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Abstract This paper examines the innovation performance of MNE subsidiaries and their embeddedness in sources of local knowledge and in a policy framework within the context of an emerging economy. Based on first-hand evidence from multiple case studies we found that: (1) There was variability between the subsidiaries in terms of the cumulative manner and speed at which they improved their innovation performance over time, using progressively levels of accumulated capability as a proxy; (2) These differences in innovation performance improvement reflected heterogeneity between the subsidiaries in terms of the *learning efforts* made by them to acquire knowledge from local organisations; (3) The varied frequency in which the subsidiaries developed such local relationships reflects their differing responses to a common industrial policy that makes use of tax incentives to stimulate such links. The paper reveals the limitations of this conventional type of industrial policy in stimulating industrial development and the embeddedness of MNEs. It also suggests that a new direction for policy, which incorporates public-private negotiations and a focus on the firm-centred building of innovation capabilities, should be pursued in order to accelerate the innovation performance progress of latecomer firms.

Keywords MNE-subsidiaries; innovation performance; capability accumulation; local embeddedness; learning links.

JEL codes O31, O32, 014

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1 Introduction

Since the early 1990s, firms in both industrialised and emerging economies have been operating in a rapidly moving business environment that has been characterised by (i) an openness to global competition, and (ii) the dispersion and decomposition of the geographical sources of production and innovation. These developments reflect an ongoing process of change in the distribution of knowledge worldwide (Schmitz and Strambach 2009). In such a context, maintaining a competitive edge increasingly depends on building and renewing knowledge bases, despite most firms no longer being self-sufficient in terms of knowledge. Successful innovation performance is becoming increasingly dependent on an ability to tap into and absorb knowledge from various external sources (Chesbrough 2006; Laursen and Salter 2006; Teece 2007).

Multinational enterprises (MNEs) would appear to be in a good strategic position to respond to these global competitive conditions, in that their subsidiaries are *potentially* embedded in the external networks of local organisations (e.g. universities, research institutes, suppliers, and competitors), which may be distributed around the world. Furthermore, since the early 1990s a rapid decentralisation of their processes of knowledge creation and innovation has been taking place, thus increasing their capacity to carry out high-value activities (Meyer-Krahmer and Roger 1999; Gerybadze 2003).

The ways in which MNEs interact with their local environment, especially with respect to their knowledge-related links, seems to play a critical role in this decentralisation process. Over the past few years, several studies have examined the effect of embeddedness in the local environment on the innovation performance of subsidiaries, in terms of the extent to which the subsidiaries develop relationships with local organisations, such as universities, research institutes, consulting firms, clients, and suppliers (Andersson et al. 2001; Andersson et al. 2002; Andersson and Forsgren 2000; Kuemmerle 2002; Almeida and Phene 2004).

Although these studies have yielded explanations for the effect of such sources of knowledge on the innovation performance of subsidiaries, they have tended to focus on those subsidiaries that are located in highly industrialised economies. In such countries, sophisticated innovation capabilities generally *already exist* because the subsidiaries normally operate at or near the international frontier of innovation. In consequence, researchers tend to focus on how these firms *exploit* and *augment* such innovation-related resources in order to push the international technological frontier forwards. Consequently, they tend to track innovation performance on the basis of patent citations and/or R&D expenditure.

In contrast to the situation in highly industrialised economies, those firms that operate in developing or emerging economies, including MNE subsidiaries, may be characterised as being “initially imitative”, regardless of how dislocated they are from markets and sources of technology. They must first familiarise themselves with various different ways of acquiring knowledge, in order to *learn* how to undertake production and to engage in innovation activities at a basic level (Bell and Pavitt 1993; Kim 1998). On the other hand, like local latecomer firms, MNE subsidiaries have become embedded in, or at least have access to, increasingly pervasive international networks of *potential* sources of technology. This finding is consistent with the view that subsidiaries are not simply strategically passive components of hierarchical corporate structures. Instead, they are potentially active enterprises in their own right that have the ability to shape their own developmental pathways in a significant way, at the interface between local economies and global corporate networks (Birkinshaw et al. 1998; Cantwell and Janne 1999; Birkinshaw et al. 2005; Cantwell and Mudambi 2005).

In order to better understand why some subsidiaries achieve a superior performance in local and global markets, researchers must explain how capability is built up within the subsidiary in the first place (Andersson et al. 2002). In the context of developing and emerging economies, a critical task for researchers is to understand the extent to which subsidiaries move from the accumulation of *production* (i.e. purely imitative) capabilities to the accumulation of different degrees of *innovation* capability, in order to achieve levels of innovation performance that enable them to compete internationally (Bell and Pavitt 1993). In addition, in highly industrialised economies, networks of local knowledge tend to be rather more consolidated, robust, and advanced than those in developing and emerging economies that are in the process of being built up (Bell 2006). Local policy frameworks would appear to play an important role in such processes (Evans 1995; Rodrik 2004); hence, it is important to understand the manner in which subsidiaries are stimulated to tap into local knowledge systems in order that their innovation performance may be improved.

To date, researchers have paid scant attention to the nature of the process of knowledge acquisition in subsidiaries that operate in developing, emerging, or latecomer contexts (Meyer 2004). Nevertheless, some studies have made use of detailed aggregate analysis to investigate the nature of spill-overs from subsidiaries (e.g. Marin and Bell 2006) and in terms of knowledge flows and innovative activities (e.g. Yamin and Otto 2004; Boehe 2007; Yang et al. 2008;). Some have focused on the role of intracorporate knowledge links in influencing the accumulation of capability by subsidiaries (e.g. Ariffin and Bell 1999; Ariffin 2000, Ariffin and Figueiredo 2004;), while others have examined the capabilities of subsidiaries from the point of view of a regional innovation system (e.g. Iammarino et al. 2008). There nevertheless remains scant evidence at the level of individual firms that relates to the differences between subsidiaries in terms of the manner in which they become embedded in local systems of knowledge under a common policy framework (hereafter, local embeddedness) and the implications of this for the development of their innovation performance.

