Paper to be presented at the

35th DRUID Celebration Conference 2013, Barcelona, Spain, June 17-19

Network Recombination, Bridging Institutions, and Firm Upgrading: Building Collective Knowledge Resources in Emerging Markets

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Abstract

How does the interaction between MNC subsidiaries and local innovation systems help or hinder emerging market firms to capture spillovers and improve their upgrading capabilities? Key barriers for developing countries are their weak institutions and dysfunctional social capital. We offer an alternative view of firm learning and institutions by combining insights from historical institutionalism and network analysis. Using unique survey data of Argentine autoparts suppliers, we argue that firms gain improved access to diverse applied knowledge via ties to even resource poor non-market institutions that act as social and knowledge bridges between isolated producer communities.

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Introduction

Scholars of international business and development have increasingly focused on how the interaction between linkages to global value chains or MNC subsidiaries and the development of domestic innovation systems shape the ability of emerging market firms to capture spillovers and improve their upgrading capabilities. (Kumaraswamy, et al, 2012; Moran, Graham & Blomstrom, 2005; Perez-Aleman 2011; Pietrobelli & Rabellotti, 2011; Spencer 2008; Thun 2006) Drawing on evolutionary and knowledge-based views of the firm (Nelson & Winter 1982, Kogut & Zander 1993), this work views upgrading -- shifting from lower to higher value added activities via constant improvements in products and processes – in large part dependent on a firm accessing a variety of knowledge resources. (Doner 2009; Fleming 2001; Ghoshal & Moran 1999; Giuliani et al 2005) At the same time, this work suggests that the ideal co-development of spillovers from MNC subsidiaries and of local innovation systems facilitating such access faces significant institutional barriers in emerging market countries.

Although market liberalization offers domestic firms incentives and international standards to improve their productivity and practices as suppliers to local subsidiaries of MNCs, they are often impeded by the technological and capabilities deficits of local firms. Overcoming this gap is often contingent on the endowments of the local innovation system – the constellation of clusters and institutions, in which firms are embedded. (Moran et al. 2005; Nelson 1993; Thun 2006) Rich inter-organizational networks enable firm to build collaborative relationships, gain resources, learn, and coordinate experiments. (McEvily & Marcus 2005, Powell et al 1996) Government and industry leaders create laws that improve the incentives to invest and transfer

sensitive technology, in turn spurring the creation of collective, non-market, knowledge resources housed in world class universities, training centers and government agencies. (Audretsch 2002; Breznitz 2007; Owen-Smith & Powell 2004)

In viewing embeddedness as function of historical endowments, however, these arguments can be problematic, since emerging market countries, especially in Latin America, are noted for their weak institutions and dysfunctional social capital, with often declining collective investments into knowledge resources and education. (Henisz & Zelner 2005; Lall 2000; Schneider 2004)

This article attempts to overcome these endowment views of upgrading by integrating recent insights from sociological and political science approaches to firm learning and institutions. Historical insitutionalism, which greatly underpins the work on "comparative capitalism," views institutions not only as the rules that constrain opportunistic behavior but especially as resources for strategic coordination that shape firm capabilities. (Deeg & Jackson 2008; Thelen 2003) At the same time, innovation scholars are viewing organizational resources in terms of the structure and composition of the knowledge networks they anchor. For instance, Safford (2009) and Zuckerman & Sgourev (2006) show how certain voluntary civic and industry associations facilitate learning because of their ability to create horizontal or cross-cutting ties between firms from different socio-economic communities. McEvily & Zaheer (1999) and Powell, Whittington & Packelan (2012) show that government support institutions (GSIs), such as public research institutes and training centers,[1] help firms access new knowledge in part

[1] This article focuses on the heterogeneity of organizations and institutions in a region. For the sake of simplicity, we refer to a GSI as any institution that receives at least partial government funding, has government actors participating in its governance and program evaluation, and provides firms with specific services. This definition follows research on government support of industries (Campbell, 2004; Knoke, 2001; Thelen, 2003). Below we distinguish further between different types of GSIs, schools, and associations.

because of their ability to forge collaborative ties with firms from different geographic localities and technological orientations.

We argue that even when both the government and the MNCs are not forthcoming in supporting the innovative capacities of local suppliers, seemingly simple efforts by certain business associations and GSIs to improve firm access to a variety of collective knowledge resources can have strong positive impacts on local firm upgrading. We demonstrate that higher levels of process upgrading depend on the firm being tied not to many or any organization but rather to those non-market institutions that provide services in adapting standards and practices to local contexts and that act as social and knowledge bridges across previously isolated production communities. The results suggest that government and industry leaders can overcome legacies of limited resources and weak institutions by constructing public and private institutions that facilitate cross-sectoral and cross-regional learning communities. (Breznitz 2005; Perez-Aleman 2011, McDermott et al. 2009) In reshaping the structure and composition of organizational fields, and in turn knowledge flows, such a process can help recombine existing social and knowledge resources in new ways at different levels of society. (Campbell 2004, Stark & Bruszt 1998; Thelen 2003)

We advance this argument by analyzing the transformation of the automotive supplier sector in Argentina. While the policies facilitated the MNCs in investing and reorganizing the industry, government and industry leaders did not create a concerted policy to invest in supply side support institutions. Like other quasi-hierarchical value chains in emerging markets (Giuliani, et al. 2005; Thun 2006), the suppliers rely heavily on the strategies of the MNCs for knowledge flows but also remained embedded in fragmented industrial districts, each with its own manufacturing traditions, networks and institutions.

Reflecting the literatures we combine, we employ both qualitative and quantitative analyses. We move beyond the largely anecdotal evidence by using our unique cross-sectional survey data set of auto suppliers from seven distinct industrial districts to measure the impact of the composition of the focal firm's network on its process upgrading capabilities. In discussing our results, we also offer qualitative analysis that attempts to specify the mechanisms underpinning the roles of key associations and GSIs in facilitating new types of firm learning and process upgrading. These institutions appear to become effective social and knowledge bridges for firms by being repositories and transmitters of diverse applied knowledge and acting as "network facilitators" for previously unconnected firms. (McEvily & Zaheer 2004)

I. MNCs, Weak Institutions, and Regional Fragmentation in the Argentine Automotive Industry

During the 1990s Argentina became a leader of promarket reforms in Latin America, with the cornerstones being a currency board, fiscal stability, price and trade liberalization, and privatization. Similar to such countries as Mexico and Brazil, Argentina also sought to revive its automotive industry, which had existed since the 1930s, by using tax-incentive and trade policies to attract FDI (Humphrey & Memedovic, 2003; Kosacoff 1999). This led to three immediate changes.

