Social Networks, Entrepreneurship and Modernity. Evidence from a Historical Episode of Industrialization

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Abstract

This paper explores the role of social networks in the emergence of industrial entrepreneurship. It uses evidence from Colombia in the late 19th and early 20th century. It finds that the social capital related with structural holes did have significant and positive effects on industrial entrepreneurship. Meanwhile, the social capital related with closure did not have significant positive effects. In fact, higher density in certain networks, like family networks, reduced industrial entrepreneurship. Through this exercise, the paper shed light on how social capital might promote modernity under weak institutional environments.

1 Introduction

There is a long tradition that explores the role of social capital in economic development and growth (e.g. Annen 2003; Ahlerup et al. 2009; Boulila et al. 2008; Francois and Zabojnik 2005; Knack and Keefer 1997; Lindner and Strulik 2014; Tabellini 2010; Zak and Knack 2001). A topic of particular interest in this tradition tests the claim that social capital can lead to modernity. Due to the conceptual complexity of modernity itself, the works on this field do not share a common object of study, but all of them explore phenomena that fit with the classic economic ideas of modernization (e.g. Kuznets 1966; Rostow 1960) which involve the emergence of industrial production, sustained growth, increasing efficiency, increasing firm size, and increasing movement of goods, people, and information (Lindner and Strulik 2014).

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The results from this particular research agenda are mixed. Authors like Putnam et al. (1994) provide evidence from Italian regions that networks of civic engagement contribute to economic prosperity and industrial development. In a similar direction, Dudley (2012) argues that the acceleration rate of innovation is directly related with the expansion of the circle of cooperation. With that postulate in mind he suggests that the Industrial Revolution was possible thanks to the role of social networks as systems of innovation diffusion, and their expansion in 18th century England. Meanwhile, Miguel et al. (2005) find that initial social capital does not predict subsequent industrial development across 274 Indonesian districts. Alesina (2013) and Alesina and Giuliano (2013, 2010) take further the skepticism about how dense social networks promote economic activity; they present evidence that shows that strong family ties are negatively correlated with generalized trust, because they imply more household production and less participation in the labor market of women, young adults and elderly. Therefore, in their view, strong family ties may interfere with activities leading to faster growth and modernity. Westlund and Adam (2010) make a meta-analysis of 65 studies and summarize the issue arguing that while there is strong evidence of a positive impact of social capital on firms’ performance, the results become less clear for spatial units with a large number of anonymous actors (i.e. at national and regional level). In their view, the contradictory results of studies on national and regional levels can be explained in part by insufficient measures of social capital and the norms and values distributed among the social networks that support them.

This paper contributes in this particular research agenda, exploring if social capital plays an important role in the modernization process, focusing on its role in the emergence of industrial activity. I try to solve the methodological issues described by Westlund and Adam (2010) through the study of a regional level episode, taking as unit of analysis individuals, for which I have precise measures of the social interactions. Concretely, taking a sample of elite members of Antioquia (a Colombian region) in the late 19th and early 20th century -at a time when industry was just staring to emerge-, I use discrete choice models that estimate how the entrepreneurial decision of investing in industrial projects would have been affected by the social capital generated by their social networks. Considering that for centuries industrial entrepreneurship was non-existent in the region, despite of the generalized knowledge of what Industry was, by identifying what drove the entrepreneurial elite to get involved in this sector, this paper interprets the determinants of industrial emergence.

This paper differs in three major aspects from previous work on the subject.

First, all of the studies at regional level use proxies of social capital, such as levels of trusts measured by surveys. In this paper, I use the effective social networks of entrepreneurs. In that sense, the quality and precision of the data used here are unique, and a more precise

Fogli and Veldkamp (2012) present a similar idea with a deeper use of social network analysis tools.
identification of the phenomena. This fact allows me to offer an argument well founded in social network theory, which is a major shortcoming of the literature on social capital and economic growth, in general. In other words, this paper follows Burt's claim (Burt 2000) claim, which argues in favor of studying network mechanisms responsible for social capital effects, rather than trying to integrate across metaphors of social capital loosely tied to distant empirical indicators.

Second, even though the use of episodes of rapid industrialization is not unusual in this literature, as well as the observation of historical evidence, my case of study captures singular characteristics of isolated industrial emergence (Antioquia in the early 20th century) in a context of unfortunate institutional conditions. These characteristics make the episode exceptionally instructive, because it can avoid the most relevant alternative explanations of industrial emergence, such as spillovers from neighborhood regions or the existence of a convenient institutional environment.

Finally, I approach the industrialization process through an entrepreneurial innovation focus, which is something uncommon in social capital literature, but widely explored in social network analysis (Stuart and Sorenson 2005) and modern economic growth (Acemoglu 2008). This approach helps to bridge the micro-evidence on social capital with the macro-consequences. In addition, it captures an important aspect of the particular historical framework of the case of study. Because, as mentioned above, industry emerged in the region completely during the period of analysis (i.e. all manufacturing production was craft-based before the late 19th century), despite of the regular knowledge and consumption of industrial goods (obviously imported) by the time, and the already existing industrial techniques of production that would be used in the regional firms. Therefore, the appearance and consolidation of industries in the region can be considered a process of entrepreneurial innovation, more concretely, an adoption process of new ways of production. In other words, the approach of the paper considers that understanding the usual variables of industrial transformation - such as the increase of the portion of manufacturing workers among population or the variety of local manufacturing goods supplied- requires the understanding of what was behind the entrepreneurial decision of investing in industry rather than on other sectors, as was done for centuries.

Due to these three singular aspects, this paper also contributes, in a more tangential way, to another set of literatures. In the first place, the growing literature on long-term economic growth (see Spolaore and Wacziarg 2013), which explores the persistent effects of historical events on economic performance, would be benefited by a better understanding of social networks, a mechanism poorly explored in that context. In the second place, a well-founded empirical exercise that explores the relevance of social networks on long-term economic performance would contribute to the literature on social network analysis, which has an increasing interest on the macro-consequences of micro-relational behavior. Finally, this
paper is important to Colombian economic history literature; a deeper look in the determinants of the industrialization of Antioquia would clarify the transition to modern capitalism in the country.

The paper is organized as follows: Section 2 presents the network theoretical basis of social capital. In section 3 I provide a general context of the industrialization of Antioquia and present the historiographical evidence that suggests how the social network mechanisms described in section 2 were important in that process. In section 4 I present the data and the empirical strategy, which pretends to measure the effects of social capital in industrial entrepreneurship. The results are presented in section 5, while section 6 offers some concluding remarks by contextualizing the results.

2 The Network Structure of Social Capital

There is a variety of definitions of social capital. They all agree identifying in social structure a kind of capital that can create for certain individuals or groups a competitive advantage in pursuing their ends. As the stylized fact that better educated people have - in average - higher returns is the key insight of human capital theory, that better connected people have higher returns is the one of social capital theory Burt (2001). Disagreements arrive when defining what it means to be better connected (i.e. which particular network mechanisms generate social capital). This discussion has two main positions, one that follows Coleman (1988, 1990), who emphasizes the role of closure, and another that follows Burt (2000, 2005), who focuses on structural holes.

