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

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This paper examines how firms in an emerging economy cope with resource challenges by implementing compensation strategies for incremental product innovations. The model is empirically tested using firm-level survey data from 497 South African manufacturing firms. Results show that higher diversity among a specific set of external knowledge sources is associated with a higher likelihood of incremental product innovation. Stronger embeddedness in non-domestic inter-organizational networks increases this likelihood as well. The positive effect of external knowledge diversity is more positive for higher levels of localized ties. Recommendations to enhance incremental product innovation concern the development of external relationships with domestic and international partners while limiting knowledge source diversity to a specific actor set. This paper shows that in an emerging economy firms have agency with which they can use contact learning leading to product innovations tailored to local market needs and opportunities.

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1. Introduction

It is no secret that many firms in emerging and developing countries, such as South Africa, operate at a distance from the technology frontier (Goedhuys and Sleuwaegen 2010; Das and Drine 2020). Many studies see these firms as technology followers (Forbes and Wield, 2000) predominantly occupied by imitating, importing, and adapting foreign technologies to enhance their innovative performance (Geroski 1995; Cameron, Proudman, and Reddings 2005; Madsen, Islam, and Ang, 2010, Lee and Tang 2018). Although following and imitating technology developed elsewhere can be a successful development strategy for firms and countries, as recent history has shown (Zanello, Fu, Mohnen, and Ventresca, 2016), such a perspective still emphasizes dependency relationships and gives little room for agency to firms in emerging and developing countries characterized by resource challenges.

More recently, there is a growing managerial and scholarly attention for innovative activities under challenging or constrained conditions with a special focus on emerging markets and low-income users (Agarwal, et al 2016; Cai, Ying, Liu, and Wu 2019). Instead of stressing a passive follower role for innovating organizations, firms are portrayed as active actors that see and can benefit from opportunities in resource-constrained situations. This emerging literature maintains that innovation in resource-challenging situations differs considerably from innovating in the developed parts of the world (Ploeg, Knoben, Vermeulen, and Van Beers, 2020). This is exemplified by a broader innovation definition (Zanello et al. 2016), stressing specific characteristics of the innovation process, like bricolage, improvisation, and frugal innovating (Cunha et al. 2014), and specific innovation outcomes. Examples of the latter are Bottom of the Pyramid (BOP) innovation, reverse innovation, or disruptive innovation (Agarwal et al. 2016).

We argue that the unique context of resource-constrained environments requires academics to reconsider some of the key assumptions around innovation and the strategies that contribute to its success (cf. Barnard, Cuervo-Cazurra, and Manning, 2017). For instance, the South African context clearly shows that innovation constraints for firms in the manufacturing sector differ significantly from their European counterparts. Whereas about 22% of EU innovators report a lack of internal resources and a too high level of innovation costs, South African firms report 32.5% and 15.5% respectively. At the same time South African firms score low on constraints such as ‘lack of demand’, and ‘lack of market information’ (all figures are from the Bogliacino et al. (2012) paper). As such, the reported constraints in South Africa show a different pattern, with severe internal resource shortages and a high potential for innovative products in the markets.

The theoretical implication of innovating in resource-constrained environments is that it requires a different set of strategies compared to environments without a relative lack of scare resources. In the latter context, technology leveraging, platform offering, creative destruction, science-based, and R&D intensive stragtegies (Clausen, Phojola, Sapprasert, and Verspagen, 2011; Bowonder, Dambal, Kumar, and Shirodkar, 2015) are important determinants for a firm's innovative performance. Yet, such strategies are not feasible in a resource-constrained context. Rosenzweig and Grinstein (2016) propose two general strategies for firms that suffer from resource-constraints: a simplification strategy and a compensation strategy. In the former strategy, firms eliminate unnecessary or less valuable parts of a process or product, which stimulates focus by (ibid: p. 117): "easing the comparison of alternatives and deconstructing complex procedures". This strategy is highly similar to previously identified strategies such as reverse innovation and BOP innovation (see also Ploeg et al., 2020). A compensation strategy pertains to the closure of the gap caused by the resource challenge by utilizing other, existing resources that compensate for the challenged resources. These resources can be found in the environment of the firm and take the shape of external networking and cooperation.