First, as was the case in many other emerging-market countries (Humphrey et al., 2003; Sturgeon & Florida, 2004), the MNCs (i.e., international assemblers and allied top-tier suppliers) took charge of reorganizing the industry to establish three tiers of suppliers and diffuse the principles of lean production throughout the value chain. Second, Argentina witnessed substantial increases in auto sales, production, and investment in the industry. During the 1990s the automotive industry in general invested over $7.3 billion, with $1.75 billion coming from autoparts suppliers. Seven international assemblers renovated existing plants or opened new

ones, including General Motors, Ford, Chrysler, Fiat, Peugeot, VW, and Renault.[2] Capacity increased to 750,000 units, with the largest output coming in 1998 with 458,000 units. The autoparts suppliers alone accounted for about 3.5% of output and 38,000 employees or about 4% of manufacturing employment (Kosacoff, 1999). Third, Argentina experienced a significant change in the terms of trade with Brazil, their largest trade partner. Exports of both mid-size autos and parts increased threefold over the decade, but imports of autoparts and small cars grew at a faster rate. By 1998 half of the original 500 autoparts suppliers in 1992 had survived, including 30% of firms foreign-owned, 30% domestic, 21% minority foreign joint ventures, and 19% under international license (Kosacoff, 1999).

The Argentine economic crisis of 2001-02, triggered by a sovereign debt default and a 70% devaluation of the currency, caused significant short-term contraction of production and investment, and thus additionally squeezed autoparts suppliers. In 2004-05, the autparts sector invested over $400 million and employment was at 45,000 (5.6% of industrial employment) as sales and exports rebounded. (CEB 2005)

This rebound, however, obscured two longer term concerns about the sector and its general technological stagnation. On the one hand, government and MNC assemblers had never created a concerted policy to support technological and capabilities upgrading for suppliers, other than a few tax and credit incentive schemes. (Kosacoff 1999; Yoguel, Moori Koenig, & Angelelli, 1999) When the government created its incentive-based auto investment policies in the early 1990s, it notably left out representatives of the autoparts sector, which would create a new sectoral association, AFAC, to improve at least their lobbying. This lack of support was part of a broader trend throughout Latin America in embracing market reforms – already weak science, technology, and training institutions watched their budgets and employment decline in

[2] Toyota invested in Argentina in 2003, but would not develop a local supplier system until after 2005.

real terms. (Lopez 2001; Sutz 2000) For instance, in Argentina overall expenditure in R&D and STE programs (public and private) barely grew in the 1990s, while key public institutions, like the national industrial technology institute (INTI), saw its employment cut by over 60% between 1992 and 2002. (Baruj, Kosacoff & Ramos 2009) During this period, no automotive MNC created a joint program with INTI or the standards certification institution, IRAM. On the other hand, the auto parts sector in particular, and manufacturing in general, suffered from weak collaborative relationships. Studies of the automotive value chain noted the sparseness of inter-firm networks and an environment of weak joint-action and collective efficiencies. (Albornoz & Yoguel 2004; McDermott & Corredoira 2010) Similar to Brazil and Mexico, the industry remained rather fragmented, as firms were embedded in many local industrial districts scattered across the three dominant industrial provinces of Buenos Aires, Santa Fe and Cordoba that varied in terms of wealth, technological profile, competitiveness, education and public policies. (Lopez et al 2008; Yoguel et al 1999) Most districts, despite being located near large universities, were patchworks of SMEs from a range of manufacturing sectors, often with their own local association, poor infrastructure and a spattering of public support programs for worker training and best practice seminars.

In sum, the Argentine autoparts sector presents an attractive setting for investigating the impact of GVCs and domestic innovation systems on the upgrading of emerging market suppliers. As in other Latin American countries, the Argentine policies allowed market forces and the MNCs to substantially reorganize the value chain, increase investment, and introduce modern production practices. The industry also has lacked a coherent technology support strategy, while firms remain embedded in a variety of industrial districts. We now examine

what types of institutional and networks forms could help firms overcome these legacies to upgrade their capabilities.

II. Upgrading and Access to Diverse Knowledge Resources

Following Schumpeter (1934), the development and management literatures have increasingly viewed that process upgrading as a particular form of innovation, in which firms focus on creating new processes to improve efficiencies, quality, and value-added by incrementally and iteratively experimenting with new combinations of material, human, and knowledge inputs. (Giuliani et al 2005; Kumaraswamy et al. 2012;) Such capabilities are indicative of the firm's ability to adapt and compete in subsequent periods. (Moran & Ghoshal 1999; Zollo & Winter 2002) There are competing perspectives about the factors that influence the paths of firm upgrading. The more traditional view is that the combination of MNCs customer demands and market competition creates powerful incentives for to invest in required upgrading capabilities. (Moran et al. 2005; Guler et al 2002)

More recently, scholars have questioned the ease with which firms from both advanced and especially developing economies adopt and develop the most fundamental process capabilities. Since production systems and product designs continue to be integrated, and knowledge cannot be fully codified, the transfer and creation of new capabilities depends often on the quality and intensity of inter-firm relationships. (Camuffo & Cabigiosu 2012; Dyer & Hatch 2006; MacDuffie & Helper 1997, 2006) Strong ties gradually promote and enhance trust, reciprocity, and a long-term perspective, which in turn helps partners develop joint projects and share tacit knowledge. Researchers on the automotive industry have increasingly focused on these types of customer-supplier relationships, calling them "pragmatic collaborations," (MacDuffie & Helper, 2006; Herrigel, 2004) as firms jointly invest in specific routines and

interactions that "permit the transfer, recombination or creation of specialized knowledge" (Dyer & Singh, 1998: 665). In this view, new knowledge and capabilities emerge for suppliers when they engage in regular, disciplined discussions with customers about product designs and processes that yield joint experiments and routinized collective problem solving. Such routines tend to develop when customers commit to assisting suppliers in product and process innovations, such as with bi-lateral production programs and value-chain specific supplier associations (Dyer & Hatch, 2006; Helper & Kiehl, 2004).

The relational specific investments, however, are not often forthcoming as they are fraught with uncertainty and limited trust. The work on development and global value chains (GVC) has amplified these views. (Pietrobelli & Rabellotti 2011; Spencer 2008) On the one hand, even if local firms know 'what' they are to via the demands of the MNC customer, they do not really know 'how' or 'why'. Learning the latter aspects comes from practice, iterative experiments and practical examples. (White 2002) These translation problems are reinforced when the firms are far from the technological frontier, as adoption of the new norms demands combining them with complementary inputs, like skills and know-how that are not readily available or only created with significant organizational and institutional changes. (Perez-Aleman 2011) On the other hand, MNCs subsidiaries and global buyers, especially in quasi-hierarchical value chains characterized by seemingly highly codified systems, may work closely with their top tier suppliers but will be less likely to get involved in such detailed, continuous training of lower tiered firms, even after obtaining international certifications, like ISO. (Giuliani 2005; Quadros 2004; Sturgeon, Van Biesebroeck & Gereffi 2008)