2.1 Network Closure as Social Capital

A network with complete closure is one in which everyone is connected such that no one can escape the notice of others. In practical terms, closure is measured with the density of the ego network, that is, the number of ties divided by the number of pairs. More dense networks (i.e. in which many members of the network are connected directly between them) are networks with higher closure.

2In addition, in an even more tangential way, a social network analysis of the emergence of the first Colombian corporations would shed some light on the origins of the modern configuration of high entrepreneurial spheres in the country, which is characterized by cross-shares, board interlocks and familiar links (Pombo et al. 2009, Gutiérrez and Pombo 2009, González et al. 2012); aspects that are related, by an, with long term stagnation of Latin-American nations (Lipset et al. 1967, Hirschman 1958).

3An ego network is the network composed by of a focal node (“ego”) and the nodes to whom ego is directly connected to (“alters”) plus the ties, if any, among those alters.
For the followers of this approach, closure is the ultimate source of social capital. In their view, closure operates through two different mechanisms. First, networks with higher closure offer a more effective flow of information. As information is valuable, the members of a network with high closure should have productive advantages with regard to the members of a network with low closure, that is to say, they will have more social capital.

The logic behind this statement is that the quality of information deteriorates as it moves from one person to the next in a chain of intermediaries (Baker [1984], Baker and Iyer [1992]). Therefore, an increase in the members of the network connected directly among them, implies that the steps required for making everyone aware of a particular unit of information are reduced and the quality of the information is improved.

The second mechanism considers that network closure facilitates sanctions that make it less risky for people in the network to trust one another (Burtt [2000]). This fact reduces transaction costs and generates incentives to develop productive activities, representing advantages for the members of the network.

To understand the rationale of this mechanism is convenient to consider a network absent of any degree of closure. In that network the collective sanctions that would ensure trustworthiness cannot be applied, simply because people do not have frequent interaction, therefore, coordinating any sort of collective activity would be quite difficult, in the case of multilateral enforcement methods. In the case of bilateral enforcement methods, the absence of mutual frequent interaction offers incentives for everyone to choose the action that maximizes their instant payoff, no matter if that would harm the other, because it is unlikely to repeat an interaction in which an alter could punish previous opportunistic behavior. In contrast, in a network with high closure, it is usual that the alters of an average member of the network are connected among them, offering reliable communication channels, and protecting him from exploitation because he (through bilateral methods) and his contacts (through multilateral methods) are more able to act in concert against someone who violates their norms of conduct (Burtt [2000]).

This mechanism was popularized by Putnam et al. (1994) and Fukuyama (2002), and has captured the attention of almost every social capital study in economics. Among the most influential exposition of this idea in economics are the seminal papers of Greif (1989, 1993) on Maghribi traders of the 11th century Mediterranean. Those papers led to the emergence of a complete literature that explores how, in the absence of formal institutions that can support market-based exchange, closely-knit and multi-stranded social networks are regarded as generating a social capital of norms, information and sanctions that provide an alternative framework within which exchange can develop Edwards and Ogilvie (2012).
2.2 Structural Holes as Social Capital

The second social network mechanism that the literature has explored as source of capital is structural holes.

A structural hole is a situation in which two sub-networks are not connected directly between them. The existence of structural holes, and more precisely, the role of bridging those holes (brokerage, as is know), has been identified as a source of profitable opportunities. For instance, in a great variety of activities, brokers (i.e. the people who bridge structural holes) have faster promotions, higher salary, and superior creativity ratings (Burt, 2007).

For that reason, structural holes are consider a major source of social capital.

A well known historical study of brokerage is the one of Padgett and Ansell (1993), which explores how Cosimo de Medici’s used his contacts with opposing elite family factions to establish his family as the core of the political market in Renaissance Florence. Similar phenomena, in different historical contexts have been identified by Caro (1982); Greif (1994); Johansen (1982); McGuire and Granovetter (2003).

There are several ideas behind the concrete functioning of this mechanism (Burt et al., 2013). Here we can think of two particular ways in which it works. First, information control, which arises from the fact that people on either sides of a structural hole share different sort of information. Structural holes are thus an opportunity to broker the flow of information between people, and control the projects that bring together people from opposite sides of the hole (Burt, 2001). This idea is usually captured with the betweenness centrality index proposed by Freeman (1979), which quantifies the number of times a node acts as a bridge along the shortest path between two other nodes, offering an idea of how important a node is in the communication (or transmission of whatever is flowing through the network) between other nodes.

The second intuitive idea behind structural holes as source social capital is, unconstrained behavior, which is related with the fact that each side of the structural hole has different type of values and norms. Brokers, do not have, usually, alters so well connected among them, and its relations with each side of the structural hole are, normally, weak ties; these two things make him less constrained for developing new ideas and having different behaviors. In that sense, structural holes as particularly useful for promoting innovation. This idea is captured, frequently, with ego network density. Therefore, the unconstrained behavior is, basically,

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4 Burt (2008) has found similar qualitative results at macro level. Industries that bridge structural holes performed better.

5 There are three assumptions under this statement, 1- there are no superior coordination methods (e.g. formal coordination institutions) 2- there are no massive diffusion information mechanisms 3- For people is costly to interact with others outside their network.
the opposite side of the closure-trust mechanism. Being part of a more cohesive community might promote positive effects related with trust, but it also generates stronger pressures for preserving status quo. For this reason, I will explore the structural holes mechanism based on betweenness centrality, focusing on the information control idea; and by exploring the network closure mechanism I will consider the effects of unconstrained behavior.

That said, structural holes describe a different process from the one of the closure-trust mechanism. While closure creates economic advantages for an individual by reducing the opportunistic behavior of his alters, structural holes generate similar advantages by offering the possibility of taking, precisely, opportunistic behavior. Even though, they both share an interesting feature, they offer an explanation of exceptional economic performance, in absence of formal institutional enforcement, both based on the network structure of social interaction. In that sense, they are promising theoretical approaches for interpreting the industrial take-off of Antioquia, a region characterized by its weak institutional environment.

3 The Industrialization of Antioquia

3.1 General Context

Antioquia was the key region in the emergence of industrial capitalism in Colombia, and a representative case in the Latin-American experience. The industrialization of Antioquia had two singular features. First, it was an isolated and autonomous process, not resulting from regional spillovers or foreign investment, something that makes it propitious for exploring endogenous determinants of industrial emergence. Second, the region did not had the type of institutional environment that modern literature argues as necessary for economic growth (see Acemoglu, 2008). Let me present those features in more detail.

3.1.1 An isolated industrialization process

Antioquia is a representation of spontaneous and isolated industrialization, that is, the paradoxical feature of a peripheral region that led the modernization of its national economy. That feature has being identified in other Latin-American regions, such as Nuevo Leon, in Mexico, and Sao Paulo, in Brazil. These three cases were widely studied by the development economists of the postwar period, which emphasized in what they called “the non-economic factors of economic development” (see Rostow, 1960; Hagen, 1962; Lipset et al., 1967; McClelland, 1961; Hirschman, 1958).