In the paper, we focus on the effect of compensation strategies on incremental product innovation[1] for resourced challenged South African innovating firms in manufacturing. More specifically, we investigate to what extent these firms use a compensation strategy by drawing on resources available in their environment. We develop this latter concept further by specifying its dimensions considering inter-organizational and geographical factors. For a long time, the environment-organization debate maintained that organizations are units that are selected by or adapt to abstract environmental pressures like uncertainty, heterogeneity, or hostility (Aldrich and Pfeffer 1976). Although these are relevant dimensions of the environment, they are not very helpful for resource-seeking organizations as they refer to any element outside organizations. Dill, Thompson and Thorelli advanced the concept of task environment, which refers to that part of the external environment of an organization which

[1] In this study, we focus on incremental product innovation as an outcome. Obviously, we are aware that firms also can develop (incremental) process innovations. In line with Gomez, Salazar and Vargas (2016), we do not want to maintain that the theoretical mechanisms for product and process innovation are identical. We therefore only focus on product innovation here.

affects its ability to reach business goals (Negandhi, and Reimann, 1973). Any external actor with direct involvement with an organization may be part of the task environment. In this study, we focus on two relevant elements: direct ties with external knowledge sources, and geographical factors. These are relevant in this context, as these sources hold the knowledge and information necessary for innovation, whereas geography influences the ease with which knowledge can travel.

This leads to the following research question: To what extent do inter-organizational and geographical factors influence incremental product innovation?

This study aims to increase our knowledge and understanding of the use of innovation strategies in resource-constrained environments. By conceptualizing resource-constrained innovators as active entities, we move away from a dependency perspective in which these innovators are 'victims of their environment'. Instead, we argue that firms can deal with resource challenges by consciously implementing context specific strategies. In this way, we add to the organizational adaptation and resilience literature for firms in non-Western contexts (Andersson et al. 2019; Sarta, Durand, and Vergne 2021). In particular, building on Rosenzweig and Grinstein (2016), we show how inter-organizational factors (external knowledge diversity and localized ties) and geographical factors (development zone location and spatial immobility of innovation firm) allow firms to attenuate the effect of resource-constraints. Consequently, we add to the literature on resource-constrained innovation as we investigate to what extent of the implementation of compensation strategies works out (Sharmelly and Ray 2021).

In addition, this paper presents unique data from innovation manufacturing firms in South Africa. African firms are relatively far away from the technology frontier and need to implement specific strategies. As such, these strategies differ from the ones found in Western economies and depend less on internal resources such as R&D or human capital. This highlights that scholars need to be more attentive to the context in which existing theories are used. In this way, this paper adds to our understanding of innovation in a non-Western context (Barnard, Cuervo-Cazurra, and Manning 2017; George et al. 2016) and develops a perspective in which innovators successfully can cope with resource-constraint situations. Hence, such firms are given more agency as is usually the case. Taking into account the fact that African innovating firms are further away from the technology frontier will help not only academics but also practitioners who too often rely on knowledge from a Western context while being confronted with unique challenges (Nkomo 2015).

The remainder of this paper is organized as follows. In the next section, we develop our theory and hypotheses related to the extent to which inter-organizational and geographical factors influence incremental product innovation. Following this, we discuss our sample and methodology. The subsequent section presents the results of our analysis. Finally, we discuss the implications of the study and provide concluding remarks.

2. Theory and hypotheses

2.1 Incremental product innovation

In this paper, the focus is on incremental product innovation as an outcome. This regards technological innovation activities resulting in the enhancement or refinement in existing products (He and Wong 2004; Bierly, Damanpour, and Santoro 2009; Jansen et al. 2006; Wu et al. 2019). 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 Dimensions of the compensation strategy and their impact on incremental product innovation

One way to deal with resource constraints is trying to access and acquire resources available in the environment of the organization. In many cases, using these resources can be realized without substantive high additional costs, for example via external (un)intended spillovers or informal knowledge exchanges. In any case, by inter-organizational collaboration and exchange, innovating firms can compensate for missing technological knowledge resulting from (internal) resource constraints.

