Keep it simple

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Published in:
Industry and Innovation

DOI:
10.1080/13662716.2021.1997724

Publication date:
2022

Document Version
Early version, also known as pre-print

Keep it simple: external resource utilisation and incremental product innovation in resource-challenged South African manufacturing firms

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To cite this article: Leon Oerlemans, Kai-Ying Chan, Joris Knoben & Patrick Vermeulen (2021): Keep it simple: external resource utilisation and incremental product innovation in resource-challenged South African manufacturing firms, Industry and Innovation, DOI: 10.1080/13662716.2021.1997724

To link to this article: https://doi.org/10.1080/13662716.2021.1997724

Abstract:

This study examines external conditions for knowledge integration and differentiation and their relationships with exploitative product innovation. We test these ideas using firm-level survey data from 497 South African manufacturing firms. We find that higher diversity of external knowledge sources (network range) gives a higher probability of exploitative product innovation. When firms are more strongly embedded in domestic inter-organizational networks (higher geographical relational embeddedness), the probability of generating exploitative product innovation is lower. The results also show that the positive effect of network range is more positive for higher levels of geographic relational embeddedness. To enhance exploitative product innovation, the firm is recommended to develop its relationships with the local and non-proximate alters while simultaneously expanding its network diversity. This paper contributes to the fields of knowledge management and network studies by showing that knowledge differentiation and integration are influenced by external spatial and relational conditions in an emerging economy.

Keywords:

Innovation; exploitation; knowledge integration; knowledge differentiation; technology-follower.

1. Introduction

Many firms in emerging and developing countries, such as South Africa, operate at a distance from the technology frontier and are so-called technology-followers (Goedhuys 2007; Goedhuys and Sleuwaegen 2010). This implies that firms in these countries often imitate foreign technologies to enhance their innovative performance (Geroski 1995; Cameron, Proudman, and Reddings 2005). As such, the innovative behavior of such firms is largely shaped by innovating organizations in technology-leader countries (Forbes and Wield, 2000) and will often lead to exploitative innovation for technology-followers. Forbes and Wield (2000) argue that such innovations can be informed by changes in daily operations and an intra-organizational set-up that supports incremental innovation. Besides, they stress the relevance of informal, non-institutionalized R&D for technology-followers (see also Drenkovska [2015]). Employees conducting R&D activities can be regarded as a formal or informal internal learning unit of knowledge produced elsewhere. For instance, schooling and formal training stimulate the development of human capital, which has been identified as an important internal determinant for innovative performance in Sub-Sahara Africa (van Uden, Knoben, and Vermeulen 2017). Also, employees could monitor external knowledge areas relevant to the firm (boundary spanning), codify external knowledge, and communicate, translate and stimulate the use of knowledge (Forbes and Wield, 2000).

Although firm-level specific resources, such as internal R&D, human capital, and information search, allow firms to engage in innovative activities (Barasa et al. 2017), we argue that the innovation task of technology-followers is substantially different from those of technology-leaders (Barasa et al. 2019). For instance, technology followers may need to adapt new technologies to local conditions (Forbes and Wield 2000) to suit the socio-economic environment in developing countries (Fu, Pietrobelli, and Soete 2011). Yet, this requires a clear understanding of the new technology, which technology-leaders may not willingly supply or remains uncodified (Forbes and Wield 2000, 1098). Hence, an important source of knowledge for technology-followers comes from external sources, such as technology-leaders, perhaps even more than from internal sources. Our study, therefore, adds an external perspective to the ideas developed by Forbes and Wield (2000) who mainly take an intra-organizational perspective on innovation by technology-followers.

We argue that the innovative performance of technology-follower firms depends on differentiated internal and external knowledge, which has to be combined to create a

systematic and usable set of knowledge that can be applied for (re)new(ed) products and processes (Lin and Chen 2006). In particular, we focus on the role of external conditions that facilitate or hinder knowledge differentiation and integration, which has received limited attention in the literature. Knowledge differentiation refers to the extent to which actors possess and use different types of knowledge (Aadland and Caplan 2003), whereas knowledge integration refers to the integration of complementary assets and knowledge across organizational boundaries (Lin and Chen 2006). We examine the characteristics of inter-organizational ties and the geographical location of these firms as they form the concrete external learning environment for knowledge differentiation and integration. This leads to the following research question: To what extent do external conditions facilitating knowledge differentiation and integration influence technology-followers' exploitative product innovation?

This study aims to increase our knowledge about external conditions facilitating knowledge differentiation and knowledge integration leading to exploitative product innovation of technology following firms. In doing so, this paper contributes to the literature in two ways. First, despite extensive research on the study of exploitative innovation, there are still unanswered questions, especially regarding the external conditions that facilitate or hinder knowledge differentiation and integration (Correia-Lima, Fourne, and Jansen 2013). Whereas previous research has included macro external factors such as environmental dynamism, competitive rivalry or exogenous shocks (Lavie, Stettner and Tushman 2010), or the institutional environment (e.g. Barasa et al. [2017]), we focus on inter-organizational ties and geographical locations of firms as external factors. Second, this paper presents unique data from manufacturing firms in South Africa. African firms are further away from the technology frontier and need to adapt new technologies to local conditions. As such, their innovation strategies may differ and depend less on internal R&D or human capital. Scholars need to be more attentive to the context in which existing theories are used. In this way, the paper adds to our understanding of innovation in a non-Western context (Barnard, Cuervo-Cazurra and Manning 2017; George et al. 2016) and assesses theoretical insights under a different so-called boundary condition (Whetten 1989). Taking into account the fact that African firms are further away from the technology frontier will help not only academics but also practitioners who often rely on knowledge from a Western context while being confronted with unique challenges (Nkomo 2015).

2. Theory and hypotheses

2.1 Dependent variable: exploitative product innovation

March (1991) first introduced the concepts 'exploitation' and 'exploration', which were theoretically articulated in the context of organizational learning. He stated that 'exploration includes things captured by terms such as search, variation, risk-taking, experimentation, play, flexibility, discovery, innovation', whereas 'exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution' (March 1991, 71). At the organizational level, this knowledge-based definition of exploitation refers to building on the organization's existing knowledge base or technological trajectory whereas exploration involves a shift in the knowledge base or technological trajectory (Benner and Tushman 2003; Lavie, Stettner and Tushman 2010).

In this paper, the focus is on exploitative innovation as an outcome. This regards technological innovation activities resulting in the enhancement or refinement in existing products (incremental innovation) (He and Wong 2004; Bierly, Damanpour and Santoro 2009; Jansen, Van Den Bosch and Volberda 2006; Wu et al. 2019). Exploitative or incremental innovation is commonly defined (Bhaskaran 2006) as an outcome of an ongoing or step-by-step process of improvements of products, processes, or services. Instead of stressing the overall newness of products, processes, or services, more recently scholarly attention (Varis and Littunen 2010) shifted to stressing what is new for the innovating organizational unit. In this way, organizational learning and knowledge development at the firm level become important.