By examining innovation performance on the basis of levels of the accumulation of progressively levels of capabilities, and by drawing on evidence from various case studies derived from field-based research, this paper seeks to identify and describe the aforementioned knowledge gap by reference to the related literature. The remainder of the paper is organised as follows. Section 2 provides details of the analytical framework used in the paper. The research methods are outlined in Section 3. Section 4 presents the empirical analysis. Section 5 presents the concluding discussions and implications. Section 6 contains addresses the paper's limitations and implications for future research.

2 The innovation performance of subsidiaries and their local embeddedness

2.1 The innovation performance of subsidiaries

The creation of value in subsidiaries, and the distinctiveness of their corporate character within their global and local markets, depend largely on their ability to innovate in products, production, and organisational processes and services (Bartlett and Ghoshal 1990; Andersson et al. 2002; Almeida and Phene 2004). In order to undertake innovation activities, firms draw on their internal capabilities and on those of their partners. In this paper, a firm's capabilities consist of a stock of resources that permit firms to undertake *production* and *differing degrees* of innovation activity. Such capabilities are accumulated in the human resources and the organisational systems that exist both inside and outside the firm (Bell and Pavitt 1995).

Following the definitions used by Bell and Pavitt (1995), this paper distinguishes between *production* capability (i.e. the resources required to *use* existing technologies and production systems at given levels of efficiency) and *innovation* capabilities (i.e. the resources required to create, change or improve products, services, processes and the organisation of production). Both kinds of capability exist within firms. The accumulation of production capability tends to constitute the basis for the accumulation of innovation capability, although the relationship is not linear. Progressively higher levels of innovation capability represent strategic assets that can distinguish a firm in the market (Lall 1992; Bell and Pavitt 1995). For this reason, this paper is concerned with the means by which subsidiaries accumulate such capabilities.

Levels of innovation performance can be classified in a number of ways. Rather than adopting traditional indicators of innovation performance (e.g. patent citations and R&D expenditure), this study draws on the typology developed in Lall (1992) and Bell and Pavitt (1995) in its differentiation between levels of capability that correspond to different degrees of novelty in innovation, in terms of processes, products, services, and organisation.

Such a typology has been used successfully in empirical studies of capability accumulation in subsidiaries (e.g. Ariffin and Bell 1999; Ariffin 2000; Figueiredo 2008; Iammarino et al. 2008). Studies of this kind have drawn on what might be referred to as a "revealed capability" approach. Rather than identifying levels of capability directly in terms of particular quantities and qualities of knowledge bases, they have instead identified levels of increasing novelty and significance in innovation *activity*. They have then inferred the different levels of capability that lie behind the different levels of *innovation performance* (see the condensed version of this typology in the Appendix). The left-hand column shows three levels of production performance and four levels of innovation performance that range from "basic" to "world leading/cutting edge". These descriptors are associated with different levels of capability.

Although the foregoing framework highlights those capabilities that are internal to the subsidiary, it also recognises the fact that a substantial part of its capability lies in the relevant corporate network and in local organisations (e.g. universities, research institutes, consulting firms, suppliers, and clients). In addition, this framework moves beyond perspectives that tend to classify a firm's performance as "innovative" *versus* "non-innovative". Instead, it adopts a nuanced perspective in terms of the levels of capability that are required to increase innovation activity, just as it also adopts a *dynamics* approach to firms' capabilities in its capture of changes in innovation performance over time. Such an approach is particularly important for examining the innovation performance of subsidiaries, because of their potential embeddedness both in the network of local organisations in their host country (Goshal and Bartlett 1990; Malnight 1995; Andersson et al. 2002). It is also relevant for examining the innovation performance of subsidiaries that operate in developing and/or emerging economies as such firms generally start from a condition of being "initially imitative".

2.2 The role of embeddedness in the innovation performance of subsidiaries

As highlighted in Granovetter (1992), embeddedness in a network can be studied either in terms of the position that partners occupy in that network (i.e. structural embeddedness) or in terms of the cohesive links that are used as mechanisms for acquiring knowledge (i.e. relational embeddeness). Given that we are concerned with the means by which subsidiaries achieve progressively higher levels of innovation performance by developing local relationships, embeddedness is herein examined from a *relational* standpoint.

Such view is consistent with the perspective that considers relational embeddedness as part of "strategic resource-seeking" strategies of subsidiaries (see Ghoshal and Barlett, 1990; Dunning, 1994, 1998; Narula and Dunning, 2010). Under such view relational embeddedness permits the access to and acquisition of knowledge underpinning subsidiaries' innovation performance. Such ties can become a unique source of information about the partners' capabilities (Gulati, 1998, p. 296). In line with Granovetter (1985, 1992), Zukin and DiMaggio (1990), Dyer and Singh (1998), Gulati (1998); Uzzi (1996), and Dacin et al. (1999), we consider that a large part of a firm's performance derives from the resource that exists in its network of relationships. Such a view has also been applied to previous research on internal and external embeddedness as sources of knowledge for capability development in subsidiaries (e.g. Andersson et al. 2002 and Garcia-Pont et al. 2009). Herein, the relational embeddedness of a subsidiary is thus defined in terms of the network of relationships with different local organisations – e.g. universities, research institutes, consulting firms, suppliers, and clients.

