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Essays on Conflict and Terrorism

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Abstract

This dissertation explores how aid affects the probability of a conflict onset and how a particular type of conflict, the phenomenon of political terrorism, can be studied using network analysis. The general goal of this work is to add new layers of analysis to the current literature, focusing in particular on new data. In fact, in the first chapter of my thesis "Localized Aid and Internal Conflicts: the Case of Uganda" I exploited new geo-localized data available through the geographic information system (GIS). Given that the literature on conflicts demonstrates that civil conflicts tend to be highly localized within a country and project-based aid are becoming one of the main channels for donors, I examined the impact of foreign aid at a local level on the probability of conflict onset. I will show that there is a positive link between aid and the probability of a conflict onset, in particular for aid directed to sectors classified as fungible, while there is no effect on the persistence of the conflict. In the second chapter of my thesis "Italian Terrorism: Network Analysis", I proposed the first original micro dataset on Italian terrorists' socio-economic characteristics, showing the sources and the procedure that I followed in order to construct the database. I reconstructed the network of the Italian terrorist groups of all political colours and I proposed an analysis using the concept of centrality in order to detect characteristics that help an individual to reach a central position in this peculiar setting. Results highlight the role of women and the importance of the trade-off which characterises those connections. In the final chapter, "Homophily in Terrorist Networks " I analysed the dataset created in the previous chapter in order to study recruitment choices made by the Italian terrorist groups. By using the concept of homophily, the goal of the work is to understand whether the recruitment policy of a terrorist organization follows a strategic path. Results confirm a different behaviour with respect to what the standard literature on social network suggests, which tends to enlarge through time, reinforcing the idea that recruitment choices are not merely based on political ideology but they are made considering strategic aspects.

Acknowledgements

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Chapter 1

Localized Aid and Internal Conflicts: the Case of Uganda

Literature on conflicts demonstrates that civil conflicts tend to be highly localized within a country. Literature on foreign aid highlights how project-based aid, which are aid directed to specific locations, are becoming one of the most used way through which governments and institutions help less developed countries. Taking into consideration the importance of the localization of these phenomena, this article empirically examines the impact of project-based aid on the conflict onset in Uganda using geolocalized panel data from 2000 to 2013. The results show that in general aid has a positive impact on the onset of a conflict at local level. Specifically, aid directed to sectors that are classified as fungible from the literature have a positive impact, while aid directed to sectors classified as non fungible have no impact. On the contrary, the study of the effect of aid on the persistence of a conflict at a local level shows an absence of impact, neither in positive or negative direction.

1.1 Introduction

The purpose of this research is to investigate whether and how foreign aid may affect the probability of conflict appearance in a territory, and more specifically to study the impact of foreign aid on internal conflict (i.e. civil conflict) by using geolocalized data, for the case of Uganda. Current literature typically analyses the topic from a macro-perspective, by means of aggregate data at a country level, and producing inconclusive results. However, according to the existing databases (such as the OECD's Creditor Reporting System) a large amount of the project-based foreign aid flows are directed to specific locations within the recipient country and this peculiar form of aid are dramatically increasing in the last years. This work aims to fill the gap in literature, dealing with the analysis from a micro-economic perspective. A new data source, AidData [1], makes it possible to have a clear idea about the spread of the aid in the country. By taking into consideration the importance of the effects at the sub-national level, this paper adds an information layer that can help to better understand whether a direct impact of foreign aid on conflicts exists and, if so, in which direction.

The main source of the data is the AidData portal, a platform established in 2009 through a partnership between three institutions (the College of William & Mary, Development Gateway and Brigham Young University) whose aim was to create the most comprehensive database by including information on aid projects of donors that do not report to the OECD (such as Brazil, South Africa, and China) and providing enhanced information on development projects and activities, in order to improve transparency as well as donor and recipient strategic planning and coordination. The most important innovation of the portal is linked to the effort given for the geocoding, i.e. the tagging of projects and activities with precise geographical information.

[1] AidData. 2015. Uganda AMP Geocoded Research Release Level1 v1.1 geocoded dataset. Williamsburg, VA and Washington, http://aiddata.org/research-datasets.

The choice of focusing on Uganda is due to three main characteristics. First of all, the country is an underdeveloped country: according to World Bank, Uganda is classified as a low income country given that its GNI per capita is lower than $1035[2]. Moreover, analysing data from the World Development Indicators, Uganda has been one of the top 20 recipient countries (ranging from the 11th place in 2007 to the 20th place in 2002) and the flow of aid represented almost 13% of the total GNI during the period under analysis. Secondly, Uganda suffered for several internal conflicts since Independence in 1962. According to ACLED database (Armed Conflicts Location Event Data), between 1997 and 2013 the state had more than 4000 fighting events, of which about a half with at least one death. Finally, the availability of data. The most comprehensive geocoded aid dataset available at the moment is the Uganda AMP Geocoded Dataset, whose latest release is July 2015. This dataset includes information on 565 projects for a total of 2458 locations[3].

In order to analyse this specific impact of foreign aid, it is important to clarify the definitions for all the core concepts used. This is a crucial aspect of the study. We have to establish a clear definition of what a foreign aid, and in particular project-based aid, is. Broadly speaking, in order to determine whether a flow can be considered as international aid, it is applied the official definition given by the Development Assistance Committee of the OECD. It defines foreign aid as "financial flows, technical assistance, and commodities that are (1) designed to promote economic development and welfare of developing countries as their main objective and that (2) is concessional in character and conveys a grant element of at least 25 per cent". If the aid is given for a specific purpose it is classified as "project-based aid"; otherwise, if it covers a general sector for all the country, it is called "programme aid".

[2]Uganda GNI per capita in 2013 is $550 according to the Atlas method.

[3]AidData released another interesting geocoded dataset in 2011 (REF) that covers the Sub-Saharan African countries with conflict between 1989-2008, including only the conflict-years. For this reason, this database is not useful for this work.

The objective of the work is to understand if there are some evidences in favour of (or possibly against) the idea that an increase in foreign aid towards a given area increases the probability of a onset of a conflict in that specific area. If so, whether the impact changes according to the type of foreign aid provided and if the presence of aid can explain the duration of a conflict in a specific area. The effect is not a priori clear: theory shows that rebels can be regarded as specific type of business for which aid can be seen as "prizes" to be reached; on the other hand, aid can represent a way for actually increase the standard of living of poor people and so decrease the need of conflict.

The results show that the impact of Aid at a local level is positive. Once we focus on the level of fungibility, the only type of aid that play a role are the one classified as fungible (as suggested by the literature). On the contrary, when we study the persistence of a conflict, the presence of aid seem not to play any type of role, neither in reducing the number of years with conflict nor in increasing it.

1.2 Literature Review

The literature concerning the effects of international aid on conflicts started at the beginning of '90s with a seminal paper of Grossman (1992) in which the author analyses the allocative and distributive effects of foreign aid within a theory of insurrections. The model is based on the idea that the objective of insurgents is to capture the state, in order to achieve financial advantages. In this pattern, aid increases the total financial amount of the State, increasing the incentives for rebellion. Following the impulse given by Grossman, other authors tried to disentangle the linkage between foreign assistance and conflicts with several important contributions, both from the theoretical and empirical side, producing opposite results with no consensus on the direction of the effect.

Few years after the first paper, another important contribution has been made by Azam (1995) in which he developed a game-theoretic model that confirms the previous approach. Aid represents a particular form of rents that increases the probability of conflict onset because it increases the prize of capturing the capital.

Apart from these theoretical contributions, some empirical work have been developed starting from the 2000's, confirming the positive channel between the two variables. The first important empirical paper in this direction is the one provided by Addison and Murshed (2001) in which the authors sustain that the positive relationship between the two variables is mainly due to the volatility of aid flows, that increases the uncertainty within the state and, consequently, increases the probability of conflict.
More recent papers consider aid similar to natural resources, since in some cases aid represents a lootable resource that can be exploited by the rebels. In particular, Blouin and Pallage (2008) provide a simplified theoretical approach that shows how the possibility to loot food aid can modify the choices of potential rebels. Their approach is confirmed also by a recent empirical paper by Nunn and Qian (2014). In their work, the authors focus on the effect of U.S. food aid on conflict in recipient countries, using changes in U.S. wheat production in order to assess the time variation in food aid shipments. They find that increases in food aid correspond to a strong increase of the duration of civil conflicts and an increase on the onset of new conflicts even if, in the latter case, the magnitude seems not to be really important.

Conversely, some papers affirm that international money can reduce the risk of rebellions, improving stability and increasing the cost of conflict. In particular, foreign aid can be used for social purpose or to increase military expenditure, reducing the incentive of rebellions against government. Collier and Hoffler (2002) provide an analytical and statistical analysis about the effects of aid and economic policy

on the risk of civil conflict. They suggest three main reasons for which flows of international money can have a positive impact on the reduction of the incentive for rebellions provided that growth (bullet 2) and less dependency (bullet 3) reduce conflicts:

- A direct effect on the economy by relaxing the government budget constraint. According to their results, this effect is the opposite of Grossman theory; as the coefficient is negative. Actually, in their analysis this coefficient is not significant but further studies, like the one made by Ree and Nillesen (2009), confirmed the negative impact, assessing that higher level of international money alleviates the budget constraints and reduces the duration of a conflict (a structural increase in aid flows by 10% decreases the continuation probability by 8% points);
- An indirect effect through the economic growth. The authors sustain that, conditional on policy, aid raises growth: an additional one dollar per capita would raise the growth rate by around 0.25%;
- An indirect effect through the diversification of the economy. In detail, the authors find that aid create a significant "Dutch disease effect": aid reduces primary commodity exports as a share of GDP, making the economy less dependent.

The second point has been the most discussed since the beginning of the debate on aid effectiveness. The most recent study that attempts to clarify this point is the one proposed by Santanu Chatterjee and Kaya (2012) in which the authors disentangle the link between how the government spends the money and the composition of foreign aid in order to find some indirect mechanisms through which aid affects growth.

In the last years, the debate concerning the topic has been enriched by a new contribution, due to availability of a new type of data from 2011. In their paper

of 2011, Michael Findley, Josh Powell, Daniel Strandow and Jeff Tanner presented a new database with detailed geographical information on foreign aid projects that have been committed to some Sub-Saharian countries between 1989 and 2008. This work represents the first effort to address the problem in a micro-perspective, highlighting how the two main channels suggested by the literature (i.e., aid can stabilize the economy of the recipient country but they can also increase the prize for capturing the capital), can be better analyzed at a disaggregated level. Similarly, Berman et al. (2013) compare the effects of several development programs with different characteristics provided during an important conflict, as the one occurred in Iraq. They find that development spending is the most violence-reducing when they are small and informed by experts. For the purposes of this study, the contribution by Tahir (2017) who focuses on the case of Pakistan is fundamental. According to the author, for the first time macro and micro data are combined to show that aid may not reduce domestic conflict. Aid is regarded as easy money, weakening the government incentive to use its own funds for reform and increasing the conflict risk in the country.

Finally, this study refers to the literature concerning Uganda. Several papers take Uganda as unit of analysis, given the large number of ethnic groups that characterize the region and the large number of internal conflicts registered also in recent years. Several papers exploited the disruption of capital due to these violent episodes, focusing mainly on the consequences of battles on different individual characteristics. The most comprehensive work in this sense is the one by Rohner et al. (2013) in which, using individual and county-level data, they exploit the effect of an ethnic conflict occurred in northern Uganda between 2002 and 2005. The main result of the paper is that battles had a strong and statistically significant negative impact on trust towards other Ugandans[4].
The study most similar to the one currently proposed is the working paper by

[4]Other studies that focus on the consequences of the conflict in Uganda are the ones of Deininger 2003 and Bozzoli et al. 2011

D'Onofrio and Maggio (2015) who focus on Uganda in order to discover the socio-economic effects of foreign aid in developing countries. Using a similar disaggregated data source for foreign aid, they find that individuals living in counties that received more aid exhibit up to 13.3% higher probability to trust others with respect to those living in counties with no aid.

1.3 Data

The empirical analysis uses annual data on Uganda from 1997 through 2013. Main data for this study come from ACLED Version 5 and AidData 3.0.

1.3.1 Civil Conflicts

Data for the construction of the dependent variable is based on ACLED Dataset Version 5 (Raleigh et al., 2010). This database covers political violence in Africa, from January 1997 to December 2014. Each event is classified according to the rules "who, what, where and when" in order to make the comparison between datasets easier. Important information for this study concerns the type of conflict event (Battle with no changes in territories; Battle in which non-state actor overtakes territory; Battle where Government regains territory; Headquarters or base established; Non-violent activity by a conflict actor and protests); the type of actors (governments, rebels, militias, ethnic groups, active political organizations, and civilians) and the number of fatalities for each event.

In the analysis, we used the structure of these data in order to construct different specifications for the dependent variable. First of all, we constructed it in order to catch the "conflict onset" in the area: it is a binary indicator equal to one if a conflict event is present at time t but not in time t-1 in a given district. Given that the characteristic of this dataset is to include a large number of events, with a broad definition of conflict; in order to avoid including some type of conflicts that from

a theoretical point of view have no relationship with the independent variable, we decided to limit the data to some particular type of events. In detail, one specification is focused only on the conflicts that register at least one fatality; while a second one is focused only to events whose actors are civilians and not organized group. Ex ante, we can sustain that the effect should be more significant in the latter case given that the theoretical link should be closer.

1.3.2 Foreign Aid

AidData is a platform established in 2009 by a partnership between College of William & Mary, Development Gateway and Brigham Young University that integrates detailed project-level data on $6 trillion in aid from over 90 agencies with information on remittances and foreign direct investment. For the purposes of this study, it is important to highlight the effort made in an initiative aimed to geocode projects (applying precise geographic coordinates to development activities), that led to the release of some country-specific geocoded datasets as, for example, the one concerning Uganda at the end of 2014. In order to have a better micro information, AidData implemented an information management system, called Aid Management Platform (AMP), at country-level. The goal of this project is to enable governments to better manage external aid in accordance with national development priorities. In general, donors report development finance information to partner governments through an Aid Information Management System (AIMS). Currently, thanks to AidData Research Assistants, all the projects with geographical information are coded.

In particular, the Ugandian dataset includes aid allocation measured in constant U.S. dollars, covering the years 1978 through 2014 and including information on 565 geocoded projects implemented by 37 donors, for a total of 2470 locations. Figure 1.1 shows the distribution of projects among donors. Even if this is the most complete database available, some weaknesses have to be highlighted. First of all, analyzing the structure of the data little information is available for projects before 1997, i.e.

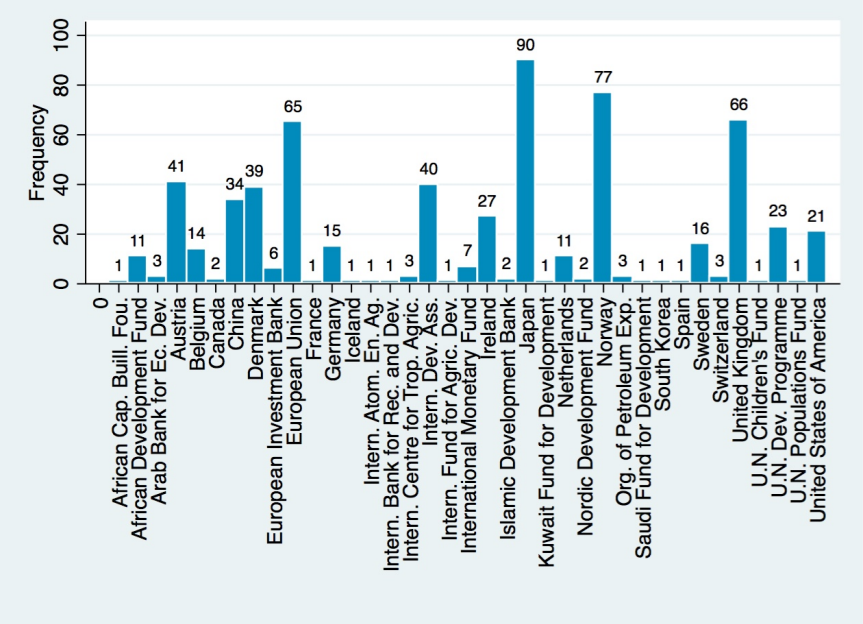

Figure 1.1: Donors distribution

there is an high probability of missing data before 1997. For this reason we decided to focus only on the period ranging from 1997 to 2013. Moreover, no assumption is made about how the financial amounts are divided when a transaction has more than one location: in the data only the total amount for each project is present.
In order to disentangle the problem, we decided to use the number of people living in the district as criteria. The only exceptions are the aid in agriculture and water and environment for which the criteria was the area of the district itself. It is important to highlight that the data does not contain precise information on the percentage of loans and grants for each project; the only information we know is that almost 25% of the total is in the form of grant, given the official definition of foreign aid.

The system of geo-referencing used is based on the Uppsala Conflict Data Program's Geo-referenced Events Dataset (Sundberg et al., 2010), with some slightly adapta-

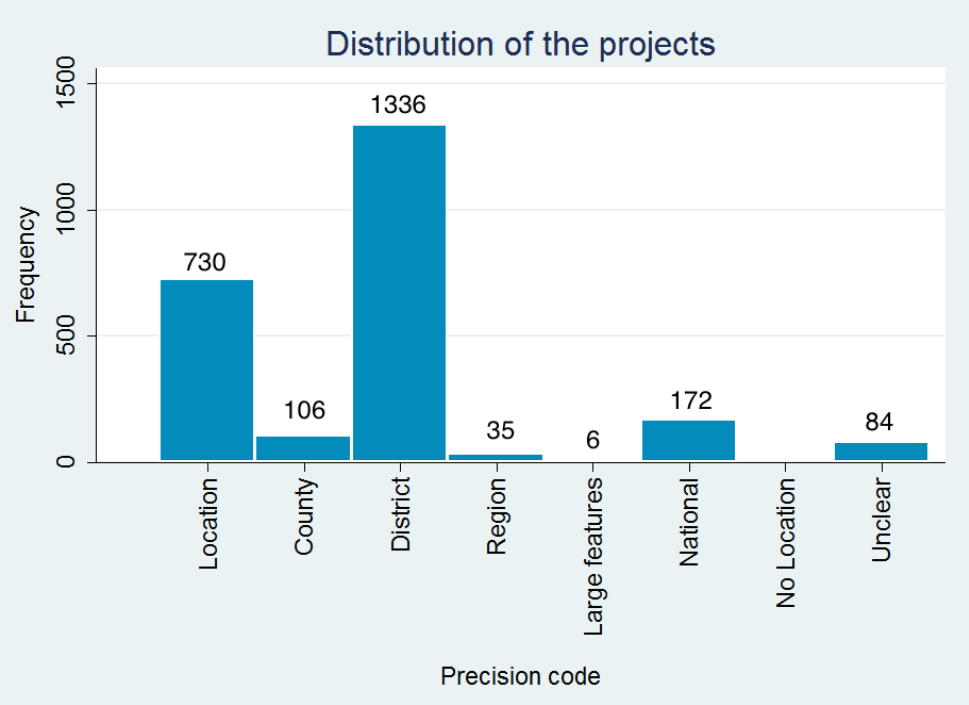

Figure 1.2: Distribution of geo-codes

tion and additional rules in order to better evaluate the location of the projects[5]. In appendix the detail of the geocoding is presented.

Figure 1.2 presents the dataset by precision code. Notice that the majority of the locations are coded at precision code 3 (54,11%), that corresponds to a district level in Uganda (they are 112), reinforcing the decision to take as unit of analysis the district-level. Aggregating the first three columns, the 87,97% of the observations are taken into account, a percentage that allows us to have interesting predictions and results.