2.2 Conditions facilitating knowledge differentiation and integration

Exploitative innovation often is studied combined with intra-organizational topics such as business strategy (Li, Zhou and Si 2010; Schmiele 2012), leadership (Jansen, Vera and Crossan 2009), structural differentiation (Jansen, Tempelaar, Van Den Bosch and Volberda 2009), or entrepreneurial behavior (Kollmann and Stöckmann 2014). Several scholars study factors external to the organization as explanatory factors for this type of innovation. Phelps (2010), for example, investigates the impact of inter-organizational network structure on innovation and composition, whereas Wang et al. (2014) relate the innovation types to knowledge and collaboration networks. Ozer and Zhang (2015) also use a network perspective and add a geographical dimension. Mueller, Rosenbusch, and Bausch (2013)

conduct a meta-analysis to find out which institutional factors impact exploitative (and exploratory) innovation.

Recent reviews of the literature (Crossan and Apaydin 2010; Turner, Swart and Maylor 2013) show that the vast majority of studies in the field deals with intra-organizational factors and conditions for this type of innovation. As far as the organizational level is concerned, many of these studies are theoretically grounded in the resource or knowledge-based view of the firm (Nason and Wiklund, 2018) and the related dynamic capabilities literature (Lin and Wu 2014). Teece, Pisano, and Shuen (1997, 516) define dynamic capabilities as 'the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments.' One way to be adaptive is through technological innovation, which can be defined as a new or substantially improved service, product, or process for a firm. To generate innovation, a certain amount of knowledge differentiation is needed.

Paraphrasing Aadland and Caplan (2003), knowledge differentiation is the extent to which actors possess and use different types of knowledge. The members of a highly differentiated organization unit (e.g. an R&D team) possess knowledge in different domains, based on several factors. Sources of knowledge differentiation are for example different functional backgrounds of organizational members and the duration of cooperation between them. Knowledge differentiation is important for innovation because if organizational members possess different knowledge bases, they tend to be experts in their respective fields and they might have different views of the world. As a result, they tend to have high absorptive capacities in different knowledge fields and they can be more creative and generate ideas and solutions. The above reasoning is, even more, the case in inter-organizational interactions between members of different organizations because the chances are higher than their knowledge is more diverse. Additionally, they come from organizations with different norms, routines, and experiences, which adds to the diversity.

To arrive at actual innovations, differentiated internal and external knowledge has to be combined to create a systematic and usable body of knowledge that can be applied for (re)new(ed) products and processes. The literature labels this latter process as knowledge integration (Lin and Chen 2006). Scholars defined knowledge integration in different but rather complementary ways. Alavi and Tiwana (2002, 1030) for example state that knowledge integration is 'the synthesis of individuals' specialized knowledge into situation-

specific systemic knowledge', whereas Huang and Newell (2003, 167) use a sociological definition and propose that knowledge integration regards the 'ongoing collective process of constructing, articulating and redefining shared beliefs through the social interaction of organizational members'. What one can get from these definitions is that interaction to combine knowledge is crucial for knowledge integration. However, because both definitions have an intra-organizational focus, a definition with an inter-organizational focus is adopted for this paper: 'Knowledge integration is defined as […..] the integration of complementary assets and knowledge across organisational boundaries for developing market-oriented new products and services through an information –sharing and communication process' (Lin and Chen 2006, 159). Several studies showed a positive relationship between levels of inter-organizational knowledge integration and firm-level outcomes such as product innovation (Yang 2005; Cantner, Joel and Schmidt 2011), project performance (Mitchell 2006), and information systems development performance (Patnayakuni, Rai, and Tiwana 2007).

An important question to ask is which conditions are conducive for knowledge differentiation and integration. This is important because such conditions set limitations on the hypotheses generated in a theoretical model (Whetten 1989). Put differently, such conditions set the boundaries of the generalizability of a theory and constitutes its range. A crucial condition for knowledge differentiation taking place is the presence of a diverse set of organizational members or units. These members and units may possess different knowledge sources that can, when shared, be used and combined to produce exploitative innovations (Jehn, Northcraft, and Neale 1999; Chen and Huang 2009; Østergaard, Timmermans, and Kristinsson 2011).

Many studies on knowledge integration in firms build on the work of Grant (1996, 377), who argues that for integration 'stability, propinquity, and social relationships' are required. More specifically, for the integration of knowledge at the organizational level two main mechanisms have to be working. The first one is labeled direction and refers to formal rules and procedures to integrate codified knowledge (e.g. information systems or manuals), whereas the second one concerns organizational routines which are defined as 'sequential patterns of interaction which permit the integration of their specialized knowledge without the need for communicating that knowledge' (Grant 1996, 379). Implicitly, Grant mentions a third condition, which is interaction and (social) networks, which enable the exchange of codified and tacit knowledge between organizational members.

Until now, the focus was on exploring the intra-organizational conditions enabling knowledge integration and differentiation facilitating organizations developing exploitative innovations. Since many organizations also interact with external actors in search of information and knowledge for their innovations, this paper now directs its focus at the external conditions for knowledge differentiation and integration, which are discussed in the next sections.

2.3 External conditions facilitating firms' knowledge differentiation

Diversity is an important condition for knowledge differentiation (Rydehell, Isaksson, and Löfsten 2018). From a structuralistic network perspective, the concept of network range captures this idea. The concept implies that the organizations that are part of the network are dissimilar in some way (Tortoriello, Reagans, and McEvily 2012). More specifically, network range is the prevalence of ties that cross-institutional, organizational, or social boundaries (Burt 1992, 148-149). Previous literature presented findings that network range is important for social and organizational actors to access diverse information, knowledge, and resources to identify and exploit market opportunities (Dong et al. 2020). However, researchers have arrived at inconsistent conclusions about the relationship between network ranges and organizational outcomes. Some report a positive relationship. Examples of this positive effect can be found in Liu, Madhavan, and Sudharshan (2005) on innovation potential, Reagans and McEvily (2003) on knowledge transfer or Ruef (2002) on the likelihood of organizational innovation. Others find negative or no effects of network range. For example, Patel and Terjesen (2011) found that network range had no significant direct effect on transnational venture performance, whereas Kijkuit and Van Den Ende (2010) showed that network range harmed decision-making at the end of an innovation process. For non-innovation related organizational outcomes, Di Vicenzo and Mascia (2012) on project outcomes, and Watson (2007) on financial firm performance even find an inverted U-shaped relationship. Such differing findings oftentimes can be explained by pointing at the relevance of boundary conditions for the relationship between network range and outcomes. We answer the call by Dong et al. (2020) to investigate such conditions. Below, we develop the argument that being part of an emerging economy might act as a boundary condition.

Having inter-organizational relationships with a diverse set of actors (higher network range) implies access to complementary assets needed to turn inventions into successful new products on the market. Furthermore, interacting with a more diverse set of actors encourages

the transfer of more diverse knowledge and information, which, when combined with internally available knowledge resources, could lead to the creation and development of products that would otherwise be difficult to mobilize and to develop. The arguments described in the above lead to a positive relationship between network range and innovation outcomes.

