Structural and geographical conditions for exploitative innovation

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Structural and geographical conditions for exploitative innovation: Evidence from South African manufacturing firms

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ABSTRACT

Firm innovation not only is a product of internal processes of knowledge differentiation and integration. It also depends on factors in the external environment of the firm stimulating or hindering these processes. This study examines external conditions for knowledge integration and differentiation among innovating South African manufacturing firms. Many South African organizations are technology-followers focused on incremental innovation by exploiting existing technologies. Informed by network and geographical theoretical perspectives, four external conditions for knowledge integration and differentiation were identified: network range and development zone (for knowledge differentiation), geographical relational embeddedness and spatial immobility (for knowledge integration). On the one hand it is found that in the South African context, a higher level of diversity of external knowledge sources (network range) is associated with a higher probability of exploitative product innovation. On the other hand, 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.

Keywords: Innovation, exploitation, knowledge integration, knowledge differentiation, South Africa

1. INTRODUCTION

This empirical paper is about incremental innovation by manufacturing firms in South Africa. More specifically, it looks into the role of external facilitators of knowledge differentiation and integration in this emerging economy. Our study builds on and extends the work by Forbes and Wield (2000), which focuses on innovation by technology-followers.

Forbes and Wield (2000) state that many firms in emerging and developing countries, like South Africa, are so-called technology-followers. This implies that for these firms the technological future is already there, since it is shaped by innovating organizations in technology-leader countries. This has a number of relevant consequences for technology-followers. First, uncertainties surrounding their innovation processes and outcomes are lower as it is already known that a certain innovation can be produced and will be commercially viable. Second, technology transfer from leaders is an important source of knowledge for followers. Third, the innovation task of technology-followers is substantially different from those of technology-leaders, but it certainly is not a minor task.

A technology-follower is, therefore, not focused on the generation of new technology. Even in case the technology-leader is willing to provide all the technological knowledge needed, the tacit dimension and dynamic nature of technology asks for considerable innovative effort on the part of the follower to maintain or lower the distance to the technological frontier. In other words, the innovative effort of technology-follower firms is not less difficult, but it is different. Now the question is: What is different?

In terms of the type of innovation, Forbes and Wield (2000: 1099) stress the importance of incremental or exploitative (process) innovation, informed by shop-floor innovation, an intra-organizational set-up that supports incremental innovation, and a different role of R&D. As to the latter and according to these authors, formal R&D efforts can productively add to the informal shop-floor innovation, which stresses the relevance of informal, non-institutionalized R&D for technology-followers (also see Drenkovska, 2015). Second, employees conducting R&D activities can be regarded as a formal or informal internal learning unit of knowledge produced elsewhere. This makes these employees technology keepers, who monitor external knowledge areas relevant to the firm (boundary spanning), codify external knowledge, and communicate, translate and (stimulate) the use of knowledge. Third, conducting R&D might have intangible spin-off benefits for other parts of the organization. Here one can think of the role R&D can play as an agent of change in organizations. In sum, innovating technology-following organizations predominantly produce incremental innovations based on an intra-organizational innovation infrastructure facilitating learning and communication.

In this study, we add an external perspective to the ideas developed by Forbes and Wield as their paper takes an intra-organizational perspective, without stating that they do not have an eye for the external environment. As a matter of fact, they clearly maintain that external knowledge can be an important source for technology-followers. What we propose in this paper is that certain external conditions facilitate or hinder knowledge differentiation and integration (see below for definitions of these concepts). That external conditions are relevant for firms' innovation processes and outcomes can be hardly regarded as something new. Many studies point for example at the negative impacts of weak institutional environments for firm innovation in developing economies (Zanello *et al.*, 2016). However, often studies describe and analyze these environments in rather general and abstract terms, such as political (in)stability or the strength of law enforcement at the national level. In this paper, we selected external elements that directly impact on the functioning of innovating firms. More specifically, we focus on characteristics of inter-organizational ties and on 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 firms' exploitative innovation?

