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Network composition, collaborative ties, and upgrading in emerging-market firms: Lessons from the Argentine autoparts sector

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Abstract
What types of relational and institutional mechanisms shape knowledge flows and the upgrading capabilities of emerging-market firms in the face of economic liberalization? We analyze the Argentine autoparts sector to distinguish the relative impact of different types of network relationships on a firm's process and product upgrading. A few social ties to international assemblers appear to be most beneficial for local suppliers, although they may be insufficient to compensate fully for the negative effect of being located in a lower tier. Supplier–customer relationships that are part of regular, disciplined discussions for product and process improvements appear to be especially beneficial for upgrading.
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INTRODUCTION

Over the past 20 years, research on the spillover benefits from foreign direct investment (FDI) has increasingly coincided with work on the sources of upgrading for domestic firms in developing countries. A key area of convergence in these debates concerns the ways in which emerging market policies of liberalization lead domestic firms to continuously improve their products and processes, and shift from lower- to higher-value-added economic activities (Giuliani, Pietrobelli, & Rabellotti, 2005; Song, 2002). For instance, through the 1990s the development literature has shown how domestic firms can improve their practices by supplying global buyers (Gereffi, Humphrey, & Sturgeon, 2005), while the international business literature has noted how host-country firms can improve their productivity as suppliers to local subsidiaries of multinational enterprises (MNEs) (Blalock & Gertler, 2004). In these views, the combination of high-powered market incentives, MNEs' superior technologies, and their demand for international standards force host-country suppliers to improve their upgrading capabilities.

However, recent research reveals the varying impact of such policies on domestic firms (Moran, Graham, & Blomström, 2005). Drawing on evolutionary and relational views of the firm, the largely case-based research in emerging markets suggests that firms vary in their upgrading capabilities, not simply because of market

signals or the presence of MNEs, but especially because of the different constellations of inter-firm networks and institutions in which they are embedded (Schmitz, 2004). Since emerging-market countries often have weak institutions and public resources, scholars have increasingly called for a greater focus on the types of inter-firm relationships that can facilitate or impede one's access to knowledge resources, and in turn broad-based upgrading (Meyer, 2004; Moran & Ghoshal, 1999).

These concerns are also central to debates in the automotive industry, which was a major beneficiary of liberalization policies and spearheaded the growth of FDI in many emerging-market countries (Holweg & Pil, 2004). In Latin America, for instance, policymakers sought to attract MNEs via market, trade, and FDI reforms to gain new investment, which amounted to over $3 billion in Argentina and $12 billion in Brazil in the automotive industry alone from 1992 to 1998. Market liberalization and the entry of international automotive firms were often viewed as ideal ways to facilitate the transfer of best practices and the latest technologies because of the predominant use of tiered, vertical supply networks, modular systems, and lean production (Sturgeon & Florida, 2004). Critics of these policies have charged that the technological imperative of global supply chains in industries such as autos, and its reliance on standardized parts and processes, inherently undermines network relations and impedes upgrading in local firms, which tend to reside in the lower tiers (Giuliani et al., 2005; Humphrey & Memedovic, 2003).

In contrast, this article builds on an often overlooked view of embeddedness to offer one of the few quantitative analyses of the relative impact of relational factors on upgrading in emerging-market firms via their roles as suppliers for foreign MNEs. Recent research on network resources has increasingly sought to distinguish how different types of inter-organizational ties, rather than simply the overall coherence of a cluster or system of incentives, can enable or constrain one's access to knowledge resources (Fleming, 2001; Gulati, 1999; Lin, 2001). This view coincides with growing anecdotal evidence from research on the automotive industry in advanced countries suggesting that suppliers, regardless of their tier or ownership, often vary in developing new capabilities, largely because of the types of collaborative relationship they have with other firms in the value chain (Dyer & Hatch, 2006; Helper, MacDuffie, & Sabel, 2000; MacDuffie & Helper, 2006).

We argue that suppliers, particularly domestically owned firms, develop different types of upgrading capabilities because of the variation in their network resources. The likelihood that a supplier will upgrade its processes and products is not determined solely by market forces, its internal resource endowments, or some technological imperative of an industry. Rather, firms are embedded in different types of networks that vary in their structural composition and relational qualities, and in turn mediate knowledge flows. That is, some types of relationships may offer more valuable knowledge resources than others. The evidence suggests that a supplier's few direct, social ties to certain firms, such as to foreign assemblers and, to some extent, other local suppliers, can improve its probability of upgrading products and processes, but not necessarily to the extent of overcoming the negative effects of being located in lower tiers of the value chain. In particular, relationships that promote disciplined, regular discussions with customers about new products and processes appear most beneficial for suppliers. To the extent that key knowledge resources do not flow freely, but rather flow through specific types of largely exclusive inter-organizational relationship, then market liberalization alone would be insufficient to facilitate broad-based upgrading, especially in environments with weak institutions. Rather, managers and policymakers alike should focus on strategies that would promote and expand the types of relationship highlighted in this article.

Our analysis utilizes a unique primary data set of autoparts suppliers located in the Argentine province of Buenos Aires.[1] The survey captured responses of firms that account for approximately 55% of the sales and employment of the autoparts sector in early 1999. Although the cross-sectional nature of the survey and the style of several questions pose some limitations, the sample has two critical advantages. First, beginning in 1991, as in many other Latin American countries, Argentine policies focused on radical market liberalization, including high-powered economic incentives to attract investment from foreign MNEs to lead the reorganization of the automotive industry. Second, our sample has a clear survivor bias. Between 1992 and 1999 the autoparts sector underwent a profound transformation, in which about 50% of the firms exited. In turn, given the research setting, to the extent that variation in upgrading of the

surviving firms is driven largely by certain types of inter-organizational relationships, the evidence would tend to support a growing view about the roles of networks and institutions in the development of emerging markets.

In the next section we give a brief overview of the major economic reforms in Argentina and in the automotive industry. The subsequent section builds on recent research in upgrading and networks to generate hypotheses. This is followed by a description of the data and methodology, and final section discusses the results.

RESTRUCTURING THE AUTOMOTIVE INDUSTRY IN ARGENTINA

During the 1990s Argentina became a leader of pro-market reforms in Latin America, with the cornerstones being a currency board, fiscal stability, price and trade liberalization, and privatization. These efforts brought price stability as well as dramatic increases in growth, trade, and investment. Similar to such countries as Mexico and Brazil, Argentina also sought to revive its automotive industry, the output of which had declined to about 100,000 units by 1989, by using focused policies to attract FDI and enhance trade in both vehicles and autoparts, albeit with little attention on supporting supply-side policies, such as the development of quasi-public institutions for improving R&D and training[2] (Humphrey & Memedovic, 2003; Yoguel, Moori-Koenig, & Angelelli, 1999). The combination of high-powered economic incentives and investment by the automotive MNEs was to lead both to increased production and to improved capabilities for domestic suppliers.

This approach led to three restructuring trends in the automotive industry. First, as was the case in many other emerging-market countries (Humphrey & Memedovic, 2003; Sturgeon & Florida, 2004), the MNEs (i.e., the international assemblers and allied top-tier suppliers) took charge of massively reorganizing the industry to establish three tiers of suppliers and diffuse the principles of lean production throughout the value chain. The first tier is dominated by foreign firms, which are responsible for complete systems, followed by the second tier (subsystems), and the third tier (components and standard inputs). Suppliers were given strong market incentives to improve quality and reduce costs by incorporating such practices as JIT, TQM, statistical process control, and six sigma. Argentine suppliers also had to regularly adapt their products to feed approximately 17–20 different platforms and 24 models, 16 of which were exclusively for the Argentine market and three of which changed annually (Kosacoff, 1999; Novick, Miravalles, & González, 1997).

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 the Big Three (General Motors, Ford, and Chrysler), Fiat, Peugeot, VW, and Renault.[3] Capacity increased to 750,000 units, with the largest output coming in 1998 with 458,000 units. By the end of the 1990s the automotive sector accounted for 7% of manufacturing output and 68,000 employees or 6.4% of manufacturing employment. The autoparts suppliers alone accounted for about 3.5% of output and 38,000 employees or about 4% of manufacturing employment (Kosacoff, 1999: 57, 61). 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.

The net effect on the autoparts sector was substantial. By 1998 just over half of the original 500 autoparts suppliers in 1992 had survived. Their ownership structure also changed, with 30% of firms foreign-owned, 30% domestic, 21% minority foreign joint ventures, and 19% under international license (Kosacoff, 1999: 57). Almost half of active suppliers had ISO certification. Productivity of the sector as a whole increased by 157% between 1994 and 1999 (Español, Lugones, Porta, & Sierra, 2000). But the sector also witnessed a sharp decline in the local production of many high-value-added subsystems and components, such as in motors and chassis (Kosacoff, 1999: 49–51).

In sum, the Argentine autoparts sector presents an attractive setting for investigating the impact of liberalization reforms on the upgrading of a developing host-country supply sector. As in other Latin American countries, the Argentine policies allowed market forces and the MNEs to substantially reorganize the value chain, increase investment, and incorporate modern industry practices. Given their ability to survive the turbulence of the 1990s and their similar geographical proximity, then the local autoparts suppliers are to have similar likelihoods of upgrading their processes and products. To the extent that they vary, we can discern the

relative impact of a firm's internal resources, the composition of its network ties, and the quality of these ties.