However, an implicit assumption in this line of reasoning is that firms have sufficient absorptive capacity to deal with higher levels of information and knowledge diversity. This might be more the case for firms in developed economies, but there is strong evidence that this capacity is lacking in economies farthest from the technological frontier (Falvey, Foster, and Greenaway, 2007; Fracasso and Marzetti, 2014). If we apply this boundary condition, it implies that high levels of network ranges (diverse inflowing knowledge from external partners) potentially hinder innovation as this knowledge and information inflow cannot be adequately processed, and it creates problems of coordination and control in decision-making in the innovation process (Kijkuit and Van Den Ende 2010). Recent empirical research conducted by Onyeiwu (2015) also concludes that the growth of African firms is hindered by a lack of absorptive capacity. This brings us to our first hypothesis that applies to South African firms:

Hypothesis 1: Network range is negatively related to exploitative product innovation.

Network range is a network structuralistic condition for knowledge differentiation, but at the same time, it also is a non-spatial concept. This study argues that geographical location is an additional condition for knowledge differentiation. Geographical space can be a relevant condition in two interrelated ways: via location and via spatial proximity. Knowledge is unlike information which can be easily codified; it is more tacit as described by Polanyi (1967, 4): ‘We can know more than we can tell’. Transmitting knowledge requires cognitive activities such as demonstration and practice and therefore often face-to-face contacts are required (Massard and Mehier 2005). Moreover, for firms to innovate, they need to obtain new knowledge via learning processes, which are situated within a geographical, social, and economic context and mostly done jointly with others (Howells 2002). Spatial proximity is therefore a condition that facilitates access to and transfer of (diverse) tacit knowledge (Gertler 2005). Studies on the effect of knowledge spillover, so-called Jacobs spillovers in particular, on innovation outcomes have shown the importance of spatial

proximity (e.g. Adams and Jaffe [1996]; Grillitsch and Nilsson [2015]; Steinmo and Rasmussen [2016]).

Being located in certain areas or regions can offer firms more easily access to knowledge resources as a host of literature on for example regional clusters, innovative milieus, and industrial districts show (Asheim and Coenen 2005; Tracey, Heide, and Bell 2014; Maennig and Ölschläger 2011). Development zones represent all types of spatially defined districts including economic and technological development zones and high-tech (science) parks which are often state/national level development zones (Wei and Leung 2005). When firms are located in a development zone, they are more likely to form geographically proximate relations with each other. When firms are proximate geographically to other firms, they will be able to gain more information about other firms' capabilities and credibility and have opportunities for informal information exchanges. Firms in these development zones also can benefit from knowledge spillovers from a diverse set of actors like for example knowledge-intensive organizations such as universities or research centers that possess new knowledge due to their intensive R&D activities (Díez-Vial and Fernández-Olmos 2015).

It is proposed that a location in a development zone provides different conditions for exploitative innovation (Ozer and Zhang 2015). Innovating firms located in development zones are likely to know more about alternative product features, designs, and marketing efforts via the co-located partners. This knowledge and information predominantly help to reinforce and improving existing products. Therefore, hypothesis 2 reads:

Hypothesis 2: Being located in a development zone is positively related to the firm's exploitative product innovation as compared to being located outside a development zone.

2.4 External conditions facilitating firms' knowledge integration

Although knowledge differentiation is necessary for innovation, it is not a sufficient condition. The higher the level of knowledge differentiation, the higher the need to integrate it. Internal mechanisms for knowledge integration are for example information systems and social networks (Robert Jr, Dennis, and Ahuja 2008). Besides internal factors facilitating knowledge integration, two external factors for knowledge integration are discussed here. This paper *focuses on two geographical conditions*, namely geographical relational embeddedness and spatial immobility.

Geographical relational embeddedness is defined here as the extent to which inter-organizational relationships are driven by social attachment, closeness, and interpersonal ties (Granovetter 1992). It provides firms the opportunity to obtain more detailed and fine-grained information (Uzzi 1996) using its direct cohesive ties (Gulati 1998). Innovation depends *partly* on valuable tacit knowledge (Johnson, Lorenz, and Lundvall 2002) which does not 'travel' easily because it often requires frequent *and more intense* interactions between actors (Gertler 2003). When the ties of a firm are embedded in a localized network, the geographic proximity *between the firm and its external actors* facilitates face-to-face interactions with these local actors. These interactions allow for multi-modal communication (to watch, touch and listen at the same time) enhancing interactive learning and providing a richer exchange of information/knowledge between the localized actors (Storper and Venables 2004). These local ties *also* favor repeated interactions (Hazir, Lesage, and Autant-Bernard 2016) and enhance the trust between local actors for transfer of tacit knowledge because they are more willing to share (Li, Zhou and Si 2010; Hemphälä and Magnusson 2012) especially sharing experiences on how to implement certain improvements (Jansen, Van Den Bosch, and Volberda 2006).

Actors in local networks *tend to* exhibit a collective mind because they are part of the same local culture and share common knowledge and experiences, which facilitates coordination between them (Huang and Newell 2003). Thus, there will be a deeper understanding of the firm of existing knowledge in the network, which will enable it to further improve its innovations (Jansen, Van Den Bosch and Volberda 2006). Besides, being embedded in a localized network benefits the firm because transaction costs *are reduced* and they are more likely to integrate (knowledge) resources more efficiently (Hazir, Lesage, and Autant-Bernard 2016; Conyers, 2000; Pucci et al. 2017). Based on the reasoning above, hypothesis 3 reads:

Hypothesis 3: Geographic relational embeddedness is positively related to exploitative product innovation.

The longer the firm stays in a location, the *higher* its spatial immobility. Spatial immobility facilitates the utilization of its existing localized network through easy access to resources for product development (Dilaver, Bleda, and Uyarra 2014), and at the same time, it creates sunk costs. Moreover, this spatial immobility allows the firm to bind more strongly with external actors (such as funding agencies, suppliers, customers) so that the firm can

create legitimacy and trust (Brouwer 2010), both facilitating localized interactive learning and knowledge transfer (Brouwer 2004; Narula 2002).

Firms that stick for a longer time to one location (*spatial immobility*) show their 'spatial loyalty' (or territorial identity) and one of the core aspects of spatial loyalty is the social construction of territory (Lebeau and Bennion 2014). Firms that have been located in a particular space for a longer time are better able to align with the regional social, cultural, and institutional environment. This implies that they are better able to absorb and adjust to the economic, regulatory, and social dynamics in the region (Wood and Reynolds 2014) and build more cohesive ties with regional partners. Especially for exploitative innovation, firms involved in spatial 'local search' can access knowledge relating to their existing knowledge base with less searching cost (Rosenkopf and Nerkar 2001; Phene, Fladmoe-Lindquist, and Marsh 2006; Sidhu, Commandeur, and Volberda 2007)

This leads us to propose the following:

Hypothesis 4: There is a positive relationship between a firm's spatial immobility and exploitative product innovation.