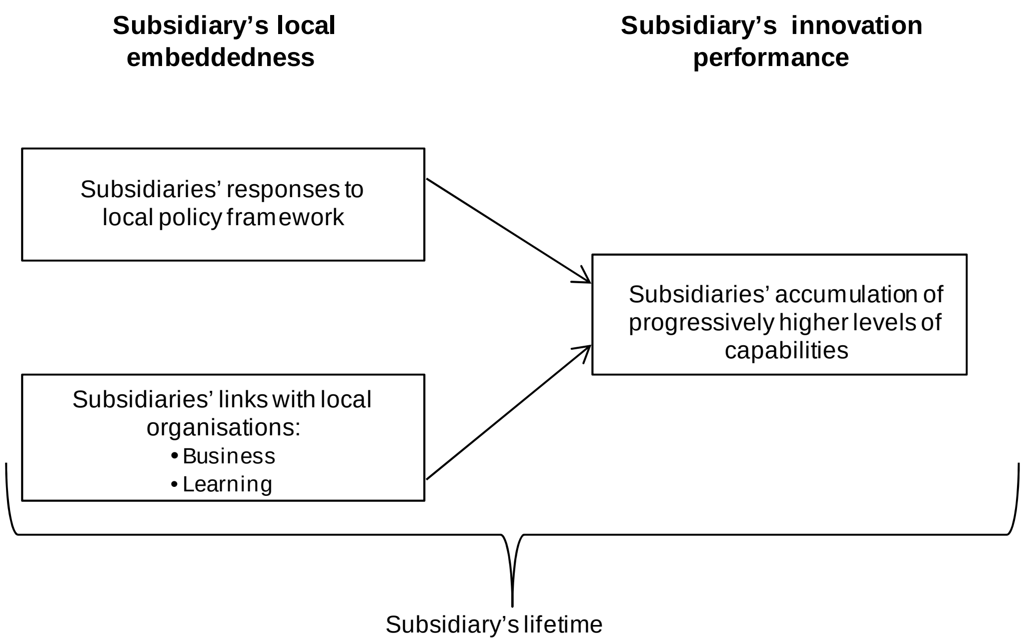
By drawing on the findings of Granovetter (1992), Gulati (1998), and Dyer and Singh (1998), relational embeddedness is herein given an operational definition using local inter-organisational links. As suggested in Dyer and Singh (1998) and empirically demonstrated in Ariffin and Bell (1999), Ariffin (2000), and Andersson et al. (2002), interorganisational interactions affect the innovation performance of subsidiaries in a variety of ways. By building on such studies, we therefore distinguish between interorganisational interactions that are based on *business links* and those based on *learning links*.

In particular, local *business links* involve market-type relationships, including the sale of goods and services, the purchase of physical systems, and other transactions that have no significant impact on the accumulation of capabilities. Local *learning links* involve the exchange and flow of different types of tacit and codified knowledge that could lead to significantly improved accumulation of capabilities. Although firms can engage in various relationships with different counterparts, the actual absorption of external knowledge will depend on the nature of firms' stock of knowledge (see Cohen and Levinthal 1990; Dyer and Singh 1998). In addition, in common with Dacin et al. (1999), we are concerned with the evolution of the local embeddedness of subsidiaries and its implications for innovation performance.

Embeddedness does not occur automatically, however, and is influenced by the response of the subsidiaries to local industrial policy and incentives (Lall 1992). Conventionally, industrial policy may be understood as a set of instruments chosen by bureaucrats and implemented on a top-down basis or by a principal (government) – agent (firms) model. Herein, industrial policy is instead framed in terms of a *process* that combines both public and private initiatives and decision-making, and involves a range of different institutional arrangements (Rodrik 2004). From such a standpoint, industrial policy-making "cannot be one in which the private sector is kept at arm's length and autonomous bureaucrats issue directives" (Rodrik 2004, p. 17). Instead, it is embedded within a network of interactions between government and the private sector and may even be targeted towards the building of innovation capability (Evans 1995; Rodrik 2004; Avnimelech and Teubal 2008).

As suggested by Rodrik (2004), the most appropriate model for industrial policy is not one in which an autonomous government applies taxes, direct credit, and R&D subsidies to determine whether (for example) the steel or the software industry should be promoted (i.e. selection). Rather, it is one in which strategic collaboration is set up between the private sector and the government. The analysis of policy should thus be focused less on outcomes and rather more on the *process* of policy making. In addition, irrespective of the availability of subsidies, MNEs are unlikely to become embedded in the absence of absorptive capacity in the domestic economy (Criscuolo and Narula 2008) and, more specifically, without subsidiaries' deliberate internal efforts to build up capabilities (Bell and Pavitt 1993, 1995). Herein, we are concerned with the dynamics of the innovation performance of subsidiaries, and the role of embeddedness in local knowledge sources and policy frameworks as illustrated in Figure 1.

Figure 1 Innovation performance of subsidiaries and the importance of local embeddedness



We recognise that the embeddedness of subsidiaries is influenced by a number of factors. However, we herein focus our analysis on the relationship between the innovation performance of subsidiaries and the underlying local links and policy framework. Consideration of intracorporate knowledge links lies beyond the scope of this paper. In addition, the embeddedness of subsidiaries is influenced by characteristics such as age, nationality, and the initiative of its leadership. These factors, however, lie outside the focus of our analysis.[2]

3 Methods

3.1 Research strategy

The thrust of this paper derives from an empirical study based on two years of fieldwork implemented in three stages: exploratory, pilot, and main fieldwork. In line with the analytical framework, we designed the study underpinning this paper using multiple case studies. Such design permits a more detailed investigation of the processes involved than other methods (Eisenhardt 1989; Yin 2003; Pauwels and Matthyssens 2004).

[2] Indeed, in the broader study from which this paper derives, we have examined the role of both intra-corporate and local link in affecting the innovation performance improvement of subsidiaries.

3.2 Empirical setting and sampling

The selection of case studies began during the exploratory stage, with the aim of testing the feasibility of the research. The original idea was to examine the technological behaviour of subsidiaries in Brazil in the electronics industry from the late 1990s onwards, under a specific local industrial policy. This policy was implemented in the mid 1990s in order to provide fiscal incentives for companies to engage in innovation, particularly that which made use of links with local organisations. The policy is known as the information and communication technologies policy (hereafter the ICT Law). In order to obtain the fiscal benefits of the policy, ICT-related firms must invest at least 2.3 percent of their revenues in universities, research institutes, and laboratories in Brazil. Firms are given the option of not undertaking such investments, but instead simply allocating the requisite amount to a government fund. However, this is a conventional type of industrial policy that is based on the selection of specific sectors and on tax incentives.

After several consultations with industry specialists, and in consideration of the fact that we required an in-depth study and an analytical generalisation (Eisenhardt 1989; Yin 2003), our initial sampling used 12 different case studies. During the pilot stage, we negotiated access to the subsidiaries. We did so by contacting the subsidiary's chief executive in order to clarify the purpose and legitimacy of our research (Marschan-Piekkari et al. 2004). This proved essential for tapping into a wide range of sources, including industrial directors, managers, engineers, researchers, technicians, consultants, operators and human resources managers, engineering departments, R&D units, labs, shop-floor personnel, retired staff, and archival records.

