Exports and innovation in emerging economies
Firm-level evidence from South Africa

Gonzague Vannoorenberghe

Université Catholique de Louvain and Tilburg University

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Using a new dataset on the innovation and exports of 500 South African firms, this paper asks whether exports affect firm innovation in the context of an emerging economy. We use a range of particularly attractive features of the dataset. Firms not only report whether they innovated but describe their innovation - which reduces measurement error - and provide extensive information on their other links with foreign countries or firms. We confirm that product innovation is strongly associated with exports, even though other measures of innovation are not (e.g. process innovation). Exporters typically report very different reasons to innovate than non-exporters, which suggests that exporting provides additional incentives to innovate, and that the causality runs at least partly from exporting to innovating. Instrumenting the export status of a firm using its distance from the nearest port or airport, we however do not find any statistically significant relationship between exports and innovation in the second stage. We conclude that, even though exports seem to causally raise innovation through some channels, the quantitative effects appear too weak to be captured by an instrument that is not extremely powerful.

1 Introduction

Liberalizing international trade and attracting foreign direct investment are at the core of many policies for development. Opening up to foreign competition may increase the pressure on domestic firms to cut inefficiencies, while access to foreign markets can raise their productivity, e.g. by increasing their scale, exposing them to foreign technology or raising their incentives to innovate. These different channels may act as a boost both to short-term and long-term growth. Although there is some evidence that exporting firms are more productive (see Wagner (2012) for a survey) and innovate more than non-exporters (Wakelin (1998) or Alvarez and Robertson (2004) for Chile and Mexico), more evidence is certainly needed as to whether exporting does trigger innovation in low or middle income countries.

The present paper looks at the link between exports and innovation using a very rich new dataset of 500 South African firms between 2011 and 2013. The detailed nature of the data allows us to examine the link between exports and innovation in a more detailed manner than most previous studies. First, we complement the traditional measures of process and product innovation[1] by asking firms to provide exact descriptions of these innovations. We observe a high level of inaccuracy in the response of firms, which often describe as product or process innovation changes which obviously do not correspond to our definition. We however show that our improved measurement does not affect the observed relationship between exports and the different types of innovation very strongly. Second, we control for a much broader set of measures of firm-level internationalization. Exporting firms are more likely to import inputs, collaborate with multinational firms or be part of a multinational themselves. We disentangle these different dimensions of globalization by controlling for them separately and highlight that different measures of innovation are associated differently with these various measures of globalization. In particular, we confirm that exporting firms are significantly more likely to introduce product innovation, while this link is weaker or even absent for process innovation or for spending on innovative activities. Interestingly, process innovation is positively correlated with the export status of the firm only if we use the typical, uncorrected, measure of process innovation (i.e. the self-reported statement of the firm) and do not control for other dimensions of globalization. Third, we asked firms detailed questions about their motives to spend on innovation activities or to introduce product innovation. We find that exporters typically report very different reasons to innovate than non-exporters. In particular, foreign competition and foreign clients provide strong incentives for exporters to innovate and exporters also more likely to state that they introduce product innovation to enter new markets, increase their market shares or meet standards and regulations. These answers provide suggestive evidence

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[1]Following the existing literature and the best practice in the field, we define a product innovation as "the introduction to market of a new or significantly improved good or service" and a process innovation as "the use of new or significantly improved methods for the production or supply of goods and services".

that exporting provides additional incentives to innovate, and that the causality runs at least partly from exporting to innovating. Finally, we instrument the export status of a firm using its distance from the nearest port or airport and test whether exporting causally raises the probability to innovate in a two-stage least squares setup. We control additionally for a number of observed and unobserved characteristics specific to the area where the firm is located. Although our instrument is related to the exporter status of the firm at the one percent significance level in the first stage, we do not find any statistically significant relationship between exports and innovation in the second stage, which could be due to an insufficient power of our identification strategy. We conclude that, even though exports seem to causally raise innovation through some channels, the quantitative effects appear too weak to be captured by an instrument that is not extremely powerful.

Our study is most directly linked to the literature examining whether and why exporting induces firms to innovate. First, if innovations reduce the cost of production per unit or raise the price obtained per unit (quality), reaching a higher scale through exports makes it more profitable to invest in innovation (e.g. Bustos (2011)). Second, the export market may be different from the home market in many ways, as foreign consumers may have different preferences, . These features of foreign markets may induce firm to concentrate on some products (Baldwin and Gu (2004), Eckel and Neary (2010), etc.), adapt some of their product attributes or develop new products. There is now ample evidence that, in particular for firms located in developing countries, selling on (typically more developed) export markets requires the firm to upgrade its product or that firms only sell their best products on export markets (Iacovone and Javorcik (2012), Manova and Zhang (2012)). Third, exporting exposes firms to international best practices and spillovers from abroad (Baldwin and Gu (2004), Harris and Li (2009)), potentially raising the returns to investing in the absorption capacity of these technologies.

The causality issue in the export innovation-export nexus is particularly difficult to isolate, partly because both activities are jointly determined and partly because they require to know the firm's motivation. Taking a stance on the role of exports for innovation requires to be clear about the counterfactual one considers. On the one hand, we can ask whether a non-exporter would innovate if it were currently exporting, for example if it were faced with a foreign order due to a random shock (Atkin, Khandelwal, and Osman (2015)). On the other hand, we can ask whether a non-exporter would innovate if it had the possibility to export in the future. If we assess causality based on the second counterfactual, we need to recognize that the perspective to export can trigger innovation and that exports can cause innovation even for a firm that has not yet exported. The difficulty of disentangling the effects of an increase is well-known (Melitz and Costantini (2009)) and has given rise to a variety of attempts. Aw, Roberts, and Yu (2011) use a structural model and show that, among Taiwanese electronic firms, investing in R&D has little effect on the returns to exporting and that exporting does not raise the probability of conducting R&D. Alvarez and Lopez (2005) show that Chilean

firms invest more before entering the export market, and take this as evidence that firms consciously aim to raise their productivity to enter the export market. Van Beveren and Vandenbussche (2010) address the issue of anticipation by instrumenting measures of innovation with the R&D spending of the firm and find that, controlling for the anticipation effect, there is no link between innovation and exports among Belgian firms. They conclude that all of the positive link between innovation and exports must therefore come from firms innovating in anticipation of their entry on the export market. Damijan, Kostevc, and Polanec (2010) on the other hand uses the time dimension to identify causality and show that past exports raise the probability of innovation while the opposite does not hold. Our contribution in the causality debate relies on using self-reported motives for innovation by the firm and using a geographic instrument which has not previously been used in this context.

We also relate to the literature examining the relationship between different types of innovation and international trade at the firm-level. These studies typically find a strong link between product innovation and the exports of a firm but a weaker link between process innovation and exporting (Cassiman, Golovko, and Martinez-Ros (2010), Caldera (2010)). Van Beveren and Vandenbussche (2010) and Becker and Egger (2013) confirm that, taken in isolation, product innovation is more linked to exports than process innovation, but also stress that the combination of both seems to be even more important. While we confirm the strong association between product innovation and exporting in the South African case, we suggest that the weaker link between exports and process innovation may fully disappear once controlling for additional dimensions of globalization and once corrected for the imperfect measure captured by traditional surveys.

