree of 10

January 1989 to implement export regulations for strategic goods, services and technology. **Licensing Authority:** Section for Export Control, Ministry of Foreign Affairs. **Consultation Procedures:** The Ministry for Foreign Affairs may consult the Ministry of Defense in cases where an application to export has particularly important implications to national defense or to participation in international defense industrial cooperation. The Ministry for Foreign Affairs may consult the Defense Research Institute within the Ministry of Defense in cases where information is required on technical aspects of the use of particular items. The Ministry for Foreign Affairs may consult the Ministry of Economy in cases where an application to export has important implications for Norwegian economic interests. **End User Requirements:** The Ministry of Foreign Affairs may require end-user statements in connection with the export of products included in lists I and II and with the export of technology or provision of services in connection with all such products. **Licensing Negotiations:** no authorization required for seller/buyer negotiations. **Licensing Exemptions:** precursors to chemical weapons if the substance in question makes up less than 10 percent of a mixture or forms a normal component of consumer goods packaged for personal use, recovery and oil rig equipment that is to be used in emergency assistance actions, arms that are cleared by Customs with the authorization "Declaration on temporary export of hunting or sporting guns", goods for use by the European Space Agency (ESA), goods, services and technologies for use on the Norwegian part of the Continental Shelf, or on board Norwegian ships under a Norwegian flag, and Norwegian aircraft during international flights. **Types of Licenses:** for items on List I an individual license (authorizing a specified shipment to a single, specified recipient) will be required. For items on List II a general license may be available, usually when exports are to recipients in Argentina, Australia, Canada, Hungary, Iceland, Japan, New Zealand, Switzerland or the United States or when the recipient is located in a European Union member state. A general license will be valid for 3 years.

POLAND

Legislation: Decision of Council of Ministers Regulation of 14 September 1999 "On prohibition and limitation in foreign special trade"; Law of 29 November 2000 concerning international trade in goods, technologies and services of strategic significance for state security and maintenance of international peace and security, and amending selected laws. **Licensing Authority:** Ministry of Economy, Department of Export Control. **Consultation Procedures:** Ministry of Foreign Affairs, the Ministry of Defense, the Ministry of Internal Affairs and Administration, the State Protection Office. **End User Requirements:** it is necessary to provide an end-user certificate for each export contract with a proper non-re-export clause to avoid risk of transfers to states subject to UN embargoes, EU restrictions or accused of supporting terrorism (as a minimum a ban on the reexport of commodities to the states which are subject to UN embargoes). **Licensing Negotiations:** the Ministry of Economy should be informed about negotiations and intent to offer controlled items but no license is required. **Licensing Exemptions:** export of arms always requires a permit. **Revocation Licenses:** export permits may be canceled in cases where a company breaks the law and when the transfer causes threat to the national interest, state security or national foreign policy goals. **Types of Licenses:** general licenses are used for export controls applied to dual-use goods. For conventional arms an individual license is used. Individual license: always required (including by those companies that do not require a general license) to carry out a particular transaction (issued on a case-by-case basis). These may be of four kinds: to enter into negotiations and provide an offer; to carry out export and/or import; to carry out re-export; to carry out transit.

RUSSIA

Legislation: Federal law of the Russian Federation on Military-Technical Cooperation of the Russian Federation With Foreign States, adopted by the State Duma on 3 July 1998 and approved by the Federation Council on 9 July 1998; Russian Federation Presidential Decree No 1953, "to form the Russian Federation Committee for Military-Technical Cooperation with Foreign States", 1 December 2000. **Licensing Authority:** Committee for Military-Technical Cooperation With Foreign States. **Consultation Procedures:** Ministry of Foreign Affairs, Ministry of Defense, Ministry of Finance, Ministry of Economics, State Customs Service, Foreign Intelligence Service, Federal Security Service. **End User Requirements:** federal executive institutions of the Russian Federation shall supervise deliveries of military products intended for transfer to foreign clients. Executive institutions monitor the development, manufacture and delivery of military products according to the procedure determined by the Government of the Russian Federation. **Licensing Negotiations:** marketing and contract negotiations require authorization from the Committee for Military-Technical Cooperation With Foreign States. **Revoca-**

tion Licenses: organizations and enterprises require authorization to take part in military-technical cooperation with foreign states. This authorization is subject to review by the Committee for Military-Technical Cooperation With Foreign States and can be withdrawn by that Committee.

