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Exchange rates and firm export performance in South Africa

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Abstract: This paper uses detailed firm transaction data on manufactured exports to analyse the dilution of the real exchange rate-export relationship in South Africa over the period 2010 to 2014. Our empirical results show that firms that are larger, have higher export shares in destination markets, and import are more likely to raise the domestic currency price of their exports in response to a depreciation, and consequently display weaker export quantity responses. The exchange rate responsiveness is also weaker for exporters of resource-based manufactured products and those that export outside Africa. South African manufactured exports are highly concentrated among a few large firms that rely heavily on imported intermediate inputs and predominantly export resource-based products. Consequently, these results provide an explanation for the low aggregate export response to the sustained depreciation over the period 2010 to 2014.

Key words: exchange rate, pass-through, exports, South Africa

JEL classification: F14, F31, F32

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1 Introduction

Export-led growth has been identified as a key driver for economic growth and employment in South Africa's economic policies, including the National Development Plan, the National Industrial Policy Framework, and the Industrial Policy Action Plan. This emphasis on leveraging exports to remedy South Africa's low economic growth and unemployment calls for a closer look at trading firms in South Africa.

One area requiring attention is how exporters and importers are affected by changes in the exchange rate. The real exchange rate (RER) has historically been an important factor in driving growth of South African exports and imports (Anand et al. 2016; Edwards and Garlick 2014; Edwards and Lawrence 2008; Hlatshwayo and Saxegaard 2016; Parsley 2012). However, the link between changes in the real effective exchange rate (REER) and export responses appears to have weakened in recent years, as reflected in a delayed export response to the substantial real depreciation of the South African rand (ZAR) from 2010 to 2016 (Hlatshwayo and Saxegaard 2016).

This paper focuses on two channels in the pricing response of exporters to exchange rate movements that may contribute to the dilution of the RER-export relationship in South Africa. The first channel is the role that imported intermediate inputs play in offsetting some of the gains in competitiveness arising from the depreciation. A depreciation raises the cost of imported intermediates used by many exporters, thus lowering the exchange rate pass-through into export destination prices and weakening the export demand response to the depreciation (Amiti et al. 2014). The second channel arises from large exporters with market power absorbing some of the depreciation in the form of higher mark-ups (Amiti et al. 2014; Berman et al. 2012). This further reduces the exchange rate pass-through to export prices paid by foreign consumers, diminishing the export response.

To identify these channels, we draw on detailed firm-level transaction data on manufactured exports for South Africa over the period 2010 to 2014. The transaction data provides export and import data for trading firms at a highly disaggregated product and destination level over time. We use this data to estimate how changes in the bilateral RER affect the quantity, price (unit value), and value of bilateral exports at the trading firm level.

Our results reveal that export prices (in domestic currency) at the firm-product-destination level are, on average, insensitive to changes in the RER. In response to a depreciation of the domestic currency, the average South African exporter of manufactured goods keeps the ZAR value of its export prices fixed, thereby reducing the foreign denominated price of its exports by the full depreciation. The implication is that there is complete exchange rate pass-through to its export prices.

However, we find substantial variations in export price responses to changes in the exchange rate across firms. As is found in the international literature (Amiti et al. 2014; Berman et al. 2012; Li et al. 2015), exporters that are larger and have higher shares in destination markets absorb some of the depreciation in the form of higher domestic currency prices, and consequently have a lower exchange pass-through to foreign prices.

To evaluate the implications for export volumes, we estimate firm-level export responsiveness to the RER. The estimated export quantity elasticity across all firms is low at 0.2, but it is even lower for firms that import, are larger, and have a higher export market share. Our estimates suggest that

the export quantity elasticity of the 99th percentile firm by export size is 64 percentage points lower than that of the median firm. These results are consistent with those for export prices: large firms and exporters that also import have lower exchange rate pass-through rates, and consequently their export volumes are less sensitive to currency movements. Our results also reveal a much weaker export relationship for exporters of resource-based manufactured products and those that export outside Africa.

The above estimates capture the intensive margin response of exporters to currency movements. We therefore complement the analysis with an estimate of the effect of exchange rate changes on the probability of a firm entering or exiting an export destination. As found by Berman et al. (2012) for France and Li et al. (2015) for China, a real depreciation of the bilateral exchange rate increases export participation in the destination market, with the effect working primarily through encouraging new entry.

These results provide an explanation for the low export response to the sustained depreciation over the period. Manufacturing exports in South Africa are highly concentrated among a few large firms, most of which are reliant on imported intermediate inputs in the production process. Our results show that the export volume response of these firms to a depreciation is low. While a depreciation raises the probability that an exporter will commence selling to that destination, these new entrants tend to be small and characterized by high churn. The aggregate trade effect from new exporters is consequently small.

Our results provide firm-level insights into various policy recommendations regarding the exchange rate. In the Harvard group's recommendations on improving growth in the South African economy, Hausmann (2008) argues for a more stable and competitive RER. This recommendation is, in part, based on the aggregate evidence that South African exports are quite responsive to the RER. This paper provides a firm-level perspective that highlights the heterogeneity of the export response behind the aggregate data and the possible dilution of the export relationship over time.

The paper is structured as follows. Section 2 reviews the relevant literature. Section 3 provides an overview of the data, while section 4 presents the methodology and regression analysis. Section 5 concludes the paper.

2 Literature review

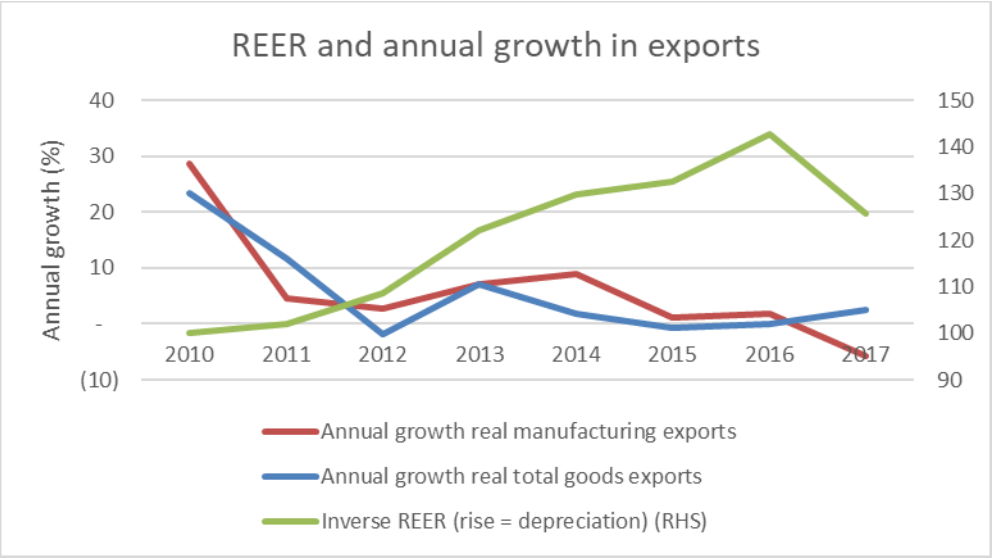
A weaker RER is expected to boost the value of exports while reducing the value of imports, thus improving the trade balance. However, its effectiveness in realizing these outcomes depends on the exchange rate elasticity of exports and imports. A depreciation has a more immediate and stronger effect in offsetting a rising trade deficit the quicker and greater the responsiveness of export and import prices and quantities are to the weakening of the currency.[1]

[1] In the standard imperfect substitutes model (Goldstein and Khan 1985), the responsiveness of the value and volume of trade flows to the exchange rate is influenced by the price elasticity of firm supply and consumer demand in the exporting and importing countries. A depreciation boosts the volume of exports through a combination of raising the relative profitability of supplying the export market for domestic firms and reducing the relative price (in the importer's currency) of these goods for consumers in the destination market. The net effect of the depreciation on the trade balance also depends on the home country's exchange rate elasticity of imports. As articulated in the Marshall-Lerner

The exchange rate elasticity is influenced by macroeconomic factors such as the exchange rate regime and the inflationary environment, as well as microeconomic factors such as product differentiation, market structure, distribution costs, and firm integration into production networks (Amiti et al. 2014; Bussière and Peltonen 2008; Bussière et al. 2016). Recognition of the contribution of microeconomic factors to export performance has grown with recent empirical literature based on micro-level data at the product or firm level. This literature reveals high levels of heterogeneity in the exchange rate elasticity across countries, products, and firms.