Finally, a substantial literature has discussed the link between foreign direct investments, productivity and innovation, in particular in the context of low or middle-income countries. Affiliates of foreign firms in developing countries are typically more productive and more likely to export (Arnold and Javorcik (2009) among others) but also firms interacting with affiliates of foreign companies may benefit from productivity spillovers (e.g. Javorcik (2004), Gorodnichenko, Svejnar, and Terrell (2010)). Importing inputs can also have an impact on productivity (Amiti and Konings (2007) or Goldberg, Khandelwal, Pavcnik, and Topalova (2010)) and on on innovation in product quality (Ferandnes and Paunov (2013)). In sum, the literature suggests a wide array of links between various dimensions of globalization and innovation that need to be controlled for.

The paper is structured as follows. Section 2 presents the data, with a particular emphasis on the measures of firm internationalization and innovation. Section 3 shows the regression results and delves into the motives of firms to innovate. Section 4 presents the instrumental variable results and section 5 concludes.

2 Data

Our survey, conducted in July and August[2] 2014 by Consulta Research, collects very detailed data on a firm's nature of business, inputs, link with other firms and institutions, as well as on its innovative behavior in the previous fiscal years. The survey focuses on firms in six core manufacturing industries[3] in the four largest South African provinces: Gauteng, Kwazulu Natal, Western Cape and Eastern Cape. This composition aims to strike a balance between a broad enough industrial and geographic coverage on the one hand and a sufficient number of observations per industry and region to control for specific effects on the other hand. Although we do not aim to have a nationally representative sample, the composition of our data concentrates on the most important manufacturing industries in the largest provinces, which is an interesting target group in itself. No conclusions should however be drawn from our study for very different industries in a rural context.

The absence of a national firm register is a very well-known concern in many low or middle income countries. Existing lists of firms in South Africa containing information on size, industry and location - whether compiled by the National Statistical agency or private consultancies - typically do not cover all firms in the country and the lists are quickly outdated due to a very high turnover of firms or changes in their contact details. With these caveats in mind, our survey company randomly selected 500 firms using stratified sampling from a list of firms provided by Matrix Marketing, a consultancy. The strata correspond to industry-region-size categories, where we restrict the strata to the industries and provinces mentioned above, and oversampled firms with 21 to 50 employees to put more focus on the innovative behavior of medium-sized firms. In other words, conditional on the set of provinces and industries that we concentrate on, the relative weight of the different industry-region is in line with those of the original list, while the size composition gives a higher weight to SMEs. Oversampling smaller firms is, in the context of an emerging economy, probably raising the representativeness of the sample as the original register of firms that we use contains relatively many large firms. As is common in low or middle-income countries, only a subset of the firms on the list did exist at the time of the survey, reflecting a very large turnover. Our survey company complemented the sample by approaching firms door to door, ensuring that the composition of firms in terms of strata corresponded to the initial target. After cleaning the data, we work with a set of 497 firm observations. The actual composition of our sample by sector and province is reported in Table 1, and Figure 1 in the appendix presents a map of the location of the firms in our sample.

Most firms in our sample are small to medium sized (35 employees or less), are relatively

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[2] During the data collection period, heavy and sometimes violent strikes erupted in some parts of the country, making access to the area of some cities dangerous for the interviewers. For obvious safety reasons, the interviewers had to contact other firms than originally planned outside of these areas. Some areas of some districts are therefore likely to be underrepresented.

[3] Automotive, chemicals, defense, food production, pharmaceuticals and textile.

Table 1: Distribution of firms by sector and province

Industry	Eastern Cape	Gauteng	KwaZulu Natal	Western Cape	Total
Automotive	2	65	10	26	103
Chemicals	0	37	5	18	60
Defense	0	15	1	3	19
Food Production	9	71	15	85	180
Pharmaceutical	0	14	2	5	21
Textile	4	31	25	54	114
Total	15	233	58	191	497

young (15 years or less) and sell only on their local market (defined as the province). Most firms are private firms held by a single owner or firms with limited liability. Only 10 firms in our sample are publicly listed and the government has a (typically small) share in 38 out of 497 firms. Table 2 provides more details about the firms in our sample and highlights the relatively large heterogeneity, notably in terms of size.

Table 2: Descriptive statistics

variable	min	p25	p50	p75	max	mean	N
Turnover 2013 ('000 Rands)	17	450	2.400	16.000	1.53e+08	5.03e+05	343
Employment 2013	1	19	35	60	6000	75	480
Age	0	8	14	20.5	109	17	496
Share of local sales (%)	0	60	100	100	100	78	494

The survey contains a very broad set of questions on the international links of firms and on measure of their innovation activities that we now turn to describe in more details.

2.1 The international links of firms

Our survey contains information about different dimensions of a firm's international links, in particular whether the firm is (partly) foreign-owned, imports any inputs, exports its output or collaborates with a foreign firm located in South Africa.

We construct a dummy for the export status of a firm in 2013 as a synthetic measure based on three types of information: the value of its exports in 2013, the destination of its exports in 2013 and the share of its sales going to international markets. We consider a firm as an exporter if at least two of the three criteria suggest that it is. For example, firms reporting a positive share of sales on international markets and reporting export destinations are considered exporters, even if they do not disclose the value of their exports. We use an export dummy as our main variable since the value of exports is often missing, most likely due to the unwillingness of firms to report actual amounts. We check at various stages the robustness of our results to different criteria for defining exporters. Turning to the other dimensions of internationalization that we consider, only 28 firms in our sample report selling to a large multinational firm. Of these 28 firms, 24 are also exporters. On the input side, 101 firms in our sample report using imported inputs while 59 firms also buy inputs from foreign-owned firms in South Africa. In the following, we will concentrate on the link between exporting and innovation, controlling for the foreign

ownership and for a composite measure of the other dimensions of internationalization. For this purpose, we define the variable "Other global" as a dummy equal to one if the firm is involved in at least one of the following three activities: importing inputs from abroad, buying inputs from multinationals located in South Africa or selling goods to large multinational firms. Section 3.3 looks more specifically at the individual effects of these different variables on innovation.

Table 3 shows the fraction of firms involved in each of these international activities per sector while Table 9 reports the correlation matrix between these activities. As shown in Table 8 in the appendix and as is commonly known in the trade literature, exporters are larger - both in terms of employees and turnover - and more productive than the average firm. The same holds true of firms for any dimension of internationalization that we consider.

Table 3: Dimensions of internationalization by sector

Percentage of firms:	Autom.	Chem.	Def.	Food	Pharma.	Textile	Total
Exporting	18%	30%	32%	9%	14%	9%	14%
Using imported inputs	25%	38%	53%	6%	38%	20%	20%
Using inputs from multinat.	15%	22%	26%	3%	10%	16%	12%
With some foreign ownership	7%	17%	21%	11%	14%	18%	13%
Selling to multinat.	6%	12%	21%	2%	10%	5%	6%

This table reports the fraction of firms which report each dimension of internationalization by sector and in the whole sample. "With some foreign ownership" is the fraction of firms which declare being at least partially foreign-owned.