The objective of this study is to increase our knowledge about the external conditions facilitating knowledge differentiation and knowledge integration leading to exploitative innovation. This paper contributes to innovation studies 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 innovation (Correia-Lima, Fourne and Jansen, 2013). By exploring the external conditions as proposed in this paper, we will shed some light to this field of study and extend the scholarly work on technology-followers. Second, this paper presents empirical analyses using unique and recent data from innovating South African manufacturing firms. In this way, the paper adds to our knowledge on innovation in a non-Western context. This is much needed as several authors (Zanello *et al.*, 2016; Goedhuys, Janz and Mohnen (2013) indicated there is a lack of studies on innovation in sub-Saharan Africa.

2. THEORY AND HYPOTHESES

2.1. Dependent variable: Exploitative firm innovation

March (1991) first introduced the concepts “exploitation” and “exploration”, which were theoretically articulated in the context of organisational 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 organisation’s existing knowledge base or technological trajectory whereas exploration involves a shift in the knowledge base or technological trajectory (Benner & Tushman 2003; Lavie *et al.*, 2010).

The introduction of the concepts and their combination, i.e., ambidexterity, triggered a host of studies. For example, taking a process view, Greve (2007) studied exploration and exploitation in a longitudinal study in the shipbuilding industry and connected the concepts to product innovation. Yalcinkaya, Calantone and Griffith (2007) conceptualized exploration and exploitation from a capability point of view and investigated the implications for product innovation and market performance, whereas Benner and Tushman (2003) and Andriopoulos and Lewis (2009) dealt with the question how firms can manage exploration and exploitation.

Other scholars use an innovation output orientation, as we will do in this paper, where exploitative innovation refers to technological innovation activities focusing on enhancement or refinement in existing products or processes (incremental innovation) (He and Wong, 2004; Bierly, Damanpour and Santoro, 2009, Jansen, Bosch, & Volberda, 2006). Exploitative or incremental innovation commonly is defined (Bhaskaran, 2006) as ongoing or step-by-step 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 integration and differentiation

Exploitative innovation often is studied in relation to intra-organizational topics such as business strategy (Li, Zhou and Si, 2010), leadership (Jansen, Vera and Crossan, 2009), structural differentiation (Jansen *et al.*, 2009), or entrepreneurial behaviour (Kollmann and Stöckmann, 2014). A number of scholars studies factors external to the organization as explanatory variables for this type of innovation. (Phelps, 2010), for example, investigates the impact of inter-organizational network structure 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, p.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 different types of knowledge. The members of a highly differentiated organization unit (e.g. a 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 results they tend to have high absorptive capacities in different knowledge fields and they are able to 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 that their knowledge is more diverse and they come from organizations with different norms, routines, and experiences.

To arrive at actual innovations, differentiated internal and external knowledge has to be combined to create a systematic and usable set 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, p.1030) for example state that knowledge integration is "the synthesis of individuals' specialized knowledge into situation-specific systemic knowledge", whereas Huang and Newell (2003, p. 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 organisational members". What we can get from these definitions is that interaction in order to combine knowledge is crucial for knowledge integration. However, because both definition 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, p. 159). Several studies showed the 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 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 & Neale, 1999; Chen & Huang, 2009; Østergaard, Timmermans & Kristinsson, 2011).

Many studies on knowledge integration in firms build on the work of Grant (1996, p. 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 are required. The first one is labelled 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, p.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 for information and knowledge for their innovations, we now direct our focus at the external conditions for knowledge differentiation and integration, which are discussed the next sections.

2.3. External conditions facilitating firms’ knowledge differentiation

It was stated that diversity is a necessary condition for knowledge differentiation. From a structuralistic network perspective the concept of network range captures this idea. Network range is a property of an inter-organizational network of a focal actor and is in the literature related to innovation. The concept implies that the organizations that are part of the network are dissimilar in some way (Tortoriello, Reagans and McEvily, 2012). Two theoretical arguments ground the relationship between network range and innovation. Firstly, if a focal actor would rely on inter-organizational relationships with actors of the same type (a so-called homogeneous set of ties; (Ruef, 2002)), there is a risk that there are no mechanisms for iterative and diverse learning feedback with respect to an innovation. This implies that innovators depending exclusively on these homogeneous actors will tend to adapt novelties to their own circumstances and needs without necessarily engaging in further innovation, leading to exploitative innovation. Focal actors related to a more diverse set of actors may subject their innovations to further modifications, as they receive diverse feedback from multiple actors, leading to more explorative innovations.