In the analysis, the independent variable would be the amount of aid disbursed in

[5]See Strandow et al. (2011) for more detailed information.

a district each year over the district total population of the same year. It is possible to include this last variable thanks to the presence of district population in the census of 1991, 2002 and 2014. By interpolating such data, we are able to have a credible reconstruction of the population in each district for each year.

1.3.3 Controls

To have a global view of the problem, other explanatory variables need to be taken into consideration. First of all a variable representing the income is taken into consideration. This is due in order to capture some important local income differences. Unfortunately, disaggregated data for developing countries are not available but, following the literature, we uses average night light intensity as a proxy for the income for each district.

Some geographic controls are included (like mean elevation, total district area and the presence of natural resources in the district, in order to consider the possibility of the presence of lootable resources). Moreover, following the suggestions given by Findley et al. (2011), also the distance of the district to the capital and to the borders is included in the analysis.

One of the characteristic of Uganda is the large number of ethnic groups in the area. According to Rohner et al. (2013) more than 50 different fractions cohabit in the region. Thanks to the Geo-referencing of Ethinc Groups project (GREG Weidmann et al. (2010)) we are able to determine the ethnic fractionalization in each district.

Finally, some district-level controls like average age, average level of education and urbanization rate are used in the analysis. These data are available from the Census of Uganda Bureau of Statistics of 2014.

1.4 Preliminary Analysis

In order to deepen our understanding of the data, some preliminary analysis are fundamental.

Figure 1.3 shows the sectoral division of the projects among 11 different sectors. This information is fundamental for this study, enabling us to take into consideration the possibility of different effects according to the fungibility of aid. In fact, the literature distinguishes between the so called “fungible aid” and “non-fungible aid”. The former class includes all the money for which is easier to divert to activities different from the original purpose, obtaining as result a different net effect with respect to the one intended. In particular, rather than increasing the government spending, this money is used to substitute the government spending. The latter class represents the aid in sector for which literature suggests that government tend to use them for the original purpose.

According to Findley et al. (2011) fungible aid are more attractive to rebels with respect to the other category because they increase the potential returns to obtaining the reins of power.

Given that literature has identified sectors for which the level of fungibility is high and others for which fungibility is not an issue (Feyzoglu et al., 1998), we provide the sector division proposed in figure 1.3 and we divide our sample in two different order of fungibility: the so called ”Non-fungible aid” represented by aid destined to health, information and communication, social development and works & transport and the ”Fungible aid” that are money provided to accountability, budget support, energy and mineral development and water,agriculture, education, public sector management and environment.

The largest number of projects is implemented by Japan (90), followed by Euro-

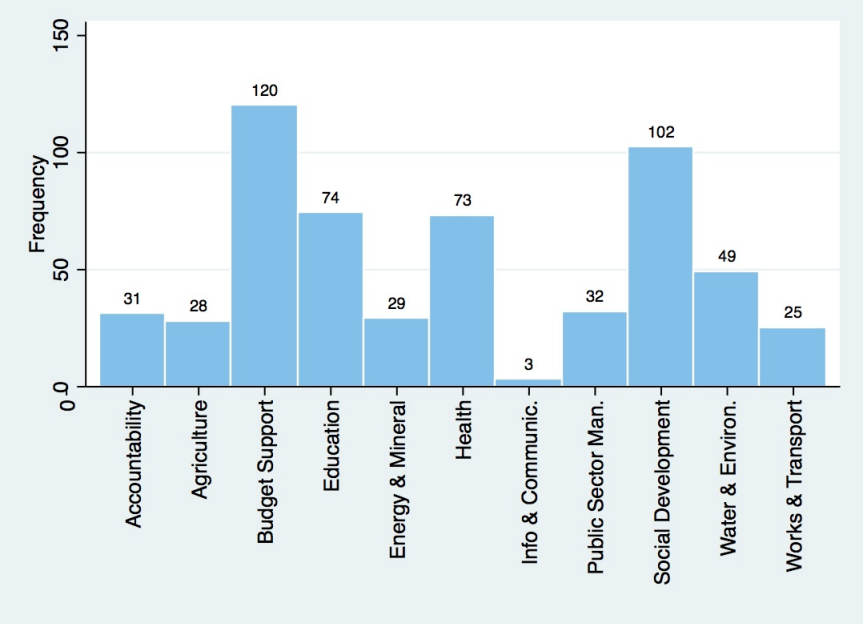

Figure 1.3: Aid flows by sector

pean Union and United Kingdom. In general, 27.33% of projects are promoted by multilateral donors while the rest (72.67%) are by bilateral ones.

To get a better idea about the relationship between international money and conflicts, we plotted both variables using ArcGIS. The output is represented in figure 1.4.

From the map it seems that the two variables follow two different patterns: except for the capital that seems to attract both variables, in the rest of the country the two events seem to be differently located. In particular the largest part of conflicts are concentrated in the north of the country, while the largest number of projects are located in the south-east and along the borders.

Even though this map gives us an initial idea about the connection between the two phenomena, it may be more interesting to look at the average amount of per capita aid instead of the number of projects. Figure 1.5 shows this situation,

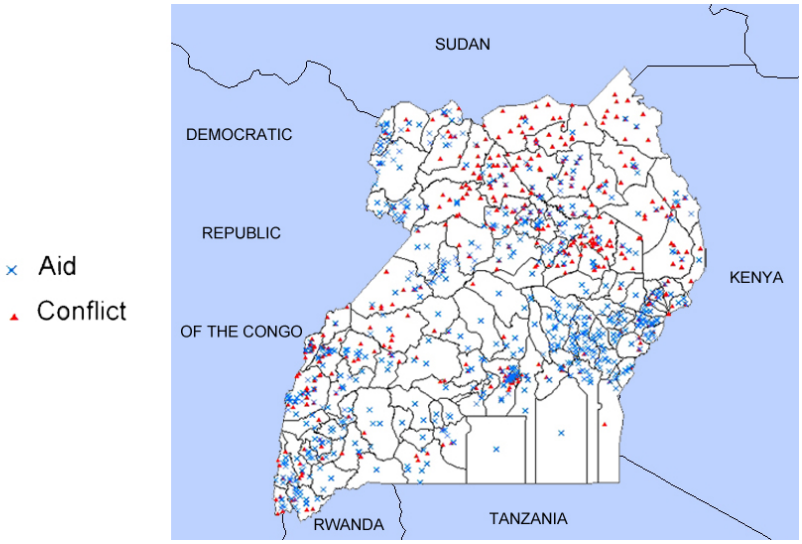

Figure 1.4: General map

with data aggregated at district level. The map on the left shows the amount of aid received by each district, while the map on the right aggregates the number of conflicts occurred in each unit of analysis. With respect to the previous analysis, some similarities seem to emerge: in both cases there is a high concentration around the capital, in the south of the country; moreover conflicts are strongly concentrated in the northern part of the country, as suggested before. Indeed, looking at the amount of aid instead of the number of projects, we notice that the large amount of projects located in the south-east are probably less important, from an economic point of view, than the ones in the north-west.

Finally, checking year by year it is possible to highlight some interesting features. According to Figure 1.6 it is easy to see how the number of conflicts remains practically constant for all the period taken into consideration, both looking at the general definition or shrinking the data only to conflict with fatalities. On the other hand, the number of districts that received an amount of international aid is greatly increased, starting from 16 districts in 1997 to all the administrative regions in 2009.

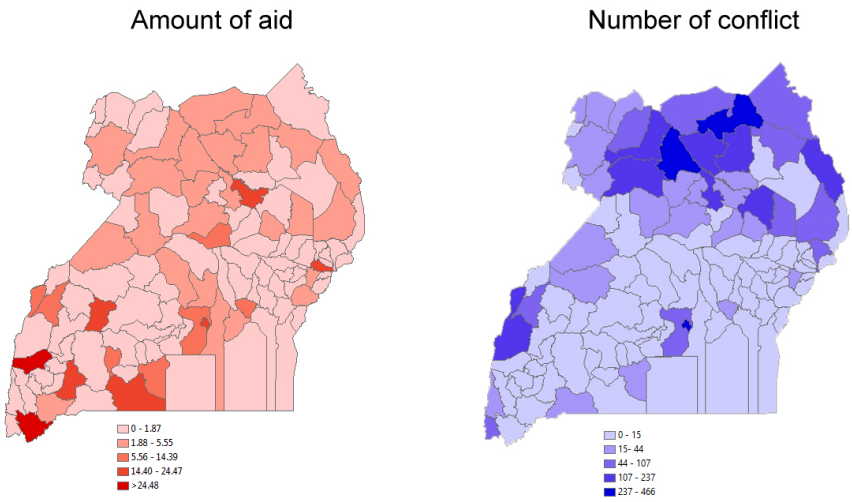

Figure 1.5: Aid flow and number of conflict per district

Taking the whole sample, 63.6% of districts received international assistance during the period under analysis, while 32.2% suffered of almost one conflict; this percentage drops to 20.3% if we consider only conflicts with at least one fatality.

1.5 Methodology and Results

As pointed out in the introduction of this work, in order to make consistent estimation, it is important to take into consideration the main problem that affects this topic: reverse causality. This problem affects estimations in directions that are ambiguous ex ante. In fact, on one hand, some of the existing literature on the topic assesses that conflicts arise where there are more aid, but it is also possible that aid are allocated where there is higher probability of conflict onset. On the contrary, it is also plausible that conflicts arise where there are less aid and that aid tends to be allocated in stable areas.

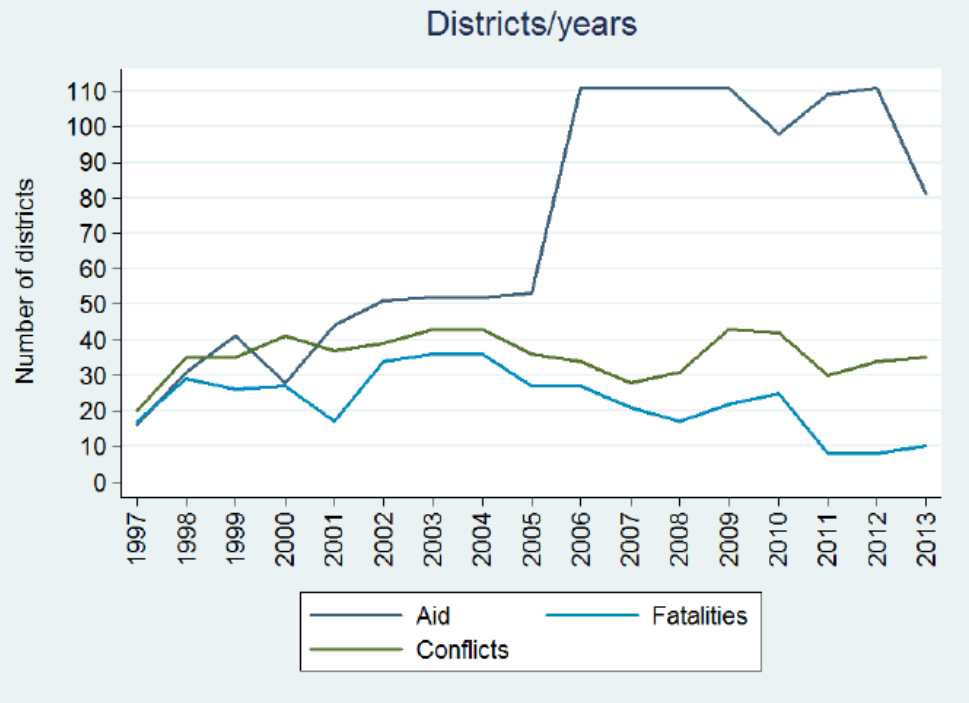

Figure 1.6: Numerosity

To take into consideration this aspect, the existing literature suggests the use of lagged aid flows data in order to solve the problem. The reason is that it seems reasonably difficult that donors are able to anticipate the arise of a conflict before the effective onset (Ree and Nillesen, 2009; Findley et al., 2011). This is the approach that we used in this work.

In order to explore in a better way the data, given that the first years of these datasets are not totally reliable, we decided to drop all the data before 2000; reducing our time span to 13 years, from 2000 to 2013.

	Obs	Mean	Std. Dev.	Min	Max
Aid per capita	1564	3.4002	13.93	0	288.084

Table 1.1: Descriptive statistics aid per capita

1.5.1 Conflict Onset

We decided to use two different definitions of the dependent variable. For each definition we run a standard logit regression and the general model is:

$$Conflict_{d,t} = \Phi[\beta_0 + \beta_1 Aidpc_{d,t-1} + \beta_2 lights_{d,t-1} + \gamma_1 \mathbf{G}_d + \gamma_2 E_d + \gamma_3 \mathbf{D}_d + \eta_t + \epsilon_{d,t}]$$

where $Aidpc_{d,t-1}$ is the main variable that represents the amount of aid per capita, which is constructed as the total amount of aid over the total population of a given district d; while $lights_{d,t-1}$ represents a proxy for the income. This variable is lagged of one period, in order to avoid a potential problem of reverse causality: the presence of a conflict in that district could reduce infrastructures, and so the amount of lights registered by the satellite could be potentially smaller. $\mathbf{G}_d$ represents the geographic controls (namely total district area, mean elevation, distance to capital and borders); E_d the Ethnic fragmentation based on the GRID project; $\mathbf{D}_d$ the demographic controls and η_t are time dummies.

Figure 1.7 presents the distribution of the main variable of interest and Table 1.1 the descriptive statistics [6].

The first strategy concerns the use of the general definition given by the Acled dataset (i.e. the entire sample) in order to catch the probability of a conflict onset.

[6]Given the presence of two important outlier in our sample, we decided to exclude them from the analysis.

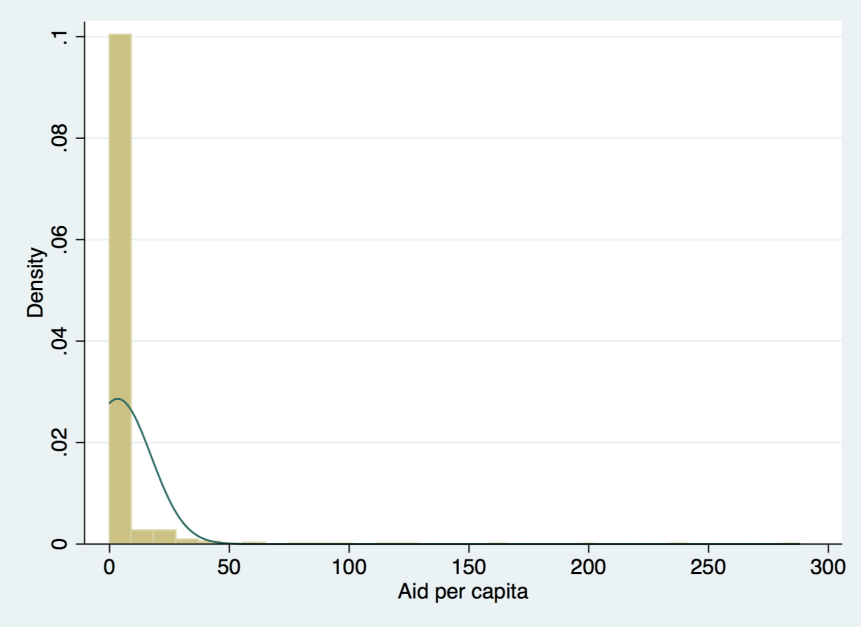

Figure 1.7: Aid per capita distribution

In details, the dependent variable is defined as follows:

$$Pr(Conflict_{d,t} = 1) = \begin{cases} 1 & if\ conflict\ is\ present\ in\ t\ and\ not\ in\ t-1 \\ 0 & otherwise \end{cases}$$

Where d represents the district.

Table 1.2 summarizes the results.

According to these results, the main variable of interest is positive and significant in all the specifications. In fact in the first column, in which the regression is done without any control, the result suggests that an increase of 1 dollar per capita increases the probability of the conflict onset in the following year of 0.0018; which

	(1)	(2)	(3)	(4)	(5)
Aid_{t-1}	0.00183**	0.00180**	0.00182**	0.00142**	0.00131**
	(0.00072)	(0.00071)	(0.00072)	(0.00065)	(0.00063)
$Lights_{t-1}$	-0.0071	-0.0078	-0.0076	-0.0073	-0.0104
	(0.0059)	(0.0071)	(0.0069)	(0.0068)	(0.011)
$Conflict_{t-2}$					-0.0173
					(0.0215)
$Conflict_{t-3}$					0.0515**
					(0.0206)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.2: Logit specification on general events

means an increase probability of 0.18%. This result is substantially constant in all the specifications, even if the magnitude tends slightly to decrease.

Column 4 presents the result of the specification with both geographic and ethnic controls as well as time dummies: the main variable of interest stays positive, suggesting an increase probability of conflict onset of 0.14%.

In order to have a complete picture it can be important to take into consideration the persistence of a conflict in a given district. For this reason, we decided to run an additional regression, adding as explanatory variables also two variables that capture the presence of a conflict in a given district respectively two and three years before the year under analysis.

Results are presented in column 5 and the coefficients are not really different with respect what we found in the previous regression. In fact, also in this specification

the main variable of interest is positive, with a magnitude of 0.0013.

Referring to the two new variables, only the presence of a conflict three years before the time taken into consideration seems to be significant at a 5% level. The impact is positive and important, suggesting that the presence of a conflict three years before, increase the probability of the onset of a new conflict of 5%.

In order to study the phenomena, a different definition of the dependent variable can be studied.

Given that the goal of aid is to help civilians, Table 1.3 presents the results limiting the dependent variable to events that involved civilians as actor.

$$Civils_{d,t} = \begin{cases} 1 & if\ conflict\ with\ civilians\ as\ actors\ is\ present\ in\ t\ and\ not\ in\ t-1 \\ 0 & otherwise \end{cases}$$

The results of this specification are substantially in line with what we found in the previous definition, with a slightly smaller magnitude. In fact, focusing on the forth column which represents the analysis with all the controls, it suggests that an increase of 1 dollar per capita increases the probability of the conflict onset in the following year of 0.0012; which means an increase probability of 0.12%.

The last column represents the specification which take into consideration also the presence of a conflict with civilians involved respectively two and three year previous the year of the analysis. While the magnitude of the main variable is substantially confirmed, it is interesting to highlight how in this specification none of the conflict variables play a role. In fact neither the variable concerning the presence of the conflict with civilians involved two years before nor the one capturing the presence of a conflict with civilians three years before is significant, suggesting that this specific

	(1)	(2)	(3)	(4)	(5)
Aid_{t-1}	0.00154**	0.00154**	0.00155**	0.00119**	0.00111**
	(0.00064)	(0.00061)	(0.00062)	(0.00056)	(0.00055)
$Lights_{t-1}$	-0.00516	-0.00459	-0.00457	-0.00433	-0.00627
	(0.0046)	(0.0049)	(0.0049)	(0.0047)	(0.0068)
$Conflict_{t-2}$					-0.0055
					(0.0214)
$Conflict_{t-3}$					0.0263
					(0.0207)
Geografic Controls	no	yes	yes	yes	yes
Ethinc Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.3: Logit specification on events with civilians involved

type of conflicts are more prone to be made for specific objectives and not for long term goals.

1.5.2 Conflict Onset - Classification According to Fungibility

Because of the different nature of aid, we decided to study if there is a different impact of aid based on their fungibility. Table 1.4 presents the descriptive statistics of this classification.