2.2 Innovation

Our survey captures different dimensions of firm-level innovation in a more detailed way than previously available. Our aim is to provide a more precise and reliable account of innovative behavior than existing studies, in particular in the context of low and middle income countries. We have information on different measures of innovative input and output - both quantitative and qualitative - as well as on the motives of the firm to innovate and the constraints it faces in the process[4].

2.2.1 Self-reported innovation measures

For comparability with previous studies, we first ask firms to self-report whether they have introduced on the market a new or significantly improved good or service from 2011 to 2013 ("product innovation"), where new means either new to the firm, to the local market or to the world. 33% of firms (i.e. 164 firms) report introducing such product innovation, ranging from 20% in pharmaceuticals to 45% in chemicals. New products account for a large share of those innovating firms' sales (55%) on average and are typically new to the firm or local market, although 8% of firms (i.e. 1/4 of product

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[4]A full description of these different variables and the actual questionnaire is available on the project webpage.

innovators) report an innovation new to the world. Similarly, we ask firms whether they used new or significantly improved methods for the production or supply of goods and services ("process innovation"). 24% of firms report introducing some process innovation between 2011 and 2013, a share varying from 17% in food production to 30% in chemicals. For both product and process innovations, 75% of the firms report that the innovation was developed mainly by themselves. About 15% report that the innovation comes from their cooperation with other firms and institutes. Only few firms report that the innovation was developed by others or that they just adapted innovation of other firms.

While product and process innovation capture the outcome of the innovation process, we also measure the input of firms into the innovation activity by their spending on different types of activities. Out of 497 firms in our sample, 167 report at least some spending for innovation purposes. Intra-mural R&D is the most widespread of these activities, with one quarter of all firms reporting that they conducted some between 2011 and 2013. Formal training and acquisition of machinery are also common (about 20% of all firms), while only 10% of firms report acquiring external knowledge or conducting extra-mural R&D. We report the exact numbers as well as a decomposition by the export status of the firm in Table 10.

Although 23 firms did hire workers with the explicit purpose of developing or improving products and processes. 62 firms report that their number of employees went up between 2011 and 2013 as a consequence of introducing innovations, 87 report no change (although 10 of these 87 say that the composition between production and non-production workers changed), and 13 report a decrease in the number of employees.

2.2.2 Qualitative descriptions of innovation

On top of the standard binary questions on whether the firm has introduced product or process innovation, we ask innovative firms to describe their main product or process innovation. This data allows us to assess if the self-reported measures correspond to what we actually think of as product or process innovation.

We check whether the firm's description of its innovations are in line with the definition of product or process innovations and construct refined measures of innovation correcting for these discrepancies. For example, some firms report that their main product innovation was an increase in production capacity. According to our definitions, such an innovation should be classified at most as a process innovation and we consider such a firm as a process - and not product - innovator[5]. Similarly, some firms report as process innovation the introduction of new types of vegetarian products, which we reclassify as product innovation. When conducting this qualitative check, we note that 21 firms out of the 96 which report both a product and a process innovation give the

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[5]We can of course not be certain that the firm has no "valid" other product innovation but it shows a misunderstanding by the firm when declaring that it introduced a product innovation.

same description for both. We can interpret this in two ways. One is that firms did not understand the difference between product and process innovation as we describe them - although we follow best practices in the field. It would for example be the case for firms reporting an increase in the production capacity both as a product an process innovation. Another possibility is that the introduction of some products goes hand in hand with the introduction of a new process. For example, the production of a new type of yoghurt may require a change in processes and be seen by the firm as both a process and product innovation. When reclassifying innovations based on their description, we therefore *redefine process innovation* as an innovation to the production or supply methods of an already existing product. We therefore reclassify a firm reporting as process innovation the introduction of new types of vegetarian products as a product innovator, but not as a process innovator. Even if the introduction of new products comes hand in hand with new processes, the firm does not satisfy our criterion that these processes be developed independently of new products.

Following our reclassification exercise, we confirm in 118 cases that the self-reported product innovation is indeed a true product innovation. In 46 cases however (28% of self-reported product innovators), we discard the self-reported product innovation as wrong. In 4 cases, we declare the firm to be a true product innovator, even if it did not report so. The difference between our judgment of who is a true product innovator and the self-reported variable by firms thus appears very large. The results for process innovation are even more dramatic. We reclassify half (57/119) of self-reported process innovators as not conducting process innovation independent of a new product. We emphasize that such a massive difference partly has to do with the different definition of process innovation that we use in this reclassification exercise, in which we exclude process innovations that accompany the introduction of a new product. On the other hand, we classify 5 firms as process innovators even though they did not self-report as such. We will use throughout the paper both the self-reported and our reclassified measures of product and process innovation.

3 Results

3.1 Conditional correlations

As evident from the raw correlations in Table 9 and as is well-known from the literature, there is a widely positive association between exporting and innovating. In a first step, we investigate whether this positive association survives controlling for obvious co-determinants of exports and innovation. For this, we use the following regression equation:

$$\text{Innovation}_i = \beta_0 + \beta_1 \text{Exporter}_i + \beta_2 \mathbf{X_i} + d_{p(i)} + d_{s(i)} + \epsilon_i, \tag{1}$$

where Innovation$_i$ measures the innovation of firm i (product, process or engaging in innovative activities), Exporter$_i$ is a dummy capturing whether the firm exports, $\mathbf{X_i}$ is a vector of additional controls such as size, age or foreign ownership and $d_{p(i)}$ and $d_{s(i)}$ are respectively dummies for the province and the sector of firm i. We present the linear regression model with robust standard errors in Table 4. All conclusions are similar when using a probit estimation (unreported).

Columns (1) and (2) use as dependent variable a dummy equal to one if the firm reports introducing a product innovation between 2011 and 2013. Age is negatively associated with product innovation while the firm's size (measured as employment in 2011) and share of employees with a university degree are positively related with product innovation. Exporters appear 20 to 30% more likely to develop product innovation than non-exporters, even after controlling for very detailed regional and industrial fixed effects. Foreign ownership and the other dimensions of internationalization together are not significantly associated with product innovation. Columns (3) and (4) replicate the analysis using as dependent variable a dummy capturing whether the firm reports the introduction of a process innovation between 2011 and 2013. Exporting is only positively associated with process innovation in column (3), without additional controls. When controlling for firm size and other measure of internationalization however, the coefficient on exporting becomes insignificant, while other measures of internationalization have a positive and significant coefficient. Columns (5) and (6) report the same analysis when using a dummy for innovation activities as the left-hand side variable. This dummy takes value one if the firm reports having engaged in any innovation activity[6] between 2011 and 2013. The results are qualitatively similar to the ones for process innovation: exporting is only significantly associated with innovation activities in column (5), without controls for size or other measures of internationalization. Foreign ownership appears positively correlated with innovation activities, which may reflect the fact that firms with a foreign parent have better access to credit or benefit more from investing in their knowledge absorption capacity. Other measures of internationalization of the firm seem strongly correlated with innovation activity, a result we come back to in section 3.3.