Until the second half of the 19th century, there was absolute no industrial activity in the region. The last two decades of the century saw the emergence of the first firms and only
in the two initial decades of the 20th century, industry could be considered an active and significant sector in the local economy (see figure 1). This industrialization process can be considered an entrepreneurial innovation process. Some few pioneers got involved in the new sector by the 1870s, and this behavior diffuse in the entrepreneurial elite in the following decades, and it was a generalized activity by the 1920s.

Figure 1: Foundation dates. Industrial firms in Antioquia. Histogram

An additional argument for considering the industrialization as the entrepreneurial diffusion process described above, is that the important aspect was the number of industrial projects founded, rather than the size of those projects. In other words, the essence of industrial growth was the foundation of new industrial firms, not the expansion of already existing firms. This idea is supported by the data. Table 1 describes how there is no significant relation between the year of foundation and the size of the industrial firms (measured in terms of initial capital and number of employees). Therefore, all the industrial firms founded during the period were of similar sizes.

As the number of firms increased considerably in the period, going from 0 to almost 300, and the size of those firms did not change systematically in time, it is possible to argue that the industrialization process can be captured by the number of firms founded.

3.1.2 Weak institutional context

Antioquia’s singularity goes beyond the isolation of its industrialization. In addition to its peripheral condition, Antioquia was, basically, a mining economy during the whole colonial

6Considering that the production methods were still pretty labor intensive and did not change dramatically during the period, is reasonable to consider that the number of employees reflected the relative size of production.
Table 1: Firm size and year of foundation. Industrial firms. OLS regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial Capital</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>-873.29</td>
<td>-0.34</td>
</tr>
<tr>
<td></td>
<td>(850.3)</td>
<td>(1.98)</td>
</tr>
<tr>
<td>Constant</td>
<td>1681776</td>
<td>747.67</td>
</tr>
<tr>
<td></td>
<td>(1627306)</td>
<td>(3687,24)</td>
</tr>
</tbody>
</table>

Observations 88 47
R-squared 0.012 0.0007

Standard errors in parentheses

period. If we compare Antioquia with regions that shared a similar mining past, such as Cauca, Chocó, Potosí, Pasco, Guanajuato and Zacatecas (see table 2), it is clear that the industrialization of Antioquia was quite a curious feature in this group. Similarly, in comparison with the rest of interesting cases of early industrialization in Latin America (São Paulo, Nuevo Leon and Buenos Aires), Antioquia’s mining tradition is completely atypical.

Table 2: Main characteristics of the principal industrial poles and colonial mining regions of Latin America

<table>
<thead>
<tr>
<th>Massive Immigration in 19th century</th>
<th>Colonial Capital</th>
<th>Coffee Plantations</th>
<th>International Trade Experience</th>
<th>Landlocked</th>
<th>Local Isolation</th>
<th>Colonial Mining Center</th>
<th>Early Industrial Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioquia</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cauca</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chocó</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Potosí</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guanajuato</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Zacatecas</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cundinamarca</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Colombian Atlantic Coast</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sao Paulo</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Nuevo Leon</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Source: Based on Vizcaya (1969); Brew (1977); de Carvalho Filho and Colistete (2010)

With mining activities, the region developed a weak institutional environment, such as the most part of economies based on extractive activities (Acemoglu and Robinson 2012). Let me present the evidence that supports that claim.

First, there was the particular ethnic composition of the region. Antioquia was a region mainly populated by mestizos they represented 58% of the total population by 1778 (it was

\^Mestizos were non-white free population
the highest rate among Colombian regions). There is a consensus about the difficult conditions in which mestizos used to live. Authors like Álvarez (1997) and Melo (1977) describe how they did not have access to public offices, were unable to receive lands from authorities, and their earnings were so low that they did not have enough resources to buy land in the market and were forced to work as servants for whites. Therefore, they cannot be considered as part of the population relevant for collective decision-making. In fact, their presence represented a threat to the rights of other social groups, such as the indigenous, because in their expansion, they used to occupy their lands and carry out all sort of violations.

In conjunction with the high population of mestizos, slavery was a key aspect in the ethnic composition of antioqueño population. 18% of the population of Antioquia was enslaved by 1778. This number is almost as high as in Popayán (19%), the archetype of a colonial economy based on slavery. The generalization of servile labor was present even after the end of slavery. By 1863, 10% of the labor force were servants outside agricultural activities. Considering that agriculture was the sector in which servitude was more common, it is reasonable to think that the share of the population that worked as servant would be higher than 20%.

Second, the structure of land property was pretty unequal. As Palacios (1979) mentions, by analyzing the data of land titling is pretty clear the absence of large mass of peasantries in the colonized areas of Antioquia, making evident an enormous problem of property rights enforcement. The great majority of those settlers were unprotected against the interests of the powerful entrepreneurial elite, and that led to serious juridical, political and social conflicts (see LeGrand, 1988). By 1912, the share of the rural population that owned the land they lived in was smaller than the national average.

Another way of observing the non-democratic composition of rural Antioquia is to look at the share of production by size of property. The large amount of production did not stem from small properties (from less than 3 hectares), but from middle and large size properties. Nariño and Cauca offered a more democratic rural production, and neither of them is considered by the literature as a region enjoying institutional virtues.

Finally, Antioquia was subject of the national political context. Even during the federal period (1863-1886), when each region enjoyed from general independence, formal institutional arrangements were limited by national laws. For instance, international trade policy, which represented, probably, the most important part of the economy of Antioquia, was controlled at the national level. As Colombia was immersed in serious political and military turmoil during the whole 19th century, what local governments could do for escaping that turmoil and offer a better institutional environment was quite limited.

For example, despite the interest of the local politicians to offer a stable scenario for business, in which private property must be respected, several times foreign armies arrived in
Antioquia during the 19th century, causing material damages and overthrowing democratic elected local governments. In those processes expropriation was a regular tool, maybe as common as in other regions of the country.

In summary, there is sufficient evidence for arguing that Antioquia did not enjoy a “convenient” institutional environment during the period. Therefore, an institutional interpretation of the industrial take-off of Antioquia seems implausible.

3.2 Social networks in Antioquia

The singularity of the industrialization of Antioquia has made it one of the most studied topics in the economic history of Latin America. Some of the arguments explored are the precise entrepreneurial conditions of the region during the last part of the 19th century and the first decades of the 20th. In particular, an important fraction of the literature emphasizes social network mechanisms that expanded entrepreneurial activity. Most of these works are based on cultural and sociological evidence collected and analyzed independently from economic or entrepreneurial historical data. In this paper, I try to structure those hypotheses in the modern theory of social capital and test them empirically with detailed network data.

3.2.1 Closure arguments

In the first hand, there is a set of hypotheses for Antioquia that represent, clearly, the trust-cohesion intuition embedded in network closure as social capital. For instance, authors like Twinam (1976) and Botero (2007) describe how the Antioqueño elite seems to have enjoyed strong cohesion, something that helped the entrepreneurship to develop informal institutions that reduced uncertainty. For example, Botero (1984) describes how, during wartime and with a serious risk of bank run, the merchants of Medellín (the largest city of Antioquia) accepted the paper money of the banks that were under more pressure, because they made part of the banking elite themselves. Implicit agreements of that sort were the base of a successful free banking system that worked both in times of war and peace (Mejía, 2012).