Secondly, having inter-organizational relationships with a diverse set of actors (higher network range) might imply access to complementary assets needed to turn inventions into successful new products on the market. Furthermore, interacting with a more diverse set of actors might encourage the transfer of more diverse knowledge and information, which, when combined with internally available knowledge resources, could lead to the creation and development of processes and products that would otherwise be difficult to mobilize and to develop. An organization with higher/lower network range will, therefore, have access to a more/less diverse and unique set of knowledge and information resources that could lead to competitive advantages in the form of exploratory/exploitative innovations. A number of empirical studies report on the positive relationship between inter-organizational network range and innovation (Powell *et al.*, 1999; Baum, Calabrese and Silverman, 2000; Ruef, 2002; Faems, van Looy and Debackere, 2005; Nieto and Santamaría, 2007; Van Beers and Zand, 2014). Although these studies use different criterion variables, they all come to the same finding: Higher levels of network range are positively related to organizational innovative performance, especially on exploratory innovation. This brings us to our first hypothesis:

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

Network range is a network structuralistic condition for knowledge differentiation, but at the same time it is a non-spatial concept. We argue that also geographical location can be a 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, p.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 shows (Asheim and Coenen, 2005; Maennig and Ölschläger, 2011; Tracey, Heide and Bell, 2014). 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 centres which possess new knowledge due to their intensive R&D activities (Díez-Vial and Fernández-Olmos, 2015).

It is proposed that being located 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 helps reinforcing and improving existing products. Therefore, hypothesis 2 reads:

Hypothesis 2: Being located in a development zone is more beneficial to the firm's exploitative 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. Actually 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. *We focus 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 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 a firm is embedded in a localized network, the geographic proximity *between the firm and its external actors* facilitates face-to-face interactions with local actors. These interactions allow for multi-modal communication (to watch, touch and listen at the same time) enhancing interactive learning and providing richer exchange of information/knowledge between the localized actors (Storper and Venables, 2004). These local ties *also* favour 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).

Actors in local networks *tend to* exhibit a collective mind due to the fact that they are part of the same local culture and share common knowledge and experience, which facilitates coordination between them (Huang and Newell, 2003). In addition, being embedded in a localized network benefits the firm because transaction costs *are reduced* and they are more likely to integrate their resources more efficiently (Conyers, 2000; Hazir, LeSage and Autant-Bernard, 2016).

Although geographic relational embeddedness enhances innovation, too *high levels* of local embeddedness can result in too dense local network where everyone knows each other and information in the local network becomes redundant *more easily*. This limits the inflow of *new or* updated knowledge for more radical innovation (White, 2008; Hazir, LeSage and Autant-Bernard, 2016), *thus for exploration*. Based on the reasoning above, the hypothesis 3 reads:

Hypothesis 3: Geographic relational embeddedness is positively related to exploitative 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 products development (Dilaver, Bleda and Uyarra, 2014) and 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 involve in spatial 'local search' which they can access knowledge relating to their existing knowledge base with less searching cost (Rosenkopf & Nerkar, 2001; Phene, Fladmoe-Lindquist & Marsh, 2006; Sidhu, Commandeur & Volberda, 2007)

This leads us to propose the following:

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

2.5. Combining external conditions facilitating knowledge differentiation and knowledge integration

Although it is well proven that diverse knowledge facilitates innovation (Breschi, Lissoni and Malerba, 2003), there exists a fundamental problem of knowledge specialisation and differentiation that is the "trade off of the superior task efficiency of specialisation against its inferior coordination properties…" (Postrel, 2002, p.306). In other words, when knowledge is differentiated, it is challenging for the firm to effectively integrate this diverse knowledge in economic activities (Tell, Carton & Cummings 2012). When interacting with a diverse set of knowledge actors, there is a need for strong relationships with individual actors so that efficient and effective knowledge exchange process can take place (Eisingerich, Rubera and Seifert, 2009). Knowledge integration, as the combination of differentiated knowledge, minimizes the cost of economic inefficiency of cross-learning (Tell, 2013). For explorative innovation there is more need for even more diverse set of knowledge which will lead even more challenge to integrate them, therefore knowledge integration plays an even greater role. The hypothesis devised from the above reasoning reads:

Hypothesis 5: The interaction effect of knowledge differentiation and knowledge integration is positively related to exploitative innovation.