Columns (7) and (8) replicate the results of columns (2) and (4) when using our reclassification of product and process innovation - and not the self reported values- as the dependent variable. In other words, and as described in section 2.2, we use our judgment on whether the described innovation are either a true product innovation or a process innovation only. Correcting for these measures only marginally affects the results and strengthens the significance of the exporter dummy in the product innovation regression. It is worth noting that, although the reclassification does concern a large number of observations as noted in section 2.2, it barely affects the measured relationship between innovation and the explanatory variables we use in the present

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[6]These consist of intra or extra-mural R&D, training, acquisition of machinery or external knowledge, market R&D or other activities.

| | Self-reported | | | | | | Reclassified | |
| Dep. var. | Prod. | Prod. | Proc. | Proc. | Innov | Innov | R. Prod | R. Proc. |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(age)	-0.07**	-0.11***	-0.02	-0.03	-0.01	-0.07*	-0.05	0.01
	(-2.26)	(-3.00)	(-0.81)	(-0.70)	(-0.43)	(-1.96)	(-1.46)	(0.53)
Exporter	0.30***	0.21***	0.17***	0.09	0.19***	0.08	0.21***	0.03
	(4.52)	(2.78)	(2.65)	(1.21)	(2.76)	(1.00)	(3.15)	(0.41)
ln(empl.) 2011		0.05**		0.05**		0.04**	0.03	0.05***
		(2.28)		(2.46)		(2.02)	(1.54)	(3.12)
Share univ.		0.00***		0.00		0.00***	0.00**	0.00*
		(3.06)		(1.44)		(2.87)	(2.13)	(1.82)
Foreign ownership		0.08		-0.09		0.14*	-0.01	-0.02
		(1.00)		(-1.27)		(1.77)	(-0.19)	(-0.36)
Other global.		0.11		0.12*		0.18**	0.10	0.13**
		(1.51)		(1.77)		(2.49)	(1.64)	(2.24)
Industry Dummies	2-dig.	3-dig.	2-dig.	3-dig.	2-dig.	3-dig.	2-dig.	3-dig.
Regional Dummies	Prov.	Munic.	Prov.	Munic.	Prov.	Munic.	Prov.	Munic.
Observations	496	437	496	437	496	437	496	437
R^2	0.117	0.252	0.059	0.201	0.050	0.255	0.167	0.197

The table reports the results of an OLS regression of Eq. (1) with different measures of innovation as dependent variables and two sets of controls. The dependent variable in col. (1) and (2) ("Prod.") is a dummy taking value one if the firm reports having introduced a product innovation, "Proc." in col. (3) and (4) is a dummy for self-reported process innovation while "Innov" in col. (5) and (6) takes value one if the firm reports at least some spending on innovation activities. "R. Prod." and "R. Proc." in col. (7) and (8) are the reclassified measures of product and process innovation described in section 2.2. Foreign ownership takes value one if the firm reports at least some foreign ownership and "Other global." captures other measures of internationalization of the firm (see section 2.1). "Exporter" takes value one if the firm exports in 2013, and "Share univ." is the share of employees with a university degree. Robust t-statistics are in parentheses, and superscripts *, **, *** indicate significance at 10%, 5%, and 1% levels respectively.

analysis.

Table 5 presents some additional robustness checks and explores different dimensions of the relationship between exports and innovation. Column (1) shows a regression of our reclassified measure of product innovation on the firm's export status in 2011. The variable "Exporter" that we use in the rest of the analysis refers to whether the firm exports in 2013, i.e. at the end of the period on which our different measures of innovation are defined. This may raise the concern that causality goes from innovating to exporting. As argued in the introduction however, timing is likely to be a very bad predictor of the direction of causality in the exports-innovation nexus due to anticipation effects. To test whether the timing could be an issue, we use the response to an additional question in our survey, which asks how much firms exported in 2011. Since there is a very large number of missing variables[7], we are reluctant to use it as our baseline measure of the firm's export status as we are likely to capture only a fraction of those firms which actually exported in 2011. Column (1) shows that using the export

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[7]The missings are partly a result of firms being reluctant to report actual values of exports. In 2013, we consider 33 firms which refuse to communicate the value of their exports as exporters because they report a positive share of sales on foreign markets and disclose the foreign destinations to which they export. The survey does not contain such questions for 2011 but only asked the value of exports in 2011. All the firms which refuse to disclose values for 2013 unsurprisingly also refuse to disclose values for 2011 and we can therefore not be certain that they already exported, although most of them probably did.

status in 2011 yields similar results to using the export status in 2013, although we lose almost a third of the sample due to missing responses on the export question. Unreported regressions confirm that exporting in 2011 is not significantly related to process innovation or innovation activities. Column (2) of Table 5 replicates column (7) of Table 4 and controls additionally for whether the firm exports to OECD countries. The literature on quality and exports (e.g. Manova and Zhang (2012)) suggests that firms in developing countries export goods of higher quality to higher income market. Exporting to OECD countries may therefore be correlated with more product innovation to cater to the needs of high-income customers. We however do not find any evidence that the 28 firms exporting to OECD countries introduce more product innovation than other exporters. As described in section 2, some of our firms were sampled from the list provided by a consultancy while other firms were recruited door to door to replace those firms in the list that did not exist anymore. Since the two groups of firms may differ in systematic ways, we control for a dummy capturing whether the firm has been recruited door to door or not. Column (3) shows that the results are unaffected and that the dummy variable is insignificant. Controlling for observables such as firm size or region and industry dummies therefore appears sufficient to capture the systematic differences between the firms recruited door to door and the others. Columns (4) and (5) use different measures of product innovation, which take into account the intensity of product innovation. In both columns, we use only the firms which report introducing a product innovation that we endorse as an actual product innovation, which makes the sample much smaller. Column (4) regresses the share of total sales accounted for by product innovation on the same covariates as before and finds no significant effect of exporting on the dependent variable. Column (5) does a similar exercise using the degree of innovativeness as the dependent variable, which takes value 1 if the firm reports that the innovation is new to the firm, 2 if it is new to the local market and 3 if it is new to the world. Foreign-owned firms and firms exporting to OECD countries are more likely to report a higher innovativeness. Finally, column (6) uses as dependent variable the log spending on innovative activities conditional on reporting a positive spending. None of the covariates of interest appears significant.

The marked difference between the role of exporting in explaining product innovation or innovation activities (columns (2) and (6) of Table 4) may appear surprising at first but can be consistent with different hypotheses. First, spending on innovative activities reflects an attempt to innovate, with no guarantee of success, while product or process innovation are output measures, which capture at least some degree of success in this attempt (while they are no guarantee of commercial success of the innovation). A potential interpretation for the observed patterns is that different firms are as likely to spend on innovative activities, but only those who are successful in developing a new product can enter the export market. In this case, the causality would run from a successful innovation to exporting. Conditional on spending on innovation activities, we however do not find any evidence that exporters are significantly more likely to introduce a