Another example of a particular informal institution, generated by the precise structure of the elite network, was the capital configuration of commercial houses, which was the dominant entrepreneurial figure in the period. Typically, those houses were owned by two partners, one of which contributed the capital, while the other contributed his labor, having each one an equal part of the property of the firm. These societies were usually backed by family or marriage relations. Commercial houses that associated people with no familiar relations were almost non-existent. That suggests that family played a role in reducing uncertainty, probably through its capacity to generate collective sanctions for opportunistic behavior, as
Greif explores for Maghribi traders.

In a similar line, there is a relevant literature about the development of Antioquia that emphasizes the apparent cultural virtues of the Antioqueños (Fajardo 1969). Those virtues were related with Basques and Jewish origins of the local population (see Twinam 1980), or as a reaction of a status deprivation (Hagen 1962). None of those arguments have been proved satisfactorily, but it is clear that since the early years of the 19th century the Antioqueños had a particular self-image, one that encouraged productivity and business life. The role of endogamy and close familiar relations seem to have been an element that perpetuated that self-image (Twinam 1976). In that sense, the closure of family networks is presented as responsible for the industrialization of the region.

3.2.2 Structural holes arguments

There is also a set of studies from a similar literature that explore ideas related with structural holes as sources of social capital.

Uribe and Alvarez (1988) y Mejía (2015) argue how successful entrepreneurs had personal relations with political actors, and, usually, they were politicians themselves. Biographical studies from local entrepreneurs such as Pepe Sierra, Coroliano Amador, Eduardo Vásquez, and Pedro Nel Ospina evidenced that their privileged position between entrepreneurial and political spheres was an fundamental aspect in their entrepreneurial success. For instance, Pedro Nel Ospina and Eduardo Vásquez, were involved in the foundation of the first electric company of Colombia, in which the government of Medellín was also a partner. In that case, it was not the cohesion of their network, but brokerage the relational source of profitable advantages.

In the second place, an important number of studies (e.g. Mayor 1984; Mejía 2015; Brew 1977); describe that certain families of the local elite incorporated rapidly European migrants by marrying with their daughters or by integrating them in other social activities. Those migrants came, in the first place, as engineers for the gold mines, and resulted offering a reliable channel of knowledge diffusion among local entrepreneurs. Therefore, there is evidence that the social networks seem to have functioned as innovation channels, just as Dudley’s argument for 18th century England.

As an instance of a concrete mechanism through which that happened, a whole generation of some elite families was educated in technical areas in Europe, thanks to the contacts of those migrants; bringing back, then, the engineering knowledge that would feed the Escuela

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8 Notice that the size of the immigration in Antioquia was quite small in comparative terms, both with Latin-American and Colombian standards.
de Minas, and the first industrial projects. Those families that were more closely related with
the immigrant community, as the Vásquez, the Restrepo, and the Ospinas, were the ones who
made the transition from traditional elites, to industrial elites. Once again, in that case it was
not closure, but brokerage (between traditional local elite networks and immigrant networks)
which originated the productive advantage.

Finally, some authors explore in detail the importance of social networks as a system
that, in the absence of a developed capital market, supported the first industrial efforts.
For example, Safford (1967) and López Toro (1970) emphasize the convenient function of
mining profits and the configuration of familiar and commercial links in the disposition of
the capital that became the bases of the first industrial projects. Those authors suggest
that entrepreneurs strategically related with mining and commercial elites could venture in
industry thanks to the capital offered by those groups.

4 Empirical Strategy

4.1 Data

One of the main contributions of the paper is the construction of a data-set that allows
the restoration of a historical social network that evolves in time. This data-set covers over
100 years and characterizes the entrepreneurial activity of Antioquia during the 19th and
20th century. The data-set puts together two large components built up from economical,
demographic, historical and biographical data.

4.1.1 Relational data

The first component of the dataset presents information of 1876 people belonging to the
Antioqueña 19th and 20th century elite. These data offers a detail compilation of the economic,
political and intellectual activity of each individual.

This component was constructed in two steps:

**First step (snowball sample):** First, I develop a snowball sample, the usual approach
to constructing social networks data, in which the existing subjects of study lead to future
subjects from among their social connections. Despite being a non-probabilistic sample
method, it is also common outside social network analysis, in particular in studies of hidden
populations, which are difficult for researchers to access, such as drug users or sex workers. In
particular, these data combines genealogical sources, written entrepreneurial reports, periodic
publications, chronicles and historical narratives, and the economic literature of the period.

The starting point of the snowball were the five larger shareholders of the banking system by 1888. The reason to start with the most important bankers is that banks were the largest entrepreneurial projects of the 19th century, both in terms of capital and in terms of number of shareholders. In that sense, the larger bankers were, certainly, big fish in the business community. All the information available about those five individuals was collected. From those five individuals the data-set grew by incorporating their parents, their marital partners, and their sons. In addition, their most important partners in other activities, such as entrepreneurial projects, were also included. For all of these new individuals all the available information was also collected and an identical process of data reproduction emerged from them. The temporal boundaries of the sample where 1740 and 1905 (i.e. people born before and after those years where not included). The final result was a sample of 953 people, for which the information collected varied significantly.

The potential of this component of the data-set overflows the reach of the paper. For the purposes of the paper it will be useful for constructing several social networks.

First, the data-set presents a detailed description of biographical events, with a particular emphasis on its relational behavior. The data contains demographic information, including, in most cases, death and birth dates, number of children, age at marriage, age of marital partner and age at having the first child and last child. Therefore, the particular feature of a perfect identification of the marital partner allows the construction of a family network that includes non-genetic links.

Second, the database also includes an exhaustive description of political activism. We know who was, at some point of his life, on public office and the characteristics of the position. As local officials were designated rather than elected, and there is information of who appointed each person to office, it is feasible to construct a political network. In addition, despite the difficulties in considering the partisan membership of people during that time[^9] we have that information for an important part of the database, even for some that did not participate actively on politics.

Third, another set of variables available in the database are those related with entrepreneurial activity. We know almost every entrepreneurial project in which the individuals were involved, having complete certainty about the economic sectors of those projects and, frequently, some other details, such as the amounts and composition of the investment and the starting and ending dates. Close entrepreneurial partners are well identified and the

[^9]: Partisan membership was not an issue of official inscription, but rather of informal sympathy. Therefore, there is no record of partisan affiliation. In addition, it was usual that people would change of partisan affiliation across their lives.
participation in large firms is complemented with the second component of the database. Thus, it is possible to construct a set of entrepreneurial networks by sector. In particular, due to the historiographical evidence, the mining and the banking networks are of our interest.

Fourth, the data allows the construction of a friendship and intellectual network, because it details the participation in projects of a not-so-productive nature, such as periodic publications, school classes, and literature and artistic groups.

Finally, a network of non-governmental organizations was also constructed. This network included people that were involved in civic organizations, and those in professional associations, such as gilds.