2.5 Combining external conditions facilitating knowledge differentiation and knowledge integration

There exists a fundamental problem in the trade-off between levels of differentiation and integration (Buckley and Carter 2004; Postrel 2002). In other words, when knowledge is differentiated, it is challenging for the firm to effectively integrate this diverse knowledge in economic activities (Carton and Cummings 2012). When interacting with a more diverse set of knowledge actors, there is a need for strong relationships with individual actors so that an efficient and effective knowledge exchange process can take place (Eisingerich, Rubera, and Seifert 2009). We argued that for firms part of an emerging economy, network range is negatively related to exploitative product innovation. However, this negative effect might be partially mitigated if the knowledge does not have to travel far. Several scholars show that smaller geographical distances between sender and receiver ease knowledge and information transfer because it implies a high probability of encounter and frequent action response. It also facilitates understanding and the integration of knowledge (Ambos and Ambos 2009; Agrawal, Kapur, and McHale, 2008). This leads to hypothesis 5:

Hypothesis 5: The negative relationship between network range and exploitative product innovation is less negative for higher levels of geographical relational embeddedness.

A second interaction effect that needs to be discussed is the effect of firms' spatial immobility on the negative relationship proposed in hypothesis 1. It is maintained that being spatially immobile brings stabilization to several organizational processes. Intra- and inter-organizational processes related to innovation are examples of these processes. If a firm is longer at one location, processes become more routinized, and external ties with other organizations can grow and become more cohesive. Such cohesive ties enable more fine-grained interaction between organizations, which increases what is often labeled as external absorptive capacity (Lewin, Massini, and Peeters, 2011). This external capacity helps firms to deal with higher knowledge diversity levels, and in this way partially compensating for the lower internal absorptive capacity that one often finds in the context of emerging economies. These arguments lead to hypotheses 6:

Hypothesis 6: The negative relationship between network range and exploitative product innovation is less negative for firms that are more spatially immobile.

Ramírez-Alesón and Fernández-Olmos (2018) and Li and Wang (2019) theoretically argue and empirically show that firms located in geographically designated areas like science parks and development zones may enhance their innovation outcomes conditional on the intensity of collaboration. If these collaborative inter-organizational ties are predominantly local, positive effects comparable to those that are observed in geographical clusters and industrial districts might emerge (Rammer, Kinne, and Blind, 2020; Davids and Frenken 2018). In sum, co-location and localized interaction ease knowledge and information flows, and enable quick cohesive interaction and collaboration, which will help the understanding and application of external knowledge acquired.

Hypothesis 7: The positive relationship between being located in a development zone and exploitative product innovation is strengthened by higher levels of geographical relational embeddedness.

The fourth and last interaction effect that we study concerns the effect of spatial immobility on the relationship between development zone location (or not) and exploitative product innovation. In hypothesis 2, we proposed that being located in a development zone is positively related to the firm's exploitative product innovation. Additionally, we maintain

that spatial immobility strengthens this positive relationship. The stability that spatial immobility brings to the innovating firm enables the deepening of the inter-organizational relationships with other co-located organizations. Therefore, hypothesis 8 reads:

Hypothesis 8: The positive relationship between being located in a development zone and exploitative product innovation is strengthened by higher levels of spatial immobility.

The next section discussed the methodological approach taken to empirically test our hypotheses.

3. Methodology

A structured face-to-face survey was designed and conducted for us by Consulta, an external data collector, in the South African manufacturing industry from July to September 2014. The design of the survey was based on the Community Innovation Survey from Eurostat and the Enterprise Survey for the Manufacturing Module from the World Bank. The survey asked about firms' economic and innovation performances and activities in the financial years 2010 - 2013.

The survey concentrated on six manufacturing sectors (automotive, chemical, defense, food production, pharmaceutical, and textile) and four provinces (Eastern Cape, Gauteng, KwaZulu-Natal, and Western Cape). The four provinces stand for about 70% of South Africa's GDP (2013, OECD). The sample was based on the population of companies received from the list provider. Out of a list of 6,000 firms that Consulta had access to, 500 firms were randomly drawn by the research team. The sample was stratified to be representative at the regional, size classification, and the industrial level, but not necessarily at intersections thereof (not for size class, within a specific industry within a specific region). There is an over-sampling of firms in the 21-50 employees range within each industry-region cell. After the data collection phase, 497 completed questionnaires were returned. Of the 497 firms, there were 164 that are innovators having introduced innovations to the market. The distribution of the innovating firms by sectors and South African provinces is shown in Table 1.

Insert Table 1 here.

The actual measurements of all variables used in the empirical analyses are provided in the appendix. It is stressed here that informed by the arguments developed by Forbes and

Wield (2000), the informal, non-institutionalized, and employee-based nature of R&D of technology-followers are taken into account in our measurements. More specifically, firms were surveyed on their proportion of highly educated employees, whether they conducted R&D, and whether they hired personnel especially for conducting R&D activities.

The empirical analyses contain two steps. In the first step, we analyzed which external conditions for knowledge differentiation and integration are associated with the probability of an innovating South African manufacturing firm having an exploitative product innovation. Given that this dependent variable is binary we use binary logistic regression models to analyze the data. The general logistic regression equation is:

$$Pr\left(Y_i = 1 \mid \mathrm{X}\right) = \frac{e^{b'_0 + b'_1 X' + b'_2 Z' + b'_3 XZ' + \varepsilon}}{1 + e^{b'_0 + b'_1 X' + b'_2 Z' + b'_3 ZX' + \varepsilon}} \quad (1)$$

Equation one is transformed into the following equation that is estimated (equation 2). In this equation Y, the dependent variable, represents the firm-level likelihood to have an exploitative product innovation, NR represents network range, DZ represents the firm being located on a development zone, GRE is geographical relational embeddedness, and SI represents spatial immobility.

$$Log\left[\frac{Y}{1-Y}\right] = b_0 + b_1 NR + b_2 DZ + b_3 GRE + b_4 SI + b_5 NR * GRE + b_6 NR * SI + b_7 DZ * GRE + b_8 DZ * SI + \varepsilon_i \quad (2)$$

In the second step, using the same independent and control variables, we estimate what percentages of sales are generated with these exploitative product innovations in the period 2010 – 2013. By definition, for this dependent variable scores ranged from 0 to 100%. This type of variable represents what is sometimes referred to as a corner solution model (Woolridge 2002). A Tobit analysis (Papalia and Di Iorio 2001) is the most appropriate method for this type of data (Woolridge 2002) (see equation 3).

$$D2_i = \begin{cases} Exploitative\ Innovation_i^* & if\ 0 < Exploitative\ Innovation_i^* < 100 \\ 0 & if\ Exploitative\ Innovation_i^* \leq 0 \\ 100 & if\ Exploitative\ Innovation_i^* \geq 100 \end{cases} \quad (3)$$

where $Exploitative\ Innovation_i^*$ is a latent variable estimated with the following equation:

$$Exploitative\ Innovation_i^* = b_0 + b_1 NR + b_2 DZ + b_3 GRE + b_4 SI + b_5 NR * GRE + b_6 NR * SI + b_7 DZ * GRE + b_8 DZ * SI + \varepsilon_i \quad (4)$$

In this equation (equation 4) the dependent variable represents the % of the firm's sales from exploitative product innovations, NR represents network range, DZ represents if the firm is located on a development zone, GRE is geographical relational embeddedness, and SI represents spatial immobility.