It is here where scholars of GVCs and FDI in emerging markets have begun to shift the debate on local spillovers and upgrading in two important ways. First, while researchers do not

deny the importance of the rule of law and securing private property rights in facilitating knowledge flows and investment – viewing institutions as rules, they are increasingly drawing on the work in historical institutionalism and comparative capitalism to view institutions as resources for strategic coordination across domains that shape the capabilities of firms. (Deeg & Jackson 2008; Spencer 2008) To the extent that adoption and implementation of "best practices" needs complementary inputs, these inputs are often drawn from collective resources, which opens analysis to the diverse constellations of public and private knowledge and industry support institutions. While firms gain experience from their own in-house activities and human capital, they access a variety of raw and applied knowledge through their peers, customers, and suppliers as well as via non-market actors, such as trade associations and government support institutions (GSIs) that promote improvements in skills, R&D, and new quality standards. (Audretsch, 2002; McEvily & Zaheer 1999; Owen-Smith & Powell, 2004)

In turn, scholars have focused often on the types of institutional configurations in advanced countries that shape FDI location decisions, spillovers and competitive capabilities. (Alcacer & Chung 2007; Spencer et al 2005) For instance, the work on national innovation systems (Nelson 1993) stresses the important roles of world class universities, research institutes, and training centers in helping firms gain access to a variety of knowledge resources in the form of skilled employees, R&D, and industry benchmarking systems.

The second shift in the debate, however, notices the limits of the above work. The types of knowledge resources and mechanisms for their diffusion specified from advanced countries are not directly applicable or obtainable in less advanced ones. (Breznitz 2005, 2007; Perez-Aleman 2011; Pietrobelli & Rabellotti 2010; Lall 2000; Thun 2006) On the one hand, the innovation process is different. While advice from advanced countries stresses R&D and frontier

innovation, that of emerging markets mostly focuses on incremental changes to absorb and apply existing practices and technologies. On the other hand, advanced science and technology institutions and linkages among them and local firms may be at best very weak. The seculiar decline or stagnation in investment into R&D and S&T institutions in Latin America (Baruj 2009; Sutz 2000) is just one symptom of the resource contraints and coordination problems among socio-economic actors in emerging markets. (Doner 2009; Perez-Aleman 2011)

This stream of research instead places greater emphasis on organizations and institutions that are providing technology application and extension services, such as in metrology, standards, testing and quality. (Pietrobelli & Rabellotti 2012) These types of services draw on knowledge of production systems in the book and especially on knowledge built on practical examples within the resource and organizational legacies at hand. It seeks to recombine old habits and practices into new process capabilities that can meet needed performance standards. (Perez-Aleman 2011)

This double shift towards diversifying the composition of institutional resources that facilitate firm access knowledge resources coincides with the growing work on innovation and embeddedness that increasingly seeks to differentiate the relative impact of a firm's network composition and structure on its capabilities and performance. (Granovetter 2002) Nan Lin (2001) has argued forcefully that an individual's or firm's network is composed of different types organizations, which in turn, provide different types of resources and information that can shape the actor's performance in different ways. In particular, Lin argues that researchers should pay closer attention to an actor's network resources, which are embedded in one's ego-networks, and not simply to an actor's total number of overall ties or an actor's location in the network. Moreover, only few ties may offer the active exchange of knowledge. The key insight that we

exploit here is whether the focal firm has ties to a certain type of organization (e.g., firms, trade association, GSI etc.) that can lend knowledge resources that are of value for the task at hand.

The legacies of weak inter-firm learning relationships in a highly uncertain environment such as emerging markets and the limitations of active joint learning for local lower tier firms through quasi-hierarchical value chains, such as the automotive industry, can greatly impede the fostering of the pragmatic collaborations deemed necessary for process upgrading. (Guiliani et al. 2005; Herrigel 2004; McDermott & Corredoira 2010; Sturgeon et a; 2008; Albronoz & Yoguel 2004) Moreover, the individual, quick fix assistance common to diadic firm relationships and consultants, may not adequately convey the tacit knowledge and problem-solving underpinning capabilities creation in complex manufacturing systems. (Helper & Kiehl 2004; Sako 1999)

An alternative is for firms to access a diversity of applied knowledge via the constellation of non-market institutions and organizations, such schools, business associations or industry centers, and GSIs. As Breznitz (2005) has noted, the distinguishing traits of these institutions to support innovation is that they provide reliable channels for collective learning and knowledge diffusion as well as create forums and programs that infuse the system with trust and cooperation. The development literature has paid growing attention to associations and GSIs in potentially having the capacities to gain an understanding of international standards, working with a variety of firms, particularly SMEs, in building on applied practices in the local context, and offering mentoring relationships to fostering ongoing learning among clients and members. (Pietrobelli & Rabellotti 2006; Schmitz 2004)[3] The foregoing yields our first hypotheses:

Hypothesis 1a: The greater number of ties the focal firm has to associations, the higher will be its level of process upgrading.

[3] In contrast, this research has also highlighted how local educational institutions often lack both the capacities and industry linkages to engage in firm training, relying instead on rote teaching of students.

Hypothesis 1b: The greater number of ties the focal firm has to GSI, the higher will be its level of process upgrading.

To the extent that linkages to collective knowledge resources can facilitate firm upgrading, it is less clear what the underlying mechanisms that improve firm access to a variety of knowledge resources are. The development literature often views suppliers of GVCs and MNC subsidiaries as needing to be embedded in dense clusters of inter-firm networks and support institutions. (Pietrobelli & Rabellotti 2006; Schmitz 2004) This can be problematic in two ways. On the one hand, a fragmentation of institutional services may come from many support institutions with different technological orientations in a variety of locations. By drawing too small and potentially homogenous pool of knowledge, they might not be able to sustain firm level upgrading, a common criticism of the NIST system of MEP centers in the US. (Sabel 1996) On the other hand, it is often the case that an industry value chain reaches across many regions and localities within a country, creating great variance in production histories, practices, technologies and degrees of cooperation.

Recent work on innovation and industrial upgrading recognizes the enabling and constraining nature of embeddedness, revealing how combining institutional and network approaches to knowledge resources can relieve these constraints. (Granovetter 2002) It begins by examining how certain relational and organizational traits of the ties within a community may be dense, but can insulate firms from new information and relationships with members of other communities. As Lin (2001) and Uzzi (1996) have shown, one's ego-network can easily restrict access to different resources and blind it from new information because of the strength of immediate ties and the limited variety of valuable information and resources that its alters (other organizations, firms etc) can pass on. That is, although a region or a country on aggregate may have a wide variety of resources and experiences that, when combined, could create value, a firm

is often embedded in a rather restricted network, be it composed of firms, associations or public agencies (Knoke, 2001) To the extent that these groups and localities have different needs and resources, are relatively isolated, and are not incorporated into more encompassing institutions, a diverse socio-economic environment can easily produce a balkanized society that thwarts broad-based innovation, knowledge diffusion, and concerted action (Locke, 1995; Ostrom, 1999; Safford, 2009; Schneider 2004; Tendler 1997). The lack of collective goods and coherent policies is rooted not in the absence of social ties but their insulating qualities and the lack of cross cutting between ties producer communities and their respective associations.