External knowledge diversity, defined as the differences in knowledge resources held by other organizations in a firm’s environment (Tortoriello, Reagans, and McEvily 2012), is important for innovation outcomes in general and product innovation in particular (Vlaisavljevic, Cabello-Medina, and Pérez-Luño 2016). Previous literature shows that external knowledge diversity 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 external knowledge diversity and innovation-related outcomes. Some report a positive relationship. Examples of this positive effect are in Liu, Madhavan, and Sudharshan (2005) on innovation potential, Reagans and McEvily (2003) on knowledge transfer, Ruef (2002) on the likelihood of organizational innovation, and more recently in Basit and Medase (2019) on the relationship between diversity and the occurrence of a broad set of innovation types. Others find negative or no effects of external knowledge diversity. For example, Patel and Terjesen (2011) reported a statistically non-significant direct effect on transnational venture performance, whereas Kijkuit and Van Den Ende (2010) showed that external knowledge diversity 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 find an inverted U-shaped relationship. Similarly, Zhang, Tang, and Yi (2020) show empirically such a curvilinear relationship between functional diversity and innovation outcomes.

To understand such differing findings oftentimes one has to consider specific boundary conditions (Dong et al. 2020). First, the vast majority of studies are conducted in developed economies. In such economies, external knowledge resources are part of a relatively resource-rich environment, which is more diverse and technologically more advanced and complex. These characteristics may lead to information overload in case firms try to tap into the full breadth of the available external knowledge which results in negative effects on innovation (Oerlemans, Knoben, and Pretorius 2013). Second, many studies focus on a variety of innovation outcomes, ranging from product to organizational innovations and from imitative, incremental to radical innovation outcomes. This hinders an unambiguous interpretation and generalization of research findings. One can doubt, therefore, whether these findings also apply to drivers of incremental product innovations in resource-challenged environments.

As stated in the first part of this study, radical innovations are scarce in resource-constrained environments and a vast majority of innovations is incremental. We argue that the nature of firms' innovations (incremental or radical) creates specific knowledge demands and search behaviours. Firms with an incremental innovation focus are not searching for high-tech R&D-generated knowledge developed in a well-developed science and technology infrastructure. Bogliacino et al. (2012) investigated the existing evidence on innovation produced by innovation surveys in developed, developing, and emerging countries in Europe, Asia, Africa, and Latin America. They concluded that among organizations in more resource-constraint contexts, there is a higher need for knowledge and information on the use of new machinery ('embodied technology', see: Wang, Xiao, and Savin, 2021), and knowledge and information facilitating these organizations to imitate products and processes developed elsewhere. In the literature, this is labelled as vicarious learning (Madsen and Desai 2018; Srinivasan, Haunschild, and Grewal 2007). This is a type of learning that happens through observing the behaviour of (organizational) others.

The implication of the above is that knowledge diversity has a different connotation for organizations striving for incremental product innovation in resource-constrained environments. First, given the nature of incremental innovations, the range of the diversity of external knowledge tends to be narrower (see: Duysters and Lokshin 2011). Second, within this narrower range, innovating organizations tend to use a specific selection of external resources. The literature, however, does not agree on how this selection set looks like. For a sample of Taiwanese firms, Hsieh, Ganotakis, Kafouros, and Wang (2018) find that foreign consultants, private research institutes, and domestic suppliers are important sources for incremental innovations. For a number of sub-Saharan African countries, Medase and Abdul-Basit (2020) report that especially workshops and new employees are used as information sources for product innovation. A study among Columbian firms shows that spillovers (e.g. in the form of observing innovative behaviour of competitors) are the most important external knowledge resource for product innovators (De Paris Caldas, De Oliveira Paula, and Da Silva 2021). Since incremental product innovation concerns the enhancement or refinement of existing products, it is important that it connects to or builds on already existing technical systems, tastes, and perceptions. Consequently, the relevant choice set of external partners consists predominantly of suppliers, buyers/consumers, and competitors as they can provide the relevant input for incremental product innovation because of their direct market experiences and knowledge.

Hypothesis 1: Higher levels of external knowledge diversity positively relate to incremental product innovation.

Especially in resource-constrained situations, economic geographical factors can be argued to be of additional importance to realize product innovations. These factors can be relevant in two interrelated ways: via spatial proximity and via location (Knoben and Oerlemans 2012). Knowledge is, unlike information which can be easily codified; 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 aspects are therefore factors facilitating access to and transfer of (diverse) tacit knowledge (Gertler 2005) between organizational actors. First, we focus on the function of localized ties for incremental product innovation.