Recently, concerns have been raised that exchange rate depreciations have become less effective in driving export responses, leading to a disconnect or dilution of the exchange rate-export relationship (Leigh et al. 2017). These concerns hold in South Africa as well (Anand et al. 2016; Hlatshwayo and Saxegaard 2016), most notably in the delayed response of exports to the large and sustained real depreciation of the ZAR over the period 2011 to 2016 (Figure 1). South Africa experienced one of the largest real depreciations globally over this period (34 per cent), but real aggregate exports increased by a mediocre 6.5 per cent (although real manufacturing exports grew by 22 per cent). This response is far lower than would have been predicted from prior estimates of South Africa's aggregate export elasticity, which fall in the range of -0.5 to -6 (Anand et al. 2016; Edwards and Garlick 2014; Hlatshwayo and Saxegaard 2016; Senhadji and Montenegro 1999).

Figure 1: REER and export growth in South Africa



Notes: export data deflated using consumer price index data from Statistics South Africa.

Source: authors' illustration based on REER from Federal Reserve Bank of St Louis, and export data from South African Revenue Service and Quantec.

Various explanations have been put forward for the dilution of the REER-export relationship in South Africa over this period. Anand et al. (2016) use firm-level export data over the period 2010 to 2014 and argue that electricity bottlenecks, limited product market competition, and labour market constraints reduce the ability of export firms to raise exports in response to currency depreciation.[2] They also find that small and medium enterprises, which export mostly manufacturing goods to sub-Saharan Africa (despite their small contribution to external trade), are

condition, a combination of low elasticity of demand for exports and imports (such that the sum of elasticities is less than one) can result in a rise in the value of the trade deficit in response to a depreciation.

[2] For international evidence, see Leigh et al. (2017), who in a cross-country study find that the export response to a depreciation is largest when countries have economic slack and normally functioning financial systems.

more responsive to exchange rate changes. Hlatshwayo and Saxegaard (2016) provide an alternative explanation and argue that policy uncertainty in South Africa has hindered export responsiveness and performance by increasing the real option value of firms adopting a 'wait and see' approach prior to incurring large, exporting-related fixed cost investments. This has given rise to two effects on firm exports: a direct effect through reduced exports (and participation), plus an indirect effect via decreased responsiveness to changes in relative prices (such as the exchange rate).

In this paper, we focus on two additional channels that potentially dilute the impact of a depreciation on export performance. Firstly, in a world that has become more interconnected through globalization, exporters are locked into global value chains where imported inputs comprise increasing shares of their total input cost. The implication for these exporters is that some of the gains in competitiveness arising from a depreciation are offset by higher marginal costs of purchasing imported intermediate inputs. Exporters respond to the higher marginal costs by raising the domestic currency price of their exports, thus reducing the pass-through of the depreciation to the prices paid by foreign consumers. The effect is a diminished foreign demand response to the depreciation. This effect has found support in cross-country comparative studies using product-level data (Bussière et al. 2016) and firm-level export studies for Belgium (Amiti et al. 2014), France (Berman et al. 2012), and China (Li et al. 2015). Hlatshwayo and Saxegaard (2016) also provide support for this channel in their study of South African exports, using industry-level data.

A second channel is through exporters adjusting their mark-ups in response to the changes in the exchange rate. Amiti et al. (2014) develop a theoretical framework that combines variable mark-ups due to strategic complementarities and endogenous choice to import intermediate inputs. Their model predicts that exporters with high import shares and high market shares will have low exchange rate pass-through. Berman et al. (2012) introduce an alternative framework that includes distribution costs in the export market to show that large productive firms are more likely to engage in pricing-to-market behaviour. The implication is that these firms absorb some of the depreciation by increasing their mark-up, lowering the pass-through of the exchange rate to foreign consumers and thus weakening the export demand response (Amiti et al. 2014; Berman et al. 2012).[3]

To analyse the contribution of these two channels, we draw on transactions/customs data at the firm, product, and destination levels, obtained from the South African Revenue Service and National Treasury tax administrative panel data set (SARS-NT panel). The data covers the period 2009 to 2014 and includes very detailed information on firm-level export and import transactions, including value, quantity, and destination/origin at the eight-digit level of the Harmonized System (HS). Our estimates use the detailed variation in firm export responses by product, destination, and year to identify how changes in the bilateral RER affect the quantity, price (unit value), and value of exports at the trading firm level.

Ours is the first study to fully exploit the disaggregated nature of the South African data to analyse how changes in the bilateral RER affect firms' exports at the product-destination-year level. While similar data has been used internationally (Belgium by Amiti et al. 2014; China by Li et al. 2015; France by Berman et al. 2014), most South African studies on export responsiveness to the

[3] As outlined in Berman et al. (2012), this behaviour can be explained by a model of a linear demand system with horizontal product differentiation, a model of Cournot competition where larger firms have a lower perceived demand elasticity, and the presence of distribution costs in the destination market that are unaffected by the exchange rate. All of these weaken the elasticity of demand as perceived by the exporter. Amiti et al. (2014) develop a theoretical model that jointly determines the firm's sourcing of intermediate inputs and setting of mark-ups in each destination.

exchange rate have used aggregated or sectoral-level data.[4] Such analyses are subject to potentially severe aggregation bias. Firms are heterogeneous in terms of their productivity and export characteristics (products, destinations, etc.), and failure to account for this heterogeneity can lead to a downward bias in estimated trade elasticities (Imbs and Mejean 2015). Our study provides new insight into the heterogeneous response of firms to the exchange rate.

Our study extends our understanding of the interaction between importing and exporting highlighted by Bernard et al. (2007, 2018) and Bas and Strauss-Kahn (2014) internationally. They find that firm export performance is strongly associated with firms' productivity and their use of imported intermediate imports. Similarly, Edwards et al. (2016, 2018) find that almost half of the South African manufacturing firms that directly export also import intermediate inputs. These exporter-importers are larger and more productive, pay higher wages, employ more workers, and are more successful in terms of exporting a greater value and number of goods to multiple destinations. In this paper, we see how this dependency on imported intermediate inputs may have contributed towards reducing the responsiveness of aggregate exports to the sustained depreciation.

Our work also relates to the literature on mark-ups and concentration in South African manufacturing industries and the extent to which this impedes economic growth. Firm-level estimates using the SARS data reveal high levels of concentration and mark-ups within South African industries, although there is considerable variation within and across sectors (Fedderke et al. 2018). Exports are also concentrated among super-exporters to a degree that exceeds that of comparator countries (Purfield et al. 2014). For example, the top five per cent of South Africa's exporting firms account for more than 90 per cent of its exports. These firms have been losing dynamism and competitiveness, with relatively slow export growth and mediocre expansion into new products and markets (Purfield et al. 2014). Our research provides some insight into the implications of this concentration for exporting firm responses to the depreciation.

Further, this paper provides additional insight on the effect of intermediate input costs on export performance in South Africa. Edwards and Lawrence (2008) use industry-level data to reveal the sensitivity of exports, particularly of non-commodity-based goods, to import tariffs on intermediate inputs. Edwards et al. (2018) show how access to imported inputs enhances South African manufacturing firms' export performance, measured in terms of export value and export variety (destination-product combinations). In this paper, we provide further insight into how changes in import costs, driven through exchange rate movements, affect export performance at the firm level.

Finally, our research contributes to the literature on exchange rate pass-through in South Africa. Almost all South African studies focus on the pass-through of the exchange rate to the domestic currency price faced by the importer, the consumer, or the producer. The product-level estimates reveal low pass-through rates to consumer goods that tend to range between 16 per cent (Parsley 2012) and 30 per cent (Aron, Creamer et al. 2014) in the two years following an exchange rate change. The pass-through estimates for imports are higher at 60 per cent, but with wide source-country variation (Parsley 2012).[5] What is missing from the South African research is a study on the exchange rate pass-through to export prices. This paper fills this gap in the empirical literature.

[4] Anand et al. (2016) also use firm-level data but aggregate firm exports to the product level, thus ignoring potentially important heterogeneity in the composition of firm exports by destination and changes in bilateral real exchanges.

[5] See also Aron, Farrell et al. (2014), who estimate a long-run pass-through to import prices using aggregate data.

3 Data

3.1 Data sources

To undertake our analysis, we integrate the export and import transaction data obtained from the SARS-NT panel. The data covers the years 2009 to 2014. The transaction data provides detailed exporter-level information on export value and quantity by unit (kilo, litre, number, etc.), destination, product (at the eight-digit HS level), and time (month). Using the export value and quantity data, we calculate export unit values to use as a proxy for export prices.[6] To ensure consistency in product classification over time, the eight-digit product data is converted into the six-digit level of the 2007 revision of the HS classification.