A key dilemma then for upgrading is identifying the types organizational and institutional architectures that can help firms overcome inherited constraining features of their localities and afford new enabling qualities. To the extent that upgrading depends on access to a variety of knowledge resources, the isolating effects of a firm's immediate inter-organizational network can be relieved by introducing new alters or nodes (other organizations) into the network that can facilitate such access. That is, reflecting the above discussion about the roles of lead firms in GVCs and the domestic innovation system, the key traits of institutional resources are not simply the content or amount of services provide by an organization but rather its ability to act as social and knowledge bridge between previously isolated producer communities. The organization – be it a firm, an association or a GSI – would be drawing on a diverse set of practical experiences and potentially linking unconnected firms to one another. The research on networks and innovation has shown that the presence of cross-cutting ties between firms from distinct producer networks or geographical locations can help them overcome these barriers and access new knowledge resources (Uzzi, 1996) For instance, Safford (2009) and Zuckerman & Sgourev (2006) have show how both civic and business associations can design coordination

forums and technical assistance programs in such ways as foster common strategies between actors from different networks and expose firms to both new benchmarks and new ways of solving old problems. Powell, et al. (2012) have demonstrated that firms from the most successful high-tech regions of the US benefit mostly from being tied to those GSIs that anchors different organizational and knowledge networks. McEvily and Zaheer (2004) have shown how public-private technology centers in the Mid-West of the US improve firm performance by becoming "network facilitators" – creating programs that help firms from different sectors and regions build new professional ties and learn from one another.

As noted in Section I, Argentine autoparts suppliers historically have ties to several associations and GSIs, yet most of them have been geographically constrained. Nevertheless, some GSIs and associations were relatively recently created or renovated with the purpose of to reaching firms across a vast geographic area (e.g., AFAC, IRAM, and INTI , as mentioned in Section I). While the former organization has a relatively narrower industrial and technological focus than the latter two, the all share a few common traits: relatively limited budgets, staff, and facilities, programs to help firms learn how to continually meet new quality standards, programs to foster inter-firm learning, and sustained ties to a many autoparts firms with a variety of technologies and locations.

The network literature though offers different views about optimal ways to determine whether organization offers relatively high levels of knowledge diversity: those that are the most central in a network or industry or those that act as the most important bridges (Burt, 2000; Fleming & Waguespack, 2007). The two traits are not necessarily exclusive, and both serve as key tests about one's access to diversity.

Firms might learn more rapidly when they are linked with organizations and institutions that are the most central or encompassing in an industry or country, because they would have access to a great number of other associated firms and in turn variety of information and resources (Borgatti, 2005; Safford, 2009). Being linked to a highly central organization or institution can also convey on the firm a particular level of legitimacy, which can act as a positive signal for its products and practices to other potential collaborators (Benjamin & Podolny, 1999; Knoke, 2001; Provan & Milward 1995). In contrast, being linked to less central mediators would not provide access to a variety of knowledge resources.

Hypothesis 2a. The greater number of ties a focal firm has to an association with high levels of network centrality, the higher will be its level of process upgrading.

Hypothesis 2b. The greater number of ties a focal firm has to GSIs with high levels of network centrality, the higher will be its level of process upgrading.

However, centrality may reflect simply the most dominant organizations and offer redundant knowledge (Burt, 1992; Romanelli & Khessina, 2005). That is, to the extent that variety is key for developing new process upgrading capabilities, then the relative importance in intermediating organizations and institutions is the geographical diversity, not the quantity, of actors associated with them. The importance of bridging roles has been noted in research on entrepreneurship (Burt, 1992, 2000) and on regional development (Safford, 2009). Obstfeld's (2005) theory of "tertius iungens" and Zuckerman & Sgourev's (2006) notion of "peer capitalism" highlight the importance of structures bringing previously unconnected actors together. McEvily & Zaheer (1999) also find that government technology centers improved firm performance by giving firms access to a variety of information from different geographic locations. In contrast, having numerous ties to mediators that have relatively few bridging qualities would not give a firm access to a variety of knowledge resources. Given the limitations

of our data, we can not estimate which firms and institutions bridge structural holes in the conventional manner. However, given the literature on localities creating search costs for the pursuit of variety (Romanelli & Khessina, 2005) and our previous discussion about the ways in which firms in the same industry can be embedded in relatively isolated industrial districts, a reasonable proxy for an intermediating organization's bridging role is the geographic diversity of the firms associated with it. We operationalize the relative value for a firm being tied to intermediaries with strong bridging qualities in the following hypothesis.

Hypothesis 3a. The greater number of ties a focal firm has to associations with high geographic diversity, the higher will be its level of product upgrading.

Hypothesis 3b: The greater number of ties a focal firm has to GSIs with high geographic diversity, the higher will be its level of product upgrading.

III. Data and Methodology

In order to capture these effects and identify such organizations and GSIs, we implemented a survey in 2004-05 of the Argentine auto parts suppliers. The universe of focal firms includes suppliers from seven different producer communities or regions that industry experts identified as being historically unique in terms of their technologies and institutional features and that cut across different provinces (Cordoba, Santa Fe, San Luis and Buenos Aires). We constructed network variables that measure the degree to which the focal firm (supplier) regularly collaborates or gains key information from other firms, schools, banks, GSIs, and associations (including voluntary centers that do not receive government funding). To capture the claim that firms gain access to diverse knowledge resources particularly via mediating alters which themselves are tied to firms from a variety of locations, we decomposed the most salient of the above ties (e.g., Ties to GSIs, Ties to Associations, Ties to Firms) into those that were the most

central and had the highest levels of network geographic diversity and those that did not.[4] We then ran regressions of these variables with a dependent variable of Process Upgrading, which our survey yielded to measure the extent to which a firm implemented practices associated with the continuous improvement of efficiencies, adaptation, and quality control. (All regressions included control variables for age, FDI, size, knowledge stock (absorptive capacity), location, tier and effects from focusing production on a few distinct final assemblers.)

Sample The data utilized to test the hypotheses come from a survey developed and implemented between 2003-2005 in collaboration with AFAC. The questionnaire was developed from our interviews with experts and managers in the autopart industry, and pre-tested with 15 autopart manufacturers in Buenos Aires. A total of 88 firms received the survey of which 59 of 62 responses had complete and consistent data (response rate of 67%). In our sample, the average number of employees is 130, with a median of 90 and ranging from 6 to 516. The average number of employees with college degree is 11, with a median of 7 and ranging from 0 to 47. Forty five percent of the firms have received foreign direct investment, with an average stake of 44%. According to industry data and experts, these demographics were found to be representative.

Dependent Variable Following a well-established research stream in the strategy and organizations literatures, we measured our dependent variable, process upgrading, by asking respondents to assess the extent to which their firms implemented several practices associated with process upgrading in this context using a five-point scale (MacDuffie, 1995; Zollo & Winter, 2002). The practices included: regular employee training improvement in quality

[4] To capture the geographic diversity of the alters, we grouped focal firms into seven location – Cordoba, San Luis, two regions of Santa Fe, and three regions of Buenos Aires. Our interviews with experts revealed that this division is justified because of the size of the latter two provinces and the ways in which firms in the latter two provinces have clustered geographically into distinct manufacturing districts.

control, promotion of employee's innovation, and re-organization and improvement of manufacturing systems. Our dependent variable is the index created by the sum of responses to the seven questions loading on factors 1 and 3 (Cronbach's alpha coefficient of .78).