Localized or geographically embedded inter-organizational relationships might be beneficial for incremental product innovators. In general, the embeddedness concept refers to 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 inter-organizational ties of a firm are (partly) localized, 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 vicarious 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 2014) 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 with localized inter-organizational ties *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 2014; Conyers, 2000; Pucci et al. 2017). Finally yet importantly, localized ties enable innovators to interact with local users. In this way, they can more easily learn about local tastes, preferences, and needs. They can adapt their products accordingly. Taking an institutional theoretical perspective, Ernst, Kahle, Dubiel, Prabhu, and Subramaniam (2015) propose and empirically find that the negative effects of formal institutional voids often present in resource-constrained contexts, can be reduced as such local partners may provide support with their own resources, their local knowledge, and their network relationships. Put differently, in the context of emerging economies, they find that local embeddedness is conducive for innovation. Based on these insights, our hypothesis 2 reads:

Hypothesis 2: Geographic relational embeddedness positively relates to incremental product innovation.

Being located in certain geographical spaces can offer firms more easily access to (international) knowledge resources and flows, as a host of literature on for example regional clusters, innovative milieus, and industrial districts shows (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 incremental 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.

Besides the knowledge-related benefits mentioned above, location in development zones can bring additional benefits to innovating organizations in resource-constrained situations. Examples of these other benefits are higher status, creating an innovative image, and safety and protection (Chan, Oerlemans, and Pretorius, 2010). The bottom line is that location in development zones compensates for different types of resources not present or accessible at other locations. Therefore, hypothesis 3 reads:

Hypothesis 3: Being located in a development zone positively relates to the firm's incremental product innovation as compared to being located outside a development zone.

The longer the firm stays in a location (i.e. the *higher* its spatial immobility) the more it can build and utilize its localized network for easy access to resources for product development (Dilaver, Bleda, and Uyarra 2014). Spatial immobility allows firms 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).

Spatially immobile firms 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 long 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 incremental 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 incremental product innovation.

2.3 Interaction effects and incremental product innovation

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, external knowledge diversity is positively related to incremental product innovation. However, this positive effect might be partially strengthened 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 positive relationship between external knowledge diversity and incremental product innovation is more positive for higher levels of geographical relational embeddedness.

A second interaction effect that we propose is the effect of innovating firms' spatial immobility on the positive relationship proposed in hypothesis 1. It is maintained that being spatially immobile brings stabilization to several organizational processes in general, and inter-organizational knowledge exchange processes in particular. 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 firms in resource constraint situations. These arguments lead to hypotheses 6:

Hypothesis 6: The positive relationship between external knowledge diversity and incremental product innovation is more positive 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 incremental 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 incremental product innovation. In hypothesis 2, we proposed that being located in a development zone is positively related to the firm's incremental 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 incremental 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

3.1 Data collection process

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 South African provinces (Eastern Cape, Gauteng, KwaZulu-Natal, and Western Cape). These 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. Table 1 shows the distribution of the innovating firms by sectors and South African provinces.

Insert Table 1 here.

The 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 resource-constrained 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.

3.2 Empirical strategy

The empirical analyses contain two steps. In the first step, we analyzed which dimensions of the compensation strategy are associated with the probability of an innovating South African manufacturing firm having an incremental product innovation. Given that this dependent variable is binary, we use binary logistic regression models to test the hypotheses. The general logistic regression equation is:

$$Pr\left(Y_i = 1|\mathrm{X}\right) = \frac{e^{b_0 + b_1X + b_2Z + b_3XZ + \varepsilon}}{1 + e^{b_0 + b_1X + b_2Z + b_3ZX + \varepsilon}} \quad (1)$$

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 incremental product innovation, EKD represents external knowledge diversity, GRE is geographical relational embeddedness, DZ represents whether the firm is located on a development zone and SI represents spatial immobility.

$$Log\left[\frac{Y}{1-Y}\right] = b_0 + b_1EKD + b_2GRE + b_3DZ + b_4SI + b_5EKD * GRE + b_6EKD * SI + b_7 DZ * GRE + b_8DZ * SI + \varepsilon_i \quad (2)$$

In the second step, using the same independent and control variables, we estimate what percentages of sales are generated with these incremental product innovations in the period 2010 – 2013. By definition, for this dependent variable values 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).

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

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

$$Incremental\ Innovation_i^* = b_0 + b_1EKD + b_2GRE + b_3DZ + b_4SI + b_5EKD * GRE + b_6 EKD * SI + b_7DZ * GRE + b_8DZ * SI + \varepsilon_i$$

(4)

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

3.3 Statistical descriptive of the database

Table 2 presents the means and standard deviation of the control, independent and dependent variables.