4. Results

4.1 Statistical descriptive of the database

The means and standard deviation of the control, independent and dependent variables can be found in Table 2.

Insert Table 2 here.

About 77% of South African firms with innovation had an exploitative product innovation in the period 2010 – 2013. The related percentage for all responding firms is 26%. In the financial year 2012/2013, firms with exploitative product innovations generated on average about 37% of their sales with these incremental innovations.[1] Furthermore, it can be observed that 19% of the employees hold a university degree, whereas about 60% of these manufacturing firms conduct some form of R&D.

Table 2 also provides the correlation matrix (Spearman's Rho) of all the variables. The correlations between the independent and control variables indicate that there are no

[1] In the vast majority of the cases (94%) a lack of exploitative innovation implies that the firm has no innovation at all. Only in 6% of the cases do firms have explorative but no exploitative innovation. To ensure that this small group of firms does not bias our results we also ran all analyses excluding this group. Doing so yielded results nearly identical to those reported here.

multicollinearity problems (all VIFs < 10). The largest coefficient is 0.680 ($p<0.01$) between firm age and spatial immobility, which indicates that older firms tend to be more spatially immobile.

4.2 Conditions for knowledge differentiation & integration: Probability of exploitative product innovation

The results of these analyses are shown in Table 3.

Insert Table 3 here.

From the first model including only the control variables, it is observed that firms that are South African owned have a higher probability of exploitative product innovation. The same is the case for firms that conduct in-house R&D. In model 2, the main direct effects are entered. Contrary to our expectations (hypothesis 1), the results showed that a higher level of diversity of external knowledge sources (NR) is associated with a higher probability of exploitative innovation. Further analyses showed that reverse engineering/observation of products already on the market, internet, and customer feedback (all indicators of external knowledge sources) are by far the most frequently mentioned external information and idea sources for innovation[2]. This unexpected and interesting result will be further discussed in the last section of this paper. Informed by the statistically non-significant coefficients of our variable Location in Development Zone (DZ), it can be deduced that hypothesis 2 is not supported.

Additionally, this model indicates that geographic relational embeddedness is negatively associated with the probability of firms having exploitative product innovations. Please note that in the analyses, higher values of the geographic relational embeddedness variable indicate higher spatial embeddedness levels. These findings indicate that the embeddedness of South African manufacturing firms in domestic inter-organizational (ego) networks is not conducive for having exploitative product innovations. The opposite seems to be the case. This finding does not support hypothesis 3, in which it was proposed that geographically closer, more embedded, and cohesive ties are beneficial for exploitative

[2] Use of external information sources is (% of innovating firms using a source): Customer feedback (94%); Supplier (76%); Competitors (70%); Parent firm (58%); Universities & research institutes (54%); Consultancy firms (50%).

innovation of South African manufacturing firms. The same holds for hypothesis 4 concerning a proposed relationship between spatial immobility and exploitative product innovation.

In models 3 to 7, interaction effects are added, testing hypotheses 5 - 8. To avoid major multicollinearity problems, each model carries one of the proposed interaction effects (model 3-6). Model 7 includes all the interaction terms in one model to estimate the relative effect of each interaction term on overall model fit. In model 3 and model 7, one of the conditions facilitating knowledge differentiation, namely network range (NR) shows a statistically significant positive relationship with exploitative product innovation. Thus, the more firms are strongly embedded in a more diverse inter-organizational network, the higher the probability that they have exploitative product innovations.

From the positive coefficient of the interaction term (NRxGRE), one can deduct that the positive effect of network range (NR) is more positive for higher levels of geographic relational embeddedness (GRE). This means that when innovating manufacturing firms have a more diverse knowledge network, this effect on innovation is strengthened by inter-organizational ties with more domestic actors. Given the size of the coefficient of this interaction effect, the combined effect of conditions for knowledge differentiation and integration turns out to be particularly strong and supports hypothesis 5, in which positive moderation was proposed (See Figure 1).

Insert Figure 1 here.

The other proposed interaction effects are not statistically significant, although the effects of domestic ownership, network range, and geographical relational embeddedness show the same patterns across the model, indicating the robustness of these effects. This implies that hypotheses 6-8 are not supported.

4.3 Conditions for knowledge differentiation & integration and innovative sales with exploitative product innovation

The results of Tobit regression analyses in which the dependent variable is the percentage of sales of exploitative product innovation is shown in Table 4.

Insert Table 4 here.

When looking at the percentage of sales generated with exploitative innovation, four control variables are statistically significant in nearly every model specification. In all models, one can see that the younger/older the firm is, the higher/lower the percentage of sales with exploitative innovation. Furthermore, firms located in urbanized regions tend to have a higher percentage of exploitative innovation sales with coefficients ranging between 28.87 and 31.23. A third statistically significant control variable is domestic ownership which has coefficient values between 63 and 69, indicating that domestically owned innovators have higher sales of products from exploitative innovations. Fourth, our findings show that higher levels of innovative sales with exploitative product innovation are accomplished by manufacturing firms with lower levels of highly educated employees.

As to the indicators of the conditions for knowledge differentiation, again a positive and statistically significant association is found between network range and the percentage of sales with exploitative product innovations. Higher levels of diversity in the inter-organizational ego-networks of the innovating South African manufacturing firms are supporting sales with these products, thus not supporting hypothesis 1.

Both variables measuring conditions for knowledge integration are showing statistically significant coefficients. The more manufacturing firms are using non-domestic (multi-national and foreign firms) knowledge for informing their innovation processes, the higher the percentage of sales with exploitative innovations. This leads to a rejection of hypothesis 3. Furthermore, it is found that spatial immobility is a conducive condition for knowledge integration, as a positive association with the dependent variable is observed. This finding supports hypothesis 4.

None of the interaction effects are statistically significant. Consequently, there is no support for hypotheses 5 to 8 as far as innovative sales are concerned.

5. Discussion and conclusion

Most researchers studied the concepts of exploitation at the organizational level (Stadler, Rajwani, and Karaba 2014), predominantly taking an intra-organizational perspective (Turner, Swart, and Maylor 2013) and testing their hypotheses using data from developed economies. Furthermore, previous studies often are theoretically grounded in the resource or knowledge-based view of the firm (Nason and Wiklund 2018). Informed by this theoretical lens, this study proposed that conditions for knowledge integration and knowledge

differentiation play important roles in generating exploitative product innovations. Furthermore, it is argued that there is a need to look beyond the intra-organizational perspective. This study expands the work on technology-followers which compared to technology-leaders, do not place their focus on generating new technology but implementing and making variations of existing technologies. The objective of this study is to increase our knowledge about the conditions facilitating knowledge differentiation and knowledge integration leading to exploitative product innovation while taking an inter-organizational network perspective. With this aim, we answer to a call by Barnard, Vuervo-Cazurra and Manning (2017, 468), who suggested that it is worth questioning established theories and current conceptions of management research in their applications to the context of Africa. Most of the literature presents findings applying to relatively resource-rich and institutionally stable environments; These environments are suitable for technology frontiers to develop explorative innovation. However, only a small part of the literature focuses on technology followers and the environment they are in. Our study takes South African as a different empirical setting and investigates whether several theoretical "received wisdom" hold under this different boundary condition, that is an unstable environment, has lower educational quality workers, and for some resources even absolute or lower quality scarcity. This is an environment in which exploitative innovation is the most feasible option. This option is the focus of this study.