product innovation than non-exporters (column (7) or Table 5). Second, conditional on engaging in innovation activities, exporting firms may spend more on these activities, or may spend on different types of innovation activities, which are more effective in developing successful product innovations. This could explain that we observe a similar propensity of innovation activity but different rates or product innovation. Column (6) of Table 5 however shows that exporters do not spend significantly more conditional on other characteristics, and Table 10 in the appendix suggests that the composition of innovative activities is not very different between exporters and non-exporters. Using different types of innovation activities as a left hand side variable in column (6) of Table 4 further shows no systematic difference conditional on other observables (unreported). Third, exporting firms may be in a better position to introduce a product innovation to the market even if they do not need to spend themselves on innovation activities. For example, exporters may have a better access to best practices in the field or may be in a better position to cooperate with other firms in the development of products. We asked firms by whom their product innovation was developed but find no significant differences between exporters and non-exporters (see Table 10), with a large majority of both exporters and non-exporters reporting to have developed it by themselves. Column (8) of Table 5 further shows that exporters are not significantly more likely to introduce a product innovation conditional on not spending on innovation. Finally, if firms innovate to export in the future, the timing of innovation may explain the difference since spending on innovative activities typically comes before the introduction of a new or improved product to the market. If a firm starts spending on innovation to export in the future, it is unlikely that the firm will already export, and we will therefore observe a non-exporter investing in innovation, even if the firm innovates because it wants to export. This effect would bias our coefficient on exporting in columns (5) and (6) downward. Since the introduction of an innovation to the market would typically take place at a later stage than the spending on innovative activities, the bias will likely be smaller for product or process innovation as there is a higher likelihood that we observe the firm exporting already. We will further comment on this channel in the next section, where we examine the motivations behind the different innovative behaviors of firms.

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Table 5: Innovation and exports, continued

	R. Prod. (1)	R. Prod. (2)	R. Prod. (3)	% sales (4)	Strength (5)	Log Spend. (6)	R. Prod. (7)	R. Prod. (8)	R. Prod. (9)	R. Proc. (10)	Innov (11)
ln(age)	-0.08*	-0.05	-0.05	-9.21	-0.21	0.55	-0.07	-0.01	-0.05	0.02	-0.08**
	(-1.89)	(-1.50)	(-1.59)	(-1.33)	(-1.60)	(1.14)	(-1.04)	(-0.37)	(-1.54)	(0.59)	(-1.99)
ln(empl.) 2011	0.05**	0.03	0.03	-2.83	0.04	0.62*	0.06*	-0.01	0.03	0.05***	0.05**
	(2.19)	(1.51)	(1.35)	(-0.61)	(0.59)	(1.73)	(1.67)	(-0.83)	(1.42)	(3.16)	(2.08)
Share univ.	0.00**	0.00**	0.00**	0.18	-0.00	0.01	0.00	0.00	0.00**	0.00*	0.00***
	(2.09)	(2.10)	(2.15)	(0.66)	(-0.36)	(0.48)	(0.06)	(1.06)	(2.17)	(1.91)	(2.90)
Foreign ownership	0.05	-0.02	-0.03	7.46	0.66*	-0.39	-0.00	-0.02	0.00	-0.02	0.17**
	(0.54)	(-0.27)	(-0.43)	(0.49)	(1.88)	(-0.57)	(-0.01)	(-0.27)	(0.02)	(-0.36)	(2.09)
Other glob.	0.10	0.09	0.09	-5.96	0.09	0.91	0.01	-0.02			
	(1.40)	(1.57)	(1.49)	(-0.61)	(0.41)	(1.35)	(0.16)	(-0.34)			
Exporter2011	0.21**										
	(2.26)										
Exporter		0.17**	0.18**	-0.05	-0.01	0.41	0.07	0.11	0.24***	0.02	0.16*
		(2.31)	(2.34)	(-0.00)	(-0.05)	(0.38)	(0.78)	(1.21)	(3.50)	(0.32)	(1.86)
Exp. OECD		0.11	0.12	17.88	0.51*	0.02	0.32***	0.05			
		(0.95)	(1.02)	(1.14)	(1.89)	(0.02)	(2.71)	(0.31)			
Door to door			-0.06	3.34	-0.11	-1.15*	-0.07	0.03			
			(-1.45)	(0.33)	(-0.55)	(-1.95)	(-0.81)	(0.66)			
Imported inputs									0.17**	0.03	0.05
									(2.34)	(0.51)	(0.61)
Inputs from multin.									-0.05	0.01	0.12
									(-0.64)	(0.12)	(1.16)
Sell to MNE									-0.14	0.13	-0.19
									(-1.22)	(0.95)	(-1.27)
Dummies	*All specifications include 3-digit industry dummies and dummies for the municipality*										
Observations	305	437	437	82	101	87	142	295	437	437	437
R^2	0.290	0.310	0.313	0.579	0.534	0.579	0.528	0.196	0.316	0.189	0.249

The dependent variable "R. Prod." is the reclassified dummy for product innovation as in col. (7) of Table 4. "% sales" is the percentage of sales accounted for by the product innovation. "Strength" takes value 1 if the product innovation is new to the firm, 2 if it is new to the local market and 3 if it is new to the world (self-reported). Log Spend. is the natural logarithm of spending on innovative activities in 2013. Columns (4) and (5) are conditional on having introduced a product innovation that we classify as such. Columns (7) and (8) condition respectively on firms having spent and not having spent on innovation activities. Exporting in 2011 is a dummy taking value 1 if the firm reports positive non-missing exports in 2011. Exp. OECD is a dummy taking value 1 if at least one destination country is in the OECD. The door to door dummy capture whether the firm was recruited door to door or was in the initial broker's list (see section 2). All internationalization dummies in col. (9) to (11) are dummies (see section 2.1) Robust t-statistics are in parentheses, and superscripts *, **, *** indicate significance at 10%, 5%, and 1% levels respectively.

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3.2 Self-reported motives for innovation

The results of Table 4 suggest that exporters are consistently more likely to introduce product innovation while it is not the case for process innovation or engaging in innovation activities. As mentioned above, these patterns are consistent with a number of competing explanations and do not lend themselves to a causal interpretation due to potential reverse causality, or omitted variable biases. For example, entrepreneurs who show a greater readiness to take risk may be more likely to engage both in exporting and in innovation activities, giving rise to an upward bias of our coefficient of interest. In this section, we provide a descriptive assessment of the motivations of firms to innovate thereby shedding some light on these questions.

We asked all the firms reporting some positive spending on innovation (e.g. R&D, training, etc.) whether domestic or foreign competitors or clients "were important in motivating [their] decision to engage in innovative activities". As shown in Table 6, innovative exporters are significantly more likely than innovative non-exporters to report that competitors are a driver of their innovation spending (68% against 52%, a statistically significant difference). Similarly, 87% of innovating exporters report that clients - whether firms or final consumers - were an important motivation for spending on innovation while only 72% of non-exporters do. Decomposing these differences shows that exporters mention both domestic and foreign competitors as drivers of innovation more often than non-exporters, with a much larger gap in their answer for foreign competitors. Only 5% of non-exporters report foreign competitors as a motivation to innovate, suggesting that import competition is of little importance as a driver of innovation in our sample. Similarly, exporters mention both domestic and foreign clients as a reason to innovate more often than non-exporters, the difference being much larger for foreign clients. Conditioning on the size, sector, location and other characteristics of the firms shows that the difference between exporters and non-exporters is only significant for international clients or competitors (in line with Baldwin and Gu (2004) for Canada). In column "Diff a", we regress the answer of the firm about the importance of different types of competitors or customers (reported in rows) on its exporter status and on the same set of controls as in column (1) of Table 4. The difference between exporters and non-exporters remains only significant for foreign clients or competitors. Column "Diff b" confirms that pattern when using the same set of controls as column (2) of Table 4. Although exporters are *per se* not more likely to spend on innovation activities (see column (6) of Table 4), it appears that competition from foreign firms and the need to satisfy foreign clients is instrumental in making them innovate, thereby highlighting one channel through which exporting can have a causal impact on innovation activities. It is worth noting that 10 non-exporters mention clients located in foreign countries as a reason to innovate, which may reflect an intention to export in the future. As mentioned above, this points to a potential reason why the coefficient on exporters is insignificant in column (6) of Table 4. If some firms engage in innovative activities in