Explanatory Variables To collect network data, we asked respondents to identify firms (up to five) and nonfirm entities (up to five) with which they regularly interacted, collaborated, or exchanged information regarding specific strategic areas, such as product development, production methods, technology acquisition, training, marketing, and exports. We classified these firms and nonfirms into five categories: associations, banks, firms, government supported institutions (GSIs), and schools.

We constructed a two-mode network consisting, on the one hand, of focal firms, and, on the other hand, of alters (firm and nonfirm). A tie was defined as any relationship between a focal firm and an alter. All the measures based on ties were generated from the total count of mentions of an alter, which included repeated counts of the same alter if a focal firm identified it as providing useful information or services in multiple operational areas of firm management and component manufacturing. We apply a log transformation to all the ties variables to correct the distribution skewness.

Several variables measured degree centrality (Freeman, 1979), which is based on ego-network and lacks any dyadic characteristic. Ties to all alters, the count of a firm's ties to all the types of organizations, was decomposed using standard methods (Ahuja, 2000; Lin, 2001; McDermott et al., 2009; Owen-Smith & Powell, 2004), into five variables that captured the composition and structure of the focal firm's ego network. The variables, Ties to Firms, Ties to Associations, Ties to Banks, Ties to Schools, and Ties to GSIs, were constructed by counting the number of ties between the focal firm and the given type of alter.

To calculate centrality of alters (for firms, associations, and GSIs), Ties to top central alter, we ranked the alter firms, associations, and GSIs by number of ties with focal firms (Frank, 2005). A rank in the top decile was considered to be highly central alters.

Similarly, for firms, associations, and GSIs, Ties to top geographically diverse alters, was calculated based on the number of ties to alters with a geographic Herfindahl index that ranked in the top decile. The index was derived from the count of an alter's direct ties to firms in seven different zones or industrial districts.[5] Though we lacked information about the complete network, our random sample of firms provided adequate information to generate unbiased estimations of such a measure (Frank, 2005).

Control Variables The location variables are dichotomous, associated with different regions. Due to the limited degrees of freedom and to control systematic differences in the anchoring of upgrading perceptual measures, we report models that control for three regions (Buenos Aires, San Luis-Cordoba and Santa Fe). As robustness check, we ran ANOVA for the seven industrial districts, and for those seven zones grouped into five and three zones and show no significant differences in Process Upgrading.

We controlled for access or control of superior resources with foreign ownership, a bounded variable between 0 and 1.0 that measures the percentage of foreign ownership in the focal firm, and with size, the natural log of the number of employees. We introduced knowledge stock, as the natural log of the count of professionals in the firm. In addition, we also controlled for firm age, a well established driver of inertia. To capture privileged access to knowledge from assemblers, we use a dummy variable for whether a firm is located in Tier1. To capture the

[5] The seven regions are Buenos Aires-South, Buenos Aires-North, Buenos Aires-West, Rosario, Santa Fe-Rafaela, Cordoba, and San Luis. While three of the regions belong to what is known as Gran Buenos Aires, because of Buenos Aires traffic patterns, driving time between any two of these regions exceeds the two hours which has historically limited the business interaction across these regions.

effects (positive or negative) of the different final assembler in the value chain, we use a dummy variable if the supplier focused production on a subgroup of assemblers.[6]

Methodological issues and Statistical inference

In order to minimize non-response bias we followed well established procedures, including gaining the enthusiastic approval of the project by the relevant sectoral associations and inviting firm directors by mail and telephone to participate (Buse, 1973; Hansen & Robinson, 1980). In order to minimize the common method variance we follow procedural remedies proposed by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). The survey includes more than 80 questions, took between 90-120 minutes to respond, and demanded the participation of several firm members to collect all the information required.

To test our hypotheses, we run robust regressions (PROC ROBUSTREG, SAS version9) with least trimmed squared (LTS) estimation (Rousseeuw, 1984), which generates OLS estimates robust to the presence of outliers. Our set models regress Process Upgrading on our variables of interest. We first introduce Model A as the baseline including only our control variables. Model B adds All Ties as explanatory variable. Models C, D and E, proceed to three different decompositions of the all ties variable in model B. In model C, we introduce the variables that count the ties to each of the five types of alter described above. Models D and E, decompose ties to Associations, Firms and GSIs into ties to those alters in each category with top-10% and bottom-90% centrality and geographic diversity reach.

Table 1 presents correlation matrix and descriptive statistics for our variables. Some correlations are moderately high; nevertheless, collinearity between variables is not a problem

[6] Because of limitations of degrees of freedom, we could not use individual controls for every assembler in our models. Instead, we first measured the influence of the assembler on the supplier as by determining the top two assembler value chains for the supplier. We then regressed Process Upgrading on a model on firm demographics and a dummy for the assemblers. We then grouped them into those who had a positive sign and those with a negative sign.

according to VIF and tolerance tests (SAS v. 9). We introduced the decomposition variables for geographic diversity in one model and for centrality in another. We did not introduce them simultaneously in the same model due to their high correlations and because we cannot decompose those ties simultaneously in alters with high geographic diversity and centrality due to the overlap between those categories.

IV. Results & Discussion

Table 2 presents the results of our regressions. Model B gives a baseline, testing the notion that firm access to a variety of knowledge depends on the total number of strong ties to all organization. The variable All Ties is negative and insignificant. In turn, homogeneity of alters should not be assumed and decomposition of the network is valid. Model C provides support to Hypotheses 1a and 1b. The relationships between Ties to Associations and Ties to GSIs with process upgrading (parameter estimates equal to 0.667 and 0.405, respectively) are positive and significant at the 0.05 level. We found no significant effect on upgrading from Ties to Banks or Ties to Schools, while Ties to Firms has a negative and marginally significant relationship. Second, Model D provides support to hypothesis 2b and marginal support to hypothesis 2a. The relationship between Ties to High Centrality Associations and process upgrading is positive (parameter estimate equal to 0.308) but only significant at the 0.10 level. The relationship between Ties to High Centrality GSIs and process upgrading is positive (parameter estimate equal to 0.557) and significant at the 0.05 level. At the same time, Ties to High Centrality Firms and ties to alters in the bottom 90 centrality percentile are not significant. Finally, Model E provides support to hypotheses 3a and 3b. The relationships between Ties to High Geo Diversity Associations and Ties to High Geo Diversity GSIs and process upgrading are positive (parameter estimates equal to 0.528 and 0.604, respectively) and significant at the 0.05 level. At the same

time, Ties to High Geo Diversity Firms and ties to alters in the bottom 90 geographic diversity percentile are not significant.