Following completion of the pilot stage, we deliberately selected (Yin 2003) those subsidiaries that: (i) were related to the ICT industry; (ii) belonged to different MNEs and countries; (iii) had began their operations in Brazil around the same time, particularly in the 1990s when the ICT Law began to be fully implemented; (iv) were located in the same geographical region, thus having similar opportunities for embeddedness within local organisations; and (v) showed different experiences of the development of local embeddedness. By combining these criteria, we ended up with seven subsidiaries, which represented a mix between different paths of innovation performance improvement.[3] This

[3] This paper does not consider levels of innovation performance achieved by the case-study firms as a measure of success or failure. Our purpose is to explore heterogeneity across the cases in terms of the extent of and speed at which they have improved their innovation performance and the role embeddedness.

number allowed us to conduct the study without running into an unmanageable volume of information (Eisenhardt, 1989). The selected cases are shown in Table 1.

Table 1 The selected cases

Subsidiaries' codified names	Home country	Inception year in home country	Inception year in Brazil	Entry strategy in Brazil
Alpha	Canada	1994	1999	Acquisition
Beta	Singapore	1969	1998	Acquisition
Gamma	US	1966	2000	Acquisition
Omega	US	1983	1996	Greenfield
Epsilon	US	1980	1997	Acquisition
Delta	Japan	1978	1998	Acquisition
Theta	US	1977	1997	Acquisition

Alpha, Beta, Gamma, Epsilon, and Theta are electronics manufacturing services (EMS) providers, while Omega and Delta are producers of consumer electronics, including computers and mobile communication devices. By the end of the fieldwork, each subsidiary had, on average, 2,500 employees, except for Omega, which had around 5,500. All the case-study subsidiaries are located in South-eastern Brazil, an industrialised region that boasts a large number of universities, research institutes, and consulting firms related to the ICT industry.

3.3 Data gathering processes and analyses

Data was gathered over the period 2005-2007, using a combination of extensive fieldwork and follow-up questionnaires. In order to achieve consistent internal validity and reliability (Eisenhardt 1989; Pauwels and Matthyssens 2004; Yin 2003), we used a triangulation methodology. Our data collection within the subsidiaries during the pilot and main fieldwork involved 91 formal interviews (from one to three hours in length), 11 informal interviews, eight direct observations, and several consultations of archival records. Eleven interviews were conducted with local universities and research institutes in order to verify the nature of their relationships with the subsidiaries.

Open-ended interviews were always conducted by both authors, in order to minimize mis-interpretation or misapplication of the interview protocols due to fatigue or other factors. Although the interviews were not recorded, verbatim notes were always taken. The strategy was to ask similar questions for different people in order to achieve a degree of coherence between the main events and projects. Snowballing and cross-checking with a third interviewee proved to be useful for clarifying any discrepancies and for obtaining details of specific projects. Reviews of the transcripts were later sent to target informants for comment. Double and triple-checks of specific events were made via e-mail and/or telephone.

Considering that the study examined the historical timeline of changes in capability accumulation in the subsidiaries, particular efforts were made to collect sufficient data to substantiate the reconstruction of the technological pathways followed by them. We scrutinised the technological milestones of the subsidiaries as claimed by different interviewees, internal presentations and records, annual reports, and independent news reports. In all the subsidiaries (except Omega), the interviewees had been working in the company since before their acquisition by the current MNE. They were thus able to recall the important milestones and the history of those projects that were critical to the reconstruction of the means by which capabilities were accumulated. Nevertheless, it was difficult to have confidence in the accuracy of the descriptions of the past events, and we recognise that this is one of the limitations of our study. Despite this, we were able to gather corroborating evidence from a range of different sources in order to substantiate our analyses.

When the main fieldwork was completed, 109 follow-up questionnaires were sent to target informants. A 95 percent response rate was achieved to these questionnaires. It is likely that the response rate was so high because most of the informants had already met the researchers during the fieldwork. The purpose of the questionnaires was to enable an expansion of the findings and, in particular, to obtain a systematic framework for the evidence of the local links developed by each subsidiary over time. The questionnaire involved the use of a matrix, in which the columns listed organisations with which the subsidiaries could have developed links and the rows listed a continuum of activities that might express the nature of the relationships developed, from business to learning links. In the cells of the matrix, the respondents were asked to write examples of innovation-related benefits for the subsidiaries that emerged from the each type of relationship.

Each event of business and learning relationship was counted as a link. This allowed us to capture 1,139 observations of local links during the period 1996-2007. The data from each questionnaire were collated for each subsidiary and sent to key respondents for review. After completion of the main fieldwork, a *case study database* was organised that contained all the transcripts from the interviews, observations, and subsidiaries' documents.

Our analysis began during the fieldwork in which we attempted to assess the role of local embeddedness in the innovation performance of the subsidiaries over time. After the fieldwork, the qualitative and quantitative evidence were combined to enrich the empirical analysis, rather than reducing all the data to quantitative observations. Formal data analysis involved techniques such as tabulating the frequency and types of events *over time* and building cross-company display tables (Miles and Huberman 1984), which permitted the tracking of the main stages in the capability accumulation of the subsidiaries and the evolution of the local links that underpinned it. The evidence obtained from the follow-up questionnaires was combined and harmonised with that derived from interviews to form the dataset on the basis of which the statistical tests were run.

The pathways of capability accumulation were carefully reconstructed and subjected to graphical analysis. By using both qualitative and quantitative types of evidence, it was possible to identify associations between innovation performance and embeddedness over time. The qualitative evidence shown in Section 4, which is presented partly in the form of narratives, helps both to strengthen the arguments made and to establish the causal relationships involved (Dougherty 2002), in addition to helping to interpret the quantitative evidence.

4 Empirical analysis

We now present our empirical analysis, using the analytical framework described above. Section 4.1 examines the manner and speed of innovation performance improvement of the case-study subsidiaries. Sections 4.2 and 4.3 explore the embeddedness of the subsidiaries and its role in affecting their innovation performance.