**Second step (expansion by large projects):** Due to the nature of the snowball method itself, the sample resulting from it is not an appropriate representation of the population. In this case, the sample resulted from the snowball, for instance, overrepsres female participation in the elite population. Women had a marginal role in the public life during the period of analysis. Their participation in entrepreneurial, political and intellectual projects was really small. Even though, women were pretty important in private spheres, and fundamental in the family network. For that reason it is not suitable to erase them from the sample. Similarly, there are other sort of bias in the sample related to the overrepresentation of some families and people associated with banking, that cannot be expelled because it would break the network configuration.

Therefore, the second step pretended to minimize those biases by expanding the sample from data that closely represented the elite of the period and were not related with the point of start of the snowball. The number of projects considered depended on the availability of information and time. The sources used where of the same characteristics as those of the first step. The criteria for considering a project was solely its relevance in each sphere; there was no particular bias in this step other than what the historiography considers a relevant project. After this process, 923 additional people were included in the sample. For these new observations there is no other information that the one related to their participation in the projects. Therefore, they would be part of the social networks constructed but there will be no "controls" for them in the empirical exercise.

Nearly 60% of the individuals recorded in the first step were found in the second step. This fact suggests that the snowball sample represents well, after all, what one can considered the elite, that is, the people that participates in the most important projects in a society.\textsuperscript{10}

\textsuperscript{10}Despite the ambiguity of this idea, it is easy to see that is closely related with the classical definition of elite as a small group of people who control a disproportionate fraction of a particular social sphere (Bottomore, 1993).
Thus, eventually, the first step sample would be used in the empirical exercise for taking into account variables other than those resulting from social networks.

4.1.2 Attributes and firm data

The second component of the data-set contains information about the ownership and productive structure of the largest firms founded during the period. This component is constructed based on founding charters and secondary sources. It includes information about the economic activity of each firm, the amounts of capital invested, the location, the number of workers, the dates of founding and closing, and the identity of the founders.

Despite the absence of frequent sectoral censuses, the quality of business history research for the region offers confidence that the data collected include almost all the relevant entrepreneurial projects founded during the period.

This component of the database will be used for three purposes. First, the information of who was a shareholder of an industrial firm will represent our dependent variable in the empirical strategy (see next section). Second, it will help to reconstruct the entrepreneurial networks, complementing the relational data. Third, it will offer the general information of the economic environment, which will be used in our model as control variables.

4.2 Descriptive statistics

For understanding the data used it is convenient to consider the evolution of the sample across time. The largest part of our individuals were in their productive lives in the last two decades of the 19th century and the first two of the 20th century. This can be seen in the demographic information of the first step sample. Our individuals were born, mainly, in the second half of the 19th century and died in the first part of the 20th century (see figure 2).

The sample seems to be a good representation of the local elite. In addition to the arguments presented in the previous section, the variety of activities they performed support that claim. The composition of the activities presented in table 3 coincide with the qualitative evidence describe by authors like Davila (2012); Brew (1977); Poveda (1981), which suggest how generalized were commercial and banking activities among the elite. The minor participation, but not infrequent, in other activities is also identified by those authors. The fact that 116 people were founders of industrial projects, which represent almost 9% of the sample, is reasonable for an agrarian society, in which industry was just emerging.

Also consistent with the historiographical evidence, the location of our sample (considering their place of death as a proxy of the place were they lived during their adulthood and developed
Figure 2: Death and birth dates. Histogram

Table 3: Firm size and year of foundation. Industrial firms. OLS regression

<table>
<thead>
<tr>
<th>Activity*</th>
<th>Observations</th>
<th>City of death</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merchant</td>
<td>208</td>
<td>Medellín</td>
<td>203</td>
</tr>
<tr>
<td>Miner</td>
<td>78</td>
<td>Bogotá</td>
<td>41</td>
</tr>
<tr>
<td>Landowner</td>
<td>69</td>
<td>Manizales</td>
<td>16</td>
</tr>
<tr>
<td>Politician</td>
<td>223</td>
<td>Rionegro</td>
<td>15</td>
</tr>
<tr>
<td>Intellectual</td>
<td>129</td>
<td>Sonsón</td>
<td>8</td>
</tr>
<tr>
<td>Farmer</td>
<td>78</td>
<td>Pereira</td>
<td>7</td>
</tr>
<tr>
<td>Industrial</td>
<td>116</td>
<td>Abejorral</td>
<td>6</td>
</tr>
<tr>
<td>Banker</td>
<td>670</td>
<td>New York</td>
<td>6</td>
</tr>
</tbody>
</table>

*Activities were not exclusive

their activities) is concentrated in Medellín, which was the epicenter of the Antioqueño elite (see table 3).

The following table presents the descriptive statistics of the variables used in the estimation. The number of industrial firms founded and having founded an industrial firm would be the dependent variables, while the measures of social capital (ego-density and betweenness centrality) the independent variables of interest. Other independent variables are considered, being a banker, immigrant and engineer. As controls, I use the gender of the individual, the years at death and a measure of the proactivity of the individual, constructed as the number of activities in which in the individual was involved throughout his life.
Table 4: Main characteristics of the social networks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ind. firms founded</td>
<td>1876</td>
<td>0.15</td>
<td>0.61</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Having founded an ind. firm</td>
<td>1876</td>
<td>0.08</td>
<td>0.28</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ego-Density*</td>
<td>1876</td>
<td>0.08</td>
<td>46.01</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Betweenness*</td>
<td>1876</td>
<td>0.03</td>
<td>0.22</td>
<td>0</td>
<td>5.26</td>
</tr>
<tr>
<td>Banker</td>
<td>1472</td>
<td>0.45</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Immigrant</td>
<td>954</td>
<td>0.01</td>
<td>0.12</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Engineer</td>
<td>954</td>
<td>0.03</td>
<td>0.19</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Male</td>
<td>1876</td>
<td>0.76</td>
<td>0.42</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Proactivity</td>
<td>954</td>
<td>1.49</td>
<td>1.89</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Age at Death</td>
<td>390</td>
<td>69.86</td>
<td>15.46</td>
<td>20</td>
<td>112</td>
</tr>
</tbody>
</table>

*Measures for the complete network

4.3 Model

In order to evaluate the existence of a relation between the emergence and consolidation of industry, and social networks, I propose a couple of simple exercises in which I focus on entrepreneurial decisions. This approach considers that the deepest origin of an industrial takeoff is the massive decision of entrepreneurs to venture on that sector. In that sense, finding the determinants of entrepreneurs’ choice to start a new enterprise, amounts to explaining industrialization.

4.3.1 Probit model

In the first exercise I will focus on the extensive margin of the decision, rather than on the intensive one. Therefore, I use a probit model that estimates how the probability of being one of the founders of an industrial project relates to the characteristics of the social network to which the individual belongs. In particular, suppose the existence of an implicit utility behind the decision of participating in a new industrial project. \( U_{i1} \) would be the utility of participating, while \( U_{i0} \) the utility of not doing so. Formally,

\[
U_{i1} = X_i \alpha + Z_i \gamma
\]

\[
U_{i0} = 0
\]

Where \( X \) is the vector that characterizes the network position of individual \( i \) (i.e. various measures of centrality on each of the networks). This is the independent variables of interest.
Z captures controls that might be of relevance.