Our primary interest is on how movements in the RER affect firm-level exports by product and destination, and how this relationship is mediated by a firm's import status and its size. To determine the exporter's import status, we use an anonymized concordance file to merge firm-level import data obtained from the import transaction database with each exporter. This allows us to identify whether an exporter directly imports, as well as the value of these imports.

For the exchange rate variable, we construct the bilateral RER between South Africa and foreign trading partners using the period average exchange rate and consumer price index (CPI) data obtained from the World Development Indicator (WDI) database. The bilateral RER is defined as the ZAR per unit of foreign currency, adjusted by the ratio of foreign prices to South African prices such that a rise reflects a real depreciation of the ZAR.[7] Data on real gross domestic product (GDP) per capita is obtained from the WDI.

There are several caveats to the data. First, exporters in the transaction data comprise a range of different entities including traders, retailers, and producers in manufacturing, agriculture, and mining. We are thus unable to restrict the data to production units that convert imported inputs into output sold in the domestic or export market.[8] This does have some important implications for our study, as we are unable to calculate firm-level measures of import intensity (share of imports in costs), and this limits our ability to fully capture the import-cost-channel effect of exchange rate movements. Further, the responsiveness of exports to the exchange rate may differ according to whether a firm is a trading company or a production company. For example, in their study of Chinese exporters, Li et al. (2015) find that trading companies are less responsive in their price to exchange rate changes, but are more responsive in volume. Our results will reflect the average response of the trading and production companies in the data.

Second, we are only able to link firms that *directly* export and import. Firms that export and/or import indirectly via traders or wholesalers are not identified in the database. The one implication

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[6] Unit values are quantity-weighted average prices and are not equivalent to constant-weighted price indices. Rising unit value may reflect shifts in the composition of exports towards higher-priced varieties. This may be present even within the narrowly defined product categories where substantial heterogeneity in prices is evident (Schott 2004).

[7] The RER (rer) is calculated as $rer = e_{SA/f} \times (CPI_f / CPI_{SA})$, where subscripts SA and f refer to South Africa and foreign partner respectively, and $e_{/f}$ is the South Africa to foreign exchange rate.

[8] It is possible to link the trade entities in the transaction database to firms in the company income tax (CIT) database also provided by SARS-NT. The CIT is a rich source of data including information on sales and cost of sales. However, the merging of the transaction data with the income tax data results in a substantial loss of observations due to failed mappings (see Edwards et al. 2018). For this study, our interest is to be as comprehensive as possible in the coverage of manufactured good exports. In subsequent studies, we will consider using the merged transaction-CIT database.

is that our study will under-represent the extent to which exporters draw on imported inputs in their production process.[9] The excluded firms tend to be smaller firms that export or import occasionally, and not the large firms that account for the bulk of South African exports.[10] Consequently, excluding these small firms from our analysis is not expected to majorly effect our estimates of the effect of exchange rate movements on exports, particularly aggregate exports.

To conduct the analysis, we drop export observations for which no quantity data or quantity units are available, and we restrict the sample to include destinations for which data on exchange rate, CPI, and real GDP is available for most of the period 2009 to 2014. The sample is then further restricted to include only exports of manufactured goods, defined according to Lall's (2000) technological classification of goods. We focus on manufactured goods because these goods comply more closely with the heterogeneous firm models underpinning this research area. To simplify the analysis, South African exports to Southern African Customs Union members (Botswana, Lesotho, Namibia, Swaziland) are excluded. Apart from Botswana, whose exchange rate moves closely with that of South Africa, the remaining members are part of a Common Monetary Area with South Africa. Their exclusion eliminates around 25 per cent of manufacturing export trade, but 47 per cent of all exporter-product-destination observations. Finally, we eliminate observations where a firm exports a product to a destination only once over the full period, as we are interested in how bilateral exports change in response to currency movements.[11]

3.2 Overview of export data

As shown in the summary statistics in Table 1, our final sample comprises just under 1.4 million exporter-product-destination observations, with between 197,000 and 252,000 observations per year. Over the period, the number of firms exporting manufactured goods increased from 11,433 in 2009 to 14,962 in 2013. The number of exporters fell to 13,515 in 2014, but some of this decline reflects the late filing of income tax statements by companies. The mean value of exports by firm rose, from 20.5 million to 28.5 million ZAR. So too did the median value of exports by firm, from 0.3 million to 0.4 million ZAR. Corresponding to these trends is a rise in the aggregate value of manufactured goods exported in the sample.

These aggregate values hide much heterogeneity at the firm level. The sample comprises many small firms that export only occasionally. For example, 35 per cent of the sample is comprised of firms with at most two product-destination export observations over the full period (57 per cent of the sample if increased to three observations).[12] Exports are highly concentrated, as is evident in the high mean firm value of exports relative to the median. The top one percentile of firms by export size makes up 73 per cent to 78 per cent of the total value of exports across years, while the share of the top 0.1 percentile ranges from 39 per cent to 46 per cent. This high level of

[9] A further problem is that international trade may be conducted by a separate entity that is indirectly linked to the firm, either as a subsidiary or as the holding company. We are only able to capture this relationship if it is explicitly included on the customs declaration form. This problem leads to an underestimate of import participation by exporting firms (Edwards et al. 2018).

[10] According to World Bank Enterprise data for South Africa, in 2007 over 95 per cent of the export value is accounted for by direct exporters. Exporters that import indirectly make up less than 10 per cent of the total value of exports by direct exporters. Further, the mean export value of direct exporters is 10 times that of indirect exporters.

[11] This eliminates a further 1.3 million exporter-product-destination observations (around 27 per cent of observations).

[12] Note that the sample already excludes single-observation exporter-product-destination combinations during the period 2009 to 2014.

churning and concentration is also observed for South Africa by Purfield et al. (2014), who use transaction data over the earlier period of 2001 to 2012.

Table 1: Summary statistics

	2009	2010	2011	2012	2013	2014
Number of observations	196,887	230,282	245,032	251,924	248,257	219,997
Number of exporters	11,433	13,125	13,748	14,512	14,962	13,515
Number of importer-exporter firms	7,740	8,739	9,210	9,775	10,046	9,226
Share importer-exporter firms	67.7%	66.6%	67.0%	67.4%	67.1%	68.3%
Mean firm export value (million ZAR)	20.5	21.6	23.6	22.3	24.8	28.5
Median firm export value (million ZAR)	0.3	0.3	0.3	0.3	0.4	0.4
Total export value (million ZAR)	233,975	283,044	324,171	323,175	371,374	385,016
Number of destinations	181	179	181	179	179	177
Mean number of products/destination	8.5	8.5	8.6	8.4	8.2	8.1
Mean number of destinations/product	2.0	2.0	1.9	1.9	1.9	1.9
Share exports top 1% firms	75.7%	78.2%	77.7%	74.7%	73.9%	73.3%
Share exports top 0.1% firms	39.3%	46.0%	45.5%	43.6%	42.6%	41.2%

Source: authors' calculations using export and import transaction data from SARS-NT panel.

Exporter characteristics differ substantially by export destination. Table 2 presents data on the mean, median, and total value of South African manufactured exports to Africa and the rest of the world (ROW) over the period 2009 to 2014. Africa makes up 82 per cent of the exporter-product-destination observations in the database, but accounts for only 19 per cent of the total value of exports on average in each year. The reason is that firms export lower values of each product to African destinations (0.31 million ZAR per year) than to ROW (6.11 million ZAR per year).

The product-destination relationship is also more stable for firms exporting to ROW than to Africa. For example, 15 per cent of exporter-product-destination combinations to Africa are made up of firms exporting in all six years in the sample, compared with 20 per cent for exports to ROW. Finally, exports to Africa are less concentrated than to ROW. The top one per cent of firms exporting to Africa accounts for 51 per cent of the total value of exports to Africa, whereas for ROW the share is 76 per cent.

Table 2: Exporter characteristics by destination: ROW and Africa, 2009–14

	ROW	Africa	Total
Exporter-product-destination observations (full period)	256,416	1,135,963	1,392,379
Share total	*18%*	*82%*	*100%*
Average annual value exports (million ZAR)	260,873	59,253	320,126
Share total	*81%*	*19%*	*100%*
Average annual value of exports by exporter-product-destination combination (million ZAR)	6.11	0.31	
Median annual value of exports by exporter-product-destination combination (million ZAR)	0.05	0.01	

Source: authors' calculations using export and import transaction data from SARS-NT panel.

One explanation is that the composition of South African exports to Africa differs markedly from exports to ROW. Table 3 presents the product composition of manufactured exports and shows that resource-based manufactured goods comprise close to 55 per cent of the observed value of exports to ROW over the period 2009 to 2014, but only 26 per cent of the value of exports to Africa. In contrast, high- and medium-technology exports make up the bulk of export value to Africa. Given these differences, we may expect different responses to the currency movements in aggregate exports to Africa and ROW. For example, resource-based products are relatively

homogenous, with prices generally invoiced in USD (Gopinath et al. 2010), so their price responsiveness to currency movements may differ from that of other products.