Insert Table 2 here.

About 77% of South African firms with innovation had an incremental product innovation in the period 2010 – 2013. The related percentage for all responding firms is 26%. In the financial year 2012/2013, firms with incremental product innovations generated on average about 37% of their sales with these innovations.[2] 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 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. Results

4.1 Dimensions of compensation strategy: Probability of incremental product innovation

Table 3 presents the results of binary logistic regressions. Both the coefficients and the standard errors are presented in the table.

Insert Table 3 here.

Goodness of fit tests were performed in each model where a chi-square value (a Hosmer-Lemeshow chi-square) and a p-value are presented in the table. All models show p-values above 5% which indicate a good fit.

From the first model including only the control variables, it is observed that firms that are South African owned have a higher probability of incremental product innovation. The same is the case for firms that conduct in-house R&D. In model 2, the main direct effects are entered. In support of hypothesis 1, the results showed that a higher level of diversity of external knowledge sources (EKD) is associated with a higher probability of incremental product innovation. Further analyses showed that reverse engineering/observation of products already on the market, internet, and customer feedback, a rather specific set of external knowledge sources, are by far the most frequently mentioned external information and idea

[2] In the vast majority of the cases (94%) a lack of incremental innovation implies that the firm has no innovation at all. Only in 6% of the cases do firms have radical but no incremental 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.

sources for innovation[3]. This telling 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 3 is not supported.

Additionally, this model indicates that geographic relational embeddedness is negatively associated with the probability of firms having incremental product innovations. Please note that in the analyses, higher values of the geographic relational embeddedness (GRE) variable indicate higher spatial embeddedness levels. These findings indicate that the embeddedness of South African manufacturing firms in non-domestic inter-organizational (ego) networks is more conducive for having incremental product innovations. This finding does not support hypothesis2, in which it was proposed that geographically closer, more embedded, and cohesive ties are beneficial for incremental product innovation of South African manufacturing firms. Also hypothesis 4 concerning a proposed relationship between spatial immobility and incremental product innovation is not empirically supported.

In models 3 to 7, interaction effects are added, testing the 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, external knowledge diversity (EKD) shows a statistically significant positive relationship with incremental product innovation. Thus, the more firms are strongly embedded in a more diverse inter-organizational network, the higher the probability that they have incremental product innovations.

From the positive coefficient of the interaction term (EKDxGRE), one can deduct that the positive effect of external knowledge diversity (EKD) 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 turns out to be particularly strong and supports hypothesis 5, in which a positive moderation effect was proposed (See Figure 1).

Insert Figure 1 here.

[3] 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%).

The other proposed interaction effects are not statistically significant, although the effects of domestic ownership, external knowledge diversity, 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.

4.2 Dimensions of compensation strategy and sales from incremental product innovation

Table 4 shows the results of Tobit regression analyses in which the dependent variable is the percentage of sales of incremental product innovation.

Insert Table 4 here.

When looking at the percentage of sales generated with incremental product 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 incremental product innovation. Furthermore, firms located in urbanized regions tend to have a higher percentage of incremental 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 incremental innovations. Fourth, our findings show that higher levels of innovative sales with incremental product innovation are accomplished by manufacturing firms with lower levels of highly educated employees.

As to the dimensions of the compensation strategy, again a positive and statistically significant association is found between external knowledge diversity (EKD) and the percentage of sales with incremental 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 supporting hypothesis 1.

Geographical relational embeddedness (GRE) and spatial immobility (SI) are showing statistically significant coefficients as well. The more manufacturing firms are using non-domestic (multi-national and foreign firms) knowledge sourced for informing their innovation processes, the higher the percentage of sales with incremental product innovations. This leads to a rejection of hypothesis 2. Furthermore, it is found that spatial immobility is a conducive condition for sales of incrementally innovated products, 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.

The robustness of the results was tested by using Fractional regressions. The results of the fractional regression are highly similar to those of the Tobit regression. The only exception is the interaction effect between external knowledge diversity and geographical relational embeddedness which becomes statistically significant in the full model (i.e. model 14). As this effect is still statistically insignificant in the partial model (model 10) and the sign of the coefficient is identical to the one obtained in the Tobit regression, we conclude that this is a negligible difference between the two statistical methods.

Insert Table 5 here.