anticipation of their entry on the export market, we will observe a set of non-exporters which are innovating because they will become exporters in the future. This would bias our estimate of the causal impact of exports on innovation downward. If we classify as exporters the 10 non-exporters mentioning foreign clients as a driver of innovation, the coefficient of exporter in column (6) of Table 4 would become 0.16, significant at the 5% level (unreported). This should not be interpreted as evidence that there is a downward bias in estimating the role of exports on innovation but that the bias could potentially be large enough to explain the difference in results between product innovation and spending on innovation activities. In any case, these differences in motives for innovating suggest that exporting causally impacts innovation through the interaction with foreign competitors or clients.

Table 6: Motives for innovation

Type	Motivation	Non-exp.	Exp.	Diff	Diff. a	Diff. b
	Competitor	.52	.68	.17*	.14	.19
	Competitor - domestic	.50	.66	.15*	.12	.16
Innovative	Competitor - foreign	.05	.32	.27***	.27***	.23***
Activities	Client	.72	.87	.14**	.06	.04
	Client - domestic	.72	.79	.07	-.01	-.04
	Client - foreign	.08	.45	.37***	.38***	.30***
	Off. motive	2.48	1.83	0.65***	0.43***	0.47**
Product	Off. motive (if not all same)	2.42	1.89	0.53***	0.37**	0.43**
Innovation	Def. motive	1.02	0.93	0.09	0.24	0.31
	Def. motive (if not all same)	0.82	0.86	-0.03	0.09	0.17

The upper part of the table shows the motives for engaging in innovative activities by exporter status of the firm. The columns "Non-exp." and "Exp." respectively show the share of innovative non-exporters and exporters stating that competitors or clients were important determinants of their decision to innovate. Diff shows the difference between exporters and non-exporters and the significance of the unconditional difference. Column "Diff. a" shows the coefficient on Exporter in a regression of the motive reported in the corresponding row on the same set of controls as in column (1) of Table 4. Column "Diff. b" shows the same coefficient when the set of controls is as column (2) of Table 4. The lower part of the table does a similar exercise for offensive or defensive motive for product innovation, which run from 0 to 3. The rows "if not all same" exclude firms which gave the same answer to all 6 motives.

In a next step, we ask firms reporting a product innovation to state whether the objectives of the innovation are among six proposed motives. As shown in Table 11 in the appendix, these motives can be broadly classified into two categories. We label the first "offensive" motives, which capture whether the firm wished to (i) extend the range of product, (ii) open up to new markets/ increase market shares or (iii) comply with standards and regulations. The second category consists of "defensive" motives, when innovation aims (i) to replace of a former product, (ii) decrease costs or (iii) deal with a decrease in demand for other products or services. We construct a variable for each category of motives as the sum of the answers to the individual motives of which it is composed. Both variables range from 0 to 3. As shown in the bottom part of Table 6, exporters and non-exporters differ greatly as to their motivation for innovating. Exporters report consistently more offensive motives for innovation than other firms, while they report similar levels of defensive motives. This pattern holds regardless of whether we exclude the firms giving the same answer to all of the motivation questions

(reported in rows "if not all same"), which could show that they are not taking the questions seriously. The differences in offensive motives are still strong and significant when controlling for various industry and regional dummies as well as for differences in age and employment as in columns "Diff. a" and "Diff. b". On average, exporters are more keen to innovate to enter new markets or extend their product range, which could reflect that they innovate because they want to export or because exporting allows them to expand more easily. An alternative explanation is that firms with some unobservable characteristics (e.g. optimism, high growth perspectives) are more willing to expand, which induces them to innovate and export at the same time. Since the motives for innovation between the two groups are different, this exercise provides some evidence that the relationship between innovation and the exporter status is not purely driven by a reverse causality from innovation to exports.

3.3 Other dimensions of internationalization

As described in section 2.1, our survey not only contains information on whether the firm exports or not, but also on a wide range of other dimensions of international contacts of the firm. Most of our specifications in the previous sections controlled for two such dimensions: whether the firm was at least partly foreign owned and the composite dummy variable ("Other glob."), which summarized all other dimensions of internationalization. As shown in Table 4 these other measures appeared to be more correlated with process innovation and engagement in innovation activities than exporting (columns (6) and (8) of Table 4). We now turn to check which of these dimensions were most important in driving the innovation behavior of firms. The last three columns of Table 5 replicate columns (6) to (8) of Table 4 decomposing the variable "Other glob." into its different components. Column (9) shows that firms that import inputs appear more likely to introduce product innovation while imports of inputs are not significantly associated with other types of innovations. We asked firms about the reason why they use inputs imported from abroad and find consistent differences between (reclassified) product innovators and other firms. Among product innovators importing inputs from abroad, more than half of firms (25/46) argue that an "important" reason for importing is that no domestic supplier produces such an input, while this fraction is less than one fourth (12/53) among the non-innovators importing inputs. The cost reason seems however to be much more important among firms which did not introduce a product innovation: more than half (29/53) of non-innovators importing inputs say that an "important" reason was that these inputs were cheaper than their domestic counterpart, while only 17/46 of importing innovators mentioned this reason. This is in line with the idea that product innovators aim to produce better quality products, for which they need more varied inputs while the cost argument is of less importance for them. It suggests that access to foreign inputs is an important part of the ability to introduce product innovation, as shown for example by Goldberg, Khandelwal, Pavcnik,

and Topalova (2010) in the Indian case. When turning to process innovation, it appears that none of the different dimensions of internationalization is individually significant and that they are also not jointly significant as shown by the (unreported) F-test. Finally, the decision of a firm to engage in innovative activities is positively correlated with the foreign ownership, as shown in column (11). Although the reason behind this correlation could be a better access to funds or a better access to the knowledge of the parent, firms with some degree of foreign ownership do not report being much less hampered by such factors than firms without any foreign ownership. It is worth noting that, in this specification, the exporter status of the firm turns significant at the 10% level while it was not in Table 4 and that all dimensions of internationalization are jointly significant.