The support for Hypotheses 1a and 1b confirms the notion that firms can improve their process upgrading by having relatively more strong ties to institutions providing collective applied knowledge resources. The motivation behind Hypotheses 2 and 3 was essentially that if access to diverse knowledge is key, then higher levels of upgrading should be associated with ties to alters that have the highest centrality and bridging traits but not with ties to alters that lack these traits. The results appear to broadly confirm our claim, though the marginal significance of Ties to Most Central Associations cautions one's embrace of the centrality mechanism.

As discussed in the previous section, the statistical analysis can suffer from problems of endogeneity because of its cross-sectional nature. For instance, given the lack of longitudinal statistical evidence, one could still argue that upgrading is driven by unobserved inter-firm relationships or that the most prominent GSIs and associations mainly work with firms with superior capabilities. To partially overcome these limitations, we offer here some added qualitative analysis about why certain types of alters appear to be contributing to process upgrading in suppliers. The combination of qualitative and quantitative analyses, in turn, reveals less a definitive theory of upgrading and more a plausible explanation about how institutional resources can improve firm access to a variety of knowledge resources (O'Mahony & Ferraro, 2007; Uzzi, 1996).

Innovative industrial districts and national innovation systems share the common traits that the institutional constellations provide efficient channels for collective learning and knowledge diffusion and infuse the relevant actors with a sense of collaboration via forums for debate on common problems. (Breznitz 2005; McDermott 2007; McEvily &Zaheer 2004)

Breznitz (2005) has further argued that these constellations are particularly effective because they create "collaborative public space." Our qualitative results suggest that these constellations emerge from organizations providing firms with practical applied knowledge in meeting international standards and being both encompassing and bridging in their network traits.

Our interviews found two sets of mechanisms that appear to have reinforced the abilities of a few non-market institutions to take advantage of their bridging traits and provide firms with improve access to a variety of applied knowledge via rather basic, intuitive efforts in training and relationship building. What is particularly relevant here is that neither the governments (federal or provincial) nor the MNCs had undertaken notable coordinated, coherent efforts to build new institutions or services for the suppliers. However, two of the GSIs with the highest measures of centrality and bridging were the previously mentioned INTI and IRAM. Despite having long histories and national reach, these GSIs have been the object of continued criticism for the last two decades for their declining budgets and personnel, fragmented internal organization, relatively backward technological and R&D capacities, incompatible with the rapidly changing demands and standards of industry. (Baruj 2009; Lopez & Ruffolo 2001) Nevertheless, around 2000 a few engineers in both GSIs began speaking with auto parts suppliers to learn of their needs that perhaps they could meet. A major complaint was that the MNCs could tell them what the standard was, but were not willing to explain the underlying logic or problem-solve with the suppliers about how to reorganize for the relevant capabilities. In turn, two of the most common requests were related to basic testing services – testing the safety of components and products as required under the 1998 transportation safety law (done by both) and testing components to meet the standards of the MNCs (done by INTI, rather than having them sent back to the MNCs headquarters as was common practice). These services not only saved time and costs, but also

accelerated firm learning since the supplier learned from the technicians where the defects were occurring and how they could remedy them. Indeed, a study of eight component suppliers in the province of Cordoba showed that INTI stood out as one of the only external actors with reliable assistance programs for helping firms improve basic process capabilities. (Motta & Morero 2008) Our findings echo previous work that shows how public-private extension centers in the agro-industry help firms meet international standards and improve quality control by acting as repositories of a variety of applied knowledge and teaching firms how to reorganize their systems and teams. (Lengyel & Bottino 2012; McDermott et al. 2009; Perez-Aleman 2011) In our case, firms and engineers noted that INTI and IRAM helped overcome the gaps in "knowing how" and "knowing why" because through their programs they could integrate different experiences and practical examples they gained from aiding clients in diverse organizational contexts and then apply those lessons in a repeated way to suppliers.

The role of the associations was not as straight forward for learning. As mentioned in Section I, like many Latin American countries, Argentina is home to a plethora of business associations, with both local and industry-wide profiles. But these organizations tend to focus on basic lobbying or can fragment coordination within an industry. (Schneider 2004) In contrast, the leading most central and bridging associations in our data gradually created programs, which in many ways reflect the mechanisms for establishing new cross-cutting ties that were emphasized by other scholars in different context. (Sgourev & Zuckerman 2006, Safford 2009, McEvily & Zaheer 2004) The case in point is AFAC. Recall from Section I that AFAC was created in 1994 because the autoparts suppliers were excluded from government negotiations with the MNC. In turn, AFAC was created first to provide a collective voice for the suppliers in future negotiations and policies. But what was distinct from other trade associations was that

AFAC gradually made consistent efforts to provide their member firms with domestic and international information that they normally had to gain on their own. AFAC built up a group of experts to collect and organize key industry data on a regular basis. It also created regular forums in which the members learned about major regional and global trends and standards in the industry, debated their key priorities and activities, and especially learned directly from one another about their respective strategies, practices, and results. In turn, these activities not only provide members with unique benchmarking and practical information, but especially create forums where members could gradually graft broader strategic considerations onto their past mutual hold-up instincts and that could act as a "network facilitator." (McDermott et al 2009; McEvily & Zaheer 2004)

It appears that organizations like INTI and AFAC, despite their limited resources, became vital conduits of new knowledge for suppliers because they acted as social and knowledge bridges in two ways. They became repositories of diverse and important standards and practices with the capabilities to transfer them to the firms themselves. They also helped firms learn directly from one another and build new professional ties. The combination of our quantitative and qualitative analyses suggests that the institutional constellations that help firms access a variety of knowledge resources can emerge not from being blessed ex ante with endowments of large material resources or a coherent industry network, but rather from creating mechanisms fostering a broader learning community that can penetrate isolated producer communities. These results have two important implications for public policy and innovation.

First, to the extent that access to a variety of knowledge resources is vital for firm upgrading, the qualitative and quantitative evidence reframes our notion about which types of alters may facilitate such access. Prior research on innovation has emphasized the importance of

firms and associations providing cross-cutting relationships between previously isolated groups of firms (Fleming, 2001; Safford, 2009; Zuckerman & Sgourev, 2006) and the role of GSIs helping diffuse knowledge in providing collective resources and having a public mission to share new knowledge (Breznitz, 2007; Owen-Smith & Powell, 2004). The evidence here supports a blending of the two views in that the effectiveness of government programs and industry organizations are rooted in the institutionalization of their network qualities. The innovations at INTI and AFAC were not in their overwhelming resources or their cutting edge technical knowledge. Rather, in a setting where interactive relationships were not the norm and where government was not dedicated to a policy of upgrading and technological change, the key GSIs and associations created value for firms because of their relative ability to ground themselves within networks of stakeholders and identify a few basic collective technical and social goods to provide. Hence, this research suggests that firms can improve their access to a variety of knowledge resources and their attendant "combinatory capacities" (Moran & Ghoshal, 1999: 409) if they participate in structures that are constituted with the aforementioned institutional and network qualities.