4.1 Levels and speeds of progress in innovation performance

Table 2 summarises the evidence related to the innovation performance improvement of the case-study subsidiaries, measured using levels of capability accumulation. In addition, we are herein also concerned with the speed at which the case-study subsidiaries have attained particular levels of innovation performance. By drawing on previous research (Ariffin 2000; Figueiredo 2003), the speed of capability development is defined here as the time taken (in years) for a firm to reach a specific level of capability. Although the building of innovation capability is a slow process (Bell 2006), the evidence presented herein indicates that the process of capability accumulation up to advanced and world-leading levels (see the Appendix), has taken place over a wide variety of time scales (see Figure 2). In particular, some subsidiaries have accumulated given levels of capability rather faster than others. For example, Alpha spent 6 years accumulating its capability to a basic level of innovation, while Gamma spent only 5 years. Beta spent 8 years accumulating capability to the same basic level of innovation.

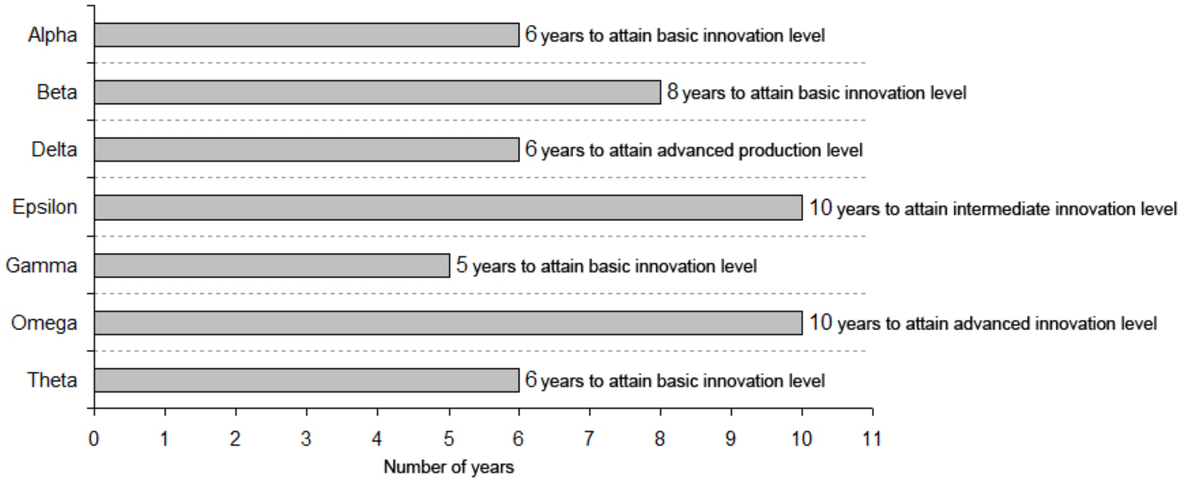
As indicated in Table 2, all the case-study subsidiaries accumulated the capability to undertake advanced levels of production activity (Level 3). In particular, by the early 2000s their products incorporated technical and design specifications and performance features close to those of the most advanced players in the global market. Similarly, their production embodied advanced technological processes, a feature reflected in rising productivity and other aspects of competitive performance close to the frontier of international *production* technology.

Table 2 Progress in the innovation performance of the case-study subsidiaries for specific functions

Subsidiaries' levels production and *innovation* performance		Technological activities or functions: Project management	Software engineering and processes	Processes and production organisation for hardware	Products and solutions in ICT
Innovation capabilities	World leading (frontier pushing) (Level 7)	Not attained	Not attained	Not attained	Not Attained
	Advanced (Level 6)	Omega	Omega	Not attained	Omega
	Intermediate (Level 5)	Epsilon Omega	Epsilon Omega	Alpha, Beta Gamma, Omega Epsilon, Theta	Omega Theta
	Basic (Level 4)	Alpha, Epsilon, Theta Omega, Gamma	Alpha, Epsilon, Theta Omega, Gamma	All	Omega, Epsilon Gamma, Theta
Production capabilities	Advanced (Level 3)	All	All	All	All
	Intermediate (Level 2)	All	All	All	All
	Basic (Level 1)	All	All	All	All

Source: Derived from the empirical study

Figure 2 Time (in years) taken by each subsidiary to attain their highest (aggregate) capability level during their lifetimes



Source: Derived from the empirical study

As described in Section 3, the inception of all the case-study subsidiaries in Brazil, except Omega, came about as a result of a strategy of acquisition. Prior to this, the subsidiaries were all either local independent electronics companies or production sites of other MNEs, such as ABC-Bull, Ericsson, IBM, NEC, and Xerox. By the time they were acquired in the late 1990s, they all had achieved at least an intermediate production capability (Level 2). Their efforts in attaining such a level of capability partly reflects the nationwide industrial restructuring that had begun in Brazil in 1990 when the economy was opened up to global competition.

The case-study subsidiaries thus built on their intermediate production capabilities (Level 2) to attain advanced levels of such capability (Level 3). For individual firms, this involved the implementation of production activities based on advanced techniques under international certification. Following acquisition, most subsidiaries intensified their modernisation efforts in production. They also retained the best managers and engineers who had been working in the company prior to the acquisition. In consideration of their qualifications and tacit accumulated knowledge, this also constituted a means by which most subsidiaries could engage in certain types and levels of innovation capability.

All seven case-study subsidiaries attained a Level 4 innovation performance (basic innovation capability) in processes and production organisation for hardware, while six of them attained a Level 5 innovation performance (intermediate innovation capability) for this activity. Five subsidiaries achieved a Level 4 innovation performance in project management and in software engineering and processes. Omega, Epsilon, and Theta achieved higher levels of innovation performance for a wider range of activities compared with the other subsidiaries, although Omega and Epsilon were even more innovative than Theta. However, Beta achieved a Level 4 innovation performance only in process and production organisation for hardware. The capabilities of Delta to undertake the other three technological activities remained confined to production levels.

Omega was the only subsidiary that attained Level 6 innovation performance (advanced innovation) within 10 years in three out of the four technological functions examined. This greenfield case had formed its top management team using executives that had been successful in local firms and other MNE subsidiaries from the ICT sector in Brazil. Some of them had been highly successful developers of projects in Brazil's former state-owned telecommunications sector. Fieldwork interviews suggested that Omega started with a cohesive management team that was determined to achieve a competitive edge within the corporation and its local market.