NETWORK VARIATION AND UPGRADING IN EMERGING MARKETS

Rooted in the evolutionary perspective of the firm, the upgrading literature has consistently argued that the long-term competitiveness of firms from emerging-market countries depends particularly on their development of new capabilities that improve on adaptive efficiencies (Moran & Ghoshal, 1999). This literature has also noted that firms may develop different types of upgrading capabilities, such as process and product upgrading (Giuliani et al., 2005: 552). Process upgrading is transforming inputs into outputs more efficiently by reorganizing the production systems or introducing superior technology. Product upgrading is moving into more sophisticated product lines in terms of increased unit values. Given the organization-specific nature of learning, a firm's ability to upgrade its products and processes can indicate its ability to innovate and compete in subsequent periods (Song, 2002). However, product and process upgrading often tend to develop at unequal rates and depths within and across firms, even within the same industry (Schmitz, 2004).

There are competing perspectives about the factors that influence whether or not a firm will upgrade its products and processes. The more traditional view, based on incentives and market forces, would argue that once MNEs have reorganized supply lines and allowed market competition to weed out the weak firms, surviving suppliers would in general have similar levels of upgrading (Moran et al., 2005). A similar perspective comes from a variant of the "modularization view" in the automotive literature. Each production tier depends on a discrete package of technologies and interfaces, which are increasingly standardized and well codified, and in turn allows little need for inter-firm coordination. At its limit, this largely technologically deterministic view understands that, once the value chain is established, modularization permits arm's length, market-based relationships between suppliers and customers to be sufficient for sustaining global supply chains and increased upgrading (Gereffi et al., 2005; Sturgeon & Florida, 2004). To the extent that one would find variation in supplier upgrading, these are likely to be products of firm traits and resources, such as ownership, firm size, and absorptive capacities.[4]

Skeptics of the upgrading benefits for domestic firms from market liberalization and supplying MNE transplants have equally embraced modularization theories (Giuliani et al., 2005; Humphrey & Memedovic, 2003). While the transnationalization of production forces domestic firms to reside in the second and third tiers, the logic of modularization relegates firms in these tiers to produce only standardized components, impeding their ability to learn about new products and processes and thus upgrade over time. The technological imperative of the auto industry creates a "glass ceiling" for upgrading in lower-tier, mainly domestic, firms as it determines the incentives and relationships that contribute to upgrading. For instance, in their analyses of the automotive industry in Latin America, Humphrey and Memedovic (2003) and Quadros (2004) argue that although market pressures and the introduction of international standards compel surviving suppliers to make initial improvements in products and processes, the use of modularization restricts the access that suppliers in the lower tiers have to the new information, knowledge, and development activities of the international assemblers and their allied international top-tier suppliers. These isolated suppliers have limited internal resources and knowledge to upgrade on their own. In turn, one would expect that firms in the second and third tiers would have similar levels of upgrading, respectively, but fewer improvements relative to firms in the first tier.

An alternative view rejects the uniform impact of market pressures, MNEs, or technology on upgrading in emerging-market firms as well as a reliance on firm-level resources alone. Grounded in sociological and relational perspectives of the firms, this view increasingly finds that upgrading capabilities are shaped by the distinct constellations of inter-organizational and institutional networks in which a firm is embedded (Gulati, Nohria, & Zaheer, 2000). The work on social capital and networks emphasizes how a firm's social and professional relationships are imbued with trust and norms of reciprocity that can provide the firm with channels to information, knowledge, and resources that it might otherwise not have on its own. In turn, these relationships help firms adapt, innovate, and learn (Ingram & Roberts, 2000; McEvily & Marcus, 2005). The work on clusters and economic development has extended this research to include non-market organizations and institutions, such as associations, universities, and government-supported training

and technology centers, which serve as supplementary channels of information, standards, and resources (Locke, 1996; McEvily & Zaheer, 1999; Powell, White, Koput, & Owen-Smith, 2005). This view is gaining increasing traction in research on emerging markets and the auto industry. For instance, recent qualitative research on post-communist economies and China shows how a firm's past social ties to other local firms and institutions can improve adaptation to rapidly changing markets as well as shape the diffusion of knowledge and patterns of restructuring strategies (McDermott, 2002; Stark & Bruszt, 1998; Zhao, Anand, & Mitchell, 2005). The case-based research by Brusoni and Prencipe (2001) and MacDuffie and Helper (1997, 2006) in advanced industrialized countries and Kotabe, Parente, and Murray (2007) in Brazil argues that modularization does not necessarily lead to a static world of technology change and arm's length relationships, since product and system designs continue to be integrated, and knowledge cannot be fully codified. The development of new production systems in different parts of the world demands that assemblers and suppliers engage in highly interactive relationships to facilitate the exchange of the attendant tacit knowledge.

But are all types of relationship and network equally beneficial for a firm? Recent work on embeddedness has increasingly sought to differentiate the relative impact of a firm's network composition and structure on its capabilities and performance. 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. The key insights that we exploit in this article are whether the focal firm has ties to a certain type of organization (e.g., customer, supplier, trade association etc.) that can lend knowledge resources that are of value for the task at hand, and the degree to which the quality of this tie and focal firm's position in the value chain (e.g., first tier, second tier, etc.) mediates this value.

This view of network resources has gained importance in the research on strategic performance and knowledge transfer in two important ways – the structural composition of the network and the relational quality of certain inter-firm ties (Gulati et al., 2000; Uzzi & Lancaster, 2003). Building on the knowledge-based view of the firm, the former approach argues that a firm's social ties and alliances with distinct types of organizations and institutions can shape its inflow of knowledge and innovative capabilities (De Carolis & Deeds, 1999; Gulati, 1999; Gulati & Higgins, 2003). This work suggests that a firm's network provides accumulated value by affording it key information that allows it to act quicker than rivals. Similarly, researchers have sought to distinguish the strategic value of certain network partners in terms of the partner's place in the value chain, status, kinship, friendship (Christensen & Bower, 1996; Ingram & Roberts, 2000; Podolny, 2001). At the same time, researchers are becoming equally aware of the limited benefits and constraining nature of certain network ties. Networks are often exclusive and path dependent, and in turn can constrain a firm's ability to gain new information while reinforcing old routines or practices (Gulati, 1999; Lin, 2001). As an industry evolves, a firm's existing set of networks may blind it from or not sufficiently support it for adopting new processes and products (Rowley, Behrens, & Krackhardt, 2000).

Consideration of the heterogeneous benefits of a firm's network and especially its composition strongly resonates in the context of this study. The growing anecdotal evidence from research on MNEs in emerging markets and on the automotive industry suggests that upgrading varies among domestic suppliers according to the ties a supplier has to different types of firms in the value chain. Multiple, strong social relationships to customers and assemblers, namely MNEs, would allow domestic suppliers to directly access key information about new products, processes, and international standards, as well as potentially allowing them to participate in exclusive design activities (Blalock & Gertler, 2005; Javorcik & Spatareanu, 2005; Moran et al., 2005). Similarly, researchers on development and automotives continue to debate the relative value of a firm's ties to international firms vs peers and suppliers (Sako, 2004; Schmitz, 2004; Stanley & Helper, 2006). While some identify ties to MNEs and global buyers as the key source for a supplier to learn about new standards, product designs, and supporting resources, others argue that a supplier's local network is of equal if not greater upgrading value, since this type of network is more likely to be imbued with greater levels of trust and

collaboration (Gereffi et al., 2005; Giuliani et al., 2005). At the same time, this debate reflects the constraining nature of network ties. Recent research in East-Central Europe has shown that one's pre-existing local networks can equally lead to a reproduction of anachronistic practices and capabilities (McDermott, 2002).

For the sake of brevity, we utilize the term "upgrading" to refer to both product and process upgrading, and summarize these views in a series of hypotheses stating the beneficial nature of ties to different types of firm in the value chain (e.g., ties to assemblers, suppliers, peers, etc.).

Hypothesis 1a–d: Suppliers in emerging markets with multiple, highly interactive social relationships with (a) assemblers, (b) customers, (c) their peers, and (d) their own suppliers, respectively, are more likely to have higher levels of upgrading than those with relatively few, weaker relationships with such firms in the automotive industry.

Both network theory and empirical work on automotives suggest that the benefit of a relationship to a particular type of firm can interact with the focal firm's structural position. Such scholars as Lin (2001) and Podolny (2001) have suggested that actors with different structural positions might accrue different benefits from ties to the same type of firm or organization. Recent qualitative work on the automotive industry in emerging markets has suggested that firms in Tiers 2 and 3 would find greater value in ties to assemblers than firms in Tier 1 (Humphrey & Memedovic, 2003). Tier 1 firms tend to be well-established international suppliers that learn relatively little from the local subsidiary of an international assembler compared with what they gain already from their own robust competencies and their parent. In contrast, ties to an assembler may represent one of the few sources of international knowledge and standards for the domestic suppliers that dominate Tiers 2 and 3 (Giuliani et al., 2005; Schmitz, 2004). Moreover, given the structure of the automotive value chain, in which firms in different tiers are given more or less explicit responsibilities to develop their supplier networks, what a firm gains from a customer or supplier varies according to tier (Herrigel, 2004). Firms in Tiers 2 and 3 may learn more about process innovations than about product innovations from their customers, suppliers, and peers, since the core knowledge about product innovations resides with the final assembler. The point is that the impact of any tie on a particular actor in the value chain will be moderated by the tier in which the firm resides, and that we expect differences across product and process innovations.