We followed the same line of reasoning of the previous point, running a similar type of model, in different versions.

The first specification concerns the study of the impact of the so called non-fungible aid. It includes sectors for which the literature suggests that the possibility that aid

	Obs	Mean	Std. Dev.	Min	Max
Fungible	1564	2.1108	11.7488	0	277.781
Non fungible	1564	1.2894	6.9146	0	192.994

Table 1.4: Descriptive statistics aid per capita classified according to their fungibility

is used in ways not intended by donors when disbursing the funds is small.

The general model is:

$$Conflict_{d,t} = \Phi[\beta_0 + \beta_1 NFaid_{d,t-1} + \beta_4 lights_{d,t-1} + \gamma_1 \mathbf{G}_d + \gamma_2 E_d + \gamma_3 \mathbf{D}_d + \eta_t + \epsilon_{d,t}]$$

where $NFaid_{d,t-1}$ represents the total amount of aid per capita classified as non fungible and it is calculated as non fungible aid over the total population of a given district d; $lights_{d,t-1}$ represents a proxy for the income: as before, this variable is lagged of one period, in order to avoid a potential problem of reverse causality.

Table 1.5 summarizes the results, taking as dependent variable the onset of a conflict with the most general definition.

The results are in line with what we expected: in all the versions of the model the main variable of interest is not significant, suggesting that project aid which are addressed to sectors in which there is more possibility of control from the donor countries have no impact on the probability of conflict onset.

	(1)	(2)	(3)	(4)	(5)
$NonFungibleAid_{t-1}$	0.00013	0.00027	0.00046	-0.00025	-0.00015
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0022)
$Lights_{t-1}$	-0.00592	-0.00653	-0.00640	-0.00614	-0.00874
	(0.0055)	(0.0065)	(0.0064)	(0.0063)	(0.0092)
$Conflict_{t-2}$					-0.0156
					(0.0215)
$Conflict_{t-3}$					0.0525**
					(0.0207)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.5: Logit specification on general events - non fungible aid

Similarly, we provided a second specification focusing only on the so called fungible aid.

The general model is:

$$Conflict_{d,t} = \Phi[\beta_0 + \beta_1 Faid_{d,t-1} + \beta_4 lights_{d,t-1} + \gamma_1 \mathbf{G}_d + \gamma_2 E_d + \gamma_3 \mathbf{D}_d + \eta_t + \epsilon_{d,t}]$$

where $Faid_{d,t-1}$ represents the total amount of aid per capita classified as fungible and it is calculated as fungible aid over the total population of a given district d.

Table 1.6 summarizes the results.

The results suggest that aid provided to sector in which the control of the donor is more difficult have a positive impact on the probability of conflict onset in that

	(1)	(2)	(3)	(4)	(5)
$FungibleAid_{t-1}$	0.00211**	0.00204**	0.00203**	0.00160**	0.00147**
	(0.00084)	(0.00082)	(0.00083)	(0.00072)	(0.00070)
$Lights_{t-1}$	-0.00657	-0.00712	-0.00689	-0.00675	-0.00941
	(0.0057)	(0.0067)	(0.0066)	(0.0065)	(0.0098)
$Conflict_{t-2}$					-0.0179
					(0.0215)
$Conflict_{t-3}$					0.0515**
					(0.0206)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.6: Logit specification on general events - fungible aid

specific location. In fact, in all the specification the main variable of interest is positive and significant, ranging from 0.0021 of the first specification to 0.0016 of the forth. This means that an increase of 1 dollar per capita of aid in sectors classified as fungible implies an increased probability of onset of a conflict of 0.16%.

Once we control also for the presence of previous conflict in the district the coefficient slightly reduces but it is still positive and significant (0.0015).

A final version in which both elements are in the model is presented in Table 1.7.

According to the theory, the impact of the so called "non fungible aid" should be lower with respect to the one classified as "fungible". The results are in line with the literature. In fact, the variable representing the sectors which has been classified as "non fungible" results not significant in any of the specifications; while the variable

	(1)	(2)	(3)	(4)	(5)
$NonFungibleAid_{t-1}$	-7.41e-06	0.00015	0.00035	-0.00026	-0.00014
	(0.00234)	(0.00231)	(0.00230)	(0.00229)	(0.00219)
$FungibleAid_{t-1}$	0.00211**	0.00204**	0.00203**	0.00160**	0.00147**
	(0.00084)	(0.00082)	(0.00083)	(0.00072)	(0.00070)
$Lights_{t-1}$	-0.00657	-0.00717	-0.00702	-0.00666	-0.00932
	(0.0058)	(0.0068)	(0.0067)	(0.0065)	(0.0093)
$Conflict_{t-2}$					-0.0179
					(0.0215)
$Conflict_{t-3}$					0.0515**
					(0.0206)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.7: Logit specification on general events - fungible and non fungible aid

representing the ones classified as "fungible" is positive and significant in all the versions of the regression.

Notice that the magnitude of the variable Fungible is confirmed in this version of the model: an increase of 1 dollar per capita of aid in sectors classified as fungible implies an increased probability of onset of a conflict which ranges from 0.21% to 0,15%.

As before, the same models are provided with a different definition for the dependent variable which focuses only on events that involved civilians as actors.

Tables 1.8, 1.9 and 1.10 show respectively the three different specifications of the model taking as main independent variables non fungible aid, fungible aid and both respectively.

	(1)	(2)	(3)	(4)	(5)
$NonFungibleAid_{t-1}$	0.00026	0.00047	0.00050	-0.00018	-0.00011
	(0.00216)	(0.00214)	(0.00214)	(0.00214)	(0.00206)
$Lights_{t-1}$	-0.00430	-0.00380	-0.00379	-0.00358	-0.00534
	(0.0044)	(0.0047)	(0.0047)	(0.0045)	(0.0063)
$Conflict_{t-2}$					-0.0046
					(0.0215)
$Conflict_{t-3}$					0.0271
					(0.0208)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.8: Logit specification on conflict with civilians - non fungible aid

	(1)	(2)	(3)	(4)	(5)
$FungibleAid_{t-1}$	0.0017**	0.0017**	0.0017**	0.0013**	0.0012**
	(0.00071)	(0.00068)	(0.00068)	(0.00060)	(0.00059)
$Lights_{t-1}$	-0.0047	-0.0041	-0.0041	-0.0040	-0.0058
	(0.0044)	(0.0048)	(0.0047)	(0.0046)	(0.0065)
$Conflict_{t-2}$					-0.0053
					(0.0214)
$Conflict_{t-3}$					0.0265
					(0.0207)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.9: Logit specification on conflict with civilians - fungible aid

	(1)	(2)	(3)	(4)	(5)
$NonFungibleAid_{t-1}$	0.00016	0.00037	0.00039	-0.00019	-0.00011
	(0.00218)	(0.00216)	(0.00216)	(0.00216)	(0.00208)
$FungibleAid_{t-1}$	0.0017**	0.0017**	0.0017**	0.0013**	0.0012**
	(0.00071)	(0.00068)	(0.00068)	(0.00060)	(0.00059)
$Lights_{t-1}$	-0.0048	-0.0042	-0.0042	-0.0039	-0.0057
	(0.0045)	(0.0048)	(0.0048)	(0.0046)	(0.0065)
$Conflict_{t-2}$					-0.0053
					(0.0215)
$Conflict_{t-3}$					0.0265
					(0.0207)
Geographic Controls	no	yes	yes	yes	yes
Ethnic Controls	no	no	yes	yes	yes
Year dummies	no	no	no	yes	yes
Observations	1450	1450	1450	1450	1224

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.10: Logit specification on conflict with civilians - fungible and non fungible aid

The results are in line with what we expected, with an higher effect of fungible aid with respect to the non fungible ones. Notice that differently to the previous definition, the magnitude is smaller: an increase of 1 dollar per capita in aid in sector classified as fungible implies an increase of the probability of conflict onset which ranges from 0.17% to 0.12% according to the specification.

1.5.3 Persistence of Conflict

The goal of this section is to understand if foreign aid has some impact on the duration of a conflict in a given area and, if so, to determine the magnitude. As before, we decided to use two different definitions of the dependent variable, running a fixed effect model. The general regression is:

$$Duration_{d,t} = \beta_0 + \beta_1 Aidpc_{d,t-1} + \beta_2 lights_{d,t-1} + \gamma_1 \mathbf{G}_d + \gamma_2 \mathbf{D}_d + \eta_{1t} + \eta_{2d} + \epsilon_{d,t}$$

where $Duration_{d,t}$ is the consecutive number of years in which at least one conflict was present in the district; $Aidpc_{d,t-1}$ is the main variable that represents the total amount of aid per capita; while $lights_{d,t-1}$ represents a proxy for the income.

$\mathbf{G}_d$ represent the geographic controls; $\mathbf{D}_d$ the demographic controls, η_{1t} and η_{2i} represents time and district fixed effects respectively. Table 1.11 presents the results.

As is evident from the table, the coefficient of the project-based aid is non statistically significant in all the versions of the model. This suggests that the presence of aid does not seem to have an impact on the duration of a conflict neither in reducing it nor in augmenting it.

Notice that, differently from all the previous analysis, the variable representing a proxy for income is strongly significant with an important magnitude. This suggests that once a conflict arises in an area with an higher level of income, the persistence of such a conflict is stronger with respect to an area with few resources.

	(1)	(2)	(3)	(4)
Aid_{t-1}	-0.0022	0.0023	-0.0006	-0.0046
	(0.0039)	(0.0039)	(0.0040)	(0.0040)
$Lights_{t-1}$	0.208***	0.208***	0.211***	0.313***
	(0.0218)	(0.0218)	(0.0217)	(0.0842)
Constant	0.514	0.807	0.401	0.785***
	(0.618)	(0.671)	(0.681)	(0.0570)
Geographic Controls	yes	yes	yes	no
Year dummies	no	yes	yes	no
Fixed effects	no	no	no	yes
Observations	1450	1450	1450	1224
Number of Id	112	112	112	112

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.11: Duration of a conflict

Following the same line of reasoning of the previous section, we present the same analysis focusing on the fungibility of the project-based aid (Tables 1.12,1.13 and 1.14).

As expected all the results are confirmed, with no impact of any of the variable of interest and the confirmation of the positive impact of the income proxy.

	(1)	(2)	(3)	(4)
$Nonfungibleaid_{t-1}$	-0.0055	-0.0058	-0.0019	-0.0113
	(0.0108)	(0.0108)	(0.0109)	(0.0111)
$Lights_{t-1}$	0.209***	0.208***	0.212***	0.309***
	(0.0221)	(0.0221)	(0.0820)	(0.0841)
Constant	0.506	0.802	0.404	0.785***
	(0.625)	(0.680)	(0.690)	(0.0573)
Geographic Controls	yes	yes	yes	no
Year dummies	no	yes	yes	no
Fixed effects	no	no	no	yes
Observations	1450	1450	1450	1224
Number of Id	112	112	112	112

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.12: Duration of a conflict - non fungible aid

	(1)	(2)	(3)	(4)
$Fungibleaid_{t-1}$	-0.0018	-0.0018	0.0010	-0.0036
	(0.0042)	(0.0042)	(0.0043)	(0.0043)
$Lights_{t-1}$	0.208***	0.207***	0.212***	0.311***
	(0.0219)	(0.0219)	(0.0218)	(0.0842)
Constant	0.510	0.801	0.400	0.779***
	(0.624)	(0.677)	(0.687)	(0.0565)
Geographic Controls	yes	yes	yes	no
Year dummies	no	yes	yes	no
Fixed effects	no	no	no	yes
Observations	1450	1450	1450	1224
Number of Id	112	112	112	112

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.13: Duration of a conflict - fungible aid

	(1)	(2)	(3)	(4)
$Nonfungibleaid_{t-1}$	-0.0053	-0.0057	-0.0017	-0.0112
	(0.0108)	(0.0108)	(0.0110)	(0.0111)
$Fungibleaid_{t-1}$	-0.0018	-0.0017	0.0010	-0.0036
	(0.0042)	(0.0042)	(0.0043)	(0.0043)
$Lights_{t-1}$	0.209***	0.208***	0.212***	0.312***
	(0.0219)	(0.0219)	(0.0219)	(0.0842)
Constant	0.515	0.810	0.401	0.790***
	(0.620)	(0.674)	(0.684)	(0.0576)
Geographic Controls	yes	yes	yes	no
Year dummies	no	yes	yes	no
Fixed effects	no	no	no	yes
Observations	1450	1450	1450	1224
Number of Id	112	112	112	112

Standard errors in parentheses
$***$ p<0.01, $**$ p<0.05, $*$ p<0.1

Table 1.14: Duration of a conflict - fungible and non fungible aid

1.6 Conclusion

The quantitative literature on civil conflict and aid has mainly relied on a macro-perspective, ignoring one of the main characteristics of conflicts which is the concentration of the phenomena in specific portion of the country and not the entire territory and founding no-consensus on the effect. Moreover, in this last years, the importance of the so called "project-based aid" is strongly increasing, representing one of the most important channels through which institutions and governments work.

In this paper we presented a first attempt of overcoming these issues by proposing a first approach based on geo-localized data. The use of specific datasets and new tools let us to study the specific characteristics of the country and to focus on

specific location instead of the whole country. The main results suggest a positive impact of this specific type of aid on the conflict onset but not on the permanence of the conflict itself.

The specificity of the project aid let us to distinguish also according the level of fungibility of each project, based on the sector to which the plan is addressed. This analysis confirms that the fungible aid are the ones that have some positive impact on the conflict onset. As a result, these founding confirm the higher possibility from rebel groups and civilians to appropriate of aid directed to accountability, budget support, energy and mineral development, agriculture, education, public sector management, environment and water and environment with respect to the ones directed to sectors like health, social development and work and transport.

This work represents a first step for future research on this topic, adding a new layer that is important to take into consideration. The direction on which this work could be expanded are several: first of all the use of an IV approach could overcome the problem of reverse causality in a different way, but the few amount of data available for underdeveloped countries makes this approach difficult to implement. Moreover, given that the study is based on geolocalized data, some positive correlation depending on distance can arise and the use of spatial models could help to capture also these aspects.

1.7 Appendix

The description of the precision code of project-based aid are the following:

1. The coordinates corresponds to an exact location;
2. The coordinates corresponds to a location within 25km or a county;
3. The coordinates corresponds to a district;
4. The coordinates corresponds to a region;
5. The coordinates corresponds to a large feature (such as rivers);
6. The project is national in scope;
7. No location is given or location is unclear;
8. Coordinates correspond to the entire country.

Chapter 2

Italian Terrorism: Network Analysis

This paper presents the first original micro dataset on Italian terrorists' socio-economic characteristics and a first study of political terrorism as a network. The dataset contains 961 individuals and it was created using a wide range of different sources and contains various information, ranging from demographic aspects; to personal background of the individual as well as information on terrorist activity. We propose a first application of the data by the use of network analysis and the concept of centrality. The main results highlight the role of women and the trade-off existing in connections.

2.1 Introduction

The phenomena of terrorism is one of the prominent problems that governments have to face in these last years. This peculiar form of organized crime is not a new form of attack: despite it was driven mainly by political reasons, it has been very relevant in the past in countries such as Germany and Italy, in which some national terrorist groups have been provoking a lot of violence for several years. Several theoretical and empirical works have tried to explain the socio-economic determinants of this type of criminal activity, mainly focusing on the macroeconomics determinants (Lai, 2007; Freytag et al., 2011). However, in the literature there are very few empirical works that study the phenomena from an individual perspective, mainly due to the absence of micro data and the difficulties in collecting them.

This paper aims to fulfill the gap in the literature, by proposing both an original dataset on the socio-economic characteristics of Italian terrorists, collected by several different sources[1], and a preliminary network analysis that explores the phenomena under a different point of view, following the idea that relationships represent an important key to understanding the specificity of this form of organized crime and, potentially, the dynamics that encourage individuals to join terrorist groups.

In order to show the potentiality of our dataset, we propose a similar approach in order to identify if there were some personal characteristics that played a crucial role in making some individuals to reach a central position within the terrorist group. The structure of the network is constructed based on some theoretical assumptions, but the results are in line with what the historical evidences suggest. By using different definitions of centrality, our results suggests that despite the number of women

[1]Namely official biographies of former terrorists, victims and relatives of victims; news and institutional reports, such as newspaper reports; archive material from newspaper and "commissioni d'inchiesta"; general books on the topic; judicial sources collected by the "Centro di documentazione Cultura della Legalità Democratica" in Tuscany and the "Archivio Dote" filed at the "Istituto Parri" in Bologna.

is sensibly lower among the subjects, females tended to be in a more central position inside the network. Moreover, if a slightly positive correlation is established with the level of education, the presence of a link between poverty and terrorism inside the group is not totally ruled out: our results suggest a negative correlation both with being student or unemployed and with the proxy of the level of income (i.e. the region of birth). Finally, an interesting result concerns the impact of being formally recognized as leader inside the group: our analysis suggests that bring in that role had a negative correlation with being in a central position. Therefore, despite what general criminal organizations do, Italian terrorist groups tend to organize themselves in a weakly hierarchical structure. Figure 2.1 and 2.2 show two potential different structures, non highly hierarchical and highly hierarchical respectively. In order to understand the difference, we take into consideration the simplest definition of centrality, i.e. the most central node is the node that has the highest number of links. When consider a structure as the one depicted in Figure 2.1, in which the darker dots represent the formal leaders of the group, the concepts of centrality and being the leader of the group can coincide. In the example nodes 1 and 2 are both the most central with 4 links each and the formal bosses of the group. When we consider a structure of the group as highly hierarchical, like the one presented in figure 2.2, the two concept are clearly distinct. In the example the most central nodes are node 3 and node 4, while the two formal leaders are represented by node 1 and 2.

Given the topic under analysis, it is important to define what "terrorism" means. Common definitions of terrorism refer to a succession of violent criminal actions against state institutions such as governments, politicians, ethnic groups, religious groups or public figures. Although Italian law does not explicitly defines this form of subversion, in general we refer to the definition made by the international community in the League of Nations' 1937 Convention. Acts of terrorism are defined as "criminal acts directed against a State and intended or calculated to create a state of terror in the minds of particular persons or a group of persons or the general public".

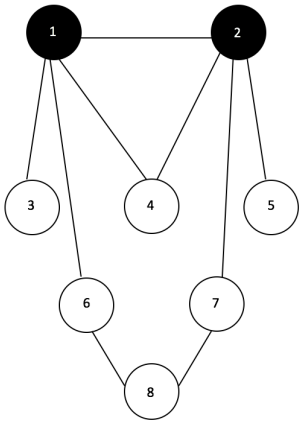

Figure 2.1: Weakly hierarchical network.

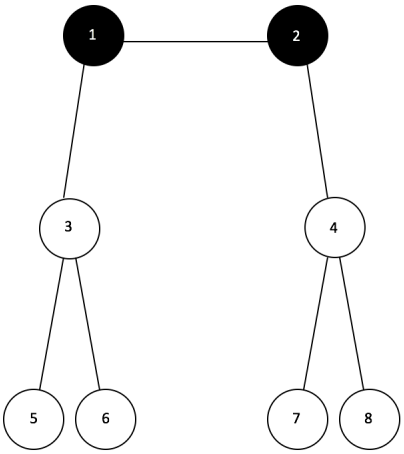

Figure 2.2: Highly hierarchical network.

Note: Dark nodes denote agents that are formally recognized as ”leaders” of the group; light nodes denote the others.