Following the bursting of the telecom bubble in the early 2000s, Omega Corporation implemented a radical reorganisation that saw the shutting down of several subsidiaries worldwide. In response to this threat, Omega Brazil intensified its local investment in innovation activity by drawing on the fiscal incentives provided by the ICT Law. By 2002, Omega had already achieved innovation performance at Level 5. This seems to have been the catalyst for Omega to begin engaging in the development of products drawing on sophisticated capabilities. By 2003, for example, in partnership with local research institutes and universities, the subsidiary had fully designed and developed a new model of a colour mobile phone based on the time division multiple access (TDMA) technology.[4] By 2006, Omega had already accumulated an advanced innovation capability (Level 6), particularly in software engineering and project management. It had also consolidated its worldwide mandate in Brazil for the testing of software components for mobile phones.

A similar path was followed by Epsilon. In 2003, by drawing on the ICT Law, Epsilon began to structure its R&D centre using advanced project management practices and capability maturity model (CMM) certification. The creation of this unit enabled the subsidiary to expand its software development activities to the automobile industry. Four years after Epsilon, Beta began to expand its software development activities and research on radio-frequency identification (RFID), in order to improve its solutions to clients.

At the other extreme, Delta accumulated only a basic level of innovation capability for processes and production organisation for hardware. Most of its capabilities were confined to

[4] This is a method of digital wireless communications transmission allowing a large number of users to access a single radio-frequency channel without interference.

production activities. Its management did not undertake the bold initiatives required to engage in more robust innovation activity. Evidence from interviews suggested that Delta sought to comply only with the minimum requirements of the ICT Law. This seems to reflect Delta's management option of focusing on strengthening its advanced *production* capabilities and accumulating only a basic innovation capability level for a specific function.

4.2 Differences between the case-study subsidiaries in terms of embeddedness: an overview

This section provides an overview of the differences between the case-study subsidiaries in terms of their local embeddedness. The manner in which they have taken deliberate steps to become locally embedded over time seems to have played a major role in the manner and speed at which each subsidiary achieved the specific levels of innovation performance described in the previous section. This is examined using the incidence of local links developed by the case-study subsidiaries over time (see Table 3).

Table 3 Types and number of links developed by the case-study subsidiaries

Types and number of local links	Sub-periods		*Totals*
	1996-2002	2003-2007	
Business	65	203	268
Learning	326	545	871
Totals	391	748	1,139

Source: Derived from the empirical study

In order to assess whether there were significant differences in the number of links developed by the case-study subsidiaries over the period 1996-2007, we conducted a Mann-Whitney test in order to compare the mean numbers of these links. In particular, we first compared subsidiary '*i*' *versus* subsidiary '*j*' in terms of the number of local links developed by each. The results are shown in Table 4. Here, we capture the only differences in terms of the *quantity* of the links developed by each subsidiary with local organisations. Although we are not capturing differences in terms of the *quality* of the links developed, the evidence in Table 4 indicates differences between the case-study subsidiaries in terms of the *learning efforts* made by them to acquire knowledge from local organisations. Such differences in learning effort were, in turn, reflected in the improvement to their innovative performance over time. It should be noted, however, that the number observations of local links with suppliers, consulting firms and clients were not considered sufficient to run the statistical tests.

Over the period 1996-2007, Beta and Delta, for example, showed no difference in terms of the number of local *business* links (p-value > 0.10), but they differed significantly in terms of the number of *learning* links developed (p-value < 0.01 and p-value < 0.05, respectively). Although Theta and Omega did not differ significantly in terms of the number of business links enjoyed by each, they did differ in terms of learning links (136 for Theta and 345 for Omega). The evidence shown in Table 4 also suggests that, although operating under the same industrial policy based on tax incentives, these subsidiaries responded differently in terms of their links with local organisations.

Table 4 Mann–Whitney test for comparing the means of the number of local links developed by the case-study subsidiaries (1996-2007)

Case-study Subsidiaries	External network links											
	Business links compared with						Learning links compared with					
	Alpha	Beta	Delta	Epsilon	Gamma	Omega	Alpha	Beta	Delta	Epsilon	Gamma	Omega
Beta	0.000***						0.109					
Delta	0.000***	0.861					0.406	0.040**				
Epsilon	0.071*	0.000***	0.001***				0.879	0.168	0.225			
Gamma	0.002***	0.002***	0.010**	0.095*			0.734	0.928	0.377	0.771		
Omega	0.046**	0.002***	0.003***	0.805	0.052*		0.010**	0.007***	0.002***	0.003***	0.131	
Theta	0.003***	0.001***	0.004***	0.133	0.788	0.170	0.022**	0.832	0.007***	0.040**	0.678	0.010**

Source: Derived from the empirical study

Note: cells contain *p*-values: $*p$-value < 0.10; ** *p*-value < 0.05; *** *p*-value < 0.01

4.3 Role of local embeddedness in the innovation performance of the subsidiaries

Table 5 shows the results of an ANOVA test that was carried out in order to compare the means of the number of external links developed by the subsidiaries in relation to their accumulated level of capability. Here, we have sorted the data into two subperiods (1996-2002 and 2003-2007) because: (i) if we had conducted just one test over the whole period, we would not have captured changes in the importance of the links over time; and (ii) these two subperiods are related to the two significant phases of the ICT Law.