In particular, X includes the measures of social capital, concretely, the ego-density and betweenness centrality.

Our dependent variable will be dichotomous, being or not one of the shareholder-founders of an industrial firm. This variable will be ruled by a regular maximization criteria, in which each entrepreneur would participate in an industrial project only if the utility of doing it is larger than the utility of not doing so. Formally,

\[
D_i = \begin{cases} 
1 & \text{if } U_{i1} > 0 \\
0 & \text{if } U_{i1} \leq 0 
\end{cases}
\] (2)

Thus, the model can be estimated by maximum likelihood. The log function of maximum likelihood would be:

\[
\ln L (\alpha, \gamma | X, Z) = \sum \{ D_i \ln Pr [D_i = 1 | X_i \alpha + Z_i \gamma] \\
+ (1 - D_i) \ln [1 - Pr [D_i = 1 | X_i \alpha + Z_i \gamma]] \} 
\] (3)

The marginal effects with regard to X indicate how much the probability of participating in industrial projects would have depended of the particular position of each entrepreneur on different social networks.

Under the hypothesis that the structure of individuals’ social networks were relevant in the entrepreneurial decision of investing in industry, some of the measures of centrality must be significant in the estimation of our model. As the industrialization of Antioquia was the result of the massive increase in the number of entrepreneurial projects of industrial nature, if we find that social networks increased the probability that an entrepreneur would have founded an industry, we could argue that social networks could explain the industrialization process. As we test different measures of centrality, we can also explore which particular aspects of the network were the ones that fostered the decision of investing in industry.

4.3.2 Negative binomial model

Venturing in the industrial sector had also an intensive margin decision that I will try to capture as a counting process of the number of industrial projects in which each entrepreneur was involved. The usual method for modeling count data with overdispersion is the negative binomial regression model.
Negative binomial regression assumes that the response variable has a negative binomial distribution, and assumes the logarithm of its expected value can be modeled by a linear combination of unknown parameters. Formally,

$$
\log (E(Y|X, Z)) = \beta + X_i \alpha + Z_i \gamma
$$

Where \(Y_i\) are the number of industries of which the individual \(i\) was one of the founders. \(X_i\) and \(Z_i\) represent, as in the previous model, the social capital measures and the controls, respectively.

The model can be estimated by maximum likelihood. The log function of maximum likelihood would be:

$$
\ln L(\beta, \alpha, \gamma | X, Z) = \sum [y_i \ln \delta + y_i (\beta + X_i \alpha + Z_i \gamma) - \left( y_i + \frac{1}{\delta} \right) \ln \left( 1 + \delta e^{\beta + X_i \alpha + Z_i \gamma} \right) + \ln \Gamma \left( y_i + \frac{1}{\delta} \right) - \ln \Gamma \left( y_i - 1 \right) - \ln \Gamma \left( y_i + \frac{1}{\delta} \right)]
$$

Where \(\delta\) is the heterogeneity parameter of the negative binomial distribution\(^{11}\). The estimates of \(\alpha\) indicate the expected increase in log count (number of industries) associated with one-unit increase in the different measures of social capital of each individual.

### 4.3.3 Networks

For running the model there is a first step, which consists in reconstructing the social networks used as input of our independent variables. The following table summarizes the criteria used in the construction of these networks.

Each network has different relational dynamics. While the family network is composed by relations that persist forever, the ties of the political network might have disappeared in few years. Therefore, a basic assumption in the empirical exercise is that all the relations were long term relations, which persisted for the whole period of analysis. This is a very strong assumption, but is reasonable as part of the first approach spirit of the paper. Subsequent exercises should explore the variance in the relational dynamics across types of social interaction.

The resulting networks varied significantly on its composition. There are very large networks, like the banking one, which had more than 100,000 edges, and others pretty small,

\(^{11}\)See Hilbe (2011) for notation details
Table 5: Criteria used in the construction of social networks

<table>
<thead>
<tr>
<th>Network</th>
<th>Nodes</th>
<th>Edges</th>
<th>Weights</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>All</td>
<td>Parents, couples, children and siblings</td>
<td>None</td>
<td>1740-1999</td>
</tr>
<tr>
<td>Political</td>
<td>Public servants</td>
<td>Members of common cabinets. Direct bosses. Direct subordinates</td>
<td>Number of interactions</td>
<td>1820-1950</td>
</tr>
<tr>
<td>NGOs</td>
<td>Civic</td>
<td>Members of civic organizations</td>
<td>Members of the same civic organization</td>
<td>1840-1950</td>
</tr>
<tr>
<td></td>
<td>Guilds</td>
<td>Members of guild associations</td>
<td>Members of the same guild association</td>
<td>1880-1935</td>
</tr>
<tr>
<td>Modern Sector</td>
<td>Banking</td>
<td>Banking shareholders</td>
<td>Shareholders of the same bank</td>
<td>1875-1888</td>
</tr>
<tr>
<td></td>
<td>Modern transport</td>
<td>Shareholders of non-animal driving firms</td>
<td>Shareholders of the same company</td>
<td>1880-1930</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>Construction shareholders</td>
<td>Shareholders of the same company</td>
<td>1880-1930</td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td>Agricultural shareholders</td>
<td>Shareholders of the same company</td>
<td>1850-1930</td>
</tr>
<tr>
<td>Traditional Sector</td>
<td>Animal husbandry</td>
<td>Shareholders of animal husbandry firms</td>
<td>Shareholders of the same company</td>
<td>1850-1930</td>
</tr>
<tr>
<td></td>
<td>Mining</td>
<td>Mining shareholders</td>
<td>Shareholders of the same company</td>
<td>1750-1880</td>
</tr>
<tr>
<td></td>
<td>Mule driving</td>
<td>Mule driving shareholders</td>
<td>Shareholders of the same company</td>
<td>1750-1865</td>
</tr>
<tr>
<td>Intellectual</td>
<td>Members of intellectual circles</td>
<td>Partners at any intellectual project</td>
<td>Number of interactions</td>
<td>1750-1999</td>
</tr>
<tr>
<td>Friendship</td>
<td>All</td>
<td>Friend. Member of the same social club</td>
<td>None</td>
<td>1750-1999</td>
</tr>
<tr>
<td>Complete</td>
<td>All</td>
<td>All excepting exclusive banking edges</td>
<td>Number of interactions</td>
<td>1750-1999</td>
</tr>
</tbody>
</table>

Like mule driving. Both of these facts are consistent with the historiographical evidence. Banking firms were the first corporations in the local economy, while mule driving represented the ancestral way of doing business, in which individual projects and companies of small sizes were the usual associative figure.

Another aspect in which these networks differ considerably is in their density. By comparing networks with similar sizes, it is possible to see that there are some pretty dense, like civic networks and other much less denser, like friendship networks. Similarly, while banking is a pretty dense network, the political network is much less dense, despite being smaller. This is also intuitive, while modern and large entrepreneurial projects required increasing efforts in multilateral cooperation, politics has more stable relational interactions, in which bilateralism dominates.