3. METHODOLOGY

A structured face-to-face survey was conducted by Consulta, an external data collector, in the South African manufacturing industry in 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 year 2010 - 2013.

The survey concentrated on six manufacturing sectors (automotive, chemical, defence, food production, pharmaceutical and textile) and four provinces (Eastern Cape, Gauteng, KwaZulu-Natal and Western Cape). 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. There is over-sampling of firms in the 21-50 employees range within an 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 about 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, it is analysed 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. Next and in a second step, using the same independent and control variables, it is estimated what percentages of sales is generated with these exploitative innovations in the period 2010 – 2013.

4. RESULTS

4.1. Descriptive statistics

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

Insert Table 3 about here.

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

For dependent variables that are measured at a nominal level, binary logistic regression models have to be used to analyse the data. The results of these analyses are shown in Table 4.

Insert Table 4 about 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 innovation. The same is the case for firms that conduct in-house R&D. In model 2, the main direct effects are entered and some of them show statistical significance. Again a positive effect of South African ownership can be noted. Contrary to our expectations as expressed in hypothesis 1, the results showed a higher level of diversity of external knowledge sources (NR) is associated with a higher probability of exploitative innovation. Further analyses show that reverse engineering/observation of products already on the market, internet, and customer feedback are by far the most frequently mentioned external information and idea sources for innovation[1]. This not-hypothesized result will be further discussed in the last section of this paper.

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. On the one hand, these findings indicate that the embeddedness of South African manufacturing firms in domestic inter-organizational (ego) networks is not very conducive for having exploitative product innovations. The opposite seems to be the case. This finding does not supports hypothesis 3, in which it was argued that geographically closer, more embedded and cohesive ties are beneficial for exploitative innovation.

In the models 3 to 6, interaction effects are added to the models. To avoid major multi-collinearity problems, each model carries one of the proposed interaction effects. In model 3, 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. Again, the results show that domestic firms and firms with in-house R&D have a higher chance of producing exploitative product innovation.

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

[1] *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%).*

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 turn out to be particularly strong and partially support hypothesis 5. Again, the results indicate that domestic ownership is a strong predictor of exploitative product innovation.

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 model, indicating the robustness of these effects.

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

The result of Tobit regression analyses in which the dependent variable is the percentage of sales of exploitative product innovation are shown in Table 5.

Insert Table 5 about 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 urbanised regions tend to have 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.

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 as inspiration for their innovation processes, the higher the percentage of sales with exploitative innovations. Furthermore, it is found that spatial immobility is a conducive condition for knowledge integration, as a positive association with the dependent variable is observed.

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

5. DISCUSSION AND CONCLUSION

Most researchers studied the concepts of exploitation at the organisational level (Stadler, Rajwani and Karaba, 2014), predominantly taking an intra-organisational perspective (Turner, Swart and Maylor, 2013). Moreover, 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, we proposed that knowledge integration and knowledge differentiation play important roles in generating exploitative innovations. Furthermore, we argued that there is a need to look beyond the intra-organisational perspective. In this study we expand the work of Forbes and Wield (2000) by focusing 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/incremental innovation while taking an inter-organisational network perspective.

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 empirical 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 were estimated. Second, 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 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 incremental improvement of processes (Kumaraswamy *et al.*, 2012). Moreover, domestic owners are more responsive to the local context (Chen *et al.*, 2014) when making modification of the existing products. This grounds the positive impact of domestic ownership on exploitative product innovation.

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 innovation. Contrary to our expectation, 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. However, taking a closer look at this result fits the typical search behaviour of (South African) exploitative innovator. Put differently, the explanation for our finding lies in the nature of the external information sources used by the South African innovating firms. 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 (Srinivasan, Haunschild and Grewal, 2007; Madsen and Desai, 2018). This is a type of learning that happens through observing the behaviour of others. Again, this fits the behavioural profile of an exploitative innovator 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 decreases both in terms of introduction as well as in terms of the percentage of sales. This finding contradicts our proposed hypothesis (H3). A probable explanation for this empirical results maybe is the so-called overembeddedness phenomenon. When a firm is too strongly 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 apparently does not take place in interaction with domestic firms, but by or with non-domestic firms who for example import product innovations developed elsewhere into South Africa (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 this matter.