We focuses on Italy where many radical groups, with different political inspirations, have been settled up starting from 1970 and their activities have covered approximately 20 years, although some attacks (and some arrests from the authorities) have also occurred in recent years. The country represents a natural environment for this type of study: according to Della Porta and Rossi, 2.712 events of political violence linked to terrorism were counted in Italy only between 1969 and 1982 and 324 of them were directed against people, with 768 injured and 351 killed (Porta and Rossi, 1984). The creation of a completely new dataset lets us, for the first time, to have a direct measure of aspects that has been discussed in literature. In fact, although the common-sense suggests that poverty and lack of education are causes of terrorism, our dataset seems to confirm what several socio-economic studies highlighted in the recent years. Now a days there is general agreement that terrorist organizations are composed in large part from people with an higher level of education and more stable positions with respect to the rest of population (Krueger, 2008; Orsini, 2012).

The paper is organized as follows: Section 2.2 presents the literature; Section 2.3 reviews the historical background in which the Italian political terrorism arose, with a particular focus on the Red Brigades; Section 2.4 presents the dataset, with a focus on its construction and descriptive statistics; Section 2.5 introduces a first application by presenting the theoretical construction of the network and a first analysis. The last section presents the conclusion.

2.2 Literature Review

The study of the dynamics that terrorism has triggered has been the subject of investigations in various disciplines. In fact, a lot of studies have been performed on this topic in several areas, such as sociology, psychology and criminology and they have become more technical and quantitatively oriented. Also economy has been in-

volved in this kind of research, with several studies concerning the economic impacts of this illicit behaviour as well as the response of economic policies adopted from the government with the aim to block the evolution of these groups.

Starting from the 50's of the last century, both theoretical and empirical works have been provided in literature concerning different aspects of conflicts in general and organized criminal behaviour in particular, although is only starting from the 80's that the literature concerning the modelling of conflict as a contest started to arise, with the works of Hirshleifer (1988) and Grossman (1991). More specifically, some literature started to focus on organized crime from the 60's (Sellin, 1963). More recent literature developed more sophisticated tools that help to predict which illegal goods will be supplied by such organizations with respect to downstream firms (Dick, 1995), which is the optimal law enforcement (Garoupa, 2000) and to understand how to allocate punishment efficiently in a general criminal behaviour(Garoupa, 2007).

Although this is not the first paper concerning the individual perspective in criminal organizations, this work represents the first attempt to study the particular phenomena of terrorism with a micro approach and actual data on terrorists. The only paper that proposed a study on terrorism under a similar perspective is the work of Krueger and Malečková (2003) in which the analysis of public opinion polls conducted in the West Bank and Gaza Strip "highlights how the support for violent attacks does not decrease among those with higher education and higher living standards". Krueger confirmed this aspect also in a more recent work with Laitin, in which they provide a study concerning both the country in which an attack occurred and the country which terrorists belong. They highlight that more a country is rich, more the probability to suffer terrorist attacks is high. Moreover, on the other side, it seems that there is not a statistically significant predictor of the economic performance as determinant of which countries terrorists emerge from (Krueger and Laitin, 2008).

One application of our dataset is through the use of network analysis technique. This approach is not new in the literature concerning organized crime given that starting from the work of Sparrow (1991), the social network approach has been taken into consideration in this field, but the lack of specific data on the phenomena did not allow such techniques to be applied. In fact, theoretical approaches that bring to the identification of the *key player* inside a group have been proposed by Ballester et al. (2006); and a first application to organized crime has been provided by Morselli (2003), who reconstructed the entire network of a single Mafia boss in New York. Mafia has been also the main organization studied by the empirical literature, in particular the work of Mastrobuoni and Patacchini (2012) documented the structure and composition of the geometry of criminal ties between mobsters and in a more recent work, Mastrobuoni estimated the criminal network effect on the economic status of Mafia members (Mastrobuoni, 2015).

2.3 Historical Background

As in many other countries around the world, starting from the 60's of the last century several movements formed in Italy in order to combat social and political prejudices, resulting in the harsh disputes of the two-year period 68-69. However, unlike in many other nations, in Italy these movements represent the roots for the formation of political subversive groups that appear in the country for at least the following 20 years, making Italy an unique example of subversive story at least in the developed countries in terms of duration, diffusion, violence and number of people involved [2]. In fact, the firsts subversive groups represent a reaction to this period in which labour unions gained a lot of power (especially in political terms), pushing the extremist groups to a strong isolation in politics. Not by chance the attack that

[2] See Laqueur (2001).

historically marks the beginning of the climate of fear is the bomb placed in Milan at the end of 1969, known as “Strage di Piazza Fontana”, even if some bombs were placed around the country starting from April of that year[3].
It is important to highlight how the country was not able to understand the extent of the phenomena as well as the roots of this attack. In fact, right after the assault, the police were convinced that left-wings groups were responsible of the act (in particular anarchist groups) while in reality was right-wings groups' responsibility. This was only the beginning of a long period of threats, attacks and deaths by several different groups. At the end of the 20 years the country registered more than 150 groups linked to Italian terrorism, both from left and right inspiration, even if only 60 of them were actually constituted and operating.

We can divide the history of Italian terrorism in at least three phases: (I) the origins, between 1969-1972; (II) the period of aggregation, between 1973-1978; (III) the period of response by institutions, after the killing of On. Moro (1978).
The first phase is characterized by few attacks, even if some of them are the most bloody of all the period. It is a phase in which the ideals of revolution that will characterize these associations begin to circulate and several groups start to form, including the biggest one called ”Brigate Rosse” (Red Brigades).
The second phase represents the real transformation of these groups in actual armed parties, both from a structural and strategical point of view. It is especially in this period that different groups of the same area start to be more homogeneous and try to work more together, maintaining anyway differences among them (often driven by personal rivalries and strategic differences). In this phase we have the first merging between groups: the ”Banda XXII Ottobre” merges with the GAP of Giangiacomo Feltrinelli in 1972; the two merge with the Brigate Rosse the year after; groups such as ”Proletari armati in Lotta” and ”Nap” start to work together as well as sev-

[3]The most important attacks were the bomb placed in Milan's fair the 25th of April and the eight bombs placed on different trains on the 9th of August.

eral other groups prepare assaults together. The end of this phase represents the definitive outbreak of the armed struggle: 1977 represents the year in which a real escalation of attacks is registered, highlighting the complexity of the phenomena and imposing an adequate response from the government. It is with the kidnapping of On. Moro on 16 March 1978 that the State begins a real organized struggle in order of dismantling the various terrorist groups.
This particular event is the starting point of the third phase. This is a period in which the institutions recognized the importance of fight terrorism with proper units and specific programs. A lot of people were arrested between 1978 and 1982 and after a first moment in which the groups reacted with even more attacks (in 1979 Italy registered 659 different attacks), the unity of the groups began to crack helping authorities in the cells dismantling process. Even if some attacks occurred in more recent years, historians agree to indicate the end of the climate of fear between 1984 and 1987.

The importance of study the Italian terrorism is linked to the period in which the phenomena developed: the 70's. This is a particular period for Italy because it follows an important structural change occurred in the previous decade, both in society and economics environment: there was a transformation in the methods of production and distribution with a weakening of the working class; a development of international markets at the expense of the national ones; a multicultural integration occurred; the advanced services became the driving force of the economy. After 25 years of economic growth, a crisis struck a precarious balance of the country, mainly due to international factors such as the end of the gold exchange standard and the first oil shock. In this economical context first national terrorists groups born, further complicating the socio-economic status of Italy.

2.3.1 Red Brigades

Among all the groups that characterise this period in Italy, the Red Brigades are without any doubt the most important group both in terms of number of people involved, number of attacks and impact on the society. Even if the first ideas and meetings arose right after the movement of 1968, the official year for the beginning of the Red Brigades is 1970. In fact, in April 1970 for the first time some leaflets signed as "BR" appear in Milan and few months later, in August, Corrado Simioni, Renato Curcio, Mara Cagol and Alberto Franceschini formally set up the group. It is only after one month that the first terrorist attack occurs: on the 17th of September 1970 the garage of a head of the Sit-Siemens, a big company in Milan, is burned. The group claims responsibility through a statement in which for the first time the logo of the group is presented: the five-pointed star.

During the first two years the group spread his idea especially in Milan, through leaflets and brief reports other than some demonstrations like the short kidnapping of Idalgo Macchiarini on the 3rd of March 1972. This year represents a first turning point for the Red Brigades: in May for the first time there is an important operation by the police against the group. The operation turns out to be not successful, with a lot of persons wanted for arrests that escape. This fact transforms officially the group from a semi-clandestine group to an illegal one. At this point the power of the group substantially increases both in terms of number of components and location in which they create bases: on the 18th of April 1974 in Genoa the BR kidnap Mario Sossi, a court judge. This is the first attack with a national perspective where instead of focusing on specific neighbourhoods or factories, the group shows general political aims. The numbers of the organization increase month by month, spreading their influence in several regions of Italy, including Emilia Romagna, Campania and Lazio. Another important date for the story of this group is the 4th of June 1975, when the first kidnap in order to self-financing lead to the killing of Margherita Cagol during the gunfight. This is the beginning of a change inside the group, resulting

in a new phase of the red Brigades starting from 1976 where the goal becomes the attack to the hearth of the State more than small attacks against specific targets. On the 12th of February 1977 the head of the Ministry of Justice is injured and on the 18th of April the president of Bar Council of Turin, Fulvio Croce, is killed. As consequence, the Government establishes high security prisons starting from 1977, provoking a big response by the group. Several policemen and magistrates are killed (as for example Riccardo Palma, Lorenzo Cotugno and Rosario Berardi) in the following months, resulting in the kidnapping of the On. Aldo Moro on the 16th of March 1978. Moro will be held by the group for 55 days, during which the terrorists ask for the release of 13 political prisoners and issue releases, as well as Moro's letters. The kidnap ends on the 9th of May, when the body of Moro is found in Rome.

The following months are characterised by a strong effort by the police in order to dismantle the group and a consequently reaction by the BR. The back-and-forth between the two parties lasts substantially for two years. The turning point is the arrests of Patrizio Peci on the 21st of February 1980. For the first time a key representative of the group cooperates with the police and several people are arrested in the following months throughout Italy. This is the beginning of the last phase of BR, characterized by problems inside the group due mainly to different strategic ideas. In fact, the last attack made as a "unique group" is the kidnapping of the judge Giovanni D'Urso from the 12th of December 1980 to the 15th January of 1981, when he is released. Starting from this date, all the other attacks are claimed by different acronyms, although all traceable to the BR, but the effort made by the police allows to destroy the organization piece by piece, bringing to declare the end of the period of fear between 1984-1987.

2.4 Data

The complexity and the extension of the phenomena is vast and a complete official database does not exist. For this reason, we had to create a completely new one.

This work is not free of problems: basing on official reports, the dimension of the Italian terrorism starting from the late 1960s is impressive, with more than 1.000 people involved. Most of them have been involved only as militants, without any substantial part in the most sensational news stories of the time, but a significant part of them played key roles in violent actions. The phenomena is further complicated by the impressive number of acronyms that appeared in that period, even if more or less only 60 are the groups that effectively have been set up and operated, considering all the political colors. Moreover, for several events there were more than one judicial trial with different people affected and with controversial outcomes that bring to confusion. Furthermore, parts of the investigations carried out in this direction have been marked as confidential.

2.4.1 Sources and Variables

In order to take into consideration all the aspects pointed out in the previous sections, our approach has been to include in the dataset all the people that have been involved in at least one trial trying to take track of the largest possible number of people and to collect the largest number of information.

The database was created using a wide range of different sources with the aim to procure as much information as possible about personal features of the terrorists, collecting variables related to demographic aspects and personal background as well as information related to the terrorist activity.

We started by analysing more than one hundred generic books in order to obtain a first list of people involved in the phenomena and we expanded the analysis to official biographies both from former terrorists, victims and relatives of victims. Moreover, given the importance of the topic from a political and institutional point of view, we analysed the so called "commissioni d'inchiesta parlamentari" (Parliamentary committees of inquiry). In fact, in order to shed light on all these attacks the Italian parliament decided to set up several different committee of inquiry starting from the 80's that provided important detailed documents. The work of these panels is still ongoing in the recent years (the last commission was setted up in 2014[4]), highlighting the complexity of the problem.
In addition we had access to official judicial sources about trials for individuals involved in Italian terrorism. This has been possible thanks to two archives that collect these sources. The first is the Archivio DOTE, created by Istituto Cattaneo starting from 1984 and currently preserved by the Istituto Parri in Bologna. The repository collects interviews to former red and black terrorists (groups of left-wing political inspiration and of right-wing political inspiration respectively); copies of flyers through which terrorists claimed the attacks as well as minutes of the interrogations and judgements. The second is the archive created by the "Centro di documentazione Cultura della Legalitá Democratica", a public structure of Tuscany region which aims to collect, produce and disclose information on organised crime in general, including terrorism. Finally, by the access to archives of the main Italian newspaper, we crossed all the data with newspaper reports increasing the information collected through official channels.

The information that we collected can be divided in 4 big groups.

The first category includes basic information on the demographic characteristics of the terrorist, namely name; surname; gender; marital status: date of birth; city of

[4]Law 30 maggio 2014, n. 82.

birth.

The second group takes track of the information related to the personal background of the individual. This category includes variable concerning education and working conditions. In particular, we registered the highest level of qualification reached by the terrorist (no education, primary education, secondary education, diploma, university degree) and, if she has a diploma or a university degree, the type of school (or university) attended. Similarly we provide a variable that register the employment conditions (student, worker, student-worker, unemployed, retired) and a second variable registering the specific type of school attended or the specific type of work. Moreover, for some of the individuals, our dataset includes the same information concerning her parents.
It is important to highlight that all the information are registered at the moment in which the individual decides to join the group; this means that if one individual decides to enter in the group while she is an university student, in the dataset she is recorded as "university student" in the variable "type of work" and as "diploma" in "level of education".

The third category includes information more related to the terrorist activity. Next to variables that register the group to which they belong and the consequent political color (right or left); we collect information on the battle name assumed by the individual; the city of militancy (that by definition coincide with the city of residence); the role that the individual played (militant or boss, which is the formal leader recognised by the group); the year of entering (and eventually either the year of exit or the year of change of the group) and all the information related to the judgement procedure (year of arrest, starting year of the trial, year of the end of the trial, type of sentences and year of sentences). Moreover, our dataset includes information about the technical role played inside the terrorist body (organisational role, executive role, logistic role) and whether the individual has been hurt or died

during an operation and the relative year of death.

Finally, the last category includes additional information such as the specific address of residence; information about hiding and eventually information about relationships with other terrorists.

Our dataset includes 961 individuals linked to terrorist groups operating in Italy since 1969. Unfortunately, the difficulties highlighted in the introductory part of this section did not allow to obtain all the information for each of the individuals. However, the richness of the dataset allows to define different samples based on the selection of specific variables. In the following subsection we present statistical evidences from the dataset.

2.4.2 Descriptive Statistics

Table 2.1 reports the percentages for each category of the most important variables in the dataset.

Literature on crime, and more specifically on organized crime, highlights how men are more inclined to take part to criminal activities than women. This idea seems to be respected also concerning terrorism: our dataset highlighted how on 961 terrorists for which we registered the information about gender, 80.85% are males. Considering the role that each individual plays inside the group, and focusing only on the individuals that are registered as boss in the dataset, this percentage even decreases. In fact, considering 100 the total number of bosses in the database, only 15,67% are women. These results seem to be in line with what the literature shows.

Some interesting considerations arise from the analysis of the date of birth of the individuals[5]. We range from 1903 to 1976, where the mean is represented by 1951.

[5]We are able to reconstruct this information for 861 individuals.

	# obs.	Dataset	Census 1981
GENDER	961	Males: 80.85% Females: 19.15%	Males: 48.90% Females: 51.10%
CIVIL STATUS	961	Married: 13.53% Divorced: 1.87% Unmarried: 84.60%	Married: 49.10% Other:50.90%
EC. COND. REGION OF BIRTH	840	Rich regions: 45.00% Mid income regions: 33.10% Poor regions: 22.00%	Rich regions: 44.88% Mid income regions: 19.29% Poor regions: 35.83%
EDUCATION	642	Elementary school: 3.27% Secondary school: 28.04% High school: 56.23% University: 12.46%	Elementary school: 61.90% Secondary school: 23.80% High school: 11.50% University: 2.80%
OCCUPATIONAL CONDITIONS	716	Student: 26.82% Worker: 65.64% Student-Worker: 3.77% Other: 3.77%	Student: 17,13% Worker: 57.80% Other: 25.07%
POLITICAL COLOUR	961	Left-wing: 80.79% Right-wing: 19.21%	Not available
ZONE OF MILITANCY	901	Rich regions: 53.39% Mid income regions: 35.18% Poor regions: 11.43%	Not available
ROLE	961	Boss: 20.32% Militant: 79.68%	Not available

Table 2.1: Descriptive statistics of main variables

Notes: Data of census is from ISTAT, we decided to use the census 1981 because it is the one in the middle of the period under analysis. Elementary school includes also individuals with no education. Occupational conditions of the census are calculated on the population between 15-65 in 1981.

Not surprising, most of the individuals were born in the late 1940s and 1950s: the percentage strongly increases during the 1950s, than decelerate again considering the beginning of 1960s. This aspect is confirmed also by the cumulative data: percentage moves from the 17.65% in 1945 to the 94.31% in 1960. Moreover, if we compute the average age when the person is arrested (or eventually died) we obtain a value which ranges from 16 to 79 years old, with an average age of 28,8 which is coherent with the previous values.

Our dataset includes also information about the place in which the individual is born. In order to make this information comparable across individuals, we computed the region and we aggregate according to the level of income following the work of Malanima and Daniele (2011). We divided the regions in three groups: high income level, that substantially correspond to the northern regions, middle income level, that are the regions of the centre of Italy and low income level, that correspond to the southern regions of the country. Despite in literature one of the motivations that are given in order to explain criminal behaviour is the presence of poverty as one of the main factors that pushes individuals to enter in organized groups, the evidences coming from this classification seems to suggest an absence of a clear pattern of poverty in this specific type of organized crime. In fact, only 22% of our sample come from regions historically pointed out as "poor regions"; while the largest number of individuals come from rich regions.
In order to have a first idea about the possibility of a migration pattern behind this phenomena we computed the same type of aggregation also for the region of militancy, that is the region in which the individual reside and consequently the region in which the individual mainly works to prepare the demonstrations and attacks. Looking at this variable the differences between the rich regions and the poor regions is increased: terrorists in poor regions pass from 22% to 11.43% while the other two categories increase their percentage.

The database also allows us to make some statistical inferences on the background of terrorists. In fact, even if the dataset contains this information only for 642 individuals, some pattern can be highlighted. Only 3.27% of terrorists has the lowest educational studies level, which is primary school or less; 28.04% has the secondary school; 56.23% the diploma and the 12.46% have the highest level of education which corresponds to the university degree. These number suggests that, on average, Italian terrorists are well educated with respect to the rest of the population (the compulsory schooling was up to the secondary school), highlighting the peculiarity of this type of organised crime.
Table 2.2 shows the type of high school attended by the individuals that reached that level of education and it is compared with the Italian census of 1981. The largest part of individuals attended either a technical institute or an high school, confirming the absence of a pattern of "low education" as one of the motivation behind the phenomena. Moreover, this concentration in some specific type of schools can reflect the idea that a large part of recruitment by terrorists groups takes place in the school environment.
The specificity of the type of school disappears when we focus on the type of faculty chosen at the university: Table 2.3 shows the comparison between the dataset and the information included in the Italian census of 1981. Table 2.4 reports the details of the dataset. It shows that in this case the level of attendance is substantially equally spread through all the faculties[6].