5. Discussion and conclusion

Most researchers studied incremental innovation 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 relatively resource-rich 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, and depicting innovating firms in an emerging economy as having agency, this study proposed that organizations actively can use strategies to cope with internal and external resource challenges. More specifically, it is argued, and empirically shown, that firms can implement a compensation strategies succesfully.

The objective of this study is to increase our understanding of the way organizations in resource-constrained environments successfully can implement specific strategies to generate innovations. With this aim, we answer 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. However, only a small part of the literature focuses on firms in emerging economies actively engaging in incremental product innovation. Our study takes

South Africa as a different empirical setting and investigates whether specifications of a compensation strategy contribute to generating incremental product innovations.

With an innovation survey, data on firms active in manufacturing in South Africa were collected. Out of 497 responding firms, 164 firms (33%) did introduce product innovations. To test the hypotheses, two dimensions indicated firms' innovation outcomes and were used as dependent variables: the probability of introducing incremental product innovations and the proportion of sales with this type of innovation to the total firm sales in a specific year were used.

The first empirical finding emerging from our analyses is that domestic ownership (a control variable) has an impact on most of the models. Domestically owned manufacturing firms have a higher probability of having incremental product innovations and have a higher proportion of sales from such innovations. In the South African 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 improvements of processes (Kumaraswamy et al. 2012). Moreover, domestic owners are more responsive to and knowledgeable about the local context (Chen et al. 2014) when modifying their existing products. This grounds the positive impact of domestic ownership on incremental product innovation.

External knowledge diversity and geographic relational embeddedness (GRE) yield interesting results for incremental product innovation. In support of our prediction, we found a positive association between external knowledge diversity (EKD) and incremental product innovation, implying that higher diversity in external knowledge sources is a driver of incremental product innovation. This finding seems to resemble similar effects observed in developed economies (De Leeuw, Lokshin, and Duysters 2014). However, taking a closer look at this finding shows that external knowledge diversity has a specific connotation in our South African context. The incremental product innovators in our sample access a specific set of external information sources instead of a broad range as is the case in a developed context. The high percentages of the use of information acquired from consumers (94%), suppliers (76%), and competitors (70%) refer to what in the literature is called contact learning (Haunschild and Miner 1997; Madsen and Desai 2018). This type of organizational learning occurs when firms learn through their networks of inter-organizational relations and are innovating in an imitation mode. This approach is beneficial for product innovation in contexts where user needs are not very articulated and environmental uncertainty is high (Bao, Wei, and DiBenetto 2020). Organizations are motivated to work in this way if they wish to reduce risks and arrive at a cost-economizing approach for effectiveness (Ordanini, Rubera, and DeFillippi 2008). From a theoretical point of view, this finding shows that the effects of external knowledge diversity are conditional on context. Furthermore, they helped us to show that these firms use a specific configuration of external knowledge sources for generating incremental product innovation, a configuration deviating from what is commonly found in more resource-rich contexts. In sum, this finding supports a specification of the compensation strategy.

The embeddedness of the innovating firm in a more internationalized inter-organizational ego-network is associated with a higher likelihood of incremental product innovation as well as in higher percentages of innovative sales. This finding contradicts our proposed hypothesis. A likely explanation for these empirical results has two dimensions. On the one hand, it confirms that the South African knowledge context is not very facilitating for (product) innovation, which stresses that the local context is indeed resource-constrained in terms of resource availability and quality. On the other hand, it shows that multinationals and organizations located outside of South Africa are important drivers of incremental product innovation. Buys (2004) coined this phenomenon the 'technology colony', where there exists a large flow of technology from the developed world into the colony. Put differently, this finding confirms an internationalized specification of the compensation strategy.

The statistically significant moderation effect of external knowledge diversity and geographic relational embeddedness in the models in which the probability of incremental product innovation is the dependent variable supports hypothesis 5. It implies that when a firm has a set of diverse external sources of information for its development of incremental product innovation, this positive effect is stronger if these alters are domestic, in our case 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 contact learning. This explains the negative main effect of geographical relational embeddedness and the positive main effect of external knowledge diversity. 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 incremental product innovations is more sensitive to geographical proximity. From this interpretation, it follows that the models show that different knowledge processes occur, which are not fully captured by a cross-sectional design. 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 in time.