Again for sake of brevity, and utilizing "upgrading" to refer to product and process upgrading, we summarize these views stating the beneficial nature of network resources.

Hypothesis 2a–d: In emerging markets the marginal effects on upgrading resulting from multiple, highly interactive social relationships with (a) assemblers, (b) customers, (c) their peers, and (d) their own suppliers, respectively, are more likely to be greater for firms in Tiers 2 and 3 than for firms in Tier 1.

As Gulati (1999: 415) has emphasized, distinguishing the impact of network resources on firm performance and capabilities should extend to organizations and institutions outside the immediate value chain, such as consultants, banks, associations, universities, and public agencies. A key insight from qualitative research on industrial restructuring and clusters in the advanced and developing worlds is that firms, especially those that are resource constrained and in lower tiers, often depend on such organizations and institutions to acquire new skills, practices, capital, and services (Locke, 1996; Schmitz, 2004). Scholars of international business, especially in emerging markets, are providing growing anecdotal evidence that a supplier's development of new capabilities and its application of new knowledge are greatly shaped by its participation in local training institutions (Blalock & Gertler, 2005; Moran et al., 2005) and public agencies providing R&D facilities and information on international process and product standards (Conceição, Heitor, & Veloso, 2003; Zhao et al., 2005). Network scholars have used qualitative and quantitative evidence from the advanced industrialized world to show how a firm's ties to professional associations (Zuckerman & Sgourev, 2006), to universities (Powell et al., 2005), and to public-private technology centers (McEvily & Zaheer, 1999) can expand its portfolio of information and collaborators to greatly shape its ability to adapt and innovate. The development literature, however, cautions that emerging-market countries often possess poorly qualified consultants, anachronistic banks, and weak associational and institutional environments in the areas of skills and technology development (Doner, Ritchie, &

Slater, 2005). Recent research on Latin America increasingly shows that the pursuit of neo-liberal reforms has led to underinvestment in knowledge bases and supply-side support institutions, especially in the sciences and engineering (Giuliani et al., 2005; Sutz, 2000).

Again for the sake of brevity, we can summarize these views in a hypothesis stating the beneficial nature of network resources gained from these types of organization and institution.

Hypothesis 3a–e: Suppliers in emerging markets with multiple ties to (a) consultants, (b) banks, (c) associations, (d) universities, (e) public agencies, respectively, are more likely to have higher levels of upgrading than those with relatively few such ties.

The second way in which scholars have tried to distinguish the relative value of and contingent nature of certain network resources is their relational embeddedness (Uzzi & Lancaster, 2003). Knowledge transfer and capabilities creation depends not simply on a firm's structural position in a value chain or on the number of socio-professional relationships it has with others, but rather on the particular quality and intensity of the relationships that suppliers have with their main customers (Christensen & Bower, 1996; Dyer & Hatch, 2006; Sako, 2004). The underlying idea is that 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 relationship, calling them "pragmatic collaborations" (Herrigel, 2004; MacDuffie & Helper, 2006), 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 bilateral production programs and focused supplier associations (Dyer & Hatch, 2006; Helper & Kiehl, 2004).[5] In their analysis of US auto suppliers, Dyer and Hatch (2006) perform, to our knowledge, the only statistical study of this view, showing how the inter-organizational routines established by Toyota's assistance programs are strategic advantages for suppliers in gaining new knowledge to improve their products and processes. Anecdotal evidence from research on FDI in emerging markets suggests that these types of relationship have particular value for domestic suppliers, since they allow the suppliers to learn faster about products and processes that are not easily codified, and to participate more readily in new product launches (Kotabe et al., 2007; Moran et al., 2005). While researchers have identified different types of customer-initiated assistance program, such as those focusing on employee training, process development, and product development, the flow of information may well benefit areas beyond the scope of the particular realm of the program (Dyer & Singh, 1998; Dyer & Hatch, 2006; MacDuffie & Helper, 2006). For the sake of brevity, we summarize these views, stating the beneficial impact of these types of collaboration on both product and process upgrading.

Hypothesis 4: Firms in emerging markets that have problem-solving relationships with customers, in which the latter provide regular assistance to the former in the areas of training, product development, or process development, are more likely to have higher levels of upgrading than those that do not.

DESCRIPTION OF DATA, METHODS, AND MODELS

The data utilized to test the hypotheses come from the Autoparts Industry Survey collected by the Institute of Social Studies in Science and Technology (Universidad Nacional de Quilmes) with the endorsement of and collaboration from the Argentine Autoparts Manufacturers Association (AFAC) in 1999. A comprehensive list of the autopart manufacturers in the Province of Buenos Aires included also non-members of AFAC. Of those 201 firms invited to participate, only 23 declined the invitation, and 14 firms went out of business or transferred their activities to Brazil. This resulted in a total of 164 firms interviewed. Of those that responded, 26 were discarded owing to inconsistencies. In total the data set contains information from 138 firms. Owing to missing data for sales concentration and network variables, the sample was further reduced to 90 observations. We found no significant difference across firms included in and excluded from the analysis for dependent

variables, tier, age, FDI, number of employees, or knowledge stock. Table 1 shows the distribution of firms by tier, size, and ownership. Similar to distributions found in Brazil and Mexico (Humphrey & Memedovic, 2003), the large majority of foreign-owned firms and large firms are in the first tier, while domestically owned small and medium-sized firms dominate Tiers 2 and 3.

Table 1 Distribution of sample by tier, employment, and FDI

Tier	*Number of firms*	*Employment (No. of firms)*			*No. of firms with FDI*
		< 50	*51–100*	*100+*	
First tier	57	23	13	21	27
Second tier	26	18	4	4	7
Third tier	55	45	4	6	5
Total	138	86	21	31	39

Variables

Dependent variables. We utilize two dependent variables to test our hypotheses (see also Tables 2 and 3). To measure product and process upgrading, we use dummy variables, *New Product* and *New Process*, respectively, which indicate whether the firm has been successful in developing and improving products and processes, respectively, between 1995 and 1998. Approximately three quarters of the firms in the sample improved and developed products and process for the period (73% and 78% respectively). As Table 3 shows, these variables are not highly correlated, consistent with

Table 2 Variable summary

Variable	*Variable type*	*Description*
New Process	Dichotomous	Successful process development and improvement during 1995–1998
New Product	Dichotomous	Successful product development and improvement during 1995–1998
Chassis	Dichotomous	Main line manufactures large metal parts and axis to build chassis and body
Plastics	Dichotomous	Main line manufactures plastic parts, upholstery, or rubber parts
Engine	Dichotomous	Main line manufactures engine parts and motorization
Knowledge Stock	Count	Number of engineers, chemists, college graduates, and technicians
Size	Count	Number of employees
Age	Count	Number of years since inception
Sales Concentration	Bounded (0–100)	Proportion of sales accounted for by largest five customers
Foreign Direct Investment	Bounded (0–100)	Percentage of foreign ownership
Tier 1	Dichotomous	Position of firm in automobile value chain.
Tier 2	Dichotomous	Position of firm in automobile value chain
Tier 3	Dichotomous	Position of firm in automobile value chain
Linkages to Assemblers	Count	Number of informal information exchanges with assemblers (weighted by exchange frequency)
Linkages to Customers	Count	Number of informal information exchanges with customers (weighted by exchange frequency)
Linkages to Suppliers	Count	Number of informal information exchanges with suppliers (weighted by exchange frequency)
Linkages to Peers	Count	Number of informal information exchanges with peers (weighted by exchange frequency)
Ties to Government Agencies	Count	Number of government agencies reported as providing valuable support to innovation
Ties to Associations	Count	Number of associations reported as providing valuable support to innovation
Ties to Universities	Count	Number of universities reported as providing valuable support to innovation
Ties to Foundations	Count	Number of foundations reported as providing valuable support to innovation
Ties to Consultants	Count	Number of consultants reported as providing valuable support to innovation
Ties to Banks	Count	Number of banks reported as providing valuable support to innovation
Process Development Assistance	Dichotomous	Customers provided assistance in process development during 1995–1998
Product Development Assistance	Dichotomous	Customers provided assistance in product development during 1995–1998
Training Assistance	Ordinal (0–5)	Number of training decisions influenced by customers.