With an innovation survey, data on firms active in the manufacturing industry in South Africa was collected. It was found that out of 497 responding firms, 164 firms (33%) have introduced product innovations. The proposed theoretical model was empirically tested by including these 164 innovators. The firms' innovation outcomes were researched using two approaches. First, models in which the probability of introducing an exploitative/incremental innovation was estimated. Second, the proportion of sales of these exploitative innovations to the total firm sales in a specific year.

A control variable having an impact in most of the models is domestic ownership. If an innovating manufacturing firm is domestically owned, it has a higher probability of having exploitative product innovations and it has a higher proportion of sales from exploitative product innovation. In the South African context with its emerging economy, domestically owned firms often are in a catch-up process. Firms in this process tend to make investments in upgrading their capabilities and focus on incremental improvement of processes (Kumaraswamy et al. 2012). Moreover, domestic owners are more responsive to the local

context (Chen et al. 2014) when modifying their existing products. This grounds the positive impact of domestic ownership on exploitative product innovation.

Tables 5 summarizes the hypotheses and the findings for the two dependent variables used in the analyses.

Insert Table 5 here

A condition facilitating knowledge differentiation, namely network range (NR), and a condition facilitating knowledge integration, namely geographic relational embeddedness (GRE), yield interesting results for exploitative product innovation. Contrary to the prediction, we found a positive association between network range (NR) and exploitative product innovation, suggesting that higher network diversity is an appropriate condition for knowledge differentiation. This would be in line with the effect observed in developed economies. However, taking a closer look at this result fits the typical search behavior of (South African) exploitative innovators. Put differently, the explanation for our finding lies in the specific external information sources used by the South African innovating firms as technology-followers. The high percentages of the use of information acquired from consumers (94%), suppliers (76%), and competitors (70%) seem to refer to what in the literature is called vicarious learning (Madsen and Desai 2018; Srinivasan, Haunschild, and Grewal 2007). This is a type of learning that happens through observing the behavior of others. Again, this fits the behavioral profile of technology-followers to a large extent.

The stronger the innovating firm is embedded in a localized inter-organizational ego-network, the more its exploitative product innovation outcomes decrease both in terms of the likelihood of introduction as well as in terms of the percentage of sales. This finding contradicts our proposed hypothesis (see Table 5). A likely explanation for these empirical results maybe is the so-called overembeddedness phenomenon. When a firm is too highly locally embedded, there might be a lack of variety in the perspectives or among the alters in the ego-network which might lead to reduced creativity (Andersen 2013). It can also be an indication of local locked-in and as a result, it is less likely to form new partnerships that can bring new information (Hagedoorn and Frankort 2008). A related explanation starts from the observation that the actual knowledge integration does not take place in interaction with domestic firms, but by or with non-domestic firms that for example import product innovations into South Africa developed elsewhere (Hansen and Ockwell 2014). This would fit an exploitative innovation orientation of domestic innovators (Chittoor, Aulakh, and Ray

2015), which would support the ideas of Forbes and Wield (2000) on technology-followers on this matter.

The hypotheses including the development zone concept were all empirically not supported, whereas we expected a positive effect. A possible interpretation is that such locations especially have a social signaling function towards external stakeholders such as customers, financiers, and suppliers (Ubeda et al., 2019). Innovation seems to be of lesser importance.

At first appearance, the statistically significant interaction effect of aspects of conditions of knowledge differentiation and knowledge integration in the models in which the probability of exploitative product innovation is the dependent variable is puzzling. It shows that the positive effect of network range on having an exploitative product innovation is positively moderated by geographic relational embeddedness. This implies that when a firm has a set of diverse alters as sources of information for its development of exploitative innovation, this positive effect is stronger if these alters are domestic, in our South African. This finding leads to a few questions. How to explain that in some models with the same dependent variable geographical relational embeddedness has an opposite effect? And, why is this interaction effect absent when the dependent variable is the percentage of innovative sales? Below, these questions are answered.

The innovation process is often modeled as an iterative process with several steps or phases (Eveleens 2010). Firms wishing to realize (product) innovations search in the early stages of the process for either internal and/or external information sources to get ideas or to find out what already is ‘out there’ on (international) markets. It was already observed that South African product innovators in manufacturing engage quite strongly in what was labeled as vicarious learning. This explains the negative main effect of geographical relational embeddedness and the positive main effect of network range. At some point in the process, however, the acquired knowledge and information have to be implemented in such a way that the product innovation actually can be realized. Several studies (Fitjar and Rodríguez-Pose 2013; Aslesen and Freel 2012; Asheim, Coenen and Vang 2007) found that the realization of such innovations asks for cooperation with partners that share similar practical problems, skills, and experiences. Furthermore, the knowledge implemented is only partially codified, and more tacit forms of knowledge, know-how, and know–who are highly relevant. Firms drawing on these types of knowledge rely more heavily on face-to-face interaction also

because of the importance of customized solutions. Consequently, the realization of these exploitative product innovations is more sensitive to geographical proximity. From this interpretation, it can be concluded that the models show that different knowledge processes occur. Because the generation of a specific or one product innovation is not studied, these processes or phases are observed and of influence concurrently and not sequentially.

So, why are these interaction effects absent in the models in which the percentage of sales from innovated products is the dependent variable? For answering this question, one has to keep in mind that this dependent variable indicates the success of the product innovation in the market, more specifically with buyers of the product. This implies that product characteristics become relevant. If the innovating firm incorporates features in the product it picked up through vicarious learning, it is more successful in the market (hence the impact of network range and non-domestic sources). Conditions for the realization of the exploitative product innovation are less relevant at this stage because the product is already there and in the market, hence the absence of interaction effects.

Our study leads to a relevant theoretical conclusion. Some organizational and management theories cannot be generalized to all settings. Theoretical insights applicable to developed economies are not replicated in emerging economies, or similar findings need a different interpretation. The findings in our study are, therefore, applicable to technology-followers and contribute to theories for which specific boundary conditions have to be taken into account.