Next, 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 innovated product. This implies that perceived product characteristics become relevant. If the innovating firm incorporates features in the product it picked up through contact learning, it is more successful in the market (hence the impact of specific external, non-domestic knowledge sources). Conditions for the realization of the incremental 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 several theoretical conclusions. First, some organizational and management theories cannot be generalized to all empirical settings. Theoretical insights, like organizational learning theory, applicable to developed economies cannot directly be applied to emerging and developing economies, or similar findings need a different interpretation. The findings in our study are, therefore, applicable to incremental product innovators in a resource-challenged context. Second, our theoretical model enabled the development of hypotheses that moves away from negative effects of environmental determinism and proposes that context specific strategies can be positive drivers of innovation. Third, this study adds relevant theoretical dimensions to the general compensation strategies proposed by Rosenzweig and Grinstein (2016). The suggested dimensions of the compensation strategy acknowledge that innovators are positioned in relational and geographical space, which facilitates them to generate (product) innovation in a feasible way.

Based on the findings of this research, two practical implications are derived. When a firm's innovation strategy is focused on incremental product innovation, the firm needs to develop its relationships with non-proximate alters and also at the same time expand 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 devised interventions 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 several contributions, it is not without limitations. Firstly, this paper has examined the determinants of incremental product innovation among South African manufacturing firms. Consequently, one knows little about the determinants of more radical (product) innovations (see: Keupp and Grassmann 2013), and how the trade-off between the two types works out in an environment characterized by resource challenges. 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, findings only can be generalized to innovative firms. Furthermore, the study makes some temporal claims, 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 focusing on specific product innovations. This asks for an in-depth longitudinal multiple case study design. 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 incremental innovations (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 the 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	External knowledge diversity (EKD)		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 the total number of "yes" for all five external actors. Maximum possible amount of different actors = 6. Diversity=Square(x/6)
X2	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 abroad: competitors, suppliers, buyers (firms), consumers (final good).	Domestic = 3 Multinational = 2 Foreign = 1 X3 is the average of all the sources.
X3	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.
X4	Spatial Immobility (SI)		For how many years has your firm been located at the present address?	Log transform of the years
Dependent variables: Incremental product innovation				
D1	Probability of incremental 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	Percentage sales of incremental 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: EKD	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: 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**	1				
11	X3: 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	-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: Probability of incremental product innovation	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 of incremental product innovation	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 probability of incremental product innovation as the dependent variable.

		D1: Incremental product innovation (probability)													
		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	-0.061	(0.115)	-0.034	(0.159)	-0.029	(0.152)	-0.035	(0.159)	-0.025	(0.160)	-0.034	(0.159)	-0.011	(0.153)
Firm size	C2	-0.028	(0.022)	-0.017	(0.076)	-0.002	(0.074)	-0.014	(0.077)	-0.010	(0.076)	-0.017	(0.076)	-0.001	(0.075)
Sector	C3	-0.069***	(0.013)	-0.041	(0.071)	-0.072	(0.069)	-0.043	(0.072)	-0.037	(0.072)	-0.040	(0.072)	-0.065	(0.070)
Urbanised region	C4	0.052	(0.113)	0.048	(0.121)	0.074	(0.112)	0.051	(0.121)	0.054	(0.121)	0.046	(0.121)	0.078	(0.114)
Domestic ownership	C5	0.208***	(0.053)	0.287***	(0.091)	0.250***	(0.090)	0.285***	(0.091)	0.298***	(0.093)	0.284***	(0.092)	0.260***	(0.092)
University degree	C6	-0.001	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)
In-house R&D	C7	0.112***	(0.016)	0.119	(0.081)	0.207**	(0.083)	0.118	(0.081)	0.118	(0.081)	0.118	(0.081)	0.218**	(0.085)
R&D recruitment	C8	0.119	(0.084)	0.151	(0.152)	0.070	(0.136)	0.144	(0.154)	0.165	(0.157)	0.153	(0.153)	0.087	(0.142)
EKD	X1			0.177*	(0.106)	0.184*	(0.105)	0.177*	(0.106)	0.175	(0.107)	0.177*	(0.106)	0.179*	(0.105)
GRE	X2			-0.115*	(0.067)	-0.075	(0.078)	-0.113*	(0.068)	-0.116*	(0.067)	-0.117*	(0.067)	-0.087	(0.081)
DZ	X3			-0.056	(0.069)	-0.047	(0.069)	-0.054	(0.070)	-0.062	(0.069)	-0.056	(0.069)	-0.070	(0.075)
SI	X4			-0.009	(0.135)	-0.032	(0.125)	-0.009	(0.135)	-0.010	(0.134)	-0.008	(0.135)	-0.046	(0.126)
EKDxGRE	I1					0.555**	(0.221)							0.584***	(0.225)
DZxGRE	I2							0.028	(0.130)					-0.096	(0.164)
EKDxSI	I3									0.162	(0.233)			0.155	(0.227)
DZxSI	I4											-0.040	(0.187)	0.033	(0.190)
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
Coefficients are marginal effects capturing the average effect of a 1 unit increase in X on the likelihood of a firm to be innovative.