Table 3 Descriptive statistics and correlation matrix

	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 *New Process*	0.78	0.42	1															
2 *New Product*	0.73	0.44	0.16	1														
3 *Chassis*	0.61	0.49	0.18	0.03	1													
4 *Plastics*	0.19	0.39	−0.02	−0.03	**−0.60**	1												
5 *Engine*	0.19	0.39	**−0.22**	−0.03	**−0.60**	**−0.23**	1											
6 *Knowledge Stock*	0.13	2.72	**0.30**	0.01	−0.13	0.14	0.01	1										
7 *Size*	3.49	1.74	**0.22**	0.00	0.05	0.15	**−0.23**	**0.43**	1									
8 *Age*	28.17	18.48	**0.21**	−0.09	0.01	0.1	−0.08	0.04	0.15	1								
9 *Sales Concentration*	0.31	0.25	−0.16	0.11	−0.03	−0.07	0.14	0.19	−0.05	**−0.34**	1							
10 *Foreign Direct Investment*	25.01	42.48	−0.02	0.06	**−0.23**	0.18	0.12	**0.5**	**0.27**	−0.15	**0.43**	1						
11 *Tier1*	0.36	0.48	0.06	0.08	−0.17	**0.23**	−0.06	**0.31**	**0.25**	−0.04	**0.33**	**0.22**	1					
12 *Tier 2*	0.20	0.40	0.07	−0.14	**0.23**	−0.17	−0.10	−0.05	−0.09	−0.04	0.10	0.03	**−0.37**	1				
13 *Tier 3*	0.44	0.50	−0.11	0.03	−0.02	−0.09	0.14	**−0.26**	−0.17	0.07	**−0.40**	**−0.24**	**−0.66**	**−0.45**	1			
14 *Linkages to Assemblers*	−1.51	3.53	0.13	−0.07	−0.06	0.09	−0.05	**0.36**	**0.24**	0.07	0.06	**0.35**	0.19	**0.26**	**−0.39**	1		
15 *Linkages to Customers*	−0.27	4.00	−0.17	−0.07	0.16	−0.19	0.02	**−0.23**	−0.10	**0.22**	**−0.29**	−0.15	**−0.33**	**0.22**	0.14	0.02	1	
16 *Linkages to Suppliers*	0.43	3.35	−0.09	0.05	0.20	−0.16	−0.11	**−0.21**	0.05	0.10	−0.17	−0.04	**−0.21**	**0.24**	0.01	**0.23**	**0.48**	1
17 *Linkages to Peers*	0.41	3.17	0.18	−0.02	−0.04	0.11	−0.06	0.07	0.06	**0.27**	**−0.31**	−0.09	−0.05	0.13	−0.06	0.12	0.19	0.12
18 *Ties to Government Agencies*	0.49	0.67	0.11	0.10	−0.03	0.03	0.03	0.12	0.13	0.07	−0.04	0.20	−0.09	0.13	−0.02	0.11	0.05	0.18
19 *Ties to Associations*	0.89	0.73	0.07	0.12	−0.19	0.03	0.19	**0.23**	**0.26**	−0.09	0.06	**0.36**	−0.05	**0.23**	−0.14	**0.42**	0.11	0.18
20 *Ties to Universities*	0.38	0.63	0.11	0.12	0.08	−0.02	−0.06	0.17	0.10	0.20	0.04	0.13	0.03	**0.32**	**−0.29**	0.15	0.16	0.13
21 *Ties to Foundations*	0.11	0.35	0.09	−0.02	0.12	−0.07	−0.07	0.19	**0.22**	0.20	−0.19	0.01	−0.10	0.00	0.10	−0.05	−0.02	0.03
22 *Ties to Consultants*	0.21	0.44	0.01	0.00	0.02	0.09	−0.10	0.19	0.04	0.08	0.09	0.04	**0.39**	−0.05	**−0.33**	0.14	0.00	−0.06
23 *Ties to Banks*	0.36	0.53	−0.15	−0.02	0.19	−0.17	−0.06	−0.13	−0.02	−0.03	0.01	−0.07	−0.02	−0.18	0.16	−0.02	0.15	−0.01
24 *Process Development Assistance*	0.88	0.33	**0.70**	**0.24**	0.05	−0.08	0.01	**0.23**	0.16	**0.22**	−0.03	0.06	0.14	0.10	**−0.21**	0.16	−0.09	−0.05
25 *Product Development Assistance*	0.89	0.32	**0.41**	**0.27**	0.01	0.08	−0.1	0.05	0.12	0.08	0.08	0.13	**0.26**	−0.18	−0.11	−0.01	−0.08	−0.08
26 *Training Assistance*	1.42	1.64	**0.22**	0.05	0.04	0.12	−0.14	**0.21**	0.15	0.06	0.18	0.20	**0.32**	0.19	**−0.46**	0.15	−0.14	0.04

	17	18	19	20	21	22	23	24	25	26
17 *Linkages to Peers*	1									
18 *Ties to Government Agencies*	0.07	1								
19 *Ties to Associations*	−0.04	0.14	1							
20 *Ties to Universities*	0.25	0.17	0.12	1						
21 *Ties to Foundations*	0.12	0.20	0.00	−0.04	1					
22 *Ties to Consultants*	0.12	−0.16	−0.1	0.16	−0.08	1				
23 *Ties to Banks*	−0.05	−0.15	−0.13	−0.04	0.03	0.16	1			
24 *Process Development Assistance*	0.11	0.02	0.13	0.06	0.02	0.10	−0.07	1		
25 *Product Development Assistance*	−0.01	0.10	−0.05	−0.01	−0.09	0.09	−0.10	0.41	1	
26 *Training Assistance*	0.22	0.06	0.01	0.17	−0.08	0.23	**−0.15**	0.28	**0.2**	1

Correlations significant at 0.05 level are in bold.

prior research on the unequal development of process and product capabilities within firms in emerging markets (Schmitz, 2004) and also the advanced industrialized world (Cohen & Klepper, 1996).

Focal independent variables. We test Hypotheses 1a–d and 2a–d through variables that capture social ties between firms in the value chain. We conceptualize social ties as channels that facilitate information transfer, and may reduce the uncertainty involved in developing new processes and products for firms. We pay particular attention to the existence of the linkage as well as its strength or quality, which enhances the flow of tacit knowledge (Borgatti, 2005). In turn, we weighted a focal firm's tie to a type of firm or organization by the reported frequency of interaction (Burt, 1983). Our measures are constructed by collecting responses from the firms about their social interaction with other types of firms in the value chain (i.e., assemblers, customers, suppliers, and peers) and capture the ability of the respondent firms to receive a wide range of information from the alter firm through this channel.

Linkages to Assemblers is a weighted value of the number of final assemblers (Fiat, Ford, etc.) to which the firm has informal information exchange, multiplied by the predominant frequency of those contacts. These information exchanges include quite varied topics, such as strategy, training, regional and national economic outlook, and the search for partners. *Linkages to Suppliers*, *Linkages to Customers*, *and Linkages to Peers* are constructed in the same manner. In contrast to the pragmatic collaborative relationships discussed below for Hypothesis 4, these variables measure the informal social relationships between firms that can provide information exchange and be sustained even without a business relationship. Since these variables are heavily skewed, we utilized their natural logarithm in our models. For Hypotheses 2a–d, we also interact these variables with the relevant *Tier* variable (see below).

We test Hypothesis 3 using variables that measure the degree centrality (Borgatti, 2005) of the firm in different two-mode networks. Six variables were created: *Ties to Government Agencies*, *Ties to Associations*, *Ties to Banks*, *Ties to Consultants*, *Ties to Foundations*, and *Ties to Universities*. These variables count the number of organizations and institutions outside the value chain providing valuable ties in 1997 and 1998 to the focal firm. This measure captures the inflow of information from those entities. By questionnaire construction, those relationships are considered valuable by the respondent: therefore, and consistent with our hypotheses, we expect positive impacts on the different types of upgrading (Borgatti, 2005).

We test Hypothesis 4 by using three variables that capture the different types of regular assistance that the focal firm received from customers. These types of collaboration are goal oriented, and the assistance received addresses distinctive issues, such as improvements in training employees, implementing new processes, and developing new products. These variables are included in models predicting product and process upgrading because theoretically it could be argued that, despite the purposive and goal-oriented characteristics of the type of assistance, the regular collaboration may provide a relationship between firms facilitating the transfer of knowledge and information beyond the specific area of assistance (Dyer & Hatch, 2006; Helper & Kiehl, 2004). Although more focused and routinized than the linkage variables described above, they do not necessarily indicate a formal alliance between the firms. *Training Assistance* is an index measuring the influence of customers in the training decisions of the firm (training, areas, methodology, trainees, and providers). *Product Development Assistance* indicates customers' assistance to develop or improve products. *Process Development Assistance* indicates customers' assistance to develop or improve processes.

Control variables. Given the cross-sectional nature of the study, we attempt to reduce concerns about endogeneity by introducing several variables that account for firm characteristics as thoroughly as possible, given the limited size of the sample. These variables follow those commonly used in the research on strategy, foreign investment, and the automotive industry. *Foreign Direct Investment* is a bounded variable from 0 to 100 that measures the percentage of foreign ownership in the focal firm: 29% of the firms have received FDI, and, among them, the average level of foreign ownership is 88%; 85% of these firms have greater than 50% foreign ownership. *Size* was measured as the number of employees, which appears better than using sales to capture the organizational challenges because our data cover the whole industry, and unit prices vary widely across tiers and subsectors. We utilized the natural logarithm of size because this variable is skewed. *Knowledge Stock*, our proxy for

absorptive capacity (Cohen & Levinthal, 1990), was measured as the firm's number of employees with advanced education (engineers, chemists, other college graduates, and technicians). This is a measure of the firm's learning capability.[6] As in the case of *Size*, we utilized the natural logarithm because this variable is skewed. We also introduce dummy variables to capture differences stemming from technology, and as such also capital intensity (*Chassis*, *Plastics*, and *Engines*). *Age* captures inertial forces that may hinder the firm's proclivity to upgrade. *Sales Concentration* measures the proportion of the sales accounted for by the largest five customers.

Following the automotive literature, we control for the focal firm's position in the value chain by identifying its *Tier*. Based on the sales profile, two experts classified the firms into Tiers 1, 2, and 3. The agreement rate was 94%. In case of disagreement, a third expert classified the firm. Firms in Tier 1 are suppliers of assemblies, and manufacture complete modules or systems that involve the assembly of subsystems, which are mainly supplied by Tier 2 firms. Tier 3 firms are suppliers of components mainly for Tier 2 firms. It is important to note that *Tier* denotes mainly the type of product the firm manufactures, and not necessarily its upgrading capabilities (MacDuffie & Helper, 2006).