A similar analysis can be made by focusing on variables concerning the working experience. At the moment of adhesion to a terrorist group, the 26.82% of individuals were students, percentage that rises to 30.59% if we consider also the "students-workers"; 65.64% of individuals was working when they decided to join the group while 3,77% were either unemployed or retired. As before, these numbers

[6]These data refers to 68 individuals that are the ones for which the dataset contains the specific type of faculty attended.

	Dataset	**Census 1981**
Scientific high school	25.12%	16.00%
Classic high school	16.26%	8.40%
Other high school	3.93%	12.30%
Technical institute	33.01%	44.40%
Specialisation in surveying	7.39%	Not available
Other Institutes	14.29%	18,90%

Table 2.2: Descriptive statistics of high school attendance

Notes: Data of census is from ISTAT, we decided to use the census 1981 because it is the one in the middle of the period under analysis. In census 1981 specialisation in surveying is included in other institutes.

	Dataset	**Census 1981**
Literature Area	27.94%	22.20%
Law Area	14.71%	14.10%
Economic Area	16.18%	16.20%
Other	41.17%	47.50%

Table 2.3: Descriptive statistics of university attendance

Notes: Data of census is from ISTAT.

	Dataset
Faculty of Literature	16.18%
Faculty of Medicine	14.71%
Faculty of Law	16.18%
Faculty of Philosophy	11.76%
Faculty of Architecture	10.29%
Faculty of Sociology	8.82%
Other Faculties	22.06%

Table 2.4: Detailed statistics of university attendance

seem to rule out poverty as one of the reasons for joining a terrorist group. In fact, if we assume that unemployment can be a signal of poverty, the largest amount of individuals in the dataset were working when they decided to enter in the terrorist activity, knowing that they were risking to lose their job.

In the dataset there are information also on the type of job that individuals were doing. According to the data of the Italian census of 1981, 12.7% of the workers worked in the primary sector; 35.7% in the secondary sector while 51.6% worked in the third sector. By focusing on the dataset that we are analyzing only 0.6% of the sample worked in the primary sector, while 46.93% of the individuals worked in the secondary sector and the rest in the third sector.

Table 2.5 shows a more detailed classification of the type of work according to the sector to which they belong.

	Dataset
Work industry	32.67%
Logistic industry	13.67%
Education industry	8.92%
Health industry	6.34%
Trade industry	4.95%
Technicians	4.76%
Publishing industry	1.99%
Professionals self-employed	4.36%
Security industry	2.78%
Journalistic industry	1.19%
Public officials	2.37%
Self-employed	2.77%
Agriculture industry	0.6%
Accountant industry	0.99%
Other industries	11.64%

Table 2.5: Descriptive statistics of type of work per sector

According to the data, the location in which the terrorists' ideology was more developed was the working class, that corresponds to the 32.67% of our sample. Important percentages are also the ones registered by the logistic industry (13.67%),which includes employers and clerks; the education industry (8.92%) which includes teachers, professors and researchers and the health sector (6.34%) which includes nurses and doctors. This results highlight two different aspects: on one hand the large number of workers may be due to the ease of transmission among people less qualified; on the other hand, the presence of more skilled jobs (such as nurses) highlight the need of these particular jobs in such peculiar organizations. In fact, given the actions that these type of groups perform, the presence of high qualified people is necessary. For example, in order to construct a bomb to place in a square, a strong knowledge of chemistry is needed; the ability to take care of wounded members is a specific task that in direct actions can be fundamental.

Finally, the dataset includes variables on aspects more closely linked to the terrorist activity. In particular, given that the database was constructed independently from the political color of the individuals, it is interesting to study the number of people involved in left-wings groups and in right-wings groups. Despite this, the statistics show that the 80.79% of records are related to subversive groups of left-wing while only the 19.21% are related to right-wing groups. The results are in line with the historical facts reported both by general books and by judicial reconstructions. In fact, the chronicles starting from the late 60's report a larger number of terrorist actions committed by left-wing groups with respect to the ones committed by right-wing associations. Moreover, the largest actions assigned to right-wing groups, such as the "strage di Bologna" or "strage di Piazza Fontana", had more than one trials with no clear ending and some of these actions are still unpunished. Table 2.6 shows the detail for the main acronyms that appeared during the period under analysis. Coherently with the historical facts, the group that is most represented are the Red Brigades, with 48,81% of the individuals recorded. Other important

left-wing organizations are Prima Linea (11,29%) and NAP (3.45%). Focusing on the right-wing groups, the most numerous group are the NAR and Terza Posizione (respectively 4,70% and 4,39% of the total). These results are coherent with the official data given by the Italian government: the most planned subversive organization was the Red Brigades which, in spite of several internal problems that have also led to several splits in time, have shown to be present in the Italian territory also in recent years.

	Political Area	**Dataset**
Prima Linea	Left	11.29%
Brigate Rosse	Left	46.81%
Partito Comunista Combattente	Left	1.88%
Ordine Nero	Right	4.81%
Terza Posizione	Right	4.39%
NAR	Right	4.70%
NAP	Left	3.45%
Collettivi Politici Veneti	Left	1.46%
Rosa dei Venti	Right	2.61%
Others	Both	16,6%

Table 2.6: Shares of terrorist groups in dataset

	Boss	**Militants**
Elementary school	5.06%	2.42%
Secondary school	25.32%	28.23%
Diploma	53.80%	56.45%
BUniversity degree	15.83%	12.90%

Table 2.7: Descriptive statistics of leaders and militants according to their level of education

Finally it is important to highlight the results registered about the variable concerning the role of the terrorists within the groups: one-fifth of the dataset includes people that has been recognised as boss inside a group. Even if this number seems really high it is coherent with the phenomena. In fact, it is shown by historical facts that once one of the leader has been caught by the police the group was really fast in organising and in eliciting a new formal boss.

An interesting point to verify is whether the key roles of the organization are covered by the most educated people. By considering as 100 the total number of managers that are recorded, it is possible to cross the data with the information concerning the educational qualification. Table 2.7 shows these results. By comparing it with the education in table 1 it is clear that the percentages are not strongly different, suggesting that education does not seem to play a role in the election of a boss inside a terrorist group.

2.5 Application

In this section we present a first application of the dataset by the use of network analysis.

2.5.1 Network Identification

In order to apply the methods of network analysis it is necessary to identify variables that can help to infer connections between the individuals in the dataset. Unfortunately, despite the large amount of sources used in order to create the database, none of the variables included gives a clear and direct indication concerning the connections that exist between terrorists. For this reason we have to find an indirect way for this definition.
By reading books on the topic, it seems reasonable an artificial construction of the connections based on three variables in the database: the terrorist group, the region of militancy and the period between the date of entry in the group and the date of arrest. Unfortunately we don't have these information for all the individuals in the dataset (especially the information concerning the precise year of entry in the group), therefore we were forced to reduce the sample only to people with the fields complete, obtaining a new database of 399 people (346 of which belong to left-wing groups). In order to rule out big differences in the two samples on the main variables, we performed a t-test in order to check the absence of differences in mean. The results are presented in the appendix.

The connection between two individuals exists if:

$$(I_{i,j}) \equiv \max[(\mathbb{1}_{i,g,t} * \mathbb{1}_{j,g,t}); (\mathbb{1}_{i,a,r,t} * \mathbb{1}_{j,a,r,t})] = 1$$

Where i and j represent the individuals; g is the group to which each individual belongs; t is the year in which the individual is inside the group; a represents the

political color of the group and r is the region of militancy.

Therefore two individuals are linked if (i) they operate in the same group during the same period or (ii) they belong to different groups of the same area but they operate in the same region of militancy in the same period.

The correctness of the artificial network is confirmed by historical evidences: this insight is due to the numerous depositions given by terrorists after their arrests in which they highlighted the importance of coordination at national level, that implies that individuals belonging to the same group probably know each others independently from the region in which they live, and the continuous flows of individuals between different groups. A clear example of this last point is given by Figure 2.3. It is a map that shows the main left-wing organizations and highlight the connections between groups.

Following this type of definition we obtain two different network based on the political color of the groups: one for the left-wing terrorists, another one for right-wing terrorists. Given a greater number of individuals in the first group, the following analysis is performed only on the left-wing network.

It is important to underline a particular feature of this specific network. In this context, connections can potentially have a double impact: they turn out to be positive, because the more connection one person has the easier is to hide, to prepare attacks, etcetera, until one of the two nodes is captured by the police; at this point this connection became negative, because the possibility that the captured terrorist confess increases the danger for the other individual (Baccara and Bar-Isaac, 2008). Following this logic it is plausible that an high-ranked terrorist tends to be more protected within its own group compared to persons holding non-managerial roles.

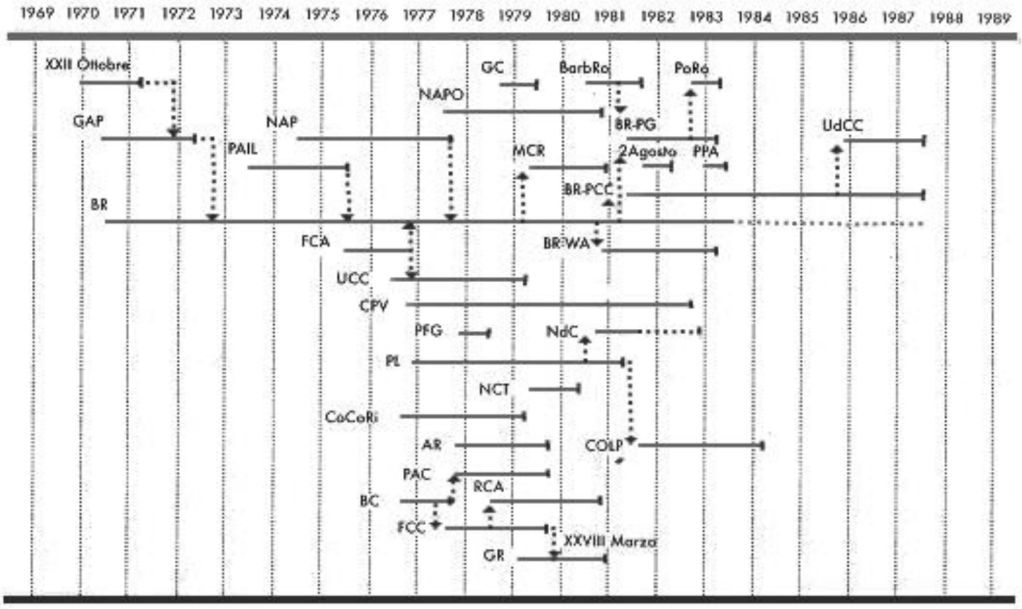

Figure 2.3: Map of main left-wing organizations. Source: Prette (2006)

2.5.2 Methodology and Descriptive Statistics

The goal of this analysis it to understand if there were factors that helped an individual to reach a central position within a terrorist group. This let us have a picture of what happened inside the network during the 20 years of the "period of fear", and identify some structural characteristics that were underestimated by the government. In fact, the government faced the phenomena of terrorism with the same tools that they used for facing the Mafia phenomena but the two follows two completely different patterns both in the structure and in the actions. One of the problem of the Italian police has been to not be able to identify specific peculiarity of the phenomena: if we are able to identify some characteristics that help one person to reach the central position, it is possible to specifically target them and accelerate the disruption of the entire network.

Average Degree	96.595
Density	0.280
Components	3
Component Ratio	0.006
Fragmentation	0.034
Average Distance	1.928
Breadth	0.410

Table 2.8: Network cohesion measures

Some preliminary analysis can be done on the structure of the network. Table 2.8 reports the main network measures (all the measures are formally defined in the appendix).

One of the most important concepts in this type of literature is the concept of density. This measure studies the degree of cohesion of the network, by taking into consideration both the potential connections and the actual ones. It is define as the ratio between the maximum number of connections over the total number of actual links. In this network the value is equal to 0.280, which means that 28% of all possible linkages is present. Even if this number is not really high in absolute terms, considering the specificity of the topic, it suggests a greater presence of links with respect to other standard criminal groups.

A second important index that describes the network is the average geodesic dis-

tance among reachable pairs. This index indicate the average number of steps that are needed in order to reach all network participants: the lower is this number, the easier is to reach all the other nodes. In this case the value is 1.928, indicating that on average it is necessary to pass through only 2 other nodes in order to reach all the other individuals. These aspects can explain why, once one of the formal bosses is captured by the police, she is easily replaced by someone else: the nodes where strongly linked one to another and even one of the official leaders was caught and ruled out from the network, the other nodes had all the necessary information to easily find someone else to put formally at the top.

Finally the fragmentation index signals the presence of isolated nodes. In fact it represents the proportion of pairs of nodes that are unreachable from each other by any path. In this network the index is really close to 0 (0.034) indicating substantially an absence of isolated nodes.

In order to reach the goal of the work we use different definition of centrality and we develop a simple linear relationship between these indexes of centrality and the observable characteristics of each single terrorist. The general model is:

$$C_k(i, \Phi) = \alpha + \beta \mathbf{X}_i + \gamma \mathbf{Z}_i + \epsilon_i$$

Where $\mathbf{X}_i$ is a vector of personal characteristics, which includes sex, civil status, region of birth; education and occupational conditions; while $\mathbf{Z}_i$ represent characteristics linked to terrorist activity such as age at the moment of entrance in the group and the official role inside the organization; ϵ_i denotes the random error term.

2.5.3 Results

In order to define the dependent variable we used different definition of centrality.

The first one is the simplest among the different definitions: it captures the prominence of a node taking in consideration its degree, meaning the number of direct links stemming from each node in the network. Formally, the degree centrality of a node i in the network Φ is the number of connections of the node divided by the maximum possible number of connections. The higher is the number of connections, the higher is the centrality of the node i.

A more sophisticated concept is the one represented by the second definition that we used, i.e. the Bonachich power centrality. Substantially it represents a weighted degree centrality: the level of centrality of individual is not determined only by the number of connections that it has, but also by the type of node to which the individual is connected, i.e. how many connections the actors in the neighbourhood have.

Once the centrality indexes are computed, it is possible to do a second check of the correctness of the artificial network. In fact, given that we are referring to a period that is historically ended, once the indexes are computed it is possible to have an ex-post check by ranking all the individuals according to their level of centrality and compare these names with the ones that historically have been recognised as the real leaders of the phenomena. Table 2.9 shows the list of the 5 members with the higher indexes for both the definitions and the 5 members with the lowest scores. In general, the names that are highlighted by these analysis correspond to the ones indicated as the key players by historians.

Table 2.10 presents the results of the OLS regression: the first two columns use Degree centrality as dependent variable while the last two use Bonachich centrality.

Degree Centrality		**Bonachich Centrality**	
(TOP 5)	**(LAST 5)**	**(TOP 5)**	**(LAST 5)**
Mario Moretti	Paolo Dorigo	Mario Moretti	Mario Rossi
Pasqua Aurora Betti	Daniele Bencini	Pasqua Aurora Betti	Paola Besuschio
Maria Carla Brioschi	Ovidio Bompressi	Remo Pancelli	Paolo Dorigo
Luca Mario Efisto Nicolotti	Giuliano Pinori	Barbara Balzerani	Renato Rinaldi
Rocco Micaletto	Luigi Fuccini	Giovanna Lombardi	Silvio Gibelli

Table 2.9: List of top 5 and last 5 individuals according to their centrality values

The first interesting result of this work is linked to the role of women. As highlighted in the previous sections, literature on criminal activities claims that inside criminal groups there is a sexual racism, which implies that males have more power with respect to women. While this situation is confirmed by looking at the descriptive statistics, in which women represent less then 20% of the total number of subjects, it does not seem confirmed once we enter inside the group. In fact the result of the regression suggests that females tend to play a more crucial role in the dynamics of the group, resulting in a more central position inside the network. In fact the coefficient of the dummy variable female (which takes vale 1 if the individual's gender is feminine and 0 otherwise) is positive and strongly significant in both the specifications even if in the second definition the magnitude is smaller. This result suggests an important different pattern with respect to the other types of organized crime that could be studied in further works.

According to our results education does not seems to be an important element for determine the centrality index: none of the education variables taken into consid-

	Degree Centrality		Bonachich Centrality	
	(1)	(2)	(1)	(2)
Female	0.0696***	0.0646***	0.0189***	0.0175***
	(0.023)	(0.023)	(0.006)	(0.006)
Born in rich regions	-0.0388	-0.0629**	-0.0147**	-0.0168**
	(0.024)	(0.026)	(0.006)	(0.007)
Born in mid regions	0.0902***	0.0650**	0.0258***	0.0138*
	(0.026)	(0.032)	(0.006)	(0.008)
Secondary school	0.0876*	0.0771	0.0195	0.0162
	(0.052)	(0.052)	(0.013)	(0.013)
Diploma	0.0613	0.0574	0.0132	0.0103
	(0.052)	(0.052)	(0.013)	(0.013)
University degree	0.1240**	0.1146**	0.0281**	0.0229*
	(0.056)	(0.056)	(0.014)	(0.014)
Unemployed	-0.0953*	-0.0961*	0.0230	0.0257
	(0.057)	(0.057)	(0.014)	(0.014)
Student	0.0638***	-0.0554**	-0.0149***	-0.0133**
	(0.023)	(0.023)	(0.006)	(0.006)
Student-Worker	0.0647	0.0574	0.0163	0.0141
	(0.051)	(0.051)	(0.012)	(0.012)
Boss		-0.0475**		-0.0151**
		(0.021)		(0.005)
Demographic controls	yes	yes	yes	yes
Terrorist activity controls	no	yes	no	yes
Constant	0.1964***	0.1363*	0.0405***	0.0302*
	(0.052)	(0.070)	(0.013)	(0.017)
Observations	346	346	346	346
R-squared	0.18	0.21	0.22	0.26

*p<0.1;**p<0.05;***p<0.01

Table 2.10: OLS regression with Degree Centrality and Bonachich Centrality

eration are significant with the exception of the highest level of education. In fact, an individual that has a university degree have more probability of being central with respect to an individual with the lowest level of education. This is particularly true if we accept as definition of centrality the degree centrality index (in both the version of the regression the coefficient is strongly significant and positive) while it is less strong if we focus on the second one (in the last column it is significant only at a 10% level).

If we accept the region of birth as a proxy of the income of the individual, the negative coefficient of the dummy variable representing the rich regions suggest a negative relationship between income and centrality in the group.

Also the employment conditions does not seems to play a crucial role. In fact, the only characteristic that plays a role in this setting is being a student: if the individual decide to enter in the terrorist group while he was still attending the school she has less probability of becoming central inside the network.

Finally, an interesting result concerns the impact of being formally recognized as leader inside the group: our analysis suggests that filling that role has a negative correlation with being in a central position. This result is in line with the theoretical trade-off highlighted by Baccara and Bar-Isaac (2008). Indeed, in such type of organizations connections play a double role: on one hand, the larger the number of connections the easier the movement inside the organization both in logistic and operative terms; on the other hand having a lot of connections makes the subject more vulnerable, especially once one of the link is caught by the authorities. Following this line of reasoning, it is not surprising that formal boss are not necessary the real central player of the network.

In order to exclude the possibility that these results are driven by the fact that

women tends to stay in the network for a longer period or that there is a greater probability that women enters only in the biggest groups, we run other two specifications. In fact, given that one of the variable on which the network structure is created is based on the temporary element, if women on average are present for a larger number of year in the network then their centrality is structurally higher with respect to men. A similar line of reasoning can be made for the dimension of the group: if women enters only in the largest groups, their centrality is higher by definition.