Table 4. Tobit regression analysis for the percentage of sales of incremental product innovations as the dependent variable

		D2: % of sales of incremental 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)
EKD	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)
GRE	X2			-36.706***	(12.917)	-37.696***	(13.711)	-38.608***	(13.690)	-36.728***	(12.866)	-37.815***	(12.912)	-40.153***	(14.133)
DZ	X3			8.027	(13.269)	7.665	(13.014)	6.469	(13.549)	7.291	(13.209)	6.789	(13.224)	4.819	(13.171)
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)
EKDxGRE	I1					-38.352	(33.707)							-36.056	(36.835)
DZxGRE	I2							-16.281	(29.857)					-11.312	(32.697)
EKDxSI	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 R-sqr		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. Fractional regression analysis for the percentage of sales of incremental product innovations as the dependent variable

		D2: % of sales of incremental product innovation													
		Model 8		Model 9		Model 10		Model 11		Model 12		Model 13		Model 14	
		Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error	Coef	Std. error
Firm age	C1	-0.157	(0.169)	-0.305***	(0.041)	-0.341***	(0.082)	-0.306***	(0.034)	-0.296***	(0.054)	-0.301***	(0.049)	-0.332***	(0.128)
Firm size	C2	-0.002	(0.125)	-0.029	(0.109)	-0.024	(0.112)	-0.032	(0.105)	-0.025	(0.111)	-0.027	(0.101)	-0.021	(0.066)
Sector	C3	-0.150*	(0.079)	-0.100*	(0.060)	-0.089	(0.063)	-0.097	(0.065)	-0.101	(0.062)	-0.097*	(0.050)	-0.085	(0.062)
Urbanised region	C4	0.150	(0.108)	0.144	(0.098)	0.150**	(0.075)	0.138	(0.104)	0.152	(0.101)	0.140*	(0.083)	0.149	(0.091)
Domestic ownership	C5	0.188***	(0.023)	0.335***	(0.056)	0.425**	(0.193)	0.345***	(0.082)	0.341***	(0.053)	0.325***	(0.088)	0.419***	(0.090)
University degree	C6	-0.001	(0.001)	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.000)	-0.003***	(0.002)
In-house R&D	C7	0.038***	(0.011)	0.114***	(0.004)	0.049	(0.056)	0.117***	(0.007)	0.118***	(0.006)	0.111***	(0.015)	0.050	(0.070)
R&D recruitment	C8	-0.008	(0.174)	0.030	(0.120)	0.054	(0.093)	0.033	(0.123)	0.030	(0.120)	0.029	(0.112)	0.052	(0.098)
EKD	X1			0.153	(0.111)	0.155	(0.105)	0.155	(0.127)	0.152	(0.107)	0.156	(0.100)	0.157**	(0.070)
GRE	X2			-0.243*	(0.125)	-0.274*	(0.145)	-0.250*	(0.150)	-0.244*	(0.127)	-0.248**	(0.111)	-0.280***	(0.068)
DZ	X3			0.058	(0.128)	0.053	(0.115)	0.048	(0.152)	0.054	(0.126)	0.051	(0.107)	0.041	(0.063)
SI	X4			0.262***	(0.096)	0.282***	(0.078)	0.257**	(0.113)	0.257**	(0.103)	0.260***	(0.092)	0.276***	(0.107)
EKDxGRE	I1					-0.471	(0.432)							-0.463**	(0.187)
DZxGRE	I2							-0.084	(0.164)					-0.025	(0.162)
EKDxSI	I3									0.123	(0.088)			0.068	(0.185)
DZxSI	I4											-0.100	(0.304)	-0.103	(0.160)

* p<0.10, ** p<0.05, *** p<0.010