Table 5 ANOVA results showing the comparisons of the mean number of links with the different innovation performance levels achieved by the case-study subsidiaries

Case-study subsidiaries	Local linkages	
	Business	Learning
1996-2002 period [(a)]	7.178 (0.001)***	17.258 (0.000)***
2003-2007 period [(b)]	1.324 (0.285)	2.663 (0.066)*

Notes: The first value in each cell refers to the F-statistics followed by the *p*-value.
(a) Degrees of freedom of F-test: (3;32); (b) Degrees of freedom of F-test: (3;30).
Dependent variable: Number of links. Factor: Level of capability. *p-value < 0.10; ** p-value < 0.05; *** p-value < 0.01

4.3.1 Local embeddedness during the period 1996-2002

In terms of the mean number of local *business links*, Table 5 shows that there were differences between the subsidiaries in terms of the number of links in relation to the different capability levels that they achieved during the period 1996-2002 (p-value < 0.01). The Duncan test showed that those subsidiaries that achieved capability at Level 4 (basic innovation) developed more of these links than subsidiaries that attained only Level 3 (advanced production). For example, in 2001, Delta developed a business relationship with a university in North-eastern Brazil, by making use of a joint acquisition of laboratory equipment. However, this was a one-time interaction. Alpha developed a similar type of connection with a university from the same region, but the business link evolved into a large training programme (i.e. a learning link) for Alpha's professionals.

With respect to local *learning links*, there was a difference between the mean number of links in relation to the capability levels achieved by the case-study subsidiaries (p-value < 0.01). Those subsidiaries that had attained Level 4 capability (basic innovation) developed from three to eight times more of these links than subsidiaries that had achieved Level 3 capability. The evidence suggests that a combination of a variety of external links was necessary for some subsidiaries to cross the threshold from production to innovation capability.

4.3.2 Local embeddedness during the period 2003-2007

The results in Table 5 show that during this period there were no significant differences in terms of local *business* and *learning links* that were related to the capability levels accumulated in the subsidiaries (*p*-value > 0.10). However, it is important to note some qualifications to this statement.

In terms of local *learning* links, the results in Table 5 show that during the period 2003-2007 there were differences between the case-study subsidiaries in terms of the mean number of these links in relation to the levels of capability that they achieved (*p*-value < 0.10). The Duncan test showed that those subsidiaries that achieved capability at Levels 4, 5, and 6 (e.g. Omega, Epsilon, and Theta) developed significantly more of these links than subsidiaries that had achieved lower levels of capability (e.g. Gamma, Alpha, Beta and Delta). The subsidiaries that had achieved Level 6 (Omega) developed more than twice as many of these links than those subsidiaries that achieved capability up to Level 3 during this period.

From 2003 onwards, the ICT Law was changed to stimulate even more interactions between industry and local universities and research institutes from the less-developed northeast of Brazil. Omega responded proactively to these changes, and the project was led by a top manager with a considerable degree of experience in the ICT industry.[5] She had championed large innovation projects in a former state-owned telecommunications research institute in Brazil. Her accumulated network of personal relationships (Granovetter 1985) and her knowledge of the strengths and weaknesses of Brazil's education and research system in ICT proved essential for identifying potential partners that could provide the knowledge required by Omega to develop products that would be suitable for the local market.

For example, from 2003, Omega intensified its partnership with local research institutes in North-eastern, South-eastern and Southern Brazil to develop software for a platform and network authentication system integrated with a mobile system. These relationships also sought to use the knowledge required for the development of a new model of TDMA colour mobile phone for the

[5] Indeed, Omega had started its relationships, based on joint education and training programme, with research institutes (e.g. Cesar) and universities in North-eastern Brazil as early as 1999. Omega's first approached neighbouring universities in South-eastern Brazil, but its proposals to develop such kind of relationship were turned down.

local market. Indeed, the evidence seems to suggest that, in particular from 2003 onwards, subsidiaries that achieved progressively higher levels of innovation performance sought to diversify their local knowledge sources by embedding with different organisations.

5 Concluding discussions and implications

This paper has sought to extend previous research on the local embeddedness of subsidiaries by providing a nuanced and dynamic perspective on the relationship between the innovation performance of subsidiaries and the local links that underpin these, by reference to evidence derived from field-based research using a variety of case studies. Moving beyond the traditional proxies of innovation performance, in this paper we have adopted a typology that identifies the levels of capability that lie behind different degrees of innovation performance (Lall 1992; Bell and Pavitt 1993,1995). The adoption of such a framework provides a clear view of the achievement of different levels of innovation performance, for specific functions, at different times. For instance, our findings indicate a cumulative and heterogeneous pattern of innovative performance improvement: higher levels (e.g. Omega and Epsilon), intermediate levels (Alpha, Beta, Theta and, to some extent, Gamma) and lower levels (Delta).

These differences in innovation performance improvement appear to reflect heterogeneity between the case-study subsidiaries in terms of the *learning efforts* made by them to acquire knowledge from local organisations. As noted in Section 4, we did not find a significant number of observations of local links with suppliers, consulting firms and clients to run the statistical tests. Such fact seems to suggest an evidence of differences between the local counterparts in terms of their importance to the subsidiaries' innovative performance. Indeed, the fact that relevant observations of external links were found only for universities and research institutes seems to be related to the ICT Law that stimulates links only with these two actors. Also, according to interviews, the research institutes had better knowledge bases and were more proactive and better prepared than the universities.

In order to have a clear notion of the nature of such links and to understand how they affect the innovation performance of subsidiaries, we have distinguished between *business* and *learning* links. On the one hand, the paper builds on previous research on the local embeddedness of subsidiaries (Andersson et al. 2001; Andersson et al. 2002; Kuemmerle 2002; Almeida and Phene 2004). On the other hand, the paper moves a step further than previous studies by examining external interorganisational links and their role in influencing differences in the innovation performance of subsidiaries based on the achievement of levels of capability in a latecomer context *over time*.

The findings suggest that the achievement of progressively higher levels of innovation performance depends largely on the ways in which the subsidiary has explored its external embeddedness using *learning* links over time. Such cohesive ties have allowed some subsidiaries to gain access to their partners' knowledge bases (Gulati 1998). In particular, those subsidiaries that have achieved intermediate to advanced innovation performance more rapidly than others have demonstrated an ability not only to *acquire* knowledge from external (local) sources in a beneficial way, but also to *internalise* this newly acquired knowledge into their existing capabilities by improving processes and developing new products. This finding is consistent with the idea that a large part of the capabilities that underpin a firm's competitive performance resides in their network of learning-based relationships (Granovetter 1985, 1992; Zukin and DiMaggio 1990; Uzzi 1996; Dyer and Singh 1998; Gulati 1998; Dacin et al. 1999). This is particularly important for an understanding of the innovation performance of subsidiaries as they operate in a diversity of local contexts. In consequence, a significant part of a subsidiary's internal capability to innovate relies on the knowledge bases required by them to embed with external organisations (Bell and Pavitt 1993).