Table 3: Product composition of manufactured exports to Africa and ROW (% total exports, 2009–14)

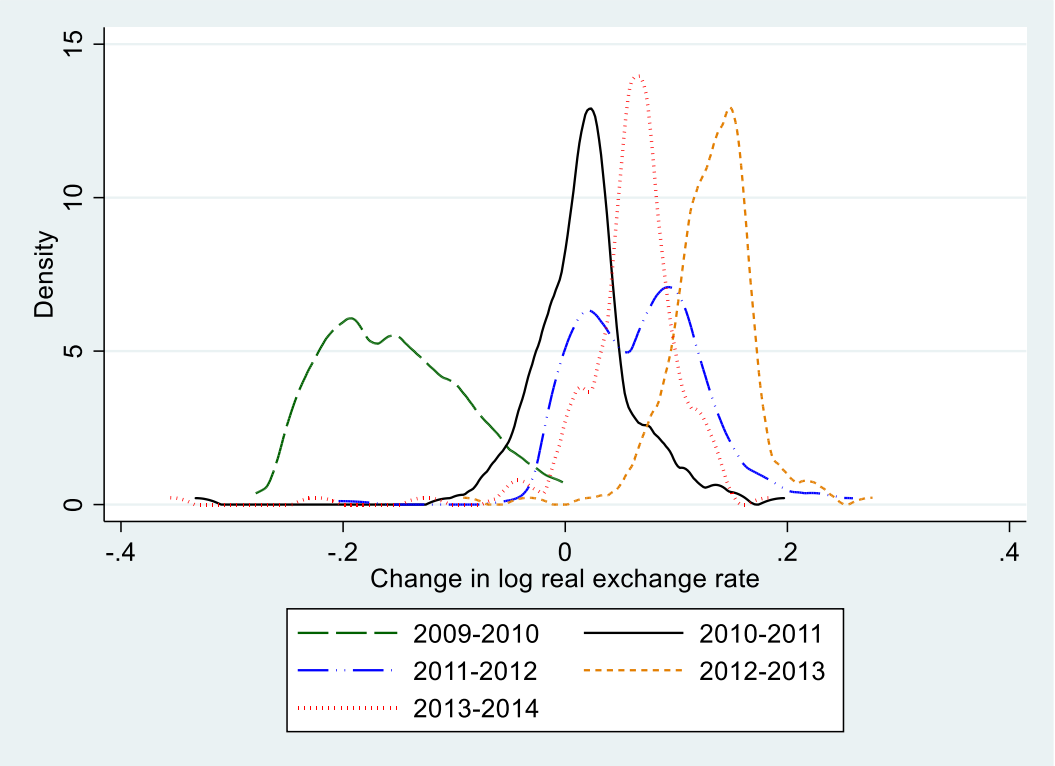
	ROW	Africa	Total
High-technology	2.5	7.4	3.4
Medium-technology	37.6	47.5	39.4
Low-technology	5.7	19.0	8.2
Resource-based	54.3	26.1	49.0
Total	100.0	100.0	100.0

Source: authors' calculations using export and import transaction data from SARS-NT panel.

Looking at the importer-exporter relationship in Table 1, we note that a stable share (67 per cent to 68 per cent) of exporters are direct importers of goods. The high share is close to the 71 per cent found by Edwards et al. (2018), who restrict the sample to manufacturing producers. They also find that importer-exporter firms are larger in terms of export value, product range, and destination coverage. Overall, these results signal the close association between exporting and importing among South African trading firms.

3.3 RER in South Africa

Figure 2: Kernel density estimates of the change in South Africa's bilateral RER across countries



Note: based on 157 export destinations of South African trading firms. The average annual RERs for each year are used in calculating the growth rates.

Source: authors' calculations using export and import transaction data from SARS-NT panel, and exchange rate and price data from WDI database.

To assess the trend and variation across countries in South Africa's RER, Figure 2 presents the kernel density estimates of the log change in South Africa's bilateral RERs relative to its export partners for various years. Over the period 2009 to 2010, South Africa's RERs appreciated strongly

(the RER fell by 15 per cent on average) across most countries as the ZAR recovered following a sharp collapse during the financial crisis of 2008 to 2009. The shift in the kernel densities towards the right from 2011 to 2013 denotes the subsequent general depreciation of the ZAR relative to other currencies. However, the currency did not depreciate equally against all currencies. For example, see 2010 to 2011, when the RER appreciated against several (mainly) emerging economies such as Viet Nam, Turkey, Kenya, and Egypt, but depreciated against most advanced economies. It is this variation in the change in the bilateral RER across South Africa's trading partners that is used to identify the response of South African exporters to currency movements.

4 Exports and the RER

4.1 Benchmark regressions: the effect of the RER on export prices and quantities

We consider two channels through which the RER affects the value of exports at the firm level. Firstly, we look at the effect of the exchange rate on the price (in ZAR) South African firms charge for their exports. Secondly, we look at its impact on the quantity of goods sold in the destination market. We follow Li et al. (2015) and specify a reduced-form price relationship as follows:

$$\ln(UV_{ipft}) = \beta_0 + \beta_1 \ln(rer_{ft}) + \beta_2 \ln(gdp_{ft}) + \lambda_{ipf} + \lambda_t + \varepsilon_{ipft} \quad [1]$$

where firms are indexed by i, products by p, destinations by f, and time (year) by t. UV denotes the export unit value (price) measured in ZAR. In this specification, we regress the log of the export unit value against the bilateral RER of South Africa with respect to the destination country and foreign GDP (gdp). The responsiveness of the export price valued in producer (domestic) currency to the RER is captured by the coefficient β_1, which is expected to fall in the range [0,1]. The value $1\text{-}\beta_1$ consequently measures the pass-through of the change in the exchange rate to the foreign currency price of the export. Low estimates of β_1 reflect an insensitivity of the export price measured in ZAR to RER movements, and consequently a high pass-through (high value of $1\text{-}\beta_1$) to the price paid by the foreign consumer.

In the second regression, we estimate the effect of the RER on export volumes of the firm:

$$\ln(Q_{ipft}) = \alpha_0 + \alpha_1 \ln(rer_{ft}) + \alpha_2 \ln(gdp_{ft}) + \lambda_{ipf} + \lambda_t + \varepsilon_{ipft} \quad [2]$$

where Q_{ipft} is the volume of exports by firm i of product p to destination f in year t. A positive sign on α_1 is expected, reflecting a rise in firm export volumes in response to a real depreciation of the ZAR.

To control for unobserved firm-product-destination heterogeneity, we include firm-product-destination fixed effects (λ_{ipf}). These account for the role of time-invariant gravity factors such as distance, common border, colonial history, etc. that influence bilateral export performance. In addition, the fixed effects control for time-invariant firm-specific factors, such as firm productivity, which influence the value of exports and the number of products and destinations exported to (Bernard et al. 2007; Melitz 2003). Consequently, our estimates identify the effect of the exchange rate on export price and quantity through the within-firm-product-destination variation over time in the data.

The regressions include foreign real GDP to control for demand effects. Some regressions also include time fixed effects (λ_t) to capture macroeconomic shocks that influence all exporters

equally. This has important implications for interpreting our results. The inclusion of time fixed effects does not allow us to estimate the effect on exports of changes in the RER driven by broad movements in the ZAR against all destinations. For example, a 10 per cent nominal depreciation of the ZAR against all currencies, holding consumer prices and all other exchange rates fixed, will be captured entirely by the year fixed effects. The implication is that the price and quantity coefficients in regressions that include year fixed effects reflect the outcome of trade partner currency movements relative to each other, as opposed to movements in the ZAR.[13] This poses a potential problem for our estimates should South African exporters respond differently to changes in the RER arising from broad movements in the ZAR, as opposed to destination-specific currency movements.[14] Consequently, we test the sensitivity of the results to excluding the year fixed effects. These results will also be more comparable with many of the other South African studies that use aggregate data where year fixed effects cannot be included.

Table 4 presents the benchmark regression results. The first column (1) presents the results for export unit values excluding year fixed effects. In response to a depreciation, a domestic exporter must decide how much of the depreciation it will absorb through raising the domestic currency price of its exports, and how much it will pass through to destination prices. The results in column (1) suggest that South African exporters of manufactured products, on average, raise the ZAR price of exports by 29 per cent of the real depreciation. The remainder (71 per cent) is passed through to consumers in the destination country in the form of lower foreign-currency prices. The exchange rate coefficient is slightly lower than those estimated for South Africa using product-level trade data by Bussière et al. (2016) (0.361) in their baseline specification, although their sample of products includes primary products, where we would expect lower exchange rate pass-through rates to foreign prices.