In summary, table 6 describes the different patterns of relational behavior associated with
Table 6: Main characteristics of the social networks

<table>
<thead>
<tr>
<th>Network</th>
<th>Nodes</th>
<th>Edges</th>
<th>Average degree</th>
<th>Diameter</th>
<th>Density</th>
<th>Connected Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>1353</td>
<td>11717</td>
<td>8.66</td>
<td>14</td>
<td>0.006</td>
<td>8</td>
</tr>
<tr>
<td>Family</td>
<td>903</td>
<td>4781</td>
<td>5.29</td>
<td>18</td>
<td>0.006</td>
<td>23</td>
</tr>
<tr>
<td>Political</td>
<td>228</td>
<td>320</td>
<td>1.4</td>
<td>9</td>
<td>0.006</td>
<td>14</td>
</tr>
<tr>
<td>Friendship</td>
<td>184</td>
<td>979</td>
<td>5.32</td>
<td>5</td>
<td>0.029</td>
<td>23</td>
</tr>
<tr>
<td>Intellectual</td>
<td>153</td>
<td>723</td>
<td>9.45</td>
<td>7</td>
<td>0.62</td>
<td>11</td>
</tr>
<tr>
<td>Traditional Sector</td>
<td>162</td>
<td>738</td>
<td>9.11</td>
<td>9</td>
<td>0.057</td>
<td>15</td>
</tr>
<tr>
<td>Agriculture</td>
<td>83</td>
<td>469</td>
<td>11.3</td>
<td>2</td>
<td>0.138</td>
<td>15</td>
</tr>
<tr>
<td>Mining</td>
<td>57</td>
<td>125</td>
<td>4.386</td>
<td>5</td>
<td>0.078</td>
<td>7</td>
</tr>
<tr>
<td>Animal Husbandry</td>
<td>26</td>
<td>113</td>
<td>8.69</td>
<td>1</td>
<td>0.348</td>
<td>4</td>
</tr>
<tr>
<td>Mule Driving</td>
<td>15</td>
<td>37</td>
<td>4.93</td>
<td>1</td>
<td>0.348</td>
<td>4</td>
</tr>
<tr>
<td>Modern Sector</td>
<td>686</td>
<td>106276</td>
<td>309.84</td>
<td>5</td>
<td>0.452</td>
<td>3</td>
</tr>
<tr>
<td>Banking</td>
<td>652</td>
<td>106058</td>
<td>325.33</td>
<td>4</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Construction</td>
<td>23</td>
<td>75</td>
<td>6.52</td>
<td>2</td>
<td>0.269</td>
<td>3</td>
</tr>
<tr>
<td>Modern Transport</td>
<td>19</td>
<td>145</td>
<td>7.62</td>
<td>2</td>
<td>0.424</td>
<td>3</td>
</tr>
<tr>
<td>NGOs</td>
<td>282</td>
<td>4111</td>
<td>29.156</td>
<td>7</td>
<td>0.104</td>
<td>4</td>
</tr>
<tr>
<td>Civic</td>
<td>193</td>
<td>2957</td>
<td>30.64</td>
<td>7</td>
<td>0.16</td>
<td>6</td>
</tr>
<tr>
<td>Guilds</td>
<td>101</td>
<td>1159</td>
<td>22.95</td>
<td>4</td>
<td>0.23</td>
<td>4</td>
</tr>
</tbody>
</table>

different aspects of life. This is a complete subject that exceeds the scope of this paper, but one that deserves to be explored in future researches.

5 Results

To begin with the discussion of the results of the models described in section 4.3, let me start with the complete network, which includes all social relations besides banking.

The first aspect to notice is that the betweenness centrality coefficient is positive and statistically significant in all the specifications considered for the intensive margin decision (the negative binomial model). This result indicates that people more important in the flow of information (or resources) between other nodes, founded more industries. In other words, social capital related with structural holes was associated with a deeper involvement of entrepreneurs in industrial activity. In contrast, the social capital related with closure does

\[12\] The reason for excluding banking is that it was an exceptionally large and dense network that included very weak ties. Banking relations differ considerably from the nature of the rest of the ties considered. Nevertheless, banking effects would not be ignored, they would be capture as a dummy in the regressions, and through individual analysis.
not seem to be associated positively with industrial investment. Actually, the ego-density coefficient, not only is non-significant when controls are considered, but it has a negative sign in most part of the specifications. Under those specifications, people surrounded by more cohesive networks founded less industries. That means that the behavioral constraints effects of cohesive networks could have dominated trust effects.

Table 7: Results. Negative Binomial Model

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable is the number of industrial firms founded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ego-density</td>
<td>0.0289***</td>
<td>0.00245</td>
<td>-0.0366***</td>
<td>-0.0378***</td>
<td>-0.0193</td>
</tr>
<tr>
<td></td>
<td>(0.00872)</td>
<td>(0.0112)</td>
<td>(0.0121)</td>
<td>(0.0120)</td>
<td>(0.0162)</td>
</tr>
<tr>
<td>Ego-denstity.2</td>
<td>-0.000214**</td>
<td>-1.27e-05</td>
<td>0.000274**</td>
<td>0.000287**</td>
<td>0.000213</td>
</tr>
<tr>
<td></td>
<td>(9.32e-05)</td>
<td>(0.000116)</td>
<td>(0.000117)</td>
<td>(0.000116)</td>
<td>(0.000156)</td>
</tr>
<tr>
<td>Betweenness</td>
<td>1.245***</td>
<td>1.471***</td>
<td>0.780***</td>
<td>0.702***</td>
<td>0.381*</td>
</tr>
<tr>
<td></td>
<td>(0.255)</td>
<td>(0.294)</td>
<td>(0.249)</td>
<td>(0.246)</td>
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<td>-0.332</td>
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<tr>
<td></td>
<td>(0.780)</td>
<td>(0.813)</td>
<td>(0.773)</td>
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</tr>
<tr>
<td>Engineer</td>
<td>0.958**</td>
<td>0.555</td>
<td></td>
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</tr>
<tr>
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<td>(0.478)</td>
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<tr>
<td>Constant</td>
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<td>-2.191***</td>
<td>-1.139***</td>
<td>-1.159***</td>
<td>-18.89</td>
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<td>(0.186)</td>
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<td>(0.285)</td>
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<td>1,472</td>
<td>954</td>
<td>954</td>
<td>390</td>
</tr>
</tbody>
</table>

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.
(5) Includes controls: years at death, proactivity and gender

The results from table 7 also offer an idea of the role of other variables that are usually referred as important in industrialization processes. Neither being a banker, an international migrant or an engineer seem to have been essential aspects for explaining why some entrepreneurs founded more industrial firms than others.

When considering the extensive margin decision, the behavior of social capital coefficients are similar, the effects of betweenness centrality is positive and larger than the one of ego-density, which is, in several occasions, negative. Nevertheless, in this case, non of the social capital coefficients is significant when all the controls are included, which indicates that other variables related with the relational behavior of individuals might have been the relevant aspects for explaining if they decided to invest (or not) in industry.