Statistical Inference

Survey data can pose issues related to non-response bias and common method variance. To deal with common method variance, Podsakoff, MacKenzie, Lee, and Podsakoff (2003) propose procedural or statistical remedies. This problem may be magnified because the survey was not designed with the purpose of addressing our specific concerns, and limits our ability to assess only whether such procedural remedies (i.e., multiple respondent, improved scale items, separation of measurement) were present.

In our case, there are several factors that reduce these concerns. The high response rate (88%) reduces non-response bias concerns. The comprehensiveness and scope of the original survey led to the participation of several people in answering the questions during the data collection process.[7] The questions utilized to generate the variables in our models also are mostly hard data or yes/no questions that reduced the amount of judgment involved in the answer, and simplified the scale. Finally, although methodological separation of the collection of dependent and independent variables is not physical, the survey incorporated psychological separation and some temporal separation (by collecting dependent and independent variables in different sections and during a long interview that lasted more than 90 min). In turn, although our data are not sufficient to pursue more sophisticated statistical remedies, we believe that common variance bias, which inflates the correlations between dependent and independent variables, is not a serious problem in our case.

In order to test the impact of our independent variables on *New Product* and *New Process*, we run logistic regression models with maximum likelihood estimations. Our model for *New Process* suffers from complete separation, which makes estimation unreliable.[8] For this reason, we present the cross-tabulation of the variables *Process Development Assistance* and *Tier* vs *New Process* (see Table 4), and we drop *Process Development Assistance* to estimate the model with the rest of the independent variables (see Table 5). The complete separation problem also prevents us from interacting *Process Development Assistance* and *Product Development Assistance* with the *Tier* variables. Some correlations are moderately high (see descriptive statistics in Table 3); nevertheless, collinearity between variables is not a problem according to VIF and tolerance tests (SAS v. 9).

Owing to the non-linearity of logistic models, the effects of interaction terms cannot be tested by the significance of the interaction parameter estimates (Ai & Norton, 2003).[9] Therefore, in order to further test Hypotheses 1a–d and 2a–d, we follow the implementation of Ai and Norton's (2003) suggestion proposed by Zelner (2009) for STATA. This procedure utilizes the delta method to estimate the

Table 4 Cross-tabulation Process Development Assistance and tier vs New Process

Process Development Assistance	*New Process*			
	Tier	*No*	*Yes*	*Total*
No	1	2	0	2
	2	1	0	1
	3	8	0	8
Yes	1	4	26	30
	2	2	15	17
	3	3	29	32
Total		20	70	90

χ^2-test for association between *Tier* and *New Process*:
Unconditional p-value=0.41.
Conditional on receiving *Process Development Assistance* p-value=0.89.
Note: Lack of *Process Development Assistance* predicts perfectly the absence of *New Processes*.

Table 5 Logistic regression with *New Product* as dependent variable

Parameter	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Intercept	0.864	0.842	3.212	2.364	2.507
Chassis	−0.021	0.014	0.034	0.081	0.207
Plastics	−0.006	−0.007	−0.021	−0.02	−0.035
Log(*Knowledge Stock*)	0.434	0.387	0.272	0.822	1.363
Log(*Size*)	1.019	1.143	2.572	2.546	3.265
Age	0.041	0.071	−0.005	−0.024	−0.115
Sales Concentration	0.003	0.004	−0.007	−0.02	−0.028*
Foreign Direct Investment	−0.025	−0.051	0.001	−0.119	−0.422
Tier 2	−0.983	−1.069	−3.848**	−4.235***	−7.469***
Tier 3	0.005	−0.047	−2.934*	−2.678	−6.58*
Log(*Linkages to Assemblers*)		−0.055	−0.269	−0.308	−0.729**
Log(*Linkages to Customers*)		−0.047	0.075	−0.041	−0.067
Log(*Linkages to Suppliers*)		0.111	0.052	−0.010	0.102
Log(*Linkages to Peers*)		0.048	0.117	0.074	0.07
Log(*Linkages to Assemblers*) × *Tier 2*			0.963***	0.998***	2.079***
Log(*Linkages to Assemblers*) × *Tier 3*			0.932***	1.001***	1.866***
Log(*Linkages to Customers*) × *Tier 2*			−0.677**	−0.827*	−1.021**
Log(*Linkages to Customers*) × *Tier 3*			−0.478**	−0.436**	−0.648**
Log(*Linkages to Suppliers*) × *Tier 2*			0.379	0.419	0.924**
Log(*Linkages to Suppliers*) × *Tier 3*			0.406*	0.54*	0.827**
Log(*Linkages to Peers*) × *Tier 2*			−0.186	0.112	−0.126
Log(*Linkages to Peers*) × *Tier 3*			−0.41	−0.222	−0.16
Ties to Government Agencies				0.449	0.253
Ties to Associations				0.851	0.852
Ties to Foundations				−0.737	−1.283
Ties to Universities				1.238*	1.937**
Ties to Consultants				−0.019	0.866
Ties to Banks				−0.066	−0.221
Process Development Assistance					1.925
Product Development Assistance					3.331**
Training Assistance					−0.534
Number of observations	90	90	90	90	90
Log likelihood	−50.113	−49.123	−39.21	−35.359	−28.656
LR test		0.74	0.01	0.26	0.04

*p < 0.10; **p < 0.05; ***p < 0.01.
Engine is the omitted variable for *Chassis* and *Plastics*.
Tier 1 is the omitted variable for Tier 2 and Tier 3.

standard errors of the predicted values, which are used to estimate the significance level of predicted values and marginal effects for a set of values for the dependent variables belonging to the relevant range for the study. In our case, we estimate the predicted probability of *New Process* and *New Product* for firms in each tier, based on changes in our measure of *Linkages* (i.e., *Linkages to Assemblers*, to *Customers*, *Suppliers*, and *Peers*, respectively). The *Linkages* variables take values ranging from 0 to 35. The rest of the independent variables were assessed at their mean values for each tier. With those predicted values and standard errors we evaluate the main effects of the variables for *Tiers* and *Linkages* at different points in the relevant range. In order to evaluate the different marginal effects of *Linkages* variables on upgrading for firms in each tier, we estimate the change in the predicted probability of the dependent variables (*New Process* and *New Product*, respectively) and its standard error associated with a one unit increase in the respective *Linkages* variables. We then run a *z*-test to determine whether the differences in the marginal effects for firms in different tiers are statistically significant.

RESULTS

To fully evaluate our hypotheses concerning the impact of different types of relationships on upgrading, we report two sets of results. Tables 5 and 6 show the results of our logistic regressions for

product and process upgrading, respectively. Each table contains five models, including the baseline model with control variables, nested models with the incremental addition of the focal variables, and the full model. Tables 7 and 8 summarize the results from the delta method. To facilitate intuition and for the sake of brevity, we also present graphically (Figures 1 and 2) the results related only to product upgrading and *Linkages to Assemblers*. (The full set of graphs can be found online at www.jibs.net.) For instance, Figure 1 depicts the estimated relationship between increases in a firm's *Linkages to Assemblers*, on the horizontal axis, and the predicted probability of *New Product* (Figure 1), measured on the vertical axis. The horizontal axis presents the relevant range over which the linkage measures take values in our sample. The three different schedules appearing in the figure illustrate these relationships for firms in each tier – when all other variables are set at their mean for the given tier. The symbols mark the 95% confidence intervals (two-tailed) for their respective schedules. (Figure 2 is constructed in the same manner to show the relationship between increases in the linkage variable and the change in the predicted probability of product upgrading.)

The regressions reveal that the control variables for firm-level characteristics and resources are

Table 6 Logistic regression models with *New Process* as dependent variable

Parameter	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Intercept	1.068	1.28	1.22	2.471	8.136
Chassis	1.243*	1.32	1.427	2.193**	−3.259
Plastics	0.284	−0.446	−0.509	−0.603	−11.671**
Log(*Knowledge Stock*)	0.363***	0.282**	0.265*	0.335*	2.779***
Log(*Size*)	0.029	0.049	0.085	0.023	−0.087
Age	0.03	0.035*	0.039*	0.05*	0.093
Sales Concentration	−2.233	−3.509*	−3.158	−3.761	−29.526***
Foreign Direct Investment	−0.004	0.002	−0.001	−0.004	−0.08
Tier 2	−0.076	0.21	0.46	−1.034	8.676
Tier 3	−0.756	−0.679	−0.915	−2.565*	−8.391
Log(*Linkages to Assemblers*)		0.022	0.062	0.041	1.04
Log(*Linkages to Customers*)		−0.241**	−0.256**	−0.349**	−1.351***
Log(*Linkages to Suppliers*)		−0.02	−0.102	−0.153	0.269
Log(*Linkages to Peers*)		0.095	0.116	0.251	0.794
Log(*Linkages to Assemblers*) × *Tier 2*			0.077	0.089	3.444**
Log(*Linkages to Assemblers*) × *Tier 3*			0.09	0.057	1.684
Log(*Linkages to Customers*) × *Tier 2*			0.208	0.398	4.162*
Log(*Linkages to Customers*) × *Tier 3*			0.271	0.427	3.794***
Log(*Linkages to Suppliers*) × *Tier 2*			−0.103	−0.465	0.762
Log(*Linkages to Suppliers*) × *Tier 3*			0.033	−0.042	−0.779
Log(*Linkages to Peers*) × *Tier 2*			0.065	0.027	−1.734
Log(*Linkages to Peers*) × *Tier 3*			−0.355	−0.528	−2.274**
Ties to Government Agencies				0.05	−5.548**
Ties to Associations				0.595	−1.079
Ties to Foundations				−1.299	−1.812
Ties to Universities				0.037	−2.409
Ties to Consultants				−2.142*	−15.016***
Ties to Banks				−0.371	3.809
Product Development Assistance					26.518***
Training Assistance					2.867**
Number of observations	90	90	90	90	90
Log likelihood	−36.754	−33.468	−31.307	−28.704	−13.491
LR test		0.16	0.83	0.52	<0.00

*p<0.10; **p<0.05; ***p<0.01.
Engine is the omitted variable for *Chassis* and *Plastics*.
Tier 1 is the omitted variable for Tier 2 and Tier 3.
Model suffers from complete separation. *Process Development Assistance*, which is omitted in these models, perfectly predicts *New Process*. See cross-tabulation reported in Table 4.