Second, the evidence in its entirety suggests that organizational fields can be reshaped in different ways, primarily because collective organizations, like GSIs and associations, can be responsive to broader needs of an industry and their stakeholders. They can experiment with programs that can create social and bridges to link firms from previously isolated producer communities. This is consistent with growing work on issues ranging from technology diffusion to health care to emerging market corporate governance that shows the impact of government policy in structuring inter-organizational networks (Knoke, 2001; Owen-Smith & Powell, 2004; Provan & Milward, 1995; Stark & Vedres, 2006). Reshaping the field can trigger new forms

recombination but is a gradual process. The efforts of AFAC and INTI are far from catapulting the industry to the technological frontier and may well not be sustained without greater participation and resources from both industry and government actors. But their relatively limited steps suggests that network restructuring and the attendant advances in knowledge diffusion may require more experiments with programs in relational learning than simply significant sums of cash.

V. Concluding Remarks

This paper has sought to understand how regions and their industries can improve their innovative capacities in the face of high uncertainty and a history of backwardness. The context of inquiry was the autoparts of Argentina -- where process upgrading improved despite the legacies of limited international exposure, weak institutions and dysfunctional social capital. The case was chosen because of its unequivocal success in innovation and international markets despite the continued burdened of uneven patterns of development that in the sector and regions that plague most emerging market countries (Doner, 2009). Rather, the unforeseen, sustained gains in process upgrading by the suppliers provided an apt context for generating lessons about the recombination of networks and institutions that can be applied elsewhere.

The social and institutional legacies of emerging market countries create a theoretical problem for analyses of the inter-action between GVCs and local innovation systems when considering the latter pre-conditioned on the endowments of institutions and clusters. To overcome this problem we integrated recent insights from sociology and political science about firm learning and institutions. By combining views of institutions as resources with views of embeddedness stressing the structure and composition of networks, we argued that firm access to a variety of applied knowledge, in turn improved upgrading. This, however, depends on being

tied to those organizations, particularly non-market institutions, that bridged the historical social and knowledge divides between different industrial districts.

The arguments and empirical evidence offered here were developed incrementally. The analysis of the transformation of the autoparts supplier sector suggested that access to diverse knowledge resources was not in the air or necessarily a function of a region's economic and social endowments. Rather, knowledge flows depended on the composition of a firm's network and the quality of inter-organizational relationships. Moreover, we found that even seemingly basic efforts to provide collective learning resources – via non-firm organizations like underfunded associations and research institutes – can have significant impacts on firm level upgrading. In particular, those associations and GSIs that functioned as encompassing, social and knowledge bridges between distinct producer communities could accelerate firm access to diverse knowledge resources because of their services and facilitating new inter-firm learning. The new constellation of networks and institutions was not given historically but facilitated through an approach based on experiments in which public and private actors gradually recombined their existing resources to create a new variety of knowledge assets for firms. There appear to be two key take-aways from this experience.

First, firms improve their access to diverse knowledge resources, in turn their capabilities to upgrade processes, to the extent that they have multiple, strong ties not just to any organizations but mainly to those that act as social and knowledge bridges between previously isolated producer communities. Second, these new pathways and their attendant recombinatory processes can emerge when governments and relevant stakeholder groups collaborate to create new types of GSIs and associations (or other types of non-market entities) that can function as these bridges by providing accessible services for new outside technical knowledge and forums

to nurture new professional relationships and joint strategies. McDermott et al. (2009) have argued that these types of organizations and institutions appear to anchor multiplex, cross-cutting knowledge networks to the extent that they are constituted with the principles of inclusion and participatory governance.

The message is here is about the key mechanisms that advance knowledge creation and diffusion and the roles public and private actors in reshaping relevant inter-organizational networks. Breznitz (2005) has argued that the critical role of industry support institutions is not necessarily the provision of material resources or advanced technology, but first creating mechanisms to foster learning communities. In their seminal work on the emergence of innovative regions in the life science industries, Woody Powell and his collaborators have shown that two critical success factors are organizational diversity and the presence of "anchor tenants" – organizations, be they public or private, that become the "scaffolding that assists subsequent connections and field formation." (Powell et al., 2012). This work speaks to the different types of organizations that can become social and knowledge bridges, and coincides with the arguments here about the roles of organizational and institutional bridges both initiating and sustaining firm learning.

The analysis in this article opens two avenues for research. First, many of the arguments here were conditioned on the constraints of local firms supplying MNCs in a quasi-hierarchical value chain, like in automotives. While this was an ideal case for our inquiry, further network research is needed in other types of industries and technologies in emerging markets. Second, as noted above we only started to scratch the surface of key issues of emergence. Our research here suggests paths for scholars to build longitudinal network data bases and design comparative case studies.