In response to the lower foreign-currency prices, foreign consumers increase the quantity of South African goods purchased, but the response is inelastic, with an estimated exchange rate elasticity of 0.214 (column 2). A 10 per cent depreciation of the ZAR is thus estimated to have raised manufactured export quantities by 21.4 per cent over the period of analysis.

This estimate of the exchange rate elasticity falls within the range of similar firm-based studies, such as that by Li et al. (2015) for China (0.226) and Berman et al. (2012) for France (0.4). It is slightly lower than the REER coefficient estimates for South Africa using product-level data (0.286

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[13] To be more precise, the year fixed effects demean the bilateral RERs using the mean value across all exporter-product-destination combinations in each year. The mean will be biased towards destinations with many exporter-product combinations in the data. To further illustrate the effect of including year fixed effects, we can decompose the RER into two components, as follows:

$$rer_{ft} = \left(e_{SA/f,t}\frac{CPI_{f,t}}{CPI_{SA,t}}\right) = \left(\frac{e_{SA/US,t}}{CPI_{SA,t}}\right)\left(\frac{CPI_{f,t}}{e_{f/US,t}}\right)$$

The first bracketed term on the far right is the South African nominal exchange rate against a base currency (USD) ($e_{SA/US,t}$) deflated by the South African CPI ($CPI_{SA,t}$), while the second bracketed term captures the inverse of the foreign nominal exchange rate against the base currency deflated by its CPI. The inclusion of year fixed effects eliminates the first bracketed term, implying that the coefficient on the RER captures the effect of changes in the foreign real exchange relative to the base currency.

[14] For example, firms exporting a product to multiple partners may fix future export prices in ZAR, based on the expected trend in the South African currency relative to all destinations (mean or export-weighted average). This would diminish their export price responsiveness (in exporter currency) to destination-specific movements in the RER. See an earlier working paper by Auer and Schoenle (2012), where they show that the pass-through rate to United States import prices following USD movements is up to four times as large as the pass-through rate following trading partner-specific movements.

by Bussière et al. 2016) and industry-panel data (0.16 to 0.55 by Hlatshwayo and Saxegaard 2016) that covers the post-1994 period. Anand et al. (2016) also estimate a higher long-run coefficient of 0.58 for manufacturing, using the export transaction data for South Africa over the period 2010 to 2014 but aggregated to the two-digit level. Common to all these studies using more recent data is that the estimated export elasticity is inelastic, and is lower than most of the earlier estimates for South Africa (from -0.5 to -6) using aggregated time-series data (Edwards and Garlick 2014; Senhadji and Montenegro 1999). The results for this paper are thus consistent with a diminished responsiveness of exports to the exchange rate, at least over the narrow 2009 to 2014 window period.

Column (3) presents estimates of the responsiveness of the value of manufacturing exports to the RER. The estimated coefficients are a combination of the price and quantity estimates in columns (1) and (2). The RER coefficient is estimated at 0.508. A 10 per cent depreciation is thus expected to raise the value of manufactured exports by 5.1 per cent, with just over half of this response driven by increases in the export unit values.

Columns (4) to (6) present results that include year fixed effects. The inclusion of year fixed effects has a dramatic impact on the estimated elasticities. The coefficient on the RER is insignificantly different from zero, implying complete pass-through of exchange rate changes to foreign prices. Exporters do not change their export price measured in ZAR in response to destination-specific shocks in the bilateral RER. While this is surprising, high exchange rate pass-through rates are also found by Li et al. (2015) for Chinese firms (coefficient of 0.034) and Amiti et al. (2014) for Belgian firms.

The quantity elasticity (column 5) and export value elasticities (column 6) also fall dramatically, to 0.087 and 0.065 respectively. However, these coefficients are also not significantly different from zero. What these results suggest, in comparison with the results without year fixed effects, is that much of the export response arises from movements in the South African exchange rate that are common to all destinations. Exporters respond more strongly to changes in the ZAR common to all foreign currencies than to country-specific changes in the bilateral RER.

Table 4: Benchmark regressions: firm export response to exchange rate

	(1)	(2)	(3)	(4)	(5)	(6)
	UV	Q	Export value	UV	Q	Export value
ln(RER)	0.294**	0.214**	0.508**	-0.022	0.087	0.065
	(0.060)	(0.059)	(0.080)	(0.046)	(0.093)	(0.080)
ln(real GDP)	0.722**	-0.033	0.689**	-0.005	0.191	0.186
	(0.076)	(0.106)	(0.123)	(0.086)	(0.179)	(0.171)
Constant	-14.053**	5.817*	-8.236*	5.061*	-0.177	4.884
	(2.029)	(2.798)	(3.271)	(2.292)	(4.729)	(4.527)
Observations	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368
Adj. R2	0.771	0.755	0.686	0.772	0.755	0.686
Fixed effects						
Year	N	N	N	Y	Y	Y
Firm-product-destination	Y	Y	Y	Y	Y	Y

Note: sample restricted to firms that export more than one million ZAR on average per year, and firm-product-destination observations where the firm has a market share of 95% or lower. Robust standard errors clustered at firm-destination level in parentheses. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel and WDI database.

4.2 Heterogeneity in firm responses to the exchange rate

A limitation of the above specification is that it does not adequately account for heterogeneity in the responsiveness of exporters to the exchange rate. The average firm in the sample is a small firm that exports few goods of low value to few countries. The results therefore do not reflect how larger, more productive firms, or firms that import intermediate inputs, adjust to movements in the RER.

We therefore extend the specification to allow for the role that imported intermediate inputs and firm size or market share play in mediating the price and quantity response of exporters to a depreciation. The revised specifications are as follows:

$$\ln(UV_{ipft}) = \beta_0 + \beta_1 \ln(rer_{ft}) + \beta_2 \ln(gdp_{ft}) + \beta_3 \ln(rer_{ft}) \times M_{it} + \beta_4 \ln(rer_{ft}) \times \bar{\varphi}_{if} + \beta_5 M_{it} + \lambda_{if} + \lambda_t + \varepsilon_{ipft} \quad [3]$$

$$\ln(Q_{ipft}) = \alpha_0 + \alpha_1 \ln(rer_{ft}) + \alpha_2 \ln(gdp_{ft}) + \alpha_3 \ln(rer_{ft}) \times M_{it} + \alpha_4 \ln(rer_{ft}) \times \bar{\varphi}_{if} + \alpha_5 M_{it} + \lambda_{ipf} + \lambda_t + \varepsilon_{ipft} \quad [4]$$

where $\bar{\varphi}_{if}$ is a measure of firm size or firm market power, and M_{it} is an indicator of firm import status. To capture the exchange rate effect through the import channel, firm import status (M_{it}) is interacted with the bilateral RER. Our hypothesis is that a depreciation raises import costs, and thus raises the domestic currency price of exports (reduces the exchange rate pass-through) and reduces the responsiveness of exports. We expect a positive coefficient on β_3 and a negative sign for α_3.

Ideally, we would like our import variable (M_{it}) to measure the import intensity of production, as in Berman et al. (2012), Amiti et al. (2014), and Li et al. (2015), but the transaction data we use does not provide information on firm production costs. As an alternative, we use a firm dummy variable if the exporter directly imports. The implication is that we are unable to isolate how changes in the import intensity affect firm export responses.[15]

The influence of firm size or market power on the export response to the exchange rate is captured by the interaction of the variable $\bar{\varphi}_{if}$ with the RER. Berman et al. (2012) and Li et al. (2015) find that higher-performance firms, as measured in terms of productivity and value added, absorb exchange rate movements in their mark-ups so that their exports are less sensitive. As we do not have measures of firm productivity, we proxy this variable using the average annual value of exports by the exporter as a measure of firm size. This is consistent with the theoretical model of Melitz (2003), where more productive firms export higher values of goods.