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 an exploitative product innovation is the dependent variable, is a puzzling one. 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 source of information for its development of exploitative innovation, this positive effect is stronger if these alters are domestic, thus 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? Second, 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 modelled as an iterative process with a number of 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 labelled 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, the acquired knowledge and information has to be implemented in such a way that the product innovation actually can be realized. Several studies (Fitjar & Rodríguez-Pose, 2013; Aslesen & Freel, 2012; Asheim, Coenen & 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 for geographical proximity. From this interpretation, it can be concluded 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 innovative sales 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 users of the product. This implies that product characteristics become relevant. If the innovating firm incorporate features in the product, it picked up through vicarious learning, it apparently 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.

Based from the findings of this research, two practical implications are derived. When a firm's innovation strategy is focused on exploitative innovation, the firm needs to develop its relationships with the local and non-proximate alters and also at same time expands its range of network in terms of diversify 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 this 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 its local actors. If the non-domestic firms can engage with the local actors, then 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 holiday, 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 less 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 determinants of exploitative product innovation among South African manufacturing firms. As a consequence, we know 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. Furthermore, some temporal claims are made, but given the static nature of our data collection, such claims only can be made plausible. The focus on manufacturing firms only, of course, impacts negatively on the generalizability of our findings.

Future research can focus changing roles of local and non-local actors in an innovation process running from ideation to market introduction by focussing on a 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 have influence on 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 employee 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, defence, pharmaceutical).
C4	Urbanised region		Province where the firm is located according to the address and GPS coordinate.	0= Less urbanised provinces (Eastern Cape, KwaZulu Natal) 1= More urbanised provinces (Gauteng, Western Cape)
C5	Domestic Ownership		What percentage of your firm is owned by private domestic individuals, companies or organisations?	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 X1 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 innovation (Exploit b)		New to your firm? Your firm introduced new or significantly improved goods or services that were already available from your competitors in our market.	0= no 1= yes
D3	Exploitative innovation (Exploit %)		Goods and services 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			
Sectors	Gauteng	KwaZulu Natal	Eastern/Western Cape	Total
Automotive	23	1	7	31 (19%)
Chemicals	20	3	4	27 (16%)
Defence	5	0	0	5 (3%)
Food Production	37	1	22	60 (37%)
Pharmaceutical	3	1	0	4 (2%)
Textile	14	7	16	37 (23%)
Total	102 (62%)	13 (8%)	48 (30%)	164 (100%)

Table 2: Means and standard deviation of control, independent and dependent variables

Variables		Unit	N	Min	Max	Mean	Std. Dev.
Control variables:							
C1	Firm age	Number of Years	164	2	119	19.23	17.338
C2	Firm size	Number of employees	159	1	6000	127.67	515.808
C3	Sector	Binary	164	0	1	0.41	0.493
C4	Urbanised region	Binary	164	0	1	0.91	0.280
C5	Domestic ownership	Binary	164	0	1	0.85	0.361
C6	University degree	%	162	0	100.0	18.72	19.874
C7	In-house R&D	Binary	161	0	1	0.63	0.485
C8	R&D recruitment	Binary	162	0	1	0.09	0.291
Independent variables							
X1	Network range (NR)	Blau’s index	164	0	1	0.395	0.414
X2	Development Zone (DZ)	Binary	164	1	2	1.36	0.481
X3	Geo relational embeddedness (GRE)	Average of 3-point Likert scale	164	0	2	0.479	0.515
X4	Spatial immobility (SI)	Number of Years	164	1	62	11.63	9.053
Dependent variable: Exploitative product innovation							
D1	New to firm	binary	164	0	1	0.77	0.419
D2	% sales of product innovation new to firm	%	164	0	100	37.11	38.196