SPAIN

Legislation: Royal Decree No. 491/1998 of 12 March 1998. **Licensing Authority:** Inter-Ministerial Regulatory Board on Foreign Trade in Defense or Dual-Use Material (JIMDDU) within the Ministry of Economy and Taxes. The Under-Director-General for Foreign Trade of Defense and Dual-Use Material at the Ministry of Economy and Taxes provides a secretariat for the Board. JIMDDU is chaired by the Secretary of State for Trade, Tourism and Small and Medium Enterprises. The Deputy Chair is Under-Secretary in the Ministry of Foreign Affairs. **Consultation Procedures:** represented on the Inter-Ministerial Regulatory Board on Foreign Trade in Defense or Dual-Use Material are the Ministries of Trade, Tourism and Small and Medium Enterprises, the Ministry of Defense, the Ministry of Domestic Affairs, the Ministry of Industry and Energy. **End User Requirements:** an end-user certificate issued by a government agency in the importing state is required for exports of war material. For other materials that are for military use an end-user certificate may be issued by a company. If there are doubts about the final destination additional controls may be applied. **Licensing Negotiations:** no authorization is needed to negotiate or sign a contract. **Licensing Exemptions:** none. **Revocation Licenses:** licenses can be revoked: when the export might threaten peace or stability on a regional or global level; when the export contravenes Spain's international commitments; when the export threatens Spain's national defense or foreign policy interests. **Types of Licenses:** Individual licenses valid for 6 months are used for war material exports.

SWEDEN

Legislation: Military Equipment Act (1992); Military Equipment Ordinance (1992). **Licensing Authority:** The National Inspectorate of Strategic Products (ISP), which is obliged to submit cases of principal significance or cases which are otherwise important to the Government. **Consultation Procedures:** Ministry of Foreign Affairs, Ministry of Defense. **End User Requirements:** in principle required for all exports. **Licensing Exemptions:** a private person may take small arms and ammunition out of the country for his personal use if entitled under the Weapons Act (1973). **Revocation Licenses:** a license may be revoked. **Types of Licenses:** only one type of license used.

SWITZERLAND

Legislation: Article 41 and article 64 of the Federal Constitution of the Swiss Confederation of 29 May 1874 (as amended); Federal Law on War Material of 13 December 1996; Federal Law on the control of dual use goods and specific military goods of 13 December 1996; Ordinance on the exportation, importation, and transit of dual use goods and specific military goods of 25 June 1997; Ordinance on War Material of 25 February 1998. **Licensing Authority:** designated by the Federal Council, the Swiss Federal Office for Foreign Economic Affairs (OFAEE, Office Fédéral des Affaires Economiques Extérieures) is authorized to issue licenses (art. 13 of ordinance of 25 February 1998). **Consultation Procedures:** procedures are established in art. 14 of ordinance of 25 February 1998 and are as follows: 1the OFAEE issues authorizations for further marketing authorizations in tandem with the Federal Department of Foreign Affairs. Moreover, the OFAEE consults the relevant branch of the Federal Department of Defense, of Civil Protection, and Sports (DDPS) if political security or armament interests are in question. It consults the Federal Office of Energy (OFEN) if nuclear issues are present; 3) the relevant services decide whether requests are of major importance regarding foreign or security policy and thus must be submitted to the Federal Council; 4) if the relevant services cannot agree on the proper treatment of the requests the latter are submitted the Federal Council; 5) in cases of minor importance or if there are precedents, the relevant authorities can authorize the OFAEE to take decisions. **End User Requirements:** Art. 18 of law of 13 December stipulates that export authorizations are usually only issued for goods destined to foreign governments or companies working for foreign governments, and a declaration that the goods will not be reexported. The clause may not be required for parts destined to be integrated (and are integrated) and then exported or for anonymous parts of negligible value. **Licensing Negotiations:** initial authorization required for commercial activity including the process of offering, acquiring, and transferring. Brokerage and transfer of intellectual property also subject to authorization (art. 6 ,9, and 20 of law of 13 December 1996). **Licensing Exemptions:** the licensing scheme is not applicable to armament companies when their activities are related to acquisition of material for the Swiss army (art. 4 of law of 13 December).Temporary export of weapons by persons participating in firing competitions or training are exempt (art 9 of ordinance of 25 February 1998). **Revocation Licenses:** licenses can be revoked or suspended in exceptional circumstances (art.19 of law of 13 December 1998). **Types of Licenses:** Six types of authorization: manufacture, brokerage, importation, exportation, transit and intellectual property (art. 12 of law of 13 December 1996). Import, export, and transit licenses last 12 months and can be extended by six months (art. 15 of ordinance of 25 February 1998).