4 Instrumental variables

In this section, we instrument for the export status of a firm as in our estimation equation (1), but use an instrumental variable for the export status of firms. We follow previous studies and instrument the export status of a firm by the distance from that firm to the closet airport or port (e.g. Vannoorenberghe (2012)), i.e. we instrument the variable Exporter_i in Equation (1) by a first stage equation:

$$\text{Exporter}_i = \gamma_0 + \gamma_1 \text{Log. dist. (air)port}_i + \gamma_2 \mathbf{X}_i + d_{p(i)} + d_{s(i)} + \nu_i, \qquad (2)$$

where our excluded instrument is the log distance to the nearest major port or airport. The economic rationale is twofold. First, firms located closer to a transport hub may face lower costs of shipping their goods abroad, making them more likely to export. Second, firms in the vicinity of an (air)port are more likely to come in contact with other exporting firms, thereby gaining information and expertise on the possibilities to export. Two conditions are necessary for this strategy to work. On the one hand, distance to the nearest port or airport must be a sufficiently strong instrument, i.e. it must be a good enough predictor of whether a firm exports or not. On the other hand, the distance of a firm to the nearest airport or port should satisfy the exclusion restriction, i.e. it should not directly affect the innovation of a firm except through its effect on exporting.

There are two main reasons to worry about a violation of the exclusion restriction. First, neighborhoods located closer to a transport hub may differ from other neighborhoods in systematic ways which are themselves related to the ease of innovating. For example, firms located close to an airport may be on average closer to innovating firms and benefit from knowledge spillovers, violating the exclusion restriction. To account for this possibility, we use a number of controls capturing the specifics of the firm's location on top of regional fixed effects, which guarantee that we only use variation within a municipality. We control for direct measures of the degree of innovation in the

neighborhood of the firm by constructing a spatial lag counting the number of inno-vating firms in our sample located within 5 km. To avoid that these proxies be only internal to our data set, we also collect the GPS coordinates of the headquarters of all companies listed on the Johannesburg Stock Exchange and create a variable counting the number of such headquarters within 5 kilometers of the firm. Since listed firms are likely to export and develop innovation, being located close to such firms could act as a confounding factors if we did not control for it. To the extent that they capture poten-tial direct channels precisely enough, these additional controls should alleviate some of the concerns regarding the exclusion restriction. The second reason why the exclusion restriction can be violated is that location is an endogenous decision of the firm. It is for example conceivable that a more risk-taking entrepreneur would set up his firm close to a transport hub and simultaneously be keener to innovate[8]. We unfortunately have very little information on this particular possibility. In a few more detailed interviews of the firms in our sample - realized a year after the original survey was conducted - we did not find any hint that firms chose their location to benefit from innovation spillovers but this qualitative evidence is only based on a handful of interviews. Still, with these caveats in mind, we think that the IV strategy has the potential to reduce the bias in the estimation.

We report the first stage of the IV estimation in column (1) of Table 7 and show that distance to the nearest airport or port is indeed a negative and significant predictor of the export status of firms. The coefficient of -0.06 suggests that an increase in the distance from the nearest port or airport reduces the probability of exporting by 6%, with a p-value virtually equal to one percent. The F-test for the excluded instrument, at around 7, is somewhat below 10. It suggests that the instrument, although it has some predictive power, is not very strong. The second stage of the estimation is reported in column (2) to (4) of Table 7 for the different measures of innovation of interest. None of our measures of innovation is significantly related to being an exporter in this framework. This is the case even though the point estimates are larger than in the OLS estimates, which could reflect that the instrument does not give enough power to statistically identify a causal link from exporting to innovating. The quantitative effects of exports on innovation therefore appear too weak to be captured by an instrument that is not extremely powerful.

5 Conclusion

Using a very rich new dataset on the innovation and on the export behavior of 500 South African firms, this paper asks whether exporting raises the probability that firms innovate in the context of an emerging economy. We confirm that, in the South African

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[8]Note that if the firm sets up close to a transport hub so as to export in the future and innovates with this perspective in mind, the exclusion restriction is not violated as the effect of the location on innovation would entirely come from the desire to export.

Table 7: Instrumental Variable estimation

	First stage	Second stage		
Dep.var	Exporter	R. Prod.	R. Proc.	Innov
	(1)	(2)	(3)	(4)
ln(age)	0.06**	-0.05	-0.01	-0.08**
	(2.05)	(-1.37)	(-0.36)	(-1.97)
ln(empl.) 2011	0.05***	0.03	0.03	0.05
	(2.86)	(1.00)	(1.39)	(1.57)
Share univ. degree	0.00	0.00**	0.00*	0.00***
	(0.08)	(2.24)	(1.72)	(3.12)
Neighbor innov.	-0.05	-0.00	0.20	0.62
	(-0.14)	(-0.01)	(0.55)	(1.55)
Nb of Listed firms within 5km	-0.00	-0.00	0.00	-0.00
	(-1.59)	(-0.06)	(1.08)	(-1.30)
Foreign ownership	0.10*	-0.02	-0.07	0.13
	(1.67)	(-0.28)	(-0.91)	(1.41)
Other global.	0.32***	0.07	-0.04	0.14
	(5.50)	(0.47)	(-0.27)	(0.85)
Log dist. to closest (air)port	-0.06**			
	(-2.58)			
Exporter		0.30	0.52	0.22
		(0.68)	(1.40)	(0.47)
Industry dummies	3-dig	3-dig	3-dig	3-dig
Regional dummies	Munic.	Munic.	Munic.	Munic.
Observations	437	437	437	437
R^2	0.338	0.303	0.022	0.256
F-test excl. instr.	6.65			

The first column reports the first stage of the 2SLS estimation, while columns (2) to (4) show the results of three different second stages, where the dependent variables are a dummy for whether the firm introduced a product innovation, a product innovation (both reclassified as described in section 2.2) or engaged in innovation activities respectively. Robust t-statistics are in parentheses, and superscripts *, **, *** indicate significance at 10%, 5%, and 1% levels respectively.

context, product innovation is positively associated with the export status of firms. This correlation is very robust even when controlling for the imprecision of traditional measures of innovation and for a range of additional dimensions of internationalization of the firm (links with MNEs, use of imported inputs, etc.). On the other hand, the link between exports and process innovation is much weaker and disappears as soon as we control for other dimensions of internationalization or for imprecise measurement. We shed some additional light on the issue of causality in two ways. First, we asked firms detailed questions about their motives to spend on innovation activities or to introduce product innovation. We find that exporters typically report very different reasons to innovate than non-exporters. In particular, foreign competition and foreign clients provide strong incentives for exporters to innovate and exporters are also more likely to state that they introduce product innovation to enter new markets, increase their market shares or meet standards and regulations. These answers provide suggestive evidence that exporting provides additional incentives to innovate, and that the causality runs at least partly from exporting to innovating. Second, we instrument the export status of a firm using its distance from the nearest port or airport and test whether exporting causally raises the probability to innovate in a two-stage least squares setup. We do not find any statistically significant relationship between exports and innovation in the second stage. These pieces of evidence taken together suggest that, even though exports seem to raise innovation through some channels, the quantitative effects appear too weak to be captured by an instrument that is not extremely powerful.