Table 7 Comparing the effect of linkages to different alters (Hypothesis 1)

Linkage measure	*New Product*			*New Process*		
	Tier 1	*Tier 2*	*Tier 3*	*Tier 1*	*Tier 2*	*Tier 3*
Assemblers	(↓) across full range	(↑) first few ties	(=) no impact	(↑) first few ties	(↑) first few ties	(↑) first few ties
Customers	(=) no impact	(↓) mostly first ties	(=) no impact	(↓) first few ties	(=) no impact	(=) no impact
Suppliers	(=) no impact	(↑) first few ties	(↑) first few ties	(↓) first few ties	(=) no impact	(↓) first few ties
Peers	(=) no impact	(↑) mostly first ties	(=) no impact	(↑) first few ties	(=) no impact	(=) no impact

Table 8 Comparing the marginal impact of ties (Hypothesis 2)

Linkage measure	*New Product*		*New Process*	
	Tier 1 vs Tier 2	*Tier 1 vs Tier 3*	*Tier1 vs Tier2*	*Tier1 vs Tier3*
Assemblers	Tier 2 > Tier 1 (significant above 5 ties, p-value 0.01 to 0.10)	Tier 3 > Tier 1 (significant above 10 ties, p-value 0.05 to 0.10)	No significant difference	No significant difference
Customers	No significant difference	No significant difference	No significant difference	No significant difference
Suppliers	No significant difference	No significant difference	No significant difference	No significant difference
Peers	No significant difference	Tier 1 > Tier 3 (significant across full range, p-value 0.05 to 0.10)	No significant difference	No significant difference

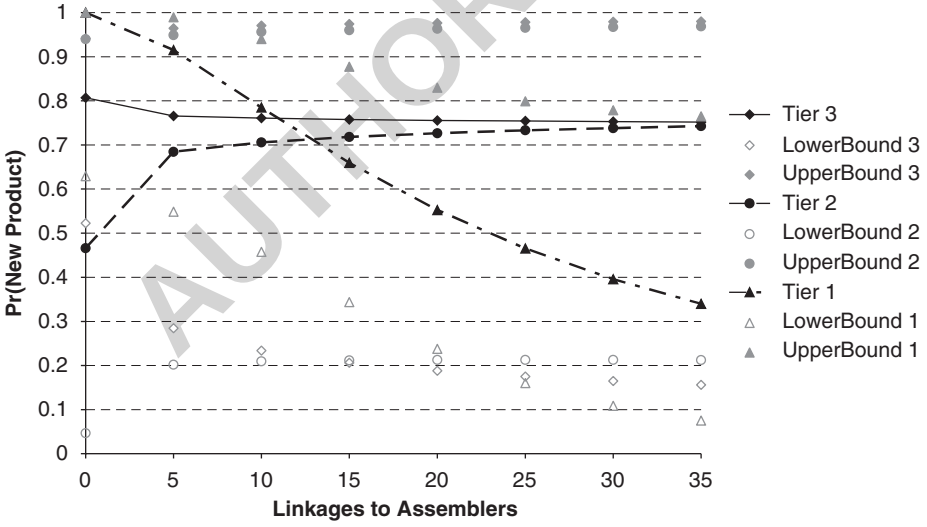

Figure 1 Probability of *New Product* vs *Linkages to Assemblers*.

almost always insignificant in product upgrading.[10] The most salient in process upgrading are *Knowledge Stock* (positive and significant at the 0.01 level), *Plastics* (negative and significant at the 0.05 level in the full model), and *Sales Concentration* (negative and significant at the 0.01 level in the full model). The results for *Knowledge Stock* are consistent with the work showing that the more a firm is populated with higher-educated employees, the more it is able to absorb new processes and practices effectively (Guillen, 1994). The results for *Sales Concentration* are consistent with work on the automotive industry and our field interviews that suggest that suppliers may underinvest because assemblers appear opportunistic by frequently changing orders regardless of prior agreements (Dyer & Hatch, 2006;

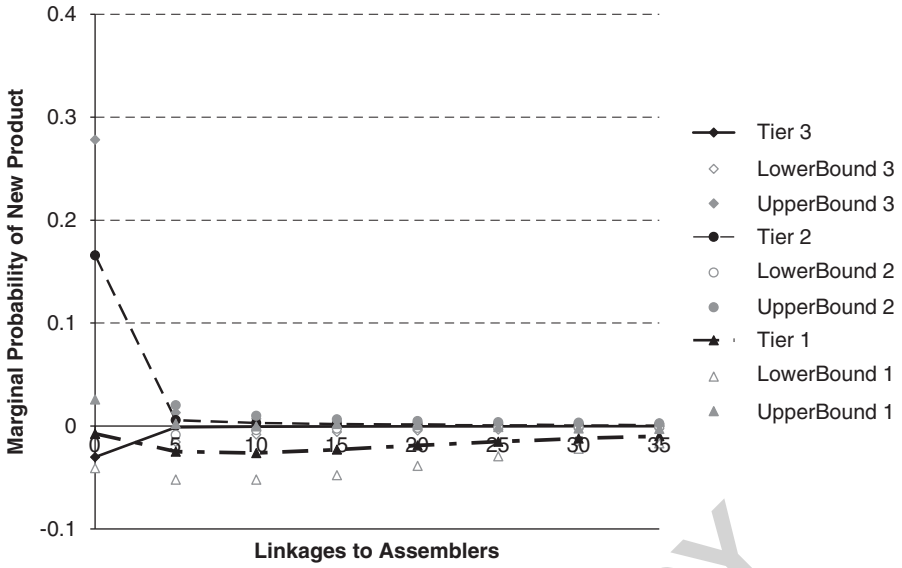

Figure 2 Marginal probability of *New Product* vs *Linkages to Assemblers*.

MacDuffie & Helper, 2006). But these researchers and our interlocutors also note how certain collaborative relationships can diminish these problems, as we will discuss below.

The *Tier* variables are often negative, but only in the full model for product upgrading do they reach notable significance (e.g., Tier 2 at the 0.01 level). This trend is also found in the graphic results for the delta method. For all types of linkages we find that the main effects for differences in the probability of process and product upgrading between Tier 2 and Tier 1 as well as between Tier 3 and Tier 1 are not significant at the 0.05 level, as indicated, e.g., in Figure 1 by the overlapping of the respective confidence intervals. One can also assess the predicted values for tiers by comparing the initial levels of the predicted probability of upgrading of the different tier schedules. Regardless of the type of linkage (and shown in the example of Figure 1), we find that firms in Tier 2 and Tier 3 have lower initial levels than firms in Tier 1 for the predicted probability of product upgrading, but that there are no differences between tiers in the initial level of the predicted probability of process upgrading. Hence the evidence suggests that being located in Tiers 2 and 3 can be a liability for product upgrading, but not necessarily for process upgrading. These results would give some support to the view that lower-tier firms in emerging markets are at an *ex ante* deficit in product upgrading but not necessarily in process upgrading. Knowledge about new products depends on the MNEs giving suppliers regular access to their product development activities, while knowledge about new processes may be more generic and dependent on the educational levels of key personnel (Humphrey & Memedovic, 2003).

The key issue, however, is whether certain types of socio-professional ties can ameliorate the possible negative effects of being located in a lower tier. With this in mind, we now evaluate how linkages to particular categories of firms and organizations, and close collaborative relationships, can improve the likelihood of upgrading. The logistic regressions reveal limited support for Hypotheses 1a–d, which focus on whether the increase of linkages to different firms in the value chain improves upgrading. For product upgrading, the addition of the blocs of *Linkages* variables does not improve the goodness of fit in Model 2, and only *Linkages to Assemblers* is significant but negative in the full model. We find similar results in process upgrading, where only *Linkages to Customers* is significant but negative.

But, as noted above, a more accurate assessment of the effects of the different types of linkages is found via the delta method: that is, discerning whether increases in the measure of the respective linkages are associated with increases in the predicted probability of upgrading for the focal firm in a given tier. Table 7 summarizes these results for all types of linkages, and Figure 1 gives an example for Linkages to Assemblers. For increases in the predicted probability of product upgrading,

we find that *Linkages to Assemblers* has a negative impact across the whole range for the average firm in Tier 1, but a positive initial impact for the average firm in Tier 2. *Linkages to Customers* has a marked negative impact for Tier 2 firms, whereas *Linkages to Suppliers* has a positive impact for firms in Tiers 2 and 3. *Linkages to Peers* has a positive impact for firms in Tier 2. For increases in the predicted probability of process upgrading, it appears that *Linkages to Assemblers* has a positive impact for the average firm in all tiers, that is, when the variable increases from 0 to 5. *Linkages to Suppliers* has a negative impact for the average firm in Tier 1 and Tier 3. *Linkages to Customers* has a negative impact on Tier 1, mostly concentrated in the first few linkages. In contrast, *Linkages to Peers* has a positive impact only for the average firm in Tier 1.