Based on the findings of this research, two practical implications are derived. When a firm's innovation strategy is focused on exploitative product innovation, the firm needs to develop its relationships with non-proximate alters and also at the same time expands its range of network in terms of diversifying the set of alters. This will allow the firm to obtain not only complementary knowledge and resources for incremental innovation development but also the close geographical proximity with alters will allow more frequent interactions and thus the transfer of more tacit knowledge which is beneficial for the realization of this type of innovation. From a policy point of view, there is a need to have interventions that facilitate the interactions between non-domestic firms and their local actors. If the non-domestic firms can engage with the local actors, then the local knowledge spillover effect can occur, which enhances domestic firms' innovation capabilities. Studies have shown that government device intervention such as lower-income taxes or income tax holidays, import

duty exemptions, and subsidies for infrastructure to attract foreign investment and to locate locally as well (Aitken and Harrison 1999). The other mechanism that enhances the interaction is through the direct control of the foreign investors, for example using fewer expatriates but the local employees who have specific knowledge about local actors and the possibility to establish such connections or having knowledge development with local actors as part of the foreign-owned firms' performance evaluation (Andersson, Björkman, and Forsgren 2005).

Although this study has provided important contributions, it is not without limitations. Firstly, this paper has examined the determinants of exploitative product innovation among South African manufacturing firms. As a consequence, one knows little about the determinants of more exploratory (product) innovations and how the trade-off between the two types works out in an environment characterized by all kinds of resource and institutional deficiencies. Secondly, the empirical focus of the paper is on firms with innovations. Although a 'new-to-the-firm' threshold is used, which is a rather low threshold, non-innovative firms are excluded from our sample. Consequently, can only be generalized to innovative firms. Furthermore, some temporal claims are made, but given the static nature of our data collection, such claims only can be made plausible and not empirically validated. The focus on manufacturing firms only, of course, impacts negatively on the generalizability of our findings.

Future research can focus on changing roles of local and non-local actors in an innovation process running from ideation to market introduction by focussing on specific product innovation. This asks for in-depth longitudinal multiple case studies. Second, there are other relevant external conditions that one can include in the model, such as environmental dynamism, competitive intensity, (local) institutional environment (Barasa et al. 2017) that influence a firm's exploitative innovation (Lavie, Stettner, and Tushman 2010). Third, the research approach in this study is cross-sectional and at the firm level. Innovation processes are known as multistage and multilevel phenomena therefore the same study can be conducted at various stages of the innovation process as well as at other levels of analysis such as individual, group or societal level (Sears and Baba 2011). This will allow the research findings to be more level-inclusive and more conclusive.

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Appendix 1: Measurement of the variables.

Variable			Question(s) used in the survey	Measurement / coding
Control variables				
C1	Firm age		In which year was the firm established?	Log transformation of firm age
C2	Firm size		Total number of employees in 2012/2013.	Log transformation of firm size
C3	Sector		One of the six sectors according to the industry code that the firm provides.	0= Traditional sector (Food production and textile). 1= Advanced sector (Automotive, chemical, defense, pharmaceutical).
C4	Urbanized region		Province where the firm is located according to the address and GPS coordinate.	0= Less urbanized provinces (Eastern Cape, KwaZulu Natal) 1= More urbanized provinces (Gauteng, Western Cape)
C5	Domestic Ownership		What percentage of your firm is owned by private domestic individuals, companies, or organizations?	0= No domestic ownership (≤ 50%) 1= Domestic ownership (> 51%)
C6	Research Capacity	University degree	% of permanent full-time employees in 2012/2013 with a university degree or diploma?	% of total number of employees
C7		In-house R&D	Did your firm conduct in-house R&D?	0= no 1= yes
C8		R&D recruitment	Employees hired specifically for R&D?	0= no 1= yes
Knowledge Differentiation				
X1	Network Range (NR)		F10. Use of following sources of information or ideas from any innovation activity from 2010/2011 to 2012/2013? (a) Parent firm; (b) Competitors; (c) Suppliers; (d) Universities and research institutes; (e) Consulting firms; (f) Customers.	Blau's index of diversity: X= Count of total number of "yes" for all five external actors. Maximum possible amount of different actors = 6. Diversity=Square(x/6)
X2	Development Zone (DZ)		Is this firm located in: an industrial development zone, a science park, a light industry zone, or a heavy industry zone?	If the firm is located either in the industrial development zone or in a science park, then it is coded as a 1; otherwise, it is coded as 0.
Knowledge Integration				
X3	Geographic Relational embeddedness (GRE)		Which of the following sources were important in motivating your decision to engage in innovation activities? *(Questionnaire F6)* Domestic (South African), Multinationals located in SA, Foreign located aboard: competitors, suppliers, buyers (firms), consumers (final good).	Domestic = 3 Multinational = 2 Foreign = 1 X3 is the average of all the sources.
X4	Spatial Immobility (SI)		For how many years has your firm been located at the present address?	Log transform of the years
Dependent variables: Exploitative innovation				
D1	Exploitative product innovation		New to your firm? Your firm introduced new or significantly improved goods that were already available from your competitors in our market.	0= no 1= yes
D2	Exploitative innovation		Percentage of sales realized with product innovations introduced during 2010/2011 to 2012/2013 that were new to your firm but not to the South African market.	Percentage

Table 1. Distribution of innovating firms by sector and province.

	Provinces				Total
Sectors	Gauteng	KwaZulu Natal	Western Cape	Eastern Cape	
Automotive	23	1	6	1	31 (19%)
Chemicals	20	3	4	0	27 (16%)
Defence	5	0	0	0	5 (3%)
Food Production	37	1	22	0	60 (37%)
Pharmaceutical	3	1	0	0	4 (2%)
Textile	14	7	16	0	37 (23%)
Total	102 (62.2%)	13 (7.9%)	48 (29.3%)	1 (0.6%)	164 (100%)

Table 2. Correlation matrix.

	Variables	Min.	Max.	Mean	Std. Dev.	VIF	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	C1 = Firm age	2	119	19.23	17.34	2.34	1													
2	C2 = Firm size	1	6000	127.67	515.81	1.46	0.338**	1												
3	C3 = Sector	0	1	0.41	0.49	1.28	0.170*	-0.188*	1											
4	C4 = Urbanised region	0	1	0.91	0.28	1.14	-0.028	0.063	-0.012	1										
5	C5 = Domestic Ownership	0	1	0.85	0.36	1.31	-0.006	-0.195*	0.042	-0.008	1									
6	C6 = University Degree	0	100	18.72	19.87	1.32	0.024	0.316**	-0.133	0.219**	-0.293**	1								
7	C7 = In-house R&D	0	1	0.63	0.49	1.50	0.105	0.225**	-0.099	-0.010	-0.214**	0.038	1							
8	C8 = R&D recruitment	0	1	0.09	0.29	1.23	0.013	-0.004	0.212**	-0.205**	-0.107	-0.071	0.162*	1						
9	X1 = NR	0	1	0.40	0.41	1.57	-0.115	0.212**	-0.139	-0.031	-0.353**	0.249**	0.510**	0.068	1					
10	X2 = DZ	1	2	1.36	0.48	1.15	-0.100	0.094	-0.054	0.047	-0.142	0.224**	0.043	0.072	0.065	1				
11	X3 = GRE	0	2	0.48	0.52	1.35	0.105	0.084	0.089	-0.160*	0.061	-0.144	0.493**	0.190*	0.361**	-0.169*	1			
12	X4 = SI	1	62	11.63	9.05	2.29	0.680**	0.362**	-0.057	0.080	-0.153	0.207**	0.078	-0.097	-0.032	-0.096	0.009	1		
13	D1 = New to firm (yes/no)	0	1	0.77	0.42	-	-0.130	-0.082	-0.026	-0.008	0.177*	-0.044	0.061	0.068	-0.032	-0.135	0.056	-0.021	1	
14	D2 = % sales new to the firm	0	100	37.11	38.20	-	-0.181*	-0.022	-0.172*	0.010	0.184*	-0.027	0.014	-0.048	-0.169*	-0.036	0.021	0.052	0.642**	1

Table 3. Binary logistic regression for exploitative product innovation as the dependent variable.