Table 2.11 shows a standard OLS regression taking as dependent variable the number of years of presence in the network, which is the difference between the year of arrest (or death) and the year of entering in the group.
Table 2.12 instead presents the results of a linear probability model in which the dependent variable is equal to 1 if the individual belongs to the Red Brigades, which is the biggest group in the dataset, and 0 otherwise.

Following the results, if it is not possible to rule out that the positive coefficient found for the variable university degree is driven by the highest probability of being caught in a longer amount of time; this is not true for the other variables.
In detail, the coefficient of the variable capturing the gender of the individual is not significant in any specifications, with the exception of the first column in Table 2.11 where it slightly positive and slightly significant. However, once we control for variables more related to the terrorist activity, this significance disappear. This suggests that the positive coefficient associated to female in the centrality regression is not a result of the theoretical structure of the network but it underlines different motivations.

Moreover, the negative and significant coefficient associated to the variable "student" in Table 2.12 can give some explanation of the negative coefficient found in

	(1)	(2)
Female	0.2496	0.2861
	(0.3813)	(0.3763)
Born in rich regions	-0.1463	-0.6319
	(0.4047)	(0.4402)
Born in mid regions	0.6228	0.5830
	(0.4242)	(0.5311)
Secondary school	0.2143	0.3538
	(0.8503)	(0.8513)
Diploma	0.2317	0.4595
	(0.8507)	(0.8519)
University degree	1.3881	1.7949**
	(0.9199)	(0.9094)
Unemployed	0.1836	0.4558
	(0.9417)	(0.9280)
Student	-0.3226	-0.2371
	(0.3790)	(0.3764)
Student-Worker	0.1557	0.1976
	(0.8350)	(0.8219)
Boss		1.0408***
		(0.3390)
Demographic controls	yes	yes
Terrorist activity controls	no	yes
Constant	3.7714***	2.8816**
	(0.8532)	(1.1518)
Observations	346	346
R-squared	0.04	0.09

*p<0.1;**p<0.05;***p<0.01

Table 2.11: OLS regression with year of presence in the network

	(1)	(2)
Female	0.1169*	0.0972
	(0.0609)	(0.605)
Born in rich regions	-0.1195*	-0.1705**
	(0.0675)	(0.0733)
Born in mid regions	0.0867	0.0135
	(0.0688)	(0.0911)
Secondary school	0.2783*	0.2193
	(0.1427)	(0.1401)
Diploma	0.1489	0.1055
	(0.1442)	(0.1414)
University degree	0.2239	0.1869
	(0.1564)	(0.1521)
Unemployed	-0.2309	-0.2463
	(0.1756)	(0.1690)
Student	-0.1681**	-0.1550**
	(0.0665)	(0.0679)
Student-Worker	0.1678*	0.1349
	(0.0953)	(0.0935)
Boss		-0.1658***
		(0.0593)
Demographic controls	yes	yes
Terrorist activity controls	no	yes
Constant	0.4509***	0.4369**
	(0.1448)	(0.1978)
Observations	346	346
R-squared	0.11	0.14

*p<0.1;**p<0.05;***p<0.01

Table 2.12: Linear probability model with Red Brigades as dependent variables and robust S.E.

Table 2.10.

Finally, the negative coefficient associated to the variable capturing the role of the individual inside the group in Table 2.12, which means that if an individual enters in the biggest group her probability of becoming a leader is lower with respect to be a simple militant, is counterbalanced by the positive coefficient reported in Table 2.10, suggesting that bosses have an higher probability of staying for a longer time inside the network. These results are in line with the prediction that bosses tend to be more protected by the group and it reinforces the results highlighted in Table 2.10.

Alternative applications can be provided using as dependent variable two different definitions of centrality: Closeness centrality and Betweenness centrality.

Table 2.13 shows the results for these two definitions.

The Closeness centrality is a measure based on proximity: it is necessary to define formally the total distance from a node i to all other nodes in a network Φ which is the sum of the number of links in the shortest path between i and j.
Analysing the first two columns the results are in line to what showed in the previous points: females tend to have a more central position inside the group as well as being born in a rich region seems to be detrimental.
The main difference is represented by the education variables: in this case both secondary school and university degree are positive and significant at a 5% level. However, given the results highlighted by Tables 2.11 and 2.12 these two coefficient seems to be driven by the structure of the network itself.
Finally, also in this specification the variable indicating the leaders inside the group has a negative sign, confirming have been found in Table 2.10.

	Closeness Centrality		Betweenness Centrality	
	(1)	(2)	(1)	(2)
Female	0.0341***	0.0297**	0.0001	0.0002
	(0.013)	(0.013)	(0.001)	(0.001)
Born in rich regions	-0.0163	-0.03638**	-0.0159*	-0.0329***
	(0.014)	(0.015)	(0.001)	(0.001)
Born in mid regions	0.02565*	0.0177	-0.0013	-0.0001
	(0.014)	(0.018)	(0.001)	(0.001)
Secondary school	0.0748***	0.0639**	-0.0046**	-0.0046**
	(0.029)	(0.028)	(0.002)	(0.002)
Diploma	0.0507*	0.0463	-0.0041 **	-0.0035*
	(0.029)	(0.028)	(0.002)	(0.002)
University degree	0.0836***	0.0775**	-0.0033*	-0.0023
	(0.031)	(0.030)	(0.002)	(0.002)
Unemployed	-0.0470	-0.0460	0.0045**	0.0053***
	(0.032)	(0.031)	(0.002)	(0.002)
Student	-0.0168	-0.01142*	-0.0015*	-0.0013
	(0.013)	(0.013)	(0.001)	(0.001)
Student-Worker	0.0454	0.0394	-0.0011	-0.0011
	(0.028)	(0.027)	(0.002)	(0.002)
Boss		-0.0396***		0.001**
		(0.011)		(0.001)
Demographic controls	yes	yes	yes	yes
Terrorist activity controls	no	yes	no	yes
Constant	0.4453***	0.4146***	0.0081***	0.0063**
	(0.029)	(0.038)	(0.002)	(0.002)
Observations	346	346	346	346
R-squared	0.12	0.18	0.07	0.13

*p<0.1;**p<0.05;***p<0.01

Table 2.13: OLS regression with Closeness Centrality and Betweenness Centrality

On the contrary, columns 3 and 4 present substantial differences with respect to what highlighted in the previous points.

In fact the betweenness centrality is a measure linked to the position of a node in all the paths of the network. It is necessary to compute the number of geodesics distances between a node k and another node j where i lies on. In other words, it indicate how important the node i is in terms of connecting nodes k and j. The closest is the index to 1, the most important is i for the connection between the other two nodes.

This is not a surprising result given that this particular definition of centrality capture an aspect completely different with respect to the previous ones and it is the most sensible to the structure of the network. Moreover, the magnitude of the coefficients suggests that if we believe that this is the best definition of centrality for this type of setting, further information are needed in order to make some useful analysis.

2.6 Conclusion

Given the total absence of micro data on individuals belonging to terrorists group, this paper presented the first original micro dataset on Italian terrorists' socio-economic characteristics and proposed a first application based on the use of network analysis, following the idea that relationships represent an important key to understand the phenomenon and potentially the dynamics that encourage individuals to join terrorist groups. The paper focuses on Italy where many radical groups, with different political inspirations, have been settled up starting from 1969 and their activities have covered approximately 20 years.

The dataset was created in order to obtain information about terrorists' personal

features at the moment they decided to join the group, by using a wide range of different sources: (i) Official biographies of former terrorists, victims and victims' relatives; (ii) News and institutional reports, such as newspaper reports, archive material from newspaper and "commissioni d'inchiesta" (inquiry board); (iii) General books on the topic; (iv) Judicial sources. We created a list of 961 terrorists linked to terrorist groups even if not for all of them all the variables have been reconstructed.

For this reason, in order to perform the analysis, we reduced the sample only to subject whose fields were nearly completed, obtaining a new database of 399 people (346 of which belong to left-wing groups). We reconstruct the network and calculated the centralities of each individual, according to 4 different definitions: Degree centrality; Bonacich's centrality; Closeness centrality and Betweenness centrality. The correctness of the artificial network is confirmed both by historical evidence and by ex-post evaluations. Therefore, we provided an analysis considering the four different indexes of centrality and the observable characteristics of each terrorist.

The main results highlight the role of women and the trade-off of connections. Firstly, differently from the general result suggested by organized crime literature, women were found to be in a more central position in the network as compared to men. Secondly, being formally recognized as a leader inside the group has a negative correlation with having a central position. Indeed, in such type of organizations connections play a double role. On one hand, they increase operational efficiency; on the other hand, they make the subject more vulnerable once one of the links is captured by the authorities. Thus, it is not surprising that formally recognised bosses are not necessary the most central players of the network.

2.7 Appendix

2.7.1 T-test in mean

2.7.2 Network Cohesion Measures

Let $N = |V|$ be the number of nodes, and $L = |E|$ be the number of edges:

- **Average Degree**: Average number of link per person

$$\frac{\sum_{i=1}^{N} deg(i)}{N} = \frac{2L}{N}$$

- **Density**: Degree of cohesion of the network

$$\frac{L}{\frac{n*(n-1)}{2}} = \frac{Actual_Connections}{Potential_Connections}$$

- **Components**: Number of disconnected parts, i.e. there is no path that can get you from a node in one component to a node in another component.

- **Component Ratio**: Number of component divided by number of nodes

$$\frac{Components}{N}$$

Variable	Category	Global Dataset	Reduced Dataset	mean<0 Pr(T<t)	mean ≠0 Pr(|T| > |t|)	mean >0 Pr(T>t)
GENDER	Males	80,85%	79,55%	0.132	0.2641	0.8680
	Females	19,15%	20,55%			
CIVIL STATUS	Unmarried	84,60%	79,95%	0.6092	0.7815	0.3908
	Divorced	13,53%	18,25%			
	Married	1,87%	2,00%			
ZONE OF BIRTH	Rich regions	45,00%	40,06%	0.001	0.001	0.9999
	Mid regions	33,10%	36,84%			
	Poor regions	22,00%	22,56%			
EDUCATION	Elementary	3,27%	3,51%	0.3758	0.7516	0.6242
	Secondary	28,04%	27,07%			
	High school	56,23%	56,64%			
	University	12,46%	12,78%			
EMPLOYM.	Student	26,82	32,33	0.999	0.0003	0.0001
	Worker	65,64	61,40			
	Stud.-Work.	3,77%	3,51%			
	Other	3,77%	2,76%			
ZONE OF MILI-TANCY	Rich regions	53,39%	53,63%	0.2158	0.4317	0.7842
	Mid regions	35,18%	39,85%			
	Poor regions	11,43%	6,79%			

Table 2.14: T-test in means of principal variables

Chapter 3

Homophily in Terrorist Networks

This work aims to study the evolution through time of a terrorist network and to understand the whether the recruitment policy follows a strategic path or it is random, focusing on the concept of "homophily". Since the mid of the last century literature has provided evidence of strong presence of homophily in social interaction under several different dimensions: age, gender, ethnicity, educational level and occupational conditions. Thanks to the new dataset presented in the previous chapter and the reconstruction of the network dimension of the phenomena, it is possible to analyse the evolution of the terrorist network using the concept of temporal social network. The main results indicate a change in the homophily structure through time, and this change goes in the opposite direction with respect to the standard literature. In fact, the analysis highlights a strong presence of heterophily in several dimensions while literature on social networks reports a standard presence of homophily. This suggests that the recruitment policy by terrorist groups does not follow the usual path, indicating a strong strategic pattern.

3.1 Introduction

Homophily is one of the most important concepts in network analysis. The main goal of this specific tool is to answer a simple question: "Are people more prone to connect with other people similar to themselves?". In general terms, it is shown that this simple concept has a lot of different implications under several points of view, some of which are really important in economic contexts. Indeed, it is shown that presence of homophily in a group improve coordination as well as tolerance and co-operation. Moreover, it helps to access information and to form opinions and social norms.

Some of these concepts can be fundamental in a terrorist group: coordination and cooperation are between the most important features that need to be achieved in order to organise and to implement attacks, even the smallest ones. As a matter of fact, having a clear plan that all the people involved in the operation need to know and to accept is necessary, especially given the high risk of these type of activities. Moreover, having easy access to the largest amount of information can be the crucial point for the preservation of the group and to avoid that some of the participants are captured by the police.

Nevertheless, applying a strategic choice in the recruitment of new militants can be fundamental for the survival of the group. In fact, selecting appropriate militants with specific characteristics and creating relationships with people that are totally different from the one already in the network, can help the group to hide inside society and to make the investigation for the police more difficult. For this reason a strategic pattern can be highlighted by the presence of heterophily in the network: acting in the opposite way from what one could expect as regards common group dynamics implies a precise recruitment policy which aims to make more difficult for the police to easily detect connections once one of the terrorists is caught.

This research provides an empirical investigation into the evolution of a political terrorist network over time, under the hypothesis that the enrolment of new militants follows a strategic path and is not merely linked to people's political ideology.

This hypothesis is motivated by the observation of the Italian phenomena: as pointed out in the previous chapters of this work, Italy underwent a period of intense terrorist attacks based on political ideology with daily assaults through all over the country. Although a major deployment of forces, this phenomenon lasted for about 20 years reflecting a huge difficulty of the authorities in facing this type of organizations, which had the ability of continuously reorganizing themselves and evolve.

As previously presented, Italy represents a natural environment for this type of studies, mainly for three reasons:

- Presence of a large amount of radical groups of different political inspirations;
- Daily-based episodes of political violence linked to these groups, with several attacks against civilians;
- Thanks to the effort presented in the previous chapters of the thesis, it is possible to have a specific micro dataset that can be exploited in order to examine the dynamics of the terrorist groups.

Having clear the motivations behind this work, the objective is to understand if there is some evidence in favour of the idea that recruitment policy made by terrorist groups is not random but it follows a strategic path. In order to explore the evolution of the characteristics of the people involved in the network, we used the dataset constructed and presented in the previous chapter of this thesis. We used the concept of Temporal Social Network and we studied the homophily of the network at regular intervals, in order to have a clear evolution of the group. Given the specificity of

this type of analysis, we overcame the problem of absence of independence between observations by applying the Multiple Regression Quadratic Assignment Procedure.

Moreover, in order to have a comprehensive view of the phenomena, we studied the community structure of the network and its evolution from one year to another, applying the Group Evolution Discovery method.

The results show that a strategic pattern is present in the recruitment policy of terrorist groups in all the variables under consideration, with the only exception of the one referring to working conditions. Moreover, this pattern is stronger the longer are the periods in which these groups survive, unless the survival of the group itself is under pressure.

The paper is organized as follows: Section 3.2 presents the literature; Section 3.3 introduces the methodologies used for constructing the network and for analysing the hypothesis; Section 3.4 presents the results of the logit specification and Section 3.5 analyses the structure evolution of the network. The last section concludes.

3.2 Literature

As pointed out in the previous chapter of this thesis, studies concerning terrorism have been performed in several different areas, such as sociology, psychology, criminology and economics, with a greater focus on quantitative analysis. Different empirical works have been proposed in the economic literature (Lai, 2007; Freytag et al., 2011) with a main focus on macro data e global impact.

Literature suggests that the use of network analysis to understand criminal behaviour is an important tool to better understand the phenomena (Sparrow, 1991; Ballester et al., 2006; Morselli, 2003; Mastrobuoni, 2015). Thanks to the effort of

creating a new micro dataset, this approach can be applied in order to understand the dynamics of a terrorist network evolution, taking into consideration also the fundamental variable of time.

This work refers to the economic literature on empirical models of network formation. From a theoretical point of view, starting from the beginning of 2000, scholars tried to solve the problem of multiple equilibria with different strategies: some have tried to model the network formation by the use of potential games (Jackson and Watts, 2001); others used subnetworks as unit of analysis (Chandrasekhar and Jackson (2014)) or considered the network formation as a game with imperfect information (Leung (2015)). Some of the recent works used the observable implications of homophily in order to understand network dynamics (Boucher (2015)) or combining them with strategic and random networks features (Mele (2017)).

Even if the empirical literature on network formation is quite new, an important branch of this literature focuses on the concept of homophily as tool for explaining the dynamics of a social network. In fact, several existing papers clearly identify homophily as a driving factor of the network formation process (Christakis et al. (2010); Currarini et al. (2009); Franz et al. (2010)).

Moreover, the dynamic behaviour of communities is a growing part of the social network literature. Several works focus on the use of graph techniques in order to capture changes in the topological properties (Leskovec et al., 2005); while other scholars used the concept of groups inside the network in order to explain the evolution (Backstrom et al., 2006; Falkowski et al., 2006). Clustering algorithms, such as k-means and agglomerative hierarchical clustering, have been proposed (Chakrabarti et al., 2006) and event-based frameworks have been developed both without the possibility of overlap between groups (Asur et al., 2007) and with the possibility of overlap thanks to the Clique Percolation Method (Palla et al., 2005; Derenyi et al.,

2005; Palla et al., 2007; Bródka et al., 2013).

Nevertheless, in order to explain the dynamics of a social network, the concept of homophily has been largely used in several different fields, including economics starting from 1954 with the work of Lazarsfeld & Merton.

In particular, the literature highlights a strong presence of homophily in:

- **Gender:** same sex people tend to connect more with respect to people of different gender (Akerlof and Kranton, 2000; McPherson et al., 2001; Maccoby, 2002; Akerlof and Kranton, 2010; Onnela et al., 2014; Laniado et al., 2016);
- **Ethnicity:** people who share same culture tend to be more prone to bond with each other (Schneider et al., 1997; Kalmijn, 1998; Currarini et al., 2009; Bisin et al., 2016);
- **Age:** people tend to connect more with an other people of same age or generation (Fischer, 1982; Blau et al., 1991; de Martí and Zenou, 2010; Carrington, 2015);
- **Education:** it is shown that also education is one of the factors that unifies people (Marsden, 1987; Louch, 2000; Akerlof and Kranton, 2010; Skopek et al., 2011; Reitz et al., 2014);
- **Occupation:** people tend to form groups with people doing the same type of work (Kalmijn, 1998; McPherson et al., 2001; Akerlof and Kranton, 2010; Block and Grund, 2014).

Several of these pieces of information are contained in the dataset under analysis, consequently the goal of this work is to understand if these typical patterns highlighted by the literature are present also in this specific setting and if homophily is one of the criteria that terrorist groups follow in order to recruit new people.

3.3 Methodology

3.3.1 The network

In order to analyse this specific evolution of the terrorist network, it is important to clarify how the network structure is constructed.

Following the line of reasoning presented in the previous chapter of the thesis, we started from some theoretical assumptions in line with historical evidences and we detected the direct connections based on three variables in the database: the terrorist group, the region of militancy and the period between the entrance date in the group and arrest date. In details we defined the connections as follows: two individuals are linked if:

1. They operate in the same group during the same period or;
2. They belong to different groups of the same area but they operate in the same region of militancy in the same period.

This insight is due to the numerous depositions given by terrorists after their arrest in which they highlighted the importance of coordination at national level and the continuous flows of individuals between different Italian areas while the organization of an important action was in plan.

3.3.2 Temporal Social Network

For the purpose of this part of the paper, it is important to understand what is a Temporal Social Network and what are the possible evolutions of a group.

Although in the previous chapter of this thesis time has not been kept into account by the metrics, it is a key element for the analysis of the dynamics of the group. Literature has identified this type of networks as "Temporal Social Network" (TSN).