For market power we follow Amiti et al. (2014) and replace $\bar{\varphi}_{if}$ with a measure of firm i's average share in destination f's market for an aggregated product category h, defined at the four-digit level of the HS. This measure is calculated as follows:

[15] In other estimates, we allocate exporters into quintiles according to their mean annual value of goods imported over the full period, and then include dummy variables for each of these (excluding the first quintile) interacted with the RER. Through this we try to estimate the differential effect of the exchange rate on export performance across firms by import size. The results are qualitatively similar. Larger importers have a lower pass-through and a lower quantity elasticity than smaller importers.

$$\bar{S}_{ihf} = \frac{1}{T}\sum_t \left(\frac{XV_{ihft}}{\sum_{i'} XV_{i'hft}} \right) \quad [5]$$

where XV_{ihft} denotes the value of firm i's exports at the four-digit level of the HS (h) to destination f in year t. We take the average of the firm's annual share excluding years in which no trade takes place. We calculate market share at the four-digit level rather than the six-digit level of the HS to minimize cases where the firm is the sole exporter of a product to a destination. Note that this measure of market power excludes domestic production in destination f as well as exports from other countries to that destination. However, as pointed out by Amiti et al. (2014), since the analysis is across South African exporters within sector destinations, the inclusion of domestic production and competing exports has a uniform downward effect on $\bar{S}_{ihf}$, and hence the measure continues to capture the relevant variation for the analysis. We will nevertheless test the robustness of this result to the inclusion of foreign-destination total imports at the HS four-digit level.

The results on the influence of imports on firm export responsiveness to the exchange rate are presented in Table 5. Unless otherwise stated, all the estimates include firm-product-destination and year fixed effects. If we look at the first column for export unit values, the coefficient on the import dummy variable interacted with the RER is positive, but it is not significantly different from zero. In contrast, the elasticity of export volumes to RER movements is lower for firms that import (-1.7 percentage points), although the coefficient is imprecisely estimated (10 per cent significance). Export volumes from firms that import are thus less responsive to movements in the RER than other exporters. However, the imprecision of the estimates implies that the results only provide tentative support for the argument that rising costs of imported inputs diminish the responsiveness of exporters to a depreciation in South Africa. The weakness of the estimates may be attributed to the crude measure of import participation used in the estimates, as opposed to a measure of the intensity of import use in the production process.

Table 5: Imports and firm export response to exchange rate

	(1)	(2)	(3)
	UV	Q	Export value
ln(RER)	-0.028	0.104	0.076
	(0.047)	(0.096)	(0.082)
ln(real GDP)	-0.006	0.195	0.190
	(0.086)	(0.179)	(0.171)
Import dummy	-0.001	0.072**	0.071**
	(0.010)	(0.021)	(0.019)
ln(RER) x Import dummy	0.006	-0.017+	-0.011
	(0.005)	(0.010)	(0.009)
Constant	5.074*	-0.351	4.722
	(2.277)	(4.728)	(4.546)
Observations	1,113,368	1,113,368	1,113,368
ar2	0.772	0.755	0.686
Fixed effects			
Year	Y	Y	Y
Firm-product-destination	Y	Y	Y

Note: each regression contains year fixed effects and firm-product-destination fixed effects. Robust standard errors clustered at firm-destination level in parentheses. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel and WDI database.

Table 6: Size, market power and firm export response to exchange rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Firm size			Market share			Firm size and market share	
	UV	Q	Export value	UV	Q	Export value	UV	Q	Export value
ln(RER)	-0.065	0.180+	0.115	-0.058	0.177+	0.119	-0.081+	0.224*	0.143+
	(0.046)	(0.093)	(0.081)	(0.047)	(0.093)	(0.082)	(0.046)	(0.091)	(0.081)
ln(real GDP)	0.004	0.175	0.179	0.008	0.163	0.171	0.012	0.154	0.166
	(0.082)	(0.181)	(0.174)	(0.082)	(0.176)	(0.172)	(0.080)	(0.179)	(0.173)
Import dummy	-0.001	0.071**	0.071**	-0.001	0.072**	0.071**	-0.000	0.071**	0.071**
	(0.010)	(0.021)	(0.019)	(0.010)	(0.021)	(0.019)	(0.010)	(0.021)	(0.019)
ln(RER) x import dummy	0.005	-0.016	-0.011	0.006	-0.017+	-0.011	0.005	-0.016	-0.011
	(0.005)	(0.010)	(0.009)	(0.005)	(0.010)	(0.009)	(0.005)	(0.010)	(0.010)
ln(RER) x ln(size)	0.052**	-0.105**	-0.054*				0.048**	-0.095**	-0.048*
	(0.016)	(0.033)	(0.024)				(0.016)	(0.032)	(0.024)
ln(RER) x (mkt share)				0.272**	-0.658**	-0.386*	0.174*	-0.463**	-0.289+
				(0.093)	(0.192)	(0.160)	(0.085)	(0.175)	(0.150)
Constant	4.825*	0.156	4.981	4.731*	0.477	5.208	4.624*	0.692	5.315
	(2.184)	(4.787)	(4.614)	(2.180)	(4.675)	(4.557)	(2.132)	(4.734)	(4.606)
Observations	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368	1,113,368
ar2	0.772	0.755	0.686	0.772	0.755	0.686	0.772	0.755	0.686
Fixed effects									
Year	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm-product-destination	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes: robust standard errors clustered at firm-destination level in parentheses. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel and WDI database.

In Table 6, we turn to analysing the heterogeneous response of exporters to the exchange rate according to firm size and market power. Three sets of results are presented. In columns (1) to (3) the estimates include interaction terms between firm export size and the RER. In columns (4) to (6) market share is interacted with the RER, while in columns (7) to (9) both interaction terms are included. All estimates include year fixed effects.[16]

Firm size is measured as the average total value of manufactured goods exported by the firm over the full period 2009 to 2014. To ease interpretation of the results, we normalize firm size by the sample average. The coefficient on the RER thus reflects the price or quantity response for an exporter of average firm size. Given the unequal distribution, this is a small firm with export sales of around 17 million ZAR per year.[17] The theoretical expectation is that larger firms and firms with high market share will have lower exchange rate pass-through (price more to market) and lower export elasticities than smaller firms with low market share.

Our results corroborate the international evidence. Firm size affects the pricing and output decisions of exporters in response to RER movements. If we look first at the export price results in column (1), the coefficient on the size-RER interaction term is positive and significant with a value of 0.052. The implication is that the larger the exporter, the more responsive it is in adjusting export prices (in local currency) to changes in the exchange rate. The effect of this lower pass-through to foreign prices is a diminished responsiveness of export volumes by these large firms to the exchange rate. In column (2), the coefficient on the interaction between size and the RER is significant (at one per cent level) and negative at -0.105.

These results imply substantially different responses by export firms to the exchange rate across firm sizes. As the exporter size increases, its export price elasticity rises, and its output elasticity falls. According to these results, the price elasticity of the 99th percentile firm by export size is 32 percentage points higher than that of the median firm. The export quantity elasticity is 64 percentage points lower.[18] The implication of these results is that larger firms are more likely to absorb part of a depreciation in the form of higher local currency prices of their exports than smaller firms, and consequently their export volume responses are lower.

In columns (4) to (6) we look at the role that market power plays in influencing exporters' responses to the exchange rate. As shown by the coefficients on the market share-exchange rate interaction term, rising market power is associated with a diminished pass-through to foreign prices and a lower responsiveness of export volumes to the exchange rate. The results are consistent with a model where firms with market power absorb some of the currency movement through changes in their mark-ups to stabilize export prices in the destination countries.[19] A 10 percentage point rise in market share is associated with a 2.7 percentage point lower pass-through to destination prices and a 6.6 percentage point reduction in the export volume elasticity.

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[16] The marginal effects captured by the interactions are unaffected by the inclusion of the year fixed effects.

[17] This firm is in the 94th percentile of the export size distribution.

[18] Using estimates without year fixed effects reveals the median exporter in terms of size to have an export price elasticity of 0.07 and an export quantity elasticity of 0.75. The 99th percentile exporter has a price elasticity of 0.3 and an export quantity elasticity of 0.14. The 100th percentile firm has an export price elasticity of 0.4 and an export quantity elasticity insignificantly different from zero.

[19] As noted by Burnstein and Gopinath (2014), this conclusion requires that firms set their mark-ups at country level.

In columns (7) to (9) we assess whether size and market share have independent influences on the price and export quantity response of firms to the exchange rate. Both characteristics are found to be significant in explaining differential export responses across firms to exchange rate movements.

These results corroborate those found in the international empirical literature and are consistent with theoretical predictions. Larger firms with high market share in destination markets are more likely to price to market. In response to a depreciation, these firms raise price mark-ups, thus reducing the pass-through rate and reducing the impact on export quantities. In addition, exporters that import experience rising marginal costs in response to a depreciation, leading to additional upward pressure on the domestic currency price of exports, further reducing the export quantity response.

4.3 The role of destination and product composition

As discussed earlier, the composition of South African manufactured exports varies considerably across destinations. Exports to Africa are concentrated in high- and medium-technology products, while exports to ROW are concentrated in resource-based products. Differences in production technology and demand elasticities across products and destinations may introduce further heterogeneity in the export response to currency movements. In this section, we briefly present additional estimates to explore the influence of differences in the destination and product composition of exports on the exchange rate elasticities.