While these results offer mixed results for Hypotheses 1a–d, they also highlight three important tendencies that depart from a common view in research on emerging markets about the binary or all-encompassing impact of variables related to embeddedness and the technological imperatives of an industry (Albornoz & Yoguel, 2004; Giuliani et al., 2005; Humphrey & Memedovic, 2003). First, no linkage is unequivocally associated with increases in the likelihood of process and product upgrading across all tiers. Rather, as Lin (2001) has emphasized, we see variation according to the type of firm, to which the focal firm is tied, and the tier of the focal firm. Depending on the tier you are in, linkages to certain firms are associated with increases in the likelihood of upgrading, while others appear less helpful. Second, to the extent that linkages to a certain type of firm do have a positive impact for firms in Tiers 2 and 3, they hardly ever help the firms overcome the liability of being located in the lower tiers. The exception is for *Linkages to Assemblers* (Figure 1), but this is tempered in product upgrading by the sharp decline in the schedule for firms in Tier 1. Third, it appears that the positive impacts of social linkages are most noticeable for the initial increases in our measures of linkages.

These considerations about the variable impact of linkages on certain types of firms and their diminishing returns, are reinforced in evaluating the results for Hypotheses 2a–d, which focus on the marginal impact of the linkage when interacted with tiers. These hypotheses appear to have stronger support. For product upgrading (Table 5), the addition of the blocs of interaction variables improves the goodness of fit in Model 3 at the 0.01 level, and all the interaction variables are significant at the 0.05 and 0.01 levels, except for those associated with *Linkages to Peers*. The interaction variables associated with *Linkages to Assemblers* and *Linkages to Suppliers* are positive, whereas those associated with *Linkages to Customers* are negative. For process upgrading, the addition of the blocs of interaction terms does not significantly improve the goodness of fit in Model 3. But in the full Model 5, the interaction variable of *Linkages to Assemblers* with Tier 2 is positive and significant at the 0.05 level, while *Linkages to Customers* is positive and significant when interacted with Tier 2 (at the 0.10 level) and with Tier 3 (at the 0.01 level).

Again, because of the non-linearity of our models, a more accurate picture emerges from the analysis using the delta method, as summarized in Table 8 and exemplified graphically in Figure 2, which depicts the estimated relationship between a one-unit increase in a focal firm's measure of *Linkages to Assemblers* and the change in the predicted probability of product upgrading. While we do not find support for Hypotheses 2a–d for process upgrading, the results for product upgrading are more intriguing. The marginal effect of *Linkages to Assemblers* on product upgrading for firms in Tiers 2 and 3 is significantly larger than for firms in Tier 1. At the same time, the marginal effect of *Linkages to Peers* on product upgrading is significantly larger for firms in Tier 1 than for firms in Tier 3. In general, we observe from our graphs that the marginal effects decline after the first few linkages.

These results buttress our above observations, and coincide with recent work on network analysis and upgrading. Our analysis of both the predicted probabilities and the marginal effects reveals that the value of certain social ties is not uniform, but varies considerably according to the type of upgrading and the tier of the focal firm. Such scholars as Burt (2000), Lin (2001), and Sorenson, Rivkin, and Fleming (2006) have increasingly sought to show how the accrual of knowledge resources to firms depends less on market forces or the overall embeddedness of the sector *per se*, and more on the ways in which relational and structural variables interact to shape the value of certain alters and certain types of information. This perspective is gaining increasing traction in recent qualitative research on upgrading the automotive industry, and in various manufacturing sectors in emerging markets. In countering the modularization view, MacDuffie and Helper (2006) and Herrigel (2004)

have emphasized that because assemblers often change orders, and bargain over costs directly with firms in lower tiers, Tier 1 firms lose their organizational role in the value chain. They tend to abandon relational contracting and become extra guarded about sharing knowledge with customers and suppliers, while lower-tier firms are forced to seek knowledge elsewhere. These observations are echoed in research on Latin America (Humphrey & Memedovic, 2003; Kotabe et al., 2007) and our own interviews in Argentina. Because of the disruptions by assemblers, MNEs in Tier 1 tend to find little value in coordinating with Tier 2 firms, and often rely on their peers and their headquarters for access to key knowledge and resources. At the same time, domestic suppliers in Tiers 2 and 3 claim to learn more about new technologies and practices from direct relationships with the international assemblers than from others in the value chain.

Since the above results emphasize the limited sources of value from social ties to other firms in the value chain and their diminishing returns, evaluating our remaining hypotheses takes on increasing relevance. Hypotheses 3a–e focus on the value found in ties to organizations and institutions in the given region, but they have minimal support. The addition of the blocs of these variables does not significantly improve the goodness of fit in Model 4, and most variables are insignificant and behave in different directions (Tables 5 and 6). In product upgrading, *Ties to Universities* is positive and significant at the 0.05 level. In process upgrading, only *Ties to Government Agencies* and to *Consultants* are significant (at the 0.05 and 0.01 levels, respectively), but negative. Although conclusions about causation are limited, owing to the cross-sectional nature of the data, these results coincide with two trends in the literature on development – the relative importance of ties between industry and universities, especially in the area of product development, and the concerns about trade associations and government providing adequate support for upgrading in Latin America (Conceição et al., 2003; Schmitz, 2004; Sutz, 2000).

Hypothesis 4 focused on the quality of relationships between suppliers and customers, and appears to have strong support. The addition of the blocs of *Assistance* variables does improve the goodness of fit in the full Model 5 at the 0.001 level for process upgrading, and at the 0.05 level for product upgrading. Moreover, we see a significant, positive impact of certain types of customer assistance. For product upgrading, only *Product Development Assistance* is positive and significant (at the 0.05 level). For process upgrading, we found complete separation of the data, which makes the maximum likelihood estimation of the model unreliable. Complete separation is caused, because none of the observations lacking *Process Development Assistance* have generated process upgrading (see Table 4 for the cross-tabulation analysis of *Process Development Assistance* and *Tier* vs *New Process*). Therefore, despite the clear effect of *Process Development Assistance*, we are forced to drop the variable from the model to be able to estimate an impact of the rest of the independent variables on *New Process*. The results for this model show that *Product Development Assistance* and *Training Assistance* are both positive and significant at the 0.01 and 0.05 levels, respectively.

These results would tend to support the arguments that collaborative relationships between suppliers and customers, as manifested in customer-initiated assistance programs, are highly associated with the transfer of tacit knowledge and innovation (Dyer & Hatch, 2006; Helper & Kiehl, 2004; Helper et al., 2000). Moreover, the combination of results for process upgrading, such as the positive impact of *Knowledge Stock* and *Process Development Assistance* as well as the negative impact of *Sales Concentration*, coincides with prior research focusing on the ways in which collaborative inter-firm routines coincide with investing in a firm's internal knowledge base and could reduce the harmful effects opportunism (Dyer & Singh, 1998; MacDuffie & Helper, 2006).

But perhaps more importantly, these results, when taken together with the those showing the decreasing returns from adding many linkages, support the notion that different types of network resources can be found not simply in measuring the number of ties a firm has to a particular type of organization but often via the quality of the relationship it has with a few other organizations. That is, in this context, the results from the delta method and our assistance measures suggest that firms are more likely to improve product and process upgrading not through many, possibly weak ties, but rather through a few collaborative ties.

Such conclusions about causality are naturally tempered by the cross-sectional nature of our data. While several of our control variables help limit the concerns about endogeneity, the growing

qualitative evidence from research in both advanced and developing countries supports the notion that this type of relationship can advance learning and knowledge diffusion. For instance, both Sorenson et al. (2006) and Christensen and Bower (1996) have shown that close, highly interactive relationships between firms, especially between customers and suppliers, facilitate the transfer of highly specialized, tacit knowledge critical for product and process innovation. Dyer and Singh (1998) and Dyer and Hatch (2006) have argued that such relationships are characterized by specific inter-firm routines that improve coordination in turbulent environments. MacDuffie and Helper (2006) and Herrigel (2004) have argued that, because of market turbulence and the highly tacit nature of knowledge related to process and product innovation, suppliers and customers accelerate their learning and ability to coordinate when they develop routines that promote joint problem-solving. This view is also echoed in recent work in emerging markets. For instance, several scholars studying a variety of industries from Asia to East Europe to Latin America give anecdotal evidence that suppliers to MNEs appear to improve their practices and productivity when they receive direct, regular assistance from the MNEs themselves (Blalock & Gertler, 2005; Schmitz, 2004). Recent work on the automotive industry in Brazil and Mexico also shows that local suppliers dramatically improved their innovation rates and lean production practices when they had access to joint R&D and training programs (Carrillo, 2004; Kotabe et al., 2007).