An interesting additional result is engineering education plays an important role in
Table 8: Results. Probit Model

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<td>0.0659***</td>
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<td>(0.0153)</td>
<td>(0.0307)</td>
<td>(0.0315)</td>
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<td>Immigrant</td>
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<td>-0.0906</td>
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</tr>
<tr>
<td>Engineer</td>
<td></td>
<td>0.249***</td>
<td>0.171*</td>
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<td>(0.0834)</td>
<td>(0.0502)</td>
<td>(0.0581)</td>
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<td></td>
<td>(0.0870)</td>
<td>(0.0964)</td>
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<td>1,472</td>
<td>954</td>
<td>954</td>
<td>390</td>
</tr>
</tbody>
</table>

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

(5) Includes controls: years at death, proactivity and gender

explaining why people got involved in industrial entrepreneurship. Engineers had around 17% more change of founding an industrial firm than non-engineers. This result is confirmed when analyzing social capital in the different social networks.

The use of the complete social network might hide, behind the aggregation process, particular mechanisms through which the effects of social interaction operates. For that reason it is convenient to replicate the same exercises with each type of network in an isolated way. The results of those new exercises are presented in the table 9, where + and - describe the sign of the coefficient if it was significant in the more detailed specification.

As mentioned above, having an engineering education was essential for being an industrial entrepreneur. Even though, it was not relevant for the number of industrial firms founded. With regard to social capital in each sphere, betweenness only was significant for entrepreneurial networks in modern sectors and in guilds networks. Meanwhile, density was significant in non-entrepreneurial networks, such as friendship, intellectual and NGOs. This two results are consistent with the general literature on social networks. While social capital related with cohesion emerged more intensely in friendship and recreational networks, social capital related with brokerage is more frequent in entrepreneurial networks.

An important final result is the negative sign of the ego-density coefficient for family network in the case of the probit model. This implies that people with a more cohesive family network, would have been less likely of founding industrial firms. This is the representation of
Table 9: Results for individual networks

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<td></td>
<td>+</td>
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<td>Political</td>
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<td></td>
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<tr>
<td>Friendship</td>
<td>+</td>
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<tr>
<td>Intellectual</td>
<td>+</td>
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<td></td>
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<td></td>
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<td>Agriculture</td>
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<td>Mining</td>
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<td>Animal Husbandry</td>
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<tr>
<td>Mule Driving</td>
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<tr>
<td>Guilds</td>
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a case in which the constrains of cohesion outweighed the positive effects of trust. It is also a reasonable result; family is one of the most rigid social spheres, in terms of the persistence of habits and traditions. As cohesion reinforces perceptions in a network, people with more cohesive families usually face more opposition to change their behaviors. Considering that investing in industry was, for the time, a behavioral innovation, is reasonable the negative relation between family ego-density and industrial entrepreneurship.

6 Concluding remarks

The paper explores, through a historical episode, the role of social capital in industrialization. It has two major contributions. First, the construction of a set of social networks for the elite of Antioquia in the late 19th and early 20th century, which could be used for the study of different social interaction questions, most of which exceed the purpose of the paper itself. Second, the paper uses these data, and an additional dataset that includes all the industrial firms founded until 1920s, to test empirically the role of social capital on industrial investment decisions, finding that social capital did have significant effects on those decisions. As the entrepreneurial choice to get involved in the sector was the origin of this particular industrialization episode, we can conclude that social capital did play a significant role in the industrialization of the region. Through this exercise, the paper shed light on how social capital might support entrepreneurial activity, promoting modernity, in weak institutional
Going into the details, the paper identifies differences in the determinants of the extensive and the intensive margin decision of industrial investment. Having an engineering background was the essential aspect for interpreting the extensive margin decision, but not for the intensive one. Engineers were much more likely to be involved in industrial activities, but did not found a larger number of industrial firms. This is a key finding, because it proves under what conditions the longstanding hypothesis, which suggests that the educational tradition in engineering in Antioquia was a relevant aspect in the regional industrialization, is true.

In contrast, social capital was not relevant in the extensive margin decision, but it was in the intensive one. Concretely, by observing the complete social network, there was an statistical significant and positive effect of the social capital related with structural holes in the number of industrial firms founded (even after controlling by engineering education). No positive effect was founded for the social capital related with closure. In other words, people in privileged positions for controlling information or resources involved deeply in industrial activities. Those which made part of denser networks did not, probably because denser networks also imply constrains for innovative behavior.

By observing the different social networks in an isolated way, social capital related with closure became important, in particular, in friendship, intellectual and NGOs networks. The constraint effects related with closure also were evident in that stage. Family density was significantly related with a lower probability of investing in industrial activities, something that contradicts the hypotheses that saw in family cohesion the mechanism through which pro-industrial habits would have been perpetuated in the local society. Meanwhile, social capital related with structural holes just appeared to be significant for modern entrepreneurial networks.

The fact that structural holes had larger and better defined effects at looking to the complete network is a reasonable result. Because brokerage is a way to profiting from the heterogeneity of non well-connected sections of the network. Therefore, the returns from bridging structural holes is larger with the larger the heterogeneity of the sections bridged. For that reason, in the complete network, which includes different type of networks, betweenness is more relevant. Meanwhile, the key aspect in the trust-closure argument is the coordination mechanisms emerged thanks to frequent interaction. When considering different social spheres, in which the kind of interactions might differ, it is harder to think that those mechanisms of coordination might work as efficiently as in a single social sphere in which individual roles are clearer and collective rules are easier to apply. Thus, it is also reasonable that the social capital related with closure appears more clearly in the isolated networks.

Finally, our results suggest that capital access was not a relevant aspect in the emergence
of industry. Being a banker was not related with industrial investment decisions, neither did having social capital in the banking network. This result contradicts a large tradition in the historiography of Antioquia but is consistent with a brief look at the average capital of industrial firms, which was not larger than the capital of commercial or mining firms.

However, the paper has some shortcomings. On the one hand, the empirical exercise could suffer from endogeneity problems for simultaneity reasons (i.e. industrial entrepreneurship could have led individuals to have higher levels of social capital) and omitted variables (i.e. not enough controls were used). The database constructed has the potential for solving these concerns. In the first place, because the data varies over time, something that could be exploited for stopping the feedback from industrial projects to social networks. In the second place, the biographical component of the sample could offer other controls, something that could relieve the concerns regarding omitted variables.

On the other hand, the fact that people with higher levels of social capital led the industrialization process does not explain why Antioquia experience an “early” industrialization. For that reason, passing from the micro-level to the macro-level conception of social capital is a fundamental step for proving if a particular social network pattern can explain the singular industrialization process of Antioquia. For that purpose, comparing Antioquia with a similar region that had different relational patterns should be the appropriate empirical approach.

References


de Carvalho Filho, I. and Colistete, R. P. (2010). Education performance: was it all determined 100 years ago? evidence from sao paulo, brazil. Technical report, MPRA.


Appendixes
Figure 3: NGOs Network
Figure 4: Traditional Sector Network
Figure 5: Modern Sector Network
Figure 7: Family Network
Figure 9: Political Network
Figure 10: Complete Network