In details, a TSN is a series of time windows T, each of which represents a single social network of edges and vertices. Following the definition of Bródka et al. (2013), a Temporary Social Network is defined as follows:

$$TSN =< T_1, T_2, ..., T_n > n \in N$$

$$T_i = SN_i(V_i, E_i), i = 1, 2...n$$

$$E_i =< x, y >: x, y \in V_i, i = 1, 2...n$$

Where SN is a social network with a set of V vertices and a set of E directed edges.

In order to reach the goal of this analysis, we considered each TSN as not independent from the previous: it represents the network in a specific period of time, which includes the connections established in the previous periods. Formally:

$$T_{i+1} = T_i + SN_{i+1}(V_{i+1}, E_{i+1}), i = 1, 2...n$$

The motivation of this choice is linked to the peculiarity of the phenomenon under analysis: as pointed out in the previous chapter of the thesis, terrorist networks are characterised by the persistence of impacts of the connections even when one of the nodes is removed from the network itself. In fact, even if one of the individuals is captured by the police, and consequently removed from the network, the risk that

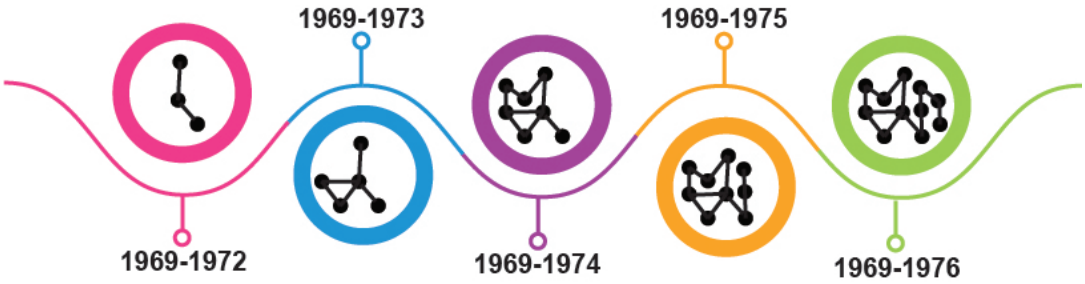

Figure 3.1: Temporal Social Network

the person confesses and indicates one of the other free terrorists to the authorities increases the danger for the other individuals connected, implying a persistence of this edge inside the group. For this reason, it is reasonable to think that in order to involve new people terrorists take into consideration also these type of connections.

In details, we took into consideration the period between 1969- 1981 which represents, according to the previous points, the period in which a lot of movement have been registered inside the network. We created 13 TSN each of them includes the full history of previous time windows, as explained by Figure 3.1. On each of these TSN we performed the analysis.

3.3.3 Multiple Regression Quadratic Assignment Procedure (MR-QAP)

In order to catch the probability of the presence of a connection between to individuals, given the socio-economic characteristics that are present in the dataset and literature showed as factors of homophily in general settings, we used a logit specification.

The dependent variable is a dummy defined as follows:

$$I_{i,j} = \begin{cases} 1 & if\ individual\ i\ and\ j\ are\ connected \\ 0 & otherwise \end{cases}$$

Where i and j represent the individuals. The baseline estimating equation is:

$$pr(\mathbf{I_{i,j}} = 1) = \Phi(\alpha + \beta_1 \mathbf{G_{i,j}} + \beta_2 \mathbf{C_{i,j}} + \beta_3 \mathbf{E_{i,j}} + \beta_4 \mathbf{Em_{i,j}} + \epsilon)$$

where:

- $\mathbf{G_{i,j}}$ is the matrix representing the gender and the elements will take value 1 if the two individuals share the same gender, 0 otherwise;
- $\mathbf{C_{i,j}}$ is the matrix representing the civil status and the elements will take value 1 if both the individuals are either married, single or divorced and 0 otherwise;
- $\mathbf{E_{i,j}}$ is the matrix representing the education and the elements will take value 1 if the maximum level of education reached by both individuals is either elementary school, secondary school, diploma or university degree and 0 otherwise;
- $\mathbf{Em_{i,j}}$ is the matrix representing the employment condition and the elements will take value 1 if both individuals are either students, workers, both student and workers or unemployed and 0 otherwise;
- ϵ represents the error term.

In order to make consistent estimation, it is important to take into consideration the main characteristics of this study: the peculiar unit of analysis. In fact, in standard regression techniques the unit of analysis is represented by an individual observation, while in social network analysis in general, and homophily studies in particular, the unit of analysis is represented by a dyads that is represented by a couple of individuals. This means that each individual appears more than one time

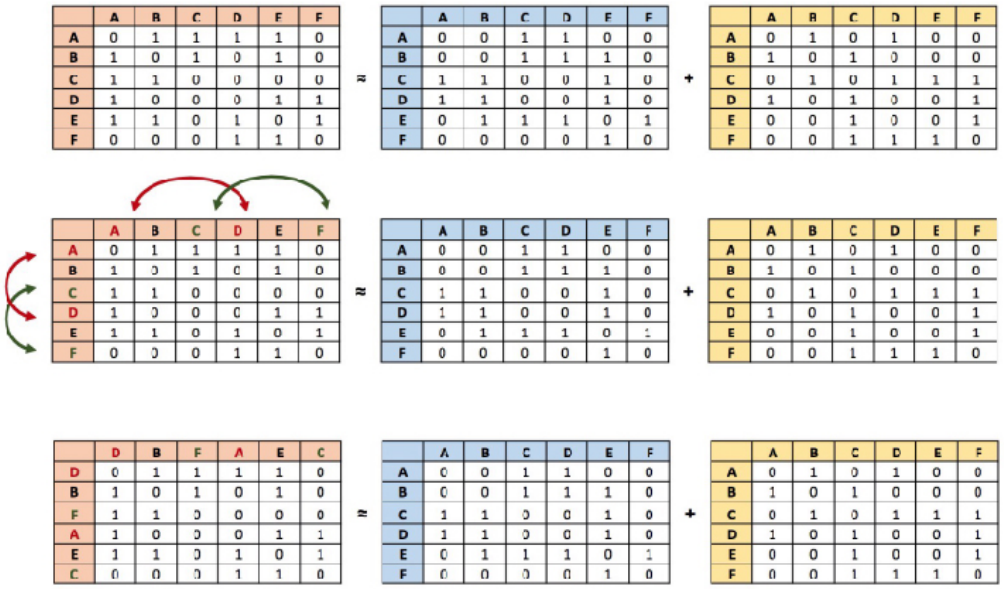

Figure 3.2: Multiple Regression Quadratic Assignment Procedure

in the analysis (she appears n-1 times) implying the absence of independence between observations and, consequently, the correlation among errors.

The solution that we adopted in order to overcome this issue is the use of the Multiple Regression Quadratic Assignment Procedure (MR-QAP) which substantially uses permutation in order to estimate standard error (Krackhardt (1988)). The procedure is quite simple and it is as follows.

Let's suppose we have a standard linear regression that in standard literature we compute with an OLS. The idea behind this procedure is that by scrambling the data following a random procedure which reassign the dependent variable to new observations, no relationship between the dependent variable and the covariates should be present.

Given that our unit of analysis is not a unique individual but dyads, the procedure needs not only to permute the rows of the matrix but also to permute the its column in the same way. Therefore, by running the regression we obtain a point under the null hypothesis; by continuing this type of procedure for a number of times we generate the distribution of correlation coefficients and by comparing it with the actual coefficient it is possible to consistently estimate the p-value of the regression. Figure 3.2 shows graphically this procedure.

3.4 Results

3.4.1 The Krackhardt E/I Ratio

In order to have a first hint on the homophily in the terrorist network we calculated the Krackhardt E/I Ratio in each of the identified TSN.

The Krackhardt E/I Ratio measures the relative density of internal connections within a group who shares the same characteristics compared to the number of connections that the group has to the external world. Formally it is defined as follows:

$$EI = \frac{EL - IL}{EL + IL}$$

Where EL are the number of links that each individual has with other individuals not belonging to the same group while IL is the number of links shared with individuals of the same group.

For lack of space, Figure 3.3 and Figure 3.4 present the results for the four covariates only for two representative TSN, namely the network representing the

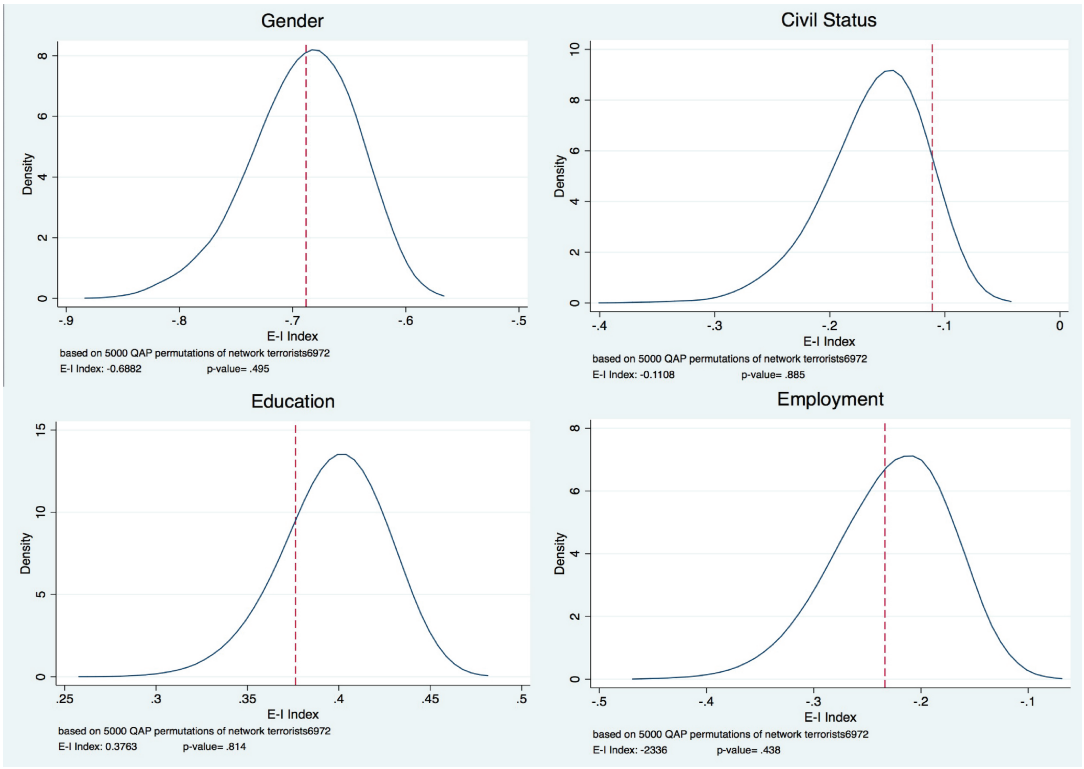

Figure 3.3: EI index - 1969-1972

period 1969-1972 and the network representing the period 1969-1981. For each E-I index, a permutation test is performed to see whether the network E-I index is significantly higher or lower than expected.

The index ranges from 1 (strong heterophily) to -1 (strong homophily) while the p-value indicates if the result obtained is statistically significant or not. According to these results the gender and civil status variables present a negative coefficient in both the analysed periods, indicating a tendency to homophily during all the periods. Indeed the coefficient obtained are not statistically significant, not allowing to reach clear conclusions. The same consideration, in the opposite direction, can be made for the education variable: in this case the presence of heterophily is registered in

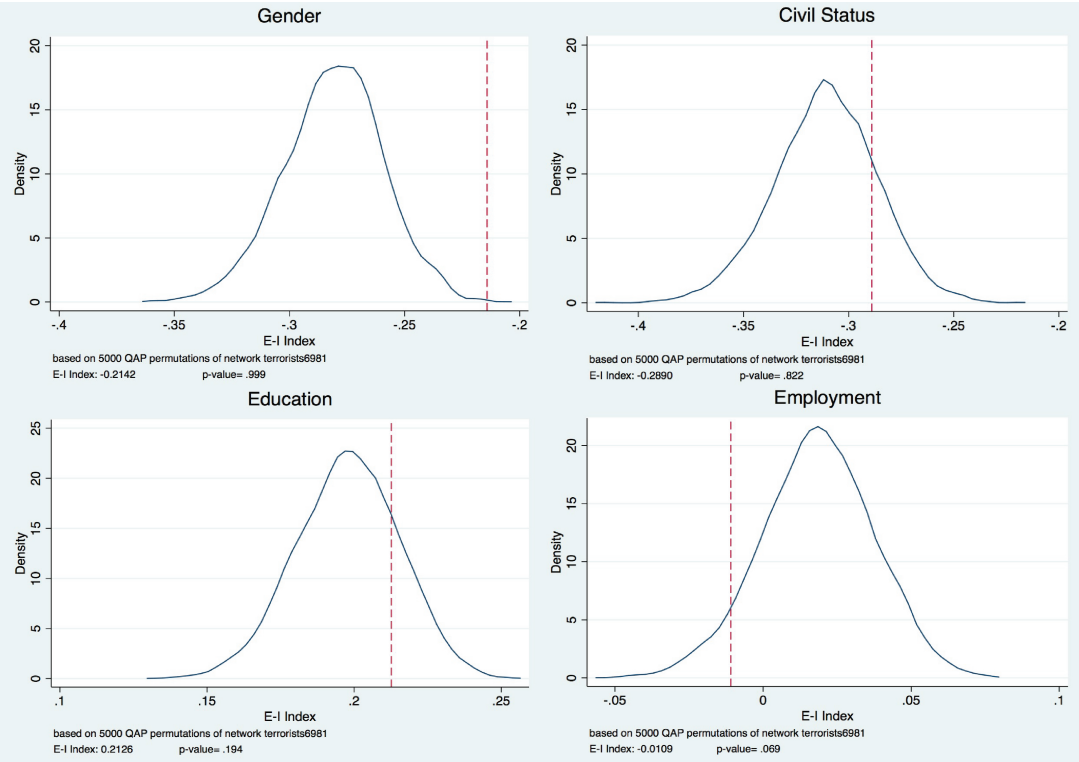

Figure 3.4: EI index - 1969-1981

both periods but the p-value suggests no significance.

The only significant variable is the one linked to the employment conditions. The E-I index of the network reflecting the 1969-1972 period is not significant, while the E-I index of the network reflecting the 1969-1981 period is slightly negative, suggesting presence of homophily. This result is acceptable at a 10 % level (p-value= 0.069) and suggests a plausible evolution in the strategy of recruitment by the terrorist group.

3.4.2 General analysis

Starting from this consideration we compute the baseline regression as presented in section 3.3. The results are showed in Table 3.1.

Each column represents a consecutive temporal social network in which the dependent matrix is run on general matrices of the covariates. Positive coefficients indicate that people tend to connect to other people with the same characteristic (homophily), while negative coefficients suggest the opposite (heterophily). Due to the few number of people involved in the firsts years under analysis, we present the results starting from the 4th temporal social network (namely the network covering the period 1969-1974) which is the first network with an important amount of nodes.

The first explanatory variable studies the homophily based on gender, namely if terrorists tend to connect with people of the same gender. The analysis highlights a peculiar behaviour from this specific type of individuals: the more we add an year under analysis, the more negative and significant the coefficient becomes, suggesting a strong and significant presence of heterophily for gender. This means that if a man enters in a terrorist group the probability that he forms links with women is grater than the probability that his links are with men. These results highlight a behaviour which differs from the usual social behaviour. In fact, as pointed out in the literature section, it suggests that people are more prone to connect with people of the same gender. These results suggest a precise choice by the terrorist group in the recruitment of new people, especially when the group is present on the territory since several years.

Focusing on the second explanatory variable, a similar analysis can be made for the civil status. With respect to the previous point, this variable is negative and substantially significant since the birth of the network under analysis. Even if the heterogeneity inside the group is not high with the vast majority of the individuals

	(1) 1969-1972	(2) 1969-1973	(3) 1969-1974	(4) 1969-1975	(5) 1969-1976
Gender	-0.00778	-0.352***	-0.0111	-0.241***	0.0114
	(-0.08)	(-3.92)	(-0.21)	(-5.94)	(0.38)
Civil status	-0.164*	-0.182**	-0.229***	-0.0848*	-0.0781**
	(-2.39)	(-2.83)	(-5.10)	(-2.27)	(-2.80)
Education	0.123	0.207**	0.130**	0.00120	-0.00749
	(1.66)	(3.00)	(2.85)	(0.03)	(-0.26)
Employment	0.0275	-0.225***	0.0229	0.111**	0.0297
	(0.40)	(-3.41)	(0.52)	(3.02)	(1.10)
_cons	-0.149	0.329**	-0.421***	-0.567***	-0.783***
	(-1.41)	(3.23)	(-7.18)	(-12.91)	(-24.62)
N	3540	4032	9120	14042	25760

	(6) 1969-1977	(7) 1969-1978	(8) 1969-1979	(9) 1969-1980	(10) 1969-1981
Gender	-0.0919***	-0.188***	-0.152***	-0.198***	-0.208***
	(-4.15)	(-10.68)	(-10.38)	(-14.60)	(-15.73)
Civil status	-0.0242	0.0183	-0.157***	-0.0202	-0.0451***
	(-1.10)	(1.04)	(-10.66)	(-1.46)	(-3.36)
Education	-0.110***	0.000582	0.0101	-0.0346*	-0.0402**
	(-5.02)	(0.03)	(0.70)	(-2.58)	(-3.09)
Employment	0.169***	0.0185	0.155***	-0.000563	0.0948***
	(8.00)	(1.10)	(11.01)	(-0.04)	(7.43)
_cons	-0.779***	-0.630***	-0.546***	-0.535***	-0.615***
	(-31.26)	(-30.94)	(-31.80)	(-33.39)	(-39.87)
N	42642	64770	90300	104652	113232

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.1: MR-QAP baseline

that are not married, this element differs from the standard literature, suggesting again a precise choice of recruitment.

Also education seems to be an element taken into consideration in the recruitment. In fact, the third row of Table 3.1 highlights a change in the behaviour inside the group. During the first years the variable is positive and slightly significant; while the more the network survives the more the coefficients tend to go in the opposite direction. Also in this case, the evolution from a situation of homophily to a situation of heterophily points to a strategic choice of the group in the recruitment.

The only variable that is in line with the standard literature is the one related to the homophily based on social classes. In fact, this variable is substantially positive and significant through all over the periods under analysis even if the coefficients tend to reduce, indicating an attention also on this aspect. The reason for which this element is the only one which stays in line with the literature can be linked to the nature of the phenomena and the consequent rules on recruitment: the largest part of the connections are made in the work environment, making natural to involve people with a more similar social class than the other variables under analysis. Taking into consideration this peculiarity, the decrease of the coefficient through the time can be interpreted as a further confirmation of the strategic behaviour of the group.

3.4.3 Educational and working conditions

In order to understand whether different levels of education and different type of working conditions have the same effects on homophily inside the group, we propose a different regression. We divided both the matrix referring to educational level and to working conditions in all the potential sub-matrices. The results are presented in Table 3.2 and 3.3 respectively, starting from the network referring to 1969-1972 as in the previous section.