UK

Legislation: Export of Goods (Control) Order 1994 (as amended). Export Control Act 2002. **Licensing Authority:** Department of Trade and Industry. **Consultation Procedures:** Foreign and Commonwealth Office, Ministry of Defense, Department for International Development. **End User Requirements:** provision of end-user certificate including obligation not to re-export needed. **Licensing Negotiations:** no authorization needed for negotiating contracts unless classified information has to be released. **Licensing Exemptions:** government to government transfers; companies acting on behalf of their governments: exemption on the grounds of Crown Status; government to government collaborative projects. **Revocation Licenses:** the Secretary of State for Trade and Industry may revoke export licenses at any time and for any reason.

USA

Legislation: Arms Export Control Act of 1976 (as amended). **Licensing Authority:** Department of State. **Consultation Procedures:** The Department of State seeks the views of the Department of Defense and other relevant specialist agencies (such as the National Aeronautics and Space Agency (NASA)) in around 30% of license cases. **End User Requirements:** a Non-Transfer and Use Certificate is required as a condition to the approval of any license or agreement that relates to significant military equipment, classified articles or classified technical data. Written approval of the Office of Defense Trade Controls must be obtained before reselling, transferring, transshipping or disposing of a defense article to any end user, end use or destination other than that stated in the export license. **Licensing Negotiations:** a marketing license is required for contacts with potential customers if information or technical data covered by the US Munitions List is revealed in the course of the contact. **Revocation Licenses:** licenses can be revoked at the discretion of the President and the Secretary of State under a wide range of circumstances. **Types of Licenses:** there are 4 types of document that can authorize exports of controlled items: 1) export licenses: Documents that permit the temporary or permanent export of items on the US Munitions List; 2) technical assistance agreements: a contract for the delivery of a defense service or disclosure of technical data; 3) manufacturing licenses: a document whereby a US legal person grants a foreign person authorization to manufacture defense articles abroad; 4) distribution agreements: a contract to establish a warehouse or distribution point abroad for defense articles exported from the US for subsequent distribution to entities in an approved sales territory.

UKRAINE

Legislation: Law on State Control of international Transfers of Goods Designated for Military Purposes and Dual-Use Goods, 20 February, 2003; Decree no. 117/98 of the President of Ukraine, 13 February 1998; Decree no. 422/99 of the President of Ukraine, 21 April 1999; Decree no. 423/97 of the President of Ukraine, 13 May 1997; Provisions approved by Decree no. 1005 of the Cabinet of Ministers of Ukraine, 22 June 1996; Provisions approved by Decree no. 125 of the Cabinet of Ministers of Ukraine, 4 February 1997 with changes according to Decree no. 1042 by the Cabinet of Ministers 15 June 1999; Provisions approved by Decree no. 1358 by the Cabinet of Ministers of Ukraine, 8 December 1997; Decree no. 1228 of the Cabinet of Ministers of Ukraine, 12 July 1999;Decree no. 473 of the Cabinet of Ministers of Ukraine, 10 March 2000. **Licensing Authority:** State Service on Export Control. **Consultation Procedures:** the Commission on Export Control Policy and Military and Technical Cooperation with Foreign Countries, which is now under the authority of the Presidential Administration. **End User Requirements:** decisions on a case-by-case basis. **Licensing Negotiations:** an exporter requires permission from the State Service on Export Control to begin contract negotiations with a foreign customer. **Licensing Exemptions:** none. **Revocation Licenses:** licenses can be revoked or suspended if: there are reasons to believe that the end-use of the items run counter to the information contained in the license application; the exporter becomes bankrupt or ceases to exist; the terms of the contract with the foreign partner that was the basis for the license application was altered after the license was issued; or if the transfer violates Ukraine's international obligations. **Types of Licenses:** general and individual licenses are available.

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