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6 Appendix

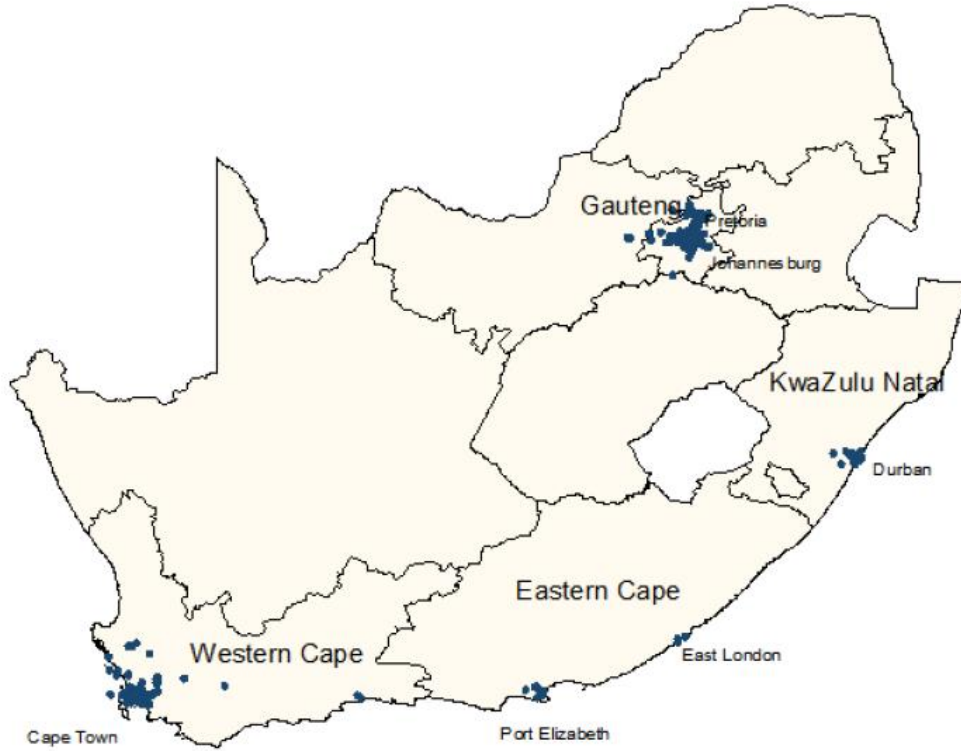## 6.1 Descriptive statistics

Figure 1: Location of firms in sample

Table 8: Size, productivity and internationalization

	Turnover 2013 ('000 R)			Employees 2013 (Number)			Labor prod. 2013 ('000 R/worker)		
	Median	Mean	N	Median	Mean	N	Median	Mean	N
All firms	2.500	57.400	341	35	74	479	135	530	334
Use imported inputs	17.000	79.000	57	42	109	95	600	1.152	56
Use inputs from MNEs	13.500	82.300	32	45	89	53	477	650	32
Sell to MNEs	26.500	170.000	14	54	126	26	592	2.245	13
Some foreign own.	10.500	82.000	38	55	91	61	124	1.126	38
Exporter	18.000	309.000	39	50	201	69	600	1.232	38

We exclude the largest firm in our sample from the descriptive statistics as it has a turnover 100 times larger than the second largest.

Table 9: Cross-correlation table

Variables	Product innov. (self)	Process innov. (self)	Innovation activities	Product innov. (recl.)	Process innov. (recl.)	Exporter	Foreign own.	Other global.	Imported inputs	Inputs from MNEs	Sell to MNEs
Product innov. (self)	1.00										
Process innov. (self)	0.57	1.00									
Innovation activities	0.62	0.49	1.00								
Product innov. (recl.)	0.77	0.52	0.53	1.00							
Process innov. (recl.)	0.37	0.63	0.35	0.27	1.00						
Exporter	0.23	0.14	0.17	0.26	0.12	1.00					
Foreign own.	0.12	*0.02*	0.17	*0.04*	0.09	0.21	1.00				
Other global.	0.20	0.18	0.21	0.25	0.17	0.43	0.26	1.00			
Imported inputs	0.19	0.13	0.16	0.26	0.12	0.45	0.26	0.91	1.00		
Inputs from MNE	*0.03*	0.10	0.10	0.09	*0.07*	0.31	0.28	0.66	0.54	1.00	
Sell to MNE	0.11	0.11	*0.07*	0.08	0.13	0.49	0.29	0.44	0.40	0.34	1.00

The table shows the correlation between different measures of innovation and internationalization. *Italic* numbers are ***NOT*** significant at the 5% level. All variables are dummies. "self" refers to self-reported by the firm while "recl." refers to our reclassification of innovation as described in section 2.2. Imported inputs takes value one if the firm uses imported inputs and zero otherwise. Inputs from MNE and sell to MNE are defined in a similar way. Foreign ownership takes value 1 if the firm has at least some foreign ownership and zero otherwise.

Table 10: Descriptive stats. Innovation

				Innovation activities				
	Intra R&D	Extra R&D	Machin.	Ext. Know.	Train.	Market R&D	Other	Any
Non-exporters	22%	10%	16%	10%	17%	15%	10%	30%
Exporters	44%	17%	28%	15%	36%	31%	23%	53%
All firms	25%	11%	18%	10%	20%	17%	11%	33%

	By whom were [the] product (goods or services) innovations developed?			
	Own firm	Own firm in coop.	Own firm adapt.	Other firm
Non-exporters	96	20	4	5
Exporters	32	6	1	4
All firms	128	26	5	9

The first part of the table shows the percentage of firms in the sample conducting different innovation activities by exporter status and for the sample (number of respondents: 489). The column Intra R&D shows the percentage of firms reporting intra-mural R&D. Extra R&D refers to extra-mural R&D, Machin. to the acquisition of machinery, equipment and software, Ext. Know. to the acquisition of other external knowledge, Train to formal training, and Market R&D to market research. The column Any reports the fraction of firms conducting any of the innovation activities. The second part of the table shows the number of firms answering the question "By whom were these product (goods or services) innovations developed?" by exporter status. "Own firm" is the answer "Mainly your own firm or enterprise group", "Own firm in coop." is "Your firm together with other firms or institutions", "Own firm adapt." is "Your firm by adapting or modifying goods or services originally developed by other firms or institutions, "Other firms" is "Mainly other firms or institutions".

6.2 Offensive and defensive motives for product innovation

One of the questions of the survey is: "Do any of the following describe why your firm introduced the main product (goods or services) innovation an where these objectives met by the innovation? (you may choose more than one option)." We proposed six answers, that firms were to reply by Yes (1) or No (0): "Extend the range of product or services offered by your firm" ("*Extend*"), "Open up new markets or increase market share" ("*New markets*"), "Comply with regulations or standards (e.g. safety or environmental regulations)" ("*Regulations*"), "Replace a product or service offered by your firm" ("*Replace*"), "Decrease the cost of producing or offering the service" ("*Costs*"), "Deal with a decrease in the demand for other products or services" ("Low Demand"). The following table gives the correlation of the answers for all firms having introduced a product innovation (self-reported) between 2011 and 2013. The high correlation between the first 3 motives and between the last 3 motives

Table 11: Correlation between motives for product innovation

	Extend	New Markets	Regulations	Replace	Costs	Low Demand
Extend	1.00					
New Markets	0.32	1.00				
Regulations	0.43	0.26	1.00			
Replace	-0.26	0.06	-0.11	1.00		
Costs	-0.01	0.14	0.15	0.36	1.00	
Low Demand	0.12	0.16	0.19	0.18	0.26	1.00

This table shows the correlation between the motives for product innovation among the 164 firms which report having introduced a product innovation.