Table 7: Export responsiveness for resource-based and other manufactured products

	(1)	(2)	(3)	(4)	(5)	(6)
	Resource-based manufactures			Other manufactures		
	UV	Q	Export value	UV	Q	Export value
ln(RER)	-0.090	0.226*	0.136	-0.079	0.228*	0.149+
	(0.056)	(0.113)	(0.094)	(0.049)	(0.094)	(0.084)
ln(real GDP)	-0.061	0.053	-0.008	0.042	0.183	0.225
	(0.065)	(0.182)	(0.176)	(0.088)	(0.191)	(0.186)
Import dummy	-0.016	0.099**	0.082**	0.005	0.062**	0.067**
	(0.011)	(0.027)	(0.026)	(0.011)	(0.022)	(0.020)
ln(RER) x import dummy	0.001	-0.026*	-0.025*	0.007	-0.012	-0.006
	(0.005)	(0.013)	(0.012)	(0.006)	(0.010)	(0.010)
ln(RER) x ln(size)	0.027	-0.065	-0.038	0.053**	-0.105**	-0.051*
	(0.018)	(0.046)	(0.035)	(0.016)	(0.032)	(0.024)
ln(RER) x (mkt share)	0.158+	-0.110	0.047	0.191+	-0.625**	-0.433**
	(0.086)	(0.238)	(0.214)	(0.102)	(0.185)	(0.160)
Constant	5.360**	5.087	10.447*	4.130+	-0.501	3.629
	(1.741)	(4.844)	(4.684)	(2.337)	(5.060)	(4.939)
Observations	219,376	219,376	219,376	893,992	893,992	893,992
R-squared	0.829	0.869	0.846	0.835	0.807	0.768
Fixed effects						
Year	Y	Y	Y	Y	Y	Y
Firm-product-destination	Y	Y	Y	Y	Y	Y

Notes: robust standard errors clustered at firm-destination level in parentheses. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel and WDI database.

Table 7 presents results, including year fixed effects, for exports classified into resource-based and other manufactured products according to Lall's (2000) technology classification of products. Our expectations are that resource-based products are less differentiated, providing less scope for firms to price to market. The influence of market power on pricing and export volumes is thus anticipated to be smaller for resource-based products.

The results for resource-based manufactures have few significant coefficients. Neither the pricing nor the output responses of exporters to the exchange rate are affected by the firm's export size. While exchange rate price elasticities are higher for firms with high market share, the association is weak. Of interest, the interaction of the RER and import status is negative and significant (five per cent level) for export quantities (but not for export prices).

In contrast, firm size and market share have a significant influence on how exporters of other manufactures respond to changes in the RER. Firms that are larger and have higher market shares have lower pass-through rates (higher price elasticities) and diminished export volume responses of non-resource-based manufactures to currency fluctuations.

Table 8: Export results by destination

	(1)	(2)	(3)	(4)	(5)	(6)
		Africa			ROW	
	UV	Q	Export value	UV	Q	Export value
ln(RER)	-0.095*	0.245*	0.150+	0.104	0.190	0.294+
	(0.044)	(0.101)	(0.087)	(0.069)	(0.176)	(0.170)
ln(real GDP)	0.284**	-0.069	0.215	-0.010	0.250	0.240
	(0.080)	(0.251)	(0.234)	(0.137)	(0.195)	(0.200)
Import dummy	0.003	0.074**	0.077**	-0.013	0.049+	0.036
	(0.011)	(0.024)	(0.022)	(0.013)	(0.028)	(0.030)
ln(RER) x import dummy	0.006	-0.013	-0.008	-0.004	-0.015	-0.019
	(0.006)	(0.011)	(0.011)	(0.006)	(0.015)	(0.016)
ln(RER) x ln(size)	0.052**	-0.103**	-0.051+	0.031	-0.046	-0.015
	(0.018)	(0.037)	(0.027)	(0.021)	(0.032)	(0.029)
ln(RER) x (mkt share)	0.083	-0.610**	-0.527**	-0.045	-0.034	-0.078
	(0.109)	(0.216)	(0.182)	(0.118)	(0.169)	(0.190)
Constant	-2.546	6.385	3.839	5.354	-1.268	4.087
	(2.105)	(6.591)	(6.158)	(3.831)	(5.441)	(5.600)
Observations	944,250	944,250	944,250	169,118	169,118	169,118
ar2	0.837	0.811	0.761	0.888	0.900	0.846
Fixed effects						
Year	Y	Y	Y	Y	Y	Y
Firm-product-destination	Y	Y	Y	Y	Y	Y

Notes: robust standard errors clustered at firm-destination level in parentheses. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel and WDI database.

The differential response to the exchange rate for exporters of resource-based and other manufactures impacts on the responsiveness of exports across destinations. Table 8 splits exports into Africa and ROW destinations. Exports to ROW appear to be poorly explained by the model, whereas the results for Africa mimic those for non-resource-based products. This is expected, as Africa has become a major destination for South African firms exporting these products. Further, the relatively large coefficients on the size and market share interactions with the exchange rate may reflect the dominance of South African exports of these products into the region. Goods sourced from South Africa comprise a very high share of total imports by African countries. For

example, in 2014 imports of Standard International Trade Classification (SITC) categories 5 to 8 (chemicals, manufactured goods classified chiefly by materials, machinery and transport equipment, and miscellaneous manufactured articles) from South Africa made up more than 30 per cent of total imports of these goods in Zimbabwe, Zambia, and Mozambique, and 21 per cent of imports in Malawi.[20] The increased market power associated with this dependence on South African imports confers a greater ability of South African firms to price to market in these countries through adjusting mark-ups in response to currency movements.

4.4 Extensive margin effects

One concern with the above estimates is that they do not account for the entry and exit of exporters into destination markets, which may itself be related to the exchange rate (Berman et al. 2012; Li et al. 2015). Consequently, our results may underestimate the total effect of exchange rate movements on firm export behaviour in South Africa.

To account for the extensive margin effects of exchange rate movements, we estimate how changes in the bilateral exchange rate affect the probability of a firm exporting to that destination. Let DX_{ift} denote a binary variable that equals one if firm i exports to destination f at time t, and zero otherwise.[21] We use a linear probability model to estimate how the RER and foreign real GDP affect the probability of a firm exporting to a region. To control for unobservable characteristics, we include firm-destination fixed effects. Unfortunately, we do not have other firm-level controls such as productivity and wage to include in the regression. Following Berman et al. (2012) and Li et al. (2015), we estimate separate regressions for new entries ($DX_{ift-1} = 0$) and existing exporters ($DX_{ift-1} = 1$). This is to control for prior experience and persistence effects associated with exporting in the prior year.

Table 9: Extensive margin responses to the exchange rate

	(1)	(2)	(3)
	All firms	Entry firms	Existing firms
ln(RER)	0.046**	0.077*	0.003
	(0.015)	(0.035)	(0.019)
ln(real GDP)	0.417**	0.392**	0.118**
	(0.025)	(0.059)	(0.033)
Constant	-10.900**	-10.455**	-2.599**
	(0.683)	(1.638)	(0.917)
Observations	398,157	130,812	200,858
R-squared	0.295	0.382	0.494
Fixed effects			
Year	Y	Y	Y
Firm-product-destination	Y	Y	Y

Notes: robust standard errors clustered at firm level in parentheses. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel and WDI database.

Table 9 presents the regression results. An exchange rate depreciation has a positive impact on export participation. As shown in column (1), a 10 per cent real depreciation is estimated to raise the probability that a firm exports to a market by 0.46 per cent. This is a much lower

[20] Authors' calculations using UN Comtrade data.

[21] The sample is a balanced panel but only includes firm-destination combinations where at least one product is exported by the firm to the destination over the full period.

responsiveness than is found for France (0.2 to 0.3, Berman et al. 2012), but is similar to that of China (0.07 to 0.08, Li et al. 2015). The effect works primarily through encouraging new entry into a market (column 2), with little effect on the probability of remaining an exporter (column 3). In all cases, rising foreign income has a strong effect on the probability of export participation in the destination market.

While a depreciation is effective in encouraging entry into exporting to destinations, its effect on aggregate export values is expected to be low. New firms are smaller and less productive than the established continuing exporters. Further, the degree of churn is high among South African exporters, and growth along the intensive margin (existing exporters expanding exports to existing destinations) has been shown to dominate South African export growth (Matthee et al. 2018).