		D1: Exploitative product innovation (Product Innovation New to firm)						
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Firm age	C1	-0.435	-0.213	-0.202	-0.220	-0.145	-0.216	-.051
Firm size	C2	-0.140	-0.086	0.027	-0.070	-0.030	-0.086	.031
Sector	C3	-0.403	-0.243	-0.483	-0.251	-0.214	-0.235	-.432
Urbanised region	C4	0.421	0.423	0.634	0.440	0.480	0.412	.690
Domestic ownership	C5	1.351***	1.961***	1.828***	1.955***	2.049***	1.946***	1.933***
University degree	C6	-0.009	-0.013	-0.012	-0.013	-0.013	-0.012	-.013
In-house R&D	C7	0.768*	0.833	1.523***	0.826	0.833	0.829	1.634**
R&D recruitment	C8	0.796	1.037	0.509	1.002	1.150	1.049	.647
NR	X1		1.254*	1.391*	1.252*	1.244*	1.252*	1.367*
DZ	X2		-0.351	-0.315	-0.339	-0.390	-0.352	-.502
GRE	X3		-0.768*	-0.523	-0.759	-0.775*	-0.775*	-.617
SI	X4		-0.113	-0.279	-0.112	-0.128	-0.105	-.405
NR x GRE	I1			4.042***				4.336**
DZ x GRE	I2				0.146			-.780
NR x SI	I3					1.214		1.279
DZ x SI	I4						-0.222	.323
Constant		0.390	0.002	-0.631	-0.032	-0.226	0.012	-.649
$N.R^2$		11.4%	16.9%	24.3%	17%	17.5%	17%	25.1%
Δ $N.R^2$			5.5%	7.4%	0.1%	0.6%	0.1%	8.2%
H-L test (Sig.)		4.821 (0.777)	6.540 (0.587)	8.740 (0.365)	4.556 (0.804)	9.807 (0.335)	2.726 (0.950)	5.362 (0.718)

*: p<0.1; **: p<0.05; ***:p<0.001 $N.R^2$ = Nagelkerke's R square; HL-test = Hosmer and Lemeshow-test

Table 4. Tobit regression analysis for the percentage of sales of exploitative product innovations.

		D2: % of sales of exploitative (new to the firm) product innovation													
		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
		Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error
Firm age	C1	-25.180	(21.479)	-63.484**	(27.171)	-66.879**	(27.516)	-64.090**	(27.264)	-62.184**	(27.090)	-62.446**	(27.110)	-65.242**	(27.421)
Firm size	C2	1.637	(14.274)	-2.830	(14.222)	-2.473	(14.119)	-3.348	(14.172)	-1.968	(14.248)	-2.709	(14.210)	-2.101	(14.142)
Sector	C3	-27.574**	(12.941)	-17.572	(12.699)	-15.815	(12.768)	-16.878	(12.663)	-17.656	(12.679)	-17.152	(12.645)	-15.043	(12.594)
Urbanised region	C4	28.451	(18.419)	29.512*	(17.423)	29.515*	(17.502)	28.100	(17.547)	31.225*	(17.710)	28.869*	(17.287)	29.189	(17.740)
Domestic ownership	C5	43.353**	(17.201)	64.920***	(18.166)	69.067***	(20.074)	66.932***	(18.414)	66.317***	(18.348)	62.992***	(18.188)	69.328***	(19.873)
University degree	C6	-0.393	(0.355)	-0.665*	(0.344)	-0.692**	(0.337)	-0.671*	(0.343)	-0.682**	(0.342)	-0.639*	(0.343)	-0.681**	(0.334)
In-house R&D	C7	9.926	(13.529)	20.608	(13.820)	14.792	(13.535)	21.191	(13.745)	21.386	(13.977)	19.927	(13.797)	15.452	(13.925)
R&D recruitment	C8	-5.390	(19.852)	3.101	(19.724)	4.802	(19.603)	4.130	(20.175)	3.553	(19.922)	3.264	(19.774)	5.821	(20.049)
NR	X1			26.576*	(14.880)	26.661*	(14.607)	27.096*	(14.941)	26.104*	(14.993)	27.377*	(14.770)	27.455*	(14.803)
DZ	X2			8.027	(13.269)	7.665	(13.014)	6.469	(13.549)	7.291	(13.209)	6.789	(13.224)	4.819	(13.171)
GRE	X3			-36.706***	(12.917)	-37.696***	(13.711)	-38.608***	(13.690)	-36.728***	(12.866)	-37.815***	(12.912)	-40.153***	(14.133)
SI	X4			58.774**	(23.097)	60.418***	(23.025)	58.200**	(22.984)	57.645**	(23.629)	58.126**	(23.183)	58.571**	(23.442)
NRxGRE	I1					-38.352	(33.707)							-36.056	(36.835)
DZxGRE	I2							-16.281	(29.857)					-11.312	(32.697)
NRxSI	I3									27.251	(41.695)			19.118	(40.532)
DZxSI	I4											-23.676	(33.968)	-23.939	(33.886)
Constant		6.437	(37.699)	-28.356	(41.174)	-24.717	(41.100)	-25.262	(41.838)	-31.842	(41.632)	-25.811	(41.235)	-22.803	(41.932)
/Sigma		67.570***	(6.847)	63.410***	(6.553)	62.848***	(6.556)	63.284***	(6.660)	63.317***	(6.541)	63.300***	(6.542)	62.60972	(6.597826)
Observations		153		153		153		153		153		153		153	
F		2.23**		2.62***		2.28***		2.42***		2.47***		2.42***		1.92**	
Pseudo Rsqr		0.0172		0.032		0.033		0.0323		0.0324		0.0325		0.0340	

Robust standard errors in parentheses

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

Table 5: Summary of predicted and estimated effects.

Independent variable	Predicted effects	Estimated effects innovation (y/n)	Estimated effects % innovative sales
Conditions for knowledge differentiation:			
H1: Network range (NR)	–	+	+
H2: Development zone (DZ)	+	n.s.	n.s.
Conditions for knowledge integration:			
H3: Geographical relational embeddedness (GRE)	+	–	–
H4: Spatial immobility (SI)	+	n.s.	+
Interaction effects conditions for differentiation and integration			
H5: NR x GRE	+	+	n.s.
H6: NR x SI	+	n.s.	n.s.
H7: DZ x GRE	+	n.s.	n.s.
H8: DZ x SI	+	n.s.	n.s.

Figure 1. Interaction effect for hypothesis 5 (NRxGRE).