Indeed, it is worth mentioning that the majority of the case-study firms had accumulated previous capabilities, although at production levels, that somehow worked as a pre-requisite absorptive capacity (Cohen and Levinthal 1990) to engage in links stimulated by the ICT Law. Additionally, there seems to be a kind of reverse causality: subsidiaries that developed more links with local organisations for sophisticated projects (e.g. Omega and Epsilon) seem to have done so because they had been accumulating high innovation capability levels.

The paper also shows that by tracking changes in local embeddedness over time (Dacin et al. 1999), we have developed a better understanding of its effect on the innovation performance of firms. While these findings are consistent with those of previous studies, they also further our understanding by providing an empirical analysis of the nature and dynamism of local embeddedness and its influence on the innovation performance of subsidiaries.

Additionally, it should be remembered that all case-study subsidiaries could all have ignored the fiscal incentive policy of the local government. They have all developed external links, but in different intensities. The evidence provided herein suggests that the traditional approach to industrial policy using sector selection, tax incentives for innovation, and a relatively distant relationship between government and industry, is rather limited in terms of its effects on industrial progress.

In conclusion, our study extends our understanding of embeddedness as a strategic resource-seeking strategy by analysing cases where local embeddedness was developed, with different degrees of frequency, and its impact on subsidiaries' innovative performance improvement. The paper does so by using a typology that captures nuances in innovative performance, proxied as levels of accumulated capability. In so doing, the paper offers a new methodological contribution to the examination of the innovation performance of subsidiaries. The empirical application of such a framework could supplement those studies of the innovation performance of subsidiaries that are based on patent citations and R&D expenditure and panel data analysis. A combination of these methods could lead to more robust explanations of the *dynamics* of subsidiaries' competitive advantage in different local contexts.

One implication for corporate management is that managers seeking to speed up innovative performance improvement need explore the possibilities for knowledge transfer between their own internal capabilities and those of local organisations, in order to participate in identified learning links with such organisations. However, they need not only to acquire new knowledge, but to *integrate* it into the subsidiary's capabilities to innovate and compete internationally.

One implication for policy is that in order to accelerate industrial progress, especially in latecomer contexts, new policies based on public-private negotiations and focused on building firm-centred innovation capability should be pursued. However, note that we are not advocating any kind of return to import substitution or a protectionist type of policy. As pointed out in Evans (1995), Rodrik (2004) and Avnimelech and Teubal (2008), more proactive and interactive types of policy are necessary to tackle industrial development, rather than mere protection, selection, tax incentives, or top-down directives emanating from governments. However, it is important to take into account the fact that government policy, no matter how robust, is not sufficient to guarantee industrial development. The innovation process, although distributed, is centred on firms, and great attention must be given to their capacity, not only to acquire external knowledge, but to internalise it and transform it into products, processes, and services in order to compete in local and global markets.

6. Limitations and implications for further studies

Some limitations in this paper are noteworthy. We recognise that, to some extent, this paper has captured only part of the story of embeddedness. This is because the *quality* of the links developed by the subsidiaries was not examined here. Examinations of the inter-firm differences in the nature of such links and the impact on subsidiaries capability building would deepen our understanding of the relationship between embeddedness of subsidiaries and their innovative performance improvement. Further studies should also examine differences between subsidiaries in terms of developing both intra-corporate and local relationships (dual embeddedness) and the effects on their innovation performance. Additionally, future studies should tackle the issues examined here on the basis of a design based on a large sample of subsidiaries and on test of hypotheses. This could lead to more robust explanations of the *dynamics* of subsidiaries' strategic resource-seeking and competitive advantage in different local contexts.

Future research should also examine the influence of various different factors on the embeddedness of the subsidiaries as referred to in Section 2. An examination of how subsidiaries' progressive levels of innovation performance shapes their intracorporate and external networks of relationships has yet to be explored. Finally, the paper has not addressed the effects of capability accumulation on the market and economic performance of subsidiaries, and neither has it addressed the changes in organisational design required to permit these knowledge links to take place. These are challenges for future studies.

Appendix A. Typology for levels of capability (condensed version)

Levels of innovative and production performance		*Illustrative activities that express levels of production and innovative performance levels*
Innovative performance	**World leading (frontier pushing)** (Level 7)	Undertaking cutting-edge innovation in products, production and organisational processes and systems (e.g. development of processes and tools for complex testing adopted corporation, subsidiaries and other companies in the sector; development of products and processes that are original to the world).
	Advanced (Level 6)	Closing in on leading global leaders in terms of innovation (e.g. development of tools for automatic inspection of code and software test; design, prototyping and development of products with clients, corporation, subsidiaries and/or partners).
	Intermediate (Level 5)	Implementation of relatively complex modifications to products, processes organisation, and systems (advanced techniques and automated to control of software development; development of non-original products and processes internally and/or with partners).
	Basic (Level 4)	Undertaking minor adaptations (e.g. formal planning and coordination of projects in medium complexity; development of software in medium complexity; simple improvements in products without change its functionality.
Production performance	**Advanced** (Level 3)	Implementation of production processes embodying advanced technological features. Products and services incorporate technical and design specifications and performance features that are close to the most advanced in global markets.
	Intermediate (Level 2)	Implementation of relatively complex production system with basic standardization of procedures that meet the requirement of national market.
	Basic (Level 1)	Implementation of non-formal operational procedures (each project follows a different process). Simple replication of specifications into processes production or products.

Note: The original framework applied during the fieldwork involved the use of a tailored matrix that identified the levels of capabilities appropriate for specific technological activities (e.g. project management, software engineering and processes, processes and production organisation for hardware, and products and solutions in ICT). The adaptation of this framework for the ICT industry took approximately 6 months and involved several consultations with industry experts to validate it. The qualitative data obtained from the application of these frameworks were transformed into quantitative observations, in order to allow the speed of capability accumulation to be calculated. The levels of capability that were achieved by each subsidiary for these four specific activities was then aggregated to represent the capability level of each subsidiary at different times.

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