CONCLUDING REMARKS

This paper attempted to examine the increasingly overlapping debates found in the international business and development literatures about the mechanisms that facilitate or impede firm-level upgrading in emerging-market countries. While controlling for several common explanatory factors, such as a firm's demographics, resource endowments, and structural position in the value chain (i.e., *Tier*), we focused our analysis on the ways in which different types of inter-organizational relationships can enable or constrain process and product upgrading in autoparts suppliers in Argentina during the 1990s. Although our cross-sectional sample and the nature of the survey posed certain limitations on causal inference, the data had some interesting advantages. As with many other countries in emerging markets, especially in Latin America, Argentina relied heavily on policies that promoted market incentives and the entry of MNEs to drive the reorganization and renewal of the automotive industry. Our sample's survivor bias after a brutal shakeout and geographic control allowed us to discern which types of firm-level, structural and relational factors appear to facilitate process and product upgrading.

Our analysis therefore not only builds on growing qualitative evidence in the international automotive industry about the role of relational factors in promoting knowledge transfer, but also contributes to the growing research in emerging markets about how the social and institutional embeddedness of firms shapes upgrading. Our analysis suggests that firm-level upgrading is not simply a product of market liberalization or technological determinism; it is, especially, a product of certain types of organizational relationships, which are not equally distributed. Given the common weaknesses of institutions and clusters in environments such as Latin America, identification of the types of relationships that can facilitate or limit upgrading allows one to focus attention on the public and private strategies that can deepen and expand the more productive organizational and institutional configurations.

While such factors as a firm's knowledge stock and tier location can significantly shape its process and product upgrading, respectively, our analysis highlighted in three important ways the relative value of a firm's social ties to certain organizations and institutions, as well as the importance of collaborative relationships between customers and suppliers. First, the evidence suggests that the value of social and professional ties is not uniform, but varies significantly according to the type of organization. Ties to some actors within and outside the value chain, such as assemblers, suppliers, and universities, appear to improve the likelihood of process and product upgrading, whereas ties to other types of organizations and institutions may constrain or offer few relevant resources or information to firms.

Second, it appears that the value a supplier gains from social ties to other firms in the value chain interacts in many ways with its structural position in the value chain or tier. For instance, social ties to assemblers appear to facilitate upgrading for suppliers in Tiers 2 and 3, which tend to be small and medium-sized domestic firms, but social ties to their peers appear to have value for suppliers in Tier 1, which tend to be MNEs. These sets of results

coincide with recent research emphasizing the notion that emerging-market firms can gain new knowledge from social ties to MNEs and from participating in R&D programs in universities, but that their local organizational and institutional environments may be too weak to offer relevant resources and information (Conceição et al., 2003; Giuliani et al., 2005; Moran et al., 2005).

Third, the evidence suggests that the quality of inter-firm relationships and not simply the quantity of social ties may be especially beneficial for upgrading. While our analysis of the marginal effects points to diminishing returns on upgrading for the addition of many social ties, our *Assistance* variables appear to significantly improve the likelihood of a supplier's ability to upgrade its products and processes. Such findings tend to support recent research arguing that collaborative, joint problem-solving relationships rooted in customer-initiated assistance programs are likely to facilitate learning and knowledge transfer for suppliers (Dyer & Hatch, 2006; MacDuffie & Helper, 2006).

These results suggest two important conclusions. First, as emphasized in this article, analysis of relational factors is likely to yield more valuable insights for managers and policymakers in emerging markets, to the extent that it can begin to differentiate the relative of impact of different types of inter-organizational relationships on upgrading. Our analysis tried to distinguish the value of relationships according to the type of organization to which a firm is tied, and the quality of the tie. We also found that the impact of certain social ties can vary according to one's tier. As several network scholars have increasingly argued (Burt, 2000; Gulati et al., 2000; Lin, 2001), considerations about the variety of network resources, be they by interacting structural and relational variables or by parsing out strong and weak ties, allow one to identify more consistently how certain types of knowledge resources flow through distinct patterns of relationships. Such an approach also allows one to identify which types of relationships and organizations may constrain upgrading, or lack the relevant resources and knowledge to support upgrading. For instance, in some contexts MNEs might be the key source of knowledge whereas in others collaborative ties among local firms and their institutions might create relative advantage, regardless of the type of industry. In the context of the Argentine automotive industry, non-market organizations and institutions appear weak as supporters of upgrading, while domestic firms appear more likely to benefit from collaborative relationships with assemblers and their customers. As mentioned above, this is an increasingly common observation from the case-based research in Latin American and other emerging-market countries (Blalock & Gertler, 2005; Carrillo, 2004; Gereffi et al., 2005). The issue is not simply whether economic activity is embedded or not in a robust cluster, but rather how network resources vary in an industry or region, and what types of firm strategies and public policies can effectively reconfigure them.

Second, to the extent that certain types of inter-organizational relationships are likely to be exclusive and unequally distributed across firms, a key issue for scholars of international business and development alike is discerning how they come about or can be expanded to a greater variety of actors. For instance, the evidence presented in the cross-tabulation analysis of the *Process Development Assistance* variable in Table 4 suggests that collaborative customer–supplier relationships are not the privilege of firms in one specific tier. Quadros (2004) also finds no clear evidence about whether even ISO certification facilitates or restricts collaborative relationships between local suppliers and foreign firms in Brazil.

There are two related ways to approach this issue. One approach that has gained increasing currency in the management literature attempts to identify the firm-level routines and resources that tend to promote inter-firm, knowledge-creating relationships. Much of the research on the spillover effects of FDI and on upgrading in developing countries has often paid closer systematic attention to firm-level resources or to the possibilities for joint action among firms, but rarely to both (Meyer, 2004; Moran et al., 2005). Given the topic of this article, research from the automotive literature may be especially helpful here, even if it tends to focus on the advanced industrialized countries. The work by Dyer and Singh (1998), Dyer and Hatch (2006), MacDuffie and Helper (2006), and Sako (2004) offers both qualitative and quantitative evidence that specific inter-firm collaborative routines go hand in hand with firm-level exploration of different organizational routines and investments in the internal knowledge base. Our own data coincide with this view, as the *Knowledge Stock* and *Process Development Assistance* variables appear to improve the likelihood of process upgrading. But whether such conditions fall strictly within the purview of firm strategy or public policy brings us

to the second analytical approach, which focuses on the institutional environment of the firm.

The research on international management and FDI spillovers often focuses on the effect of secure property rights, patents, and policies such as local content requirements (Henisz & Zelner, 2005; Zhao, 2006; Moran et al., 2005). This perspective on institutions has yielded several important insights into the likelihood of foreign firms sharing proprietary knowledge, but rarely incorporates network analysis. At the same time, research on inter-firm relationships often takes the institutional environment as given. In turn, there is a great opportunity for researchers on FDI, development, and economic sociology to learn from one another about how institutions and inter-firm networks co-evolve, and what types of public policies can improve collaborative relationships and the upgrading value of local non-market organizations and institutions. Qualitative research on China and Mexico suggests that policies that strengthen local R&D and training institutions can expand the universe of potential partners for MNEs, and facilitate the flow of knowledge between them (Carrillo, 2004; Zhao et al., 2005). Research on manufacturing and agricultural sectors in the United States, East Europe, and South America also gives evidence that certain types of public-private institutions providing technology and extension services can reshape the quality and structure of relationships among participating firms (Herrigel, 2004; McDermott, 2007; McEvily & Zaheer, 1999). This article can be viewed as a first step toward integrating these approaches.

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NOTES

[1]Some firms are located on the edge of the city of Buenos Aires, which borders the province of Buenos Aires. Practitioners view this as a single region, as firms are relatively close to one another.

[2]The Argentine government used three policy levers. First, it established a new Auto Regime that combined tax and tariff incentives with local content rules. Second, it reformed labor laws to increase labor flexibility. Third, Argentina and Brazil deepened trade within the Mercosur, which included specific agreements for the automotive industry to ensure tariff-free trade in vehicles and parts, and a common tariff barrier. Special provisions for common local content rules and balancing intra-industry trade would be phased out by 2000.

[3]Toyota would enter Argentina in 2000, and ramp up production after 2001. Hence the effects of Toyota are not captured in the aforementioned survey.

[4]Geography would be another factor. But since our sample includes firms for more or less the same region in Argentina, geographic distance is implicitly controlled in our study.

[5]It is worth noting that much of the evidence for these relationships has come from studies of Japanese assemblers and their suppliers. There were no Japanese OEMs in Argentina, until Toyota entered at the end of the 1990s.

[6]We utilized this measure instead of R&D expenditures since anecdotal evidence and analysis of the data in the sample reveal that in this sector small firms cannot allocate R&D expenditures easily, and usually under-report their investment.

[7]A full discussion of the data collection and survey methods can be found in Español et al. (2000). They note that the focal firm had the survey before the actual interview, and in the meantime the contact person in the firm collected data on different issues from the relevant employees of the firm.

[8]Complete separation occurs when there is a linear combination of the prediction variable such that whenever the combination is above 0 then the dependent variable is equal to 1, and when the combination is below 0 then the dependent variable is equal to 0. In our case, *Process Development Assistance* is a strong predictor of *New Process.*

[9]We want to thank an anonymous reviewer for making us aware of this issue, and for pointing us in this direction.

[10]Somewhat surprisingly, the variable for FDI is not significant, and often the sign is negative. We also ran models interacting FDI with the *Linkages* variables, but these were insignificant too. The literature offers several possible reasons, including buyers' remorse and asymmetric information problems. This may also

be an artifact of the data, as Ravi Ramamurti pointed out to us. In a context such as Argentina, the foreign-owned firms were the first to upgrade, and then lower-tier firms followed. In turn, by the time of the survey, foreign firms may not have recently undertaken big improvements.

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