Table 3: Correlation matrix

	C1	C2	C3	C4	C5	C6	C7	C8	X1	X2	X3	X4	D1	D2
C1 = Firm age	1.000													
C2 = Firm size	.338**	1.000												
C3 = Sector	.170*	-.188*	1.000											
C4 = Urbanised region	-0.028	0.063	-0.012	1.000										
C5 = Domestic Owndership	-0.006	-.195*	0.042	-0.008	1.000									
C6 = University Degree	0.024	.316**	-0.133	.219**	-.293**	1.000								
C7 = In-house R&D	0.105	.225**	-0.099	-0.010	-.214**	0.038	1.000							
C8 = R&D recruitment	0.013	-0.004	.212**	-.205**	-0.107	-0.071	.162*	1.000						
X1 = NR	-0.115	.212**	-0.139	-0.031	-.353**	.249**	.510**	0.068	1.000					
X2 = DZ	-0.100	0.094	-0.054	0.047	-0.142	.224**	0.043	0.072	0.065	1.000				
X3 = GRE	0.105	0.084	0.089	-.160*	0.061	-0.144	.493**	.190*	0.361**	-.169*	1.000			
X4 = SI	.680**	.362**	-0.057	0.080	-0.153	.207**	0.078	-0.097	-0.032	-0.096	0.009	1.000		
D1 = New to firm (yes/no)	-0.130	-0.082	-0.026	-0.008	.177*	-0.044	0.061	0.068	-0.032	-0.135	0.056	-0.021	1.000	
D2 = % sales new to the firm	-.181*	-0.022	-.172*	0.010	.184*	-0.027	0.014	-0.048	-.169*	-0.036	0.021	0.052	.642**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4: Binary logistic regression for exploitative product innovation as dependent variable

		DV1: Exploitative innovation (Product Innovation New to firm)					
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Firm age	C1	-0.435	-0.213	-0.202	-0.220	-0.145	-0.216
Firm size	C2	-0.140	-0.086	0.027	-0.070	-0.030	-0.086
Sector	C3	-0.403	-0.243	-0.483	-0.251	-0.214	-0.235
Urbanised region	C4	0.421	0.423	0.634	0.440	0.480	0.412
Domestic ownership	C5	1.351***	1.961***	1.828***	1.955***	2.049***	1.946***
University degree	C6	-0.009	-0.013	-0.012	-0.013	-0.013	-0.012
In-house R&D	C7	0.768*	0.833	1.523***	0.826	0.833	0.829
R&D recruitment	C8	0.796	1.037	0.509	1.002	1.150	1.049
NR	X1		1.254*	1.391*	1.252*	1.244*	1.252*
DZ	X2		-0.351	-0.315	-0.339	-0.390	-0.352
GRE	X3		-0.768*	-0.523	-0.759	-0.775*	-0.775*
SI	X4		-0.113	-0.279	-0.112	-0.128	-0.105
NR x GRE	I1			4.042***			
DZ x GRE	I2				0.146		
NR x SI	I3					1.214	
DZ x SI	I4						-0.222
Constant		0.390	0.002	-0.631	-0.032	-0.226	0.012
N.R^2		11.4%	16.9%	24.3%	17%	17.5%	17%
Δ N.R^2			5.5%	7.4%	0.1%	0.6%	0.1%
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)

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

Table 5: Tobit regression analysis for percentage of sales of exploitative product innovations

		DV2: % of sales of exploitative (new to the firm) product innovaiton											
		Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**	
		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)
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)
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)
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)
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)
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)
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)
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)
NR	X1			26.576*	(14.880)	26.661*	(14.607)	27.096*	(14.941)	26.104*	(14.993)	27.377*	(14.770)
DZ	X2			8.027	(13.269)	7.665	(13.014)	6.469	(13.549)	7.291	(13.209)	6.789	(13.224)
GRE	X3			-36.706***	(12.917)	-37.696***	(13.711)	-38.608***	(13.690)	-36.728***	(12.866)	-37.815***	(12.912)
SI	X4			58.774**	(23.097)	60.418***	(23.025)	58.200**	(22.984)	57.645**	(23.629)	58.126**	(23.183)
NRxGRE	I1					-38.352	(33.707)						
DZxGRE	I2							-16.281	(29.857)				
NRxSI	I3									27.251	(41.695)		
DZxSI	I4											-23.676	(33.968)
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)
/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)
Observations		153		153		153		153		153		153	
F		2.23**		2.62***		2.28***		2.42***		2.47***		2.42***	
Pseudo Rsqr		0.0172		0.032		0.033		0.0323		0.0324		0.0325	
Robust standard errors in parentheses													
*** p<0.01, ** p<0.05, * p<0.1													