Table 1. Correlation Matrix and Descriptive Statistics

		V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17
V1	*Process Upgrading*	1																
V2	*Log(Age)*	0.13	1															
V3	*Log(Number of Employees)*	0.19	0.36	1														
V4	*Log(Knowledge Stock)*	0.02	0.28	0.74	1													
V5	*Foreign Ownership*	-0.1	0.04	0.27	0.39	1												
V6	*San Luis-Cordoba*	0	-0.11	0.14	0.06	-0.13	1											
V7	*Santa Fe*	0.17	0.13	-0.13	-0.04	-0.17	-0.24	1										
V8	*Assemblers*	-0.29	0.1	0.08	0.14	0.03	0.02	-0.19	1									
V9	*Tier 1*	-0.07	-0.05	0.16	0.14	0.17	0.2	-0.28	0.11	1								
V10	*Log(Ties to Associations)*	0.23	0.3	0.16	0.31	-0.04	0.19	0.19	-0.16	-0.07	1							
V11	*Log(Ties to Banks)*	-0.22	0.12	-0.04	0.14	0.06	0.01	0.06	-0.17	-0.01	0.16	1						
V12	*Log(Ties to Firms)*	0.03	0.02	0.24	0.22	0.29	0.05	-0.2	-0.24	0.22	0.18	0.39	1					
V13	*Log(Ties to GSIs)*	0.12	0.18	-0.04	0	-0.24	-0.03	0.53	-0.17	-0.22	0.24	0.14	-0.11	1				
V14	*Log(Ties to Schools)*	-0.21	-0.16	0.07	0.09	-0.09	0.36	-0.03	0.13	0.16	0.16	-0.22	0.07	0.09	1			
V15	*Log(Ties to All)*	0.03	0.11	0.2	0.27	0.12	0.17	0.11	-0.26	0.12	0.49	0.48	0.84	0.23	0.23	1		
V16	*Log(Ties to High Centrality Associations)*	-0.01	0.21	-0.03	0.13	-0.03	0.05	-0.05	0.03	0.08	0.64	0.05	0.06	-0.05	0.03	0.21	1	
V17	*Log(ties to NOT-High Centrality Associations)*	0.21	0.2	0.3	0.36	0.06	0.27	0.23	-0.28	-0.08	0.67	0.3	0.24	0.32	0.2	0.52	0.06	1
V18	*Log(Ties to High Centrality Firms)*	0.07	0.04	0.2	0.23	0.33	0.13	-0.33	-0.14	0.3	0.19	0.21	0.74	-0.24	-0.02	0.56	0.14	0.14
V19	*Log(ties to NOT-High Centrality Firm)*	0.06	-0.2	0.14	0.07	0.21	-0.14	-0.08	-0.1	0.13	0	0.2	0.32	-0.04	0.07	0.28	0	0.08
V20	*Log(Ties to High Centrality GSIs)*	0.04	-0.05	0.08	0.1	0	0.11	0.24	0.05	-0.08	0.08	0.02	-0.15	0.65	0.21	0.12	-0.15	0.26
V21	*Log(ties to NOT-High Centrality GSIs)*	0.2	0.28	-0.1	-0.06	-0.33	-0.06	0.56	-0.2	-0.34	0.31	0.23	0	0.79	-0.03	0.26	0.08	0.28
V22	*Log(Ties to High GeoDiversity Associations)*	0.03	0.17	0.06	0.19	0.17	-0.21	-0.01	0.07	0.11	0.61	-0.03	0.07	-0.01	0.08	0.19	0.81	0.14
V23	*Log(ties to NOT-High GeoDiversity Associations)*	0.28	0.22	0.25	0.34	-0.07	0.4	0.2	-0.26	-0.1	0.7	0.27	0.25	0.27	0.17	0.52	0.17	0.9
V24	*Log(Ties to High GeoDiversity Firms)*	-0.07	0.06	0.32	0.34	0.37	0.12	-0.35	-0.09	0.12	0.06	0.23	0.66	-0.23	-0.18	0.44	0.04	0.12
V25	*Log(ties to NOT-High GeoDiversity Firms)*	-0.18	-0.03	0.04	0.06	-0.02	0.35	0.18	0.1	0.06	0.08	-0.12	0.21	0.12	0.65	0.33	-0.08	0.15
V26	*Log(Ties to High GeoDiversity GSIs)*	0.04	-0.05	0.08	0.1	0	0.11	0.24	0.05	-0.08	0.08	0.02	-0.15	0.65	0.21	0.12	-0.15	0.26
V27	*Log(ties to NOT-High GeoDiversity GSIs)*	0.2	0.28	-0.1	-0.06	-0.33	-0.06	0.56	-0.2	-0.34	0.31	0.23	0	0.79	-0.03	0.26	0.08	0.28
V28	*Log(Ties to Banks and Schools)*	-0.26	0.02	0	0.16	-0.07	0.31	0.04	0.01	0.24	0.31	0.53	0.35	0.15	0.57	0.57	0.05	0.43
	Mean	28.39	3.04	4.45	1.92	0.54	0.2	0.19	0.64	0.64	-0.13	-1.35	2.16	-1.18	-1.35	2.7	-1.2	-1.37
	Standard Deviation	5.19	0.95	1.01	1.15	0.5	0.41	0.39	0.48	0.48	1.89	2.16	0.89	2.22	2.18	0.67	1.97	2.17

		*V*18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28
V18	*Log(Ties to High Centrality Firms)*	1										
V19	*Log(ties to NOT-High Centrality Firm)*	-0.05	1									
V20	*Log(Ties to High Centrality GSIs)*	-0.18	-0.04	1								
V21	*Log(ties to NOT-High Centrality GSIs)*	-0.2	-0.01	0.19	1							
V22	*Log(Ties to High GeoDiversity Associations)*	0.09	0.17	-0.1	0.04	1						
V23	*Log(ties to NOT-High GeoDiversity Associations)*	0.2	-0.09	0.16	0.31	0.08	1					
V24	*Log(Ties to High GeoDiversity Firms)*	0.72	0.13	-0.2	-0.14	-0.06	0.18	1				
V25	*Log(ties to NOT-High GeoDiversity Firms)*	0.12	0.01	0.2	0.05	-0.08	0.16	0.09	1			
V26	*Log(Ties to High GeoDiversity GSIs)*	-0.18	-0.04	1	0.19	-0.1	0.16	-0.2	0.2	1		
V27	*Log(ties to NOT-High GeoDiversity GSIs)*	-0.2	-0.01	0.19	1	0.04	0.31	-0.14	0.05	0.19	1	
V28	*Log(Ties to Banks and Schools)*	0.16	0.12	0.19	0.08	0.03	0.37	0.03	0.37	0.19	0.08	1
	Mean	0.22	1.28	-2.27	-1.87	-1.27	-1.27	-0.05	-2.32	-2.27	-1.87	0.1
	Standard Deviation	2.49	1.52	1.84	2.11	1.97	2.12	2.38	1.9	1.84	2.11	1.82

Table 2 Results of Regression Analysis with Process Upgrading as Dependent Variable

Parameter	*Model A*	*Model B*	*Model C*	*Model D*	*Model E*
Intercept	-6.471*	-3.597	-4.040	-4.943	-2.830
Log(Age)	-0.656	-0.611	-1.343***	-1.021**	-0.949*
Log(Number of Employees)	-0.538	-0.705	0.074	-0.151	-0.678
Log(Knowledge Stock)	0.522	0.691	0.167	0.529	0.488
Foreign Ownership	0.287	0.424	1.218	-0.332	0.377
San Luis-Cordoba	-1.104	-0.787	-2.416**	-0.972	-1.732
Santa Fe	1.943	1.983	0.220	0.733	0.952
Assemblers	-1.942**	-2.214**	-2.181***	-2.209**	-1.613*
Tier 1	-1.734*	-1.797*	-0.867	-0.101	-0.447
Log(Ties to All)		-0.921			
Log(Ties to Associations)			0.667***		
Log(Ties to Banks)			-0.209		
Log(Ties to Firms)			-1.030*		
Log(Ties to GSIs)			0.405**		
Log(Ties to Schools)			-0.029		
Log(Ties to Banks and Schools)				-0.595**	-0.631**
Log(Ties to High Centrality Associations)				0.380*	
Log(Ties to High Centrality Firms)				-0.117	
Log(Ties to High Centrality GSIs)				0.557**	
Log(ties to NOT-High Centrality Associations)				0.390	
Log(ties to NOT-High Centrality Firms)				-0.135	
Log(ties to NOT-High Centrality GSIs)				0.150	
Log(Ties to High GeoDiversity Associations)					0.528**
Log(Ties to High GeoDiversity Firms)					-0.294
Log(Ties to High GeoDiversity GSIs)					0.604**
Log(ties to NOT-High GeoDiversity Associations)					0.303
Log(ties to NOT-High GeoDiversity Firms)					-0.065
Log(ties to NOT-High GeoDiversity GSIs)					0.234
R^2	0.464	.458	0.617	0.602	0.549

Buenos Aires Zone is the omitted location.
* p- value < 0.10 ** p-value < 0.05 *** p-value < 0.01

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