	(1) 1969-1972	(2) 1969-1973	(3) 1969-1974	(4) 1969-1975	(5) 1969-1976
Elementary school	0.550***	0.947***	0.392***	0.0851	0.131**
	(5.96)	(10.20)	(6.19)	(1.60)	(3.13)
Secondary school	0.0305	-0.0481	-0.00842	-0.0514	-0.0150
	(0.43)	(-0.71)	(-0.18)	(-1.34)	(-0.52)
Diploma	-0.134	-0.0197	0.00433	0.0430	0.0336
	(-1.92)	(-0.30)	(0.09)	(1.11)	(1.16)
University degree	0.147	0.0743	0.137*	-0.0356	-0.121***
	(1.85)	(1.01)	(2.55)	(-0.85)	(-3.85)
Covariates	yes	yes	yes	yes	yes
N	3540	4032	9120	14042	25760

	(6) 1969-1977	(7) 1969-1978	(8) 1969-1979	(9) 1969-1980	(10) 1969-1981
Elementary school	0.0308	0.275***	0.378***	0.308***	0.418***
	(0.86)	(8.82)	(13.72)	(11.71)	(15.64)
Secondary school	-0.206***	-0.0145	-0.0142	-0.0492**	-0.0998***
	(-8.80)	(-0.76)	(-0.87)	(-3.22)	(-6.69)
Diploma	0.0232	-0.0113	0.00872	-0.00266	0.0305*
	(0.99)	(-0.60)	(0.54)	(-0.17)	(2.05)
University degree	0.00437	-0.0464*	-0.0941***	-0.0941***	-0.118***
	(0.17)	(-2.31)	(-5.43)	(-5.84)	(-7.47)
Covariates	yes	yes	yes	yes	yes
N	42642	64770	90300	104652	113232

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.2: MR-QAP education

	(1) 1969-1972	(2) 1969-1973	(3) 1969-1974	(4) 1969-1975	(5) 1969-1976
Student	0.0633	-0.129	-0.0540	0.182**	0.0829
	(0.49)	(-1.01)	(-0.68)	(3.08)	(1.73)
Unemployed	0.0527	0.0755	0.420***	0.277***	0.571***
	(0.38)	(0.55)	(4.94)	(4.06)	(9.26)
Both	-0.693***	-0.580**	-0.312*	0.143	-0.220***
	(-3.33)	(-2.86)	(-2.05)	(1.62)	(-3.49)
Workers	0.0314	-0.105	0.000559	-0.109	-0.0966*
	(0.24)	(-0.82)	(0.01)	(-1.86)	(-2.02)
Covariates	yes	yes	yes	yes	yes
N	3540	4032	9120	14042	25760

	(6) 1969-1977	(7) 1969-1978	(8) 1969-1979	(9) 1969-1980	(10) 1969-1981
Student	0.149***	0.0802**	0.129***	0.0578**	0.0710***
	(4.45)	(3.00)	(5.39)	(2.68)	(3.42)
Unemployed	-0.0144	0.0148	0.602***	0.0238	0.268***
	(-0.33)	(0.39)	(16.36)	(0.75)	(9.09)
Both	0.344***	-0.140***	0.00637	-0.184***	0.0139
	(7.81)	(-4.33)	(0.23)	(-7.07)	(0.55)
Workers	0.00137	-0.0307	-0.00819	-0.0262	0.00572
	(0.04)	(-1.15)	(-0.34)	(-1.21)	(0.28)
Covariates	yes	yes	yes	yes	yes
N	42642	64770	90300	104652	113232

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.3: MR-QAP working class

According to Table 3.2, in general terms we notice that the greater is the level of education, the greater is the level of heterophily inside the group. In fact, the lowest level of education, which is elementary school, involve a strong and significant homophily which persists all over the period, suggesting that people with less educational background tend to bond together with respect to people who have a higher level of education (the coefficient associated to individuals with an university degree is strongly negative). This is in line with the idea that terrorists tend to act more in a strategic way. In fact, the cleverest people tend to act against the standard procedure in social networks, probably in order to hide themselves better.

Results highlighted in Table 3.3 substantially confirm what we found in the baseline version of the regression: students and unemployed people tend to bond with people of the same social class, while workers seem not to follow any specific pattern. In fact, even if they are not always significant, coefficients reflecting the behaviour of unemployed people and students tend to be positive, underlying a tendency to homophily. On the contrary, workers seem not to have a specific pattern: coefficients persist around zero for all the years under analysis and they are never significant.

These results are not surprising, given that recruitment by terrorist groups was mostly made through word of mouth in firms and schools among colleagues. This specific aspect implies that for the largest part of the individuals, work places or attended schools are the starting point for entering the group. Moreover, the type of occupation of each individual affects the amount of time that it is possible to dedicate to illegal activities: unemployed people have more time with respect to students and even more with respect to workers. Therefore, the presence of homophily in this setting is almost inevitable.

3.5 Evolution of the group

In order to have a more comprehensive interpretation of the results, it is important to have an idea about the internal structure of the group and the evolution it faces during the period under analysis.

3.5.1 Community structure

Literature on complex networks suggests that networks tend to present group of nodes with dense internal connections and sparse connections between groups. The presence of these characteristics identifies the so called "communities" which can be defined as a set of nodes who more frequently collaborate with each other rather than with other members of the population. The study of such a type of groups can highlight peculiar characteristics that help to understand how a network works and, consequently, how nodes affect each other. In this precise context, the existence of communities affects the spreading of the risk to be caught when one of the nodes is removed from the network. In fact, the higher is the number of communities, which implies a more disperse network, the safer is the position of each node inside the network.

In order to find communities inside the network, we applied the Fast Modularity Optimization method also called Louvain method (Blondel et al., 2008). The algorithm is based on the concept of modularity proposed by Newman and Girvan (2004), which is formally defined as follows:

$$M = \sum_{i=1}^{k} (c_{ii} - a_i^2)$$

where c_{ii} is the percentage of existing connections in a given module i and a_i is the percentage of connection with at least one end in module i.

This value ranges from -1 to 1: the closer it is to 1, the higher is the level of modularity. Therefore, if one module presents a value close to 1 it means that it contains more edges within the module with respect to what we would expect if these connections were allocated by chance.

The Louvain method is based on the iterative repetition of two steps: first, it optimizes modularity locally trying to detect small communities; second, it aggregates nodes of the same community and it creates a new network taking as nodes these communities. This process stops when the maximum level of modularity is reached.

The detailed procedure is reported in the Appendix 3.7.1.

Table 3.4 reports the number of communities detected by the Louvain method.

Period of analysis	**Communities**
1969-1972	3
1969-1973	3
1969-1974	3
1969-1975	4
1969-1976	4
1969-1977	5
1969-1978	3
1969-1979	3
1969-1980	3
1969-1981	3

Table 3.4: Number of communities based on Louvain method

According to the table, the number of communities inside the network grew constantly until the period 1969-1977. These numbers suggest a period of strong evolution, in which the new nodes of the network tend to collaborate with people already present in the groups, maintaining their different identity at the same time.

Starting from the period 1969-1978 there is a sharp decline in the number of communities, returning to the initial values. In this period authorities started to react against terrorism as pointed out in the previous chapter of this work. In fact, it is the period in which police took strong actions against the most known terrorist groups and, at the same time, the most striking attacks occurred (such as, for example, the kidnap of the Onorevole Moro, among others).

These results are in line with what we found in the analysis of the previous section. Although Table 3.3 presents a clear pattern in the homophily structure of the network, it presents some important jumps in the coefficient, especially as regards the period 1969-1976 and period 1969-1978. The analysis of communities gives a partial explanation: this is a period of major structural change in the network, which is reflected in recruitment choices. Given the results of the Louvain method, the strategic path seems to be even more evident: the stronger is the response of the government, the more difficult is for the group to be organised in communities. Consequently, the recruitment policy becomes more strict and strategic, making harder for the police to detect the nodes.

3.5.2 Group Evolution Discovery

In order to have a further confirmation of the network evolution, we applied the so called "Group evolution discovery method" (GED method) to our network (Bródka et al., 2013).

The GED procedure is a methodology which is useful to identify the dynamics of social groups. It takes into consideration not only the quantity of the people involved in the network, but also the quality of the people itself. In fact, the peculiarity of this methodology with respect to other techniques, is the presence of both aspects in a single measure, thanks to the concept of centrality inside the formula. In order to be consistent to what we presented in the previous part of this work, we decided to use the Bonachich power centrality as measure of centrality .

This procedure is based on a measure called "Inclusion" which is formally represented as follows:

$$I(G_i, G_j) = \frac{\mid G_i \bigcap G_j \mid}{\mid G_i \mid} \cdot \frac{\sum_{x \in (G_i \bigcap G_j)} B_{G_i}(x)}{\sum_{x \in (G_i)} B_{G_i}(x)}$$

Where i and j represent the first and the second group under analysis and $B_{G_i}(x)$ is the value of the Bonachich centrality index.

The first part of the inclusion index takes into consideration the quantity of the elements inside the network while the second part of the formula takes into consideration the quality of the edges inside the group.

The determination of the evolution is explained by Figure 3.5.

The detailed calculation is reported in Appendix 3.7.2.

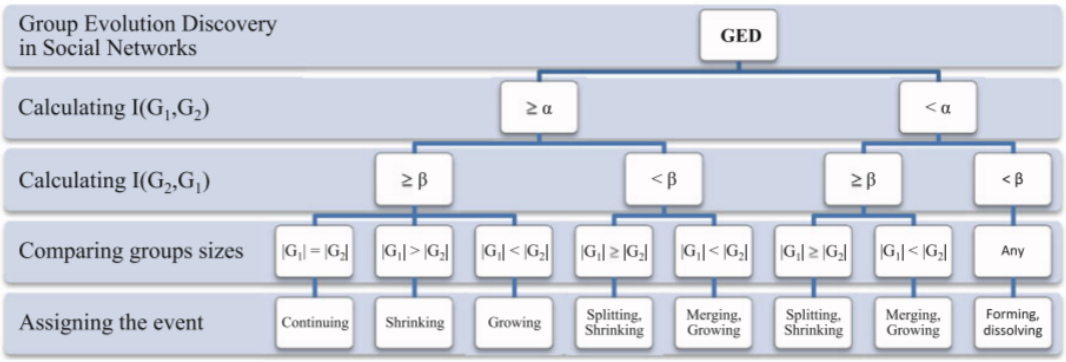

Figure 3.5: Procedure for the Group Evolution Method - Bródka et al (2011)

According to the authors it is possible to identify six possible evolutions of the group:

1. *Stagnation*: Two groups are identical or differ by few nodes in two consecutive time frames;
2. *Shrinking*: The group becomes smaller in the second time frame;
3. *Growing*: The group becomes bigger in the second time frame;
4. *Splitting*: Some groups from the second time window consist of members of one group from the first time window;
5. *Merging*: Some groups from the first time window form an unique group in the second time window.
6. *Dissolving*: A group ends its life and does not occur in the next time window at all.

Given the goal of the analysis, which is to understand the global evolution of the network from t to t+1, we applied the method considering independent Temporal Social Network. In details, opposite to what we did in the previous sections,

we recreated a snapshot of the social network in each time window, not considering people that are not in the field in that precise moment, as shown in Figure 3.6. We considered each TSN as a unique group.

The values of α and β thresholds are fixed following the literature. According to Bródka et al. (2013) these values should be at minimum 50%, which guarantees that at least a half of the people in the starting group are included in the second group. The maximum value of the threshold should be 100%, meaning that the first group matches perfectly the group in t+1.

Given the peculiarity of the network under consideration, which is characterised by a strong level of risk for the actors and an higher probability of being removed from the network with respect to standard social networks, we decided to put this threshold at 75%. This choice reflects the idea that maintaining three quarters of the same individuals can be likely considered as a success for a terrorist group. The results are presented in the Table 3.5.

Periods	**Threshold**		**Values**		**Group sizes**		**Type of event**
	α	β	α	β	G_1	G_2	
1972-1973	75	75	67,37	81,71	55	46	Shrinking
1973-1974	75	75	95,26	41,20	46	77	Growing
1974-1975	75	75	57,00	55,85	77	81	Dissolving
1975-1976	75	75	50,17	30,71	81	97	Dissolving
1976-1977	75	75	76,74	42,40	97	131	Growing
1977-1978	75	75	84,28	49,51	131	165	Growing
1978-1979	75	75	75,39	54,99	165	187	Growing
1979-1980	75	75	63,88	75,45	187	172	Shrinking
1980-1981	75	75	44,13	82,85	172	121	Shrinking

Table 3.5: Results of GED computation

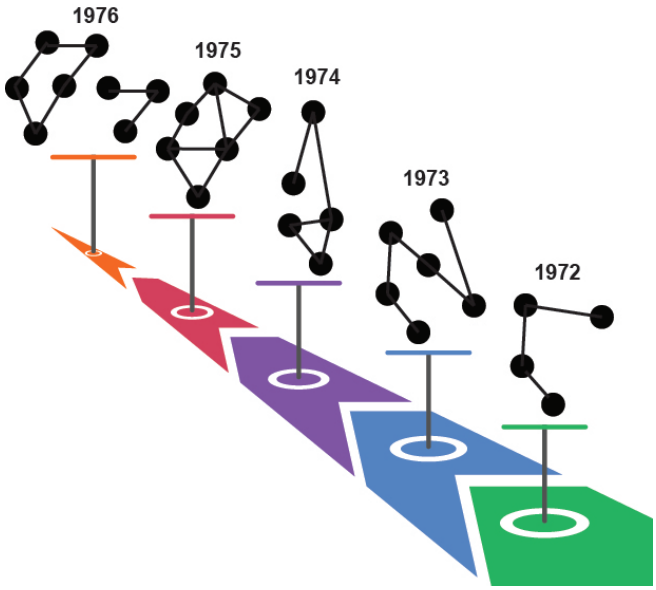

Figure 3.6: Temporal Social Network in GED procedure

With respect to the results shown by the analysis of the community structure made in the previous section, the GED procedure suggests a more complex situation. In fact, even if the group size is increasing from one year to another, the first years under analysis are characterised by the loss of the most central people in the network implying a impoverishment of the quality of the group and, consequently, a period of dissolving with the exception of the period between 1973-1974.

These results help to read the homophily evolution reported in Table 3.1 of previous section. In fact, although the direction of the homophily structure is clear in the period under analysis, some jumps in the coefficients are present. By comparing the two tables together, it is possible to highlight how changes in the strategic pattern of terrorist groups correspond to the periods in which the network changes from a situation of dissolving to a situation of growing, namely 1974 and 1977. This aspect confirms that the recruitment policy by terrorist organizations tends to be strategic, unless the difficulties of the survival of the group are so strong that any type of new

connection is considered and accepted.

3.6 Conclusion

The phenomenon of terrorism is one of the most discussed problems of the recent years, with impacts on several different elements of the society. Despite in the last years scholars talk about "transnational terrorism", some western countries, such as Italy, had to face internal political attacks since the mid of the sixties.

The surprising period of survival of these political internal groups, with huge difficulties from government to combat the phenomena, suggests a plausible strategic behaviour of these groups for their evolution. In fact, terrorist networks represent a peculiar type of social groups given the illicit nature of their constitution. One of the possible explanations of their survival can be linked to clever decisions of which type of people include in the network; indeed behaving in an opposite direction with respect to the natural way identified by the social network literature can help to disorient the Government and to make investigation more difficult.

Thanks to the exploitation of a new dataset with micro data on individuals presented in the previous chapters of this work, this paper presents the first analysis of the choices of recruitment of a terrorist network during time, using the tools of the network analysis and, in particular, the concept of homophily. This work in based on the four characteristics that literature highlights as typically characterized by homophily inside a social group (Gender, Civil status, Educational level and Working conditions) and tests the concepts in the terrorist network.

We recreated the network as suggested by historical evidence and, given that the units of analysis are dyads and not single elements, we performed the analysis using the Multiple Regression Quadratic Assignment Procedure (MR-QAP) which allows

to correctly estimate standard errors.

The main results highlight the strategic path that this type of groups follow in recruiting new people.
Although the presence of some jumps in the coefficients, the analysis suggests that the longer the group lasts in the field, the more the choices become strategic, especially with respect to gender and education. In fact, differently from the general result suggested by literature, terrorists tend to bond more with people of different gender and a different level of education. The focus on this last characteristic allows us to understand that this peculiarity is stronger the higher is the level of education reached by the person under analysis.
Moreover, taking into consideration the nature of the phenomenon which is born inside the work environment, even if the homophily based on the working conditions is the only variable that is in line with standard literature of social network. The magnitude and the evolution of coefficients suggest a path in line with the strategic behaviour highlighted by the other variables.

In order to provide an explanation to the jumps highlighted in the homophily study, we analysed the evolution of the network studying both the community structure and the group evolution from one year to the other. The analysis suggests a strong change in the internal structure especially in two periods, which correspond to the shifts in the homophily structure. These results confirm the idea that, in general, the recruitment policy of terrorist groups takes into consideration the importance of hiding. It means that groups involve people with different characteristics in relation to the one already present in the network, unless the survival of the group itself is under pressure; a that point the strategic approach is partially abandoned.

3.7 Appendix

3.7.1 Louvain method

The Louvain algorithm is as follows (Zygmunt et al., 2012):

1. Assign each node in a separate group.
2. For each vertex remove it from its group, put it in another group (G_y) of its neighbour y separately for each neighbour y and calculate their modularity increase. At this point, place the neighbour x in the group for which the modularity increase is the highest. If modularity increase is not positive for all neighbours y than node x stays in its original group.
3. Repeat step 2 until the modularity stops its growth.
4. Construct a new network by using as nodes the super-nodes created in the previous points. The super-nodes are connected if at least one vertex in the two super-nodes are connected.
5. Repeat until a maximum of modularity is achieved.

3.7.2 GED method

The GED method is as follows (Bródka et al., 2013):

1. For each pair of groups $< G_1, G_2 >$ in consecutive time frames T_i and T_{i+1} compute the inclusion inclusion measure $I(G_1, G_2)$ and $I(G_2, G_1)$.
2. Based on both inclusions $I(G_1, G_2)$, $I(G_2, G_1)$ and sizes one of these events can be identified:
   - **Continuing:** $I(G_1, G_2) \geq \alpha$ and $I(G_2, G_2) \geq \beta$ and $|G_1| = |G_2|$;

- **Shrinking:** $I(G_1, G_2) \geq \alpha$ and $I(G_2, G_1) \geq \beta$ and $|G_1| > |G_2|$ OR $I(G_1, G_2) < \alpha$ and $I(G_2, G_1) \geq \beta$ and $|G_1| > |G_2|$ and there is only one match (matching event) between G_2 and all groups in the previous time window T_i;
- **Growing:** $I(G_1, G_2) \geq \alpha$ and $I(G_2, G_1) \geq \beta$ and $|G_1| < |G_2|$ OR $I(G_1, G_2) \geq \alpha$ and $I(G_2, G_1) < \beta$ and $|G_1| \leq |G_2|$ and there is only one match (matching event) between G_1 and all groups in the next time window T_{i+1};
- **Splitting:** $I(G_1, G_2) < \alpha$ and $I(G_2, G_1) \geq \beta$ and $|G_1| \geq |G_2|$ and there is more than one match (matching event) between G_2 and all groups in the previous time window T_i;
- **Merging:** $I(G_1, G_2) \geq \alpha$ and $I(G_2, G_1) < \beta$ and $|G_1| \leq |G_2|$ and there is more than one match (matching event) between G_1 and all groups in the next time window T_{i+1};
- **Dissolving:** for G_1 in T_i and each group G_2 in T_{i+1} $I(G_1, G_2) < 10\%$ and $I(G_2, G_1) < 10\%$
- **Forming:** for G_2 in T_{i+1} and each group G_1 in T_i $I(G_1, G_2) < 10\%$ and $I(G_2, G_1) < 10\%$

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