4.5 Robustness of findings

We estimate several alternative specifications to test the sensitivity of the regression results. These results are presented in Table A1 in the appendix. One concern is that we have not controlled for global product-specific demand trends. For example, given South Africa's resource abundance, changes in the relative price of commodities may be correlated with both the RER and unit values of resource-intensive products. While the splitting of the sample of products into resource-based and other manufactures, as in Table 7, may ameliorate some of this bias, we also re-estimate the equations including two-digit HS by year fixed effects to capture broad product-specific trends in global demand. The results, presented in columns (1) and (2) of Table A1, change little from those in Table 6.

Our measure of market power only looks at the share of the firm in total South African exports to the destination, and does not consider the total value of imports from all sources by that country. Consequently, in columns (3) and (4) of Table A1 we include the total value of imports at the HS four-digit level by each destination in each year. We only include imports from low- and middle-income countries against which South African exporters are more likely to compete, although the results are qualitatively similar when including total imports from all sources. The coefficient on the size-RER interaction variable loses significance in both regressions, but the coefficient on the market share-RER variable remains significant in both cases (although only at 10 per cent level for output). Market power, as measured in our indicator, continues to be associated with a diminished pass-through to foreign prices and a lower responsiveness of export volumes to the exchange rate.

In their theoretical model, Berman et al. (2012) show how in the face of distribution costs in the export market, exporters increase more their producer prices and increase less their export volume following a depreciation. This effect may explain the diminished pass-through and export responsiveness to exchange rate movements of large firms that we find in our data, as these firms are more likely to be able to access export markets with high distribution costs. To control for this potential effect, we use distance to the export market as a crude measure of distribution costs, and include its interaction with the RER in the estimations presented in columns (5) and (6). Consistent with the theory of Berman et al. (2012), the coefficients on the distance-RER interactions are positive for unit value equations and negative for the export quantity regressions, but are only significant at the five per cent level for former. The coefficients on the size interactions hardly change, suggesting that size continues to independently influence firm export responsiveness to the exchange rate.

Finally, as an alternative to the Lall technology classification of products used in Table 7, we present estimates in columns (7) to (10) for homogenous and differentiated products, classified

according to the approach followed by Rauch (1999).[22] The results are qualitatively similar to those found earlier, with firm size and market share playing a significant role in the responsiveness of differentiated exports, but not homogenous exports, to changes in the RER.[23]

Overall, our results and conclusions are robust to the inclusion of additional control variables.

5 Conclusion

What can we conclude based on the results so far? Our results corroborate those of the emerging international literature on firm export responses to the exchange rate. The ZAR price charged by South African exporters is insensitive to exchange rate movements, with much of the depreciation passed through to foreign-currency denominated prices. This high pass-through, however, does not translate into a strong export quantity response, as is also found for Chinese exporters by Li et al. (2015). The implication is a low export volume response to the depreciation over the period.

Our results also reveal substantial heterogeneity in the responsiveness of firms to the exchange rate. Exporters that import tend to show a weaker export volume response to a depreciation than other exporters. Further, larger export firms (a proxy for productivity) and firms that hold high market shares (a proxy for market power) absorb exchange rate movements through changes in mark-ups, as is also found by Berman et al. (2012) for France and Li et al. (2015) for China. The implication is that these firms raise their ZAR price in response to a depreciation compared with smaller firms with low market share. The effect is also a reduced export volume response to the depreciation for larger exporters.

We find stark differences in the responsiveness of exporters according to the product and destination composition of the goods exported. Exporters of non-resource-based manufactured products respond as expected to a depreciation, with results comparable to the aggregate results. In contrast, the estimated results for exporters of resource-based manufactured products are weaker. Looking at export behaviour to Africa and ROW, we note a stronger export price and quantity responsiveness to the RER for exports to the rest of Africa compared with other destinations. This outcome is consistent with the results for non-commodity exports, as these products make up the bulk of manufactured good exports to Africa. Finally, real depreciations raise the probability of a firm commencing exporting to that destination, but the contribution to aggregate exports is low and is likely to be swamped by the high levels of churn among small exporters in South Africa.

Our results provide some explanation for the weak manufacturing export response in South Africa over the period 2009 to 2014. Firstly, the high concentration of South African exports among large firms dampened the aggregate response in export volumes to the sustained depreciation over the period 2009 to 2014. Our findings for large firms are not new and corroborate international

[22] Rauch (1999) classifies products at the SITC (Revision 2) level on the basis of whether they were traded on an exchange (organized), had prices listed in trade publications (reference), or were brand name products (differentiated). We classify organized and reference products as homogenous.

[23] The Rauch (1999) classification has also been used to test how currency invoicing affects exchange rate pass-through (Gopinath et al. 2010). Homogenous goods on average tend to be USD-priced and show a lower pass-through than differentiated goods. Regressions of unit values on the RER (with no year fixed effects) using the South African data produce results broadly consistent with this finding. The estimated pass-through for differentiated products is 0.72, compared with 0.67 for homogenous products.

empirical research. However, the effect on aggregate exports is likely to be more pronounced in South Africa, given its high concentration of exports relative to its peers (Purfield et al. 2014).

Secondly, large firms tend to rely more heavily on imported intermediate inputs in the production process. For these firms, the depreciation raises marginal costs, thus diminishing the export response. This relationship highlights a tension for firms linking into global value chains. Access to imported intermediate inputs raises productivity and export performance (Edwards et al. 2018), but it reduces the export volume sensitivity of these firms to exchange rate movements.

Thirdly, Africa has become a major destination for South African exports of non-resource-based manufactured products. These products tend to be more sensitive to movements in the exchange rate. However, the REER depreciated far less against key export destinations such as Zimbabwe, Malawi, Mozambique, and Zambia over the period than against other economies, including the advanced economies.[24] Consequently, the export stimulus to these key African destinations via the exchange rate was lower.

Irrespective of these explanations, the estimated export volume elasticity is low, despite the high pass-through rates (even for large firms). This suggests that other factors are constraining firm exports. One possible explanation is high distribution costs, foreign tariffs, and destination retail margins that drive a wedge between the export price and the consumer price. South Africa is remote from many markets, resulting in high distribution costs to destination markets. These dilute the consumer price response of South African goods in foreign markets, leading to low demand responses. Our results where we control for distance to destination support this view.

Supply constraints are also a consideration. Anand et al. (2016) find that structural features such as electricity bottlenecks, limited product market competition, and labour market constraints have reduced the responsiveness of South African firm exports to currency depreciation. Hlatshwayo and Saxegaard (2016) argue that policy uncertainty has resulted in firms holding off investments in exporting. Together, these further diminish the responsiveness of South African exporters to currency movements.

Finally, an important caveat to the study is that the analysis focuses on a relatively short time period of the six years that followed the global financial crisis in 2008. Uncertainty around the global recovery could have delayed the response by exporters to the exchange rate depreciation. Further analysis using more recent exporter-level data would be required to analyse whether this has been the case.

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[24] The RER depreciated on average by 2.2 per cent against Zimbabwe, Malawi, Mozambique, and Zambia over the period 2009 to 2014, compared with an average of 5.8 per cent for the European Union, United States, Canada, Sweden, Switzerland, and Australia.

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Appendix

Table A1: Sensitivity tests of results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Control for HS-2 by year FE		Control for destination imports		Control for distance to trading partner		Rauch differentiated		Rauch homogenous	
	UV	Q	UV	Q	UV	Q	UV	Q	UV	Q
ln(RER)	-0.088*	0.230*	-0.043	0.151	-1.214**	0.876	-0.101+	0.255**	-0.007	0.160
	(0.044)	(0.092)	(0.055)	(0.121)	(0.295)	(0.636)	(0.052)	(0.098)	(0.060)	(0.108)
ln(real GDP)	0.047	0.146	-0.018	0.018	0.072	0.120	0.038	0.170	-0.130+	0.279
	(0.079)	(0.185)	(0.075)	(0.191)	(0.068)	(0.171)	(0.087)	(0.199)	(0.067)	(0.174)
Import dummy	-0.001	0.069**	-0.007	0.064**	-0.000	0.071**	0.004	0.063**	-0.005	0.068**
	(0.010)	(0.021)	(0.012)	(0.024)	(0.010)	(0.021)	(0.012)	(0.022)	(0.014)	(0.024)
ln(RER) x import dummy	0.005	-0.015	0.007	-0.013	0.005	-0.016	0.009	-0.022*	-0.001	-0.001
	(0.005)	(0.010)	(0.006)	(0.011)	(0.005)	(0.010)	(0.007)	(0.011)	(0.006)	(0.012)
ln(RER) x ln(size)	0.050**	-0.098**	0.024	-0.055	0.045**	-0.094**	0.057**	-0.109**	0.008	-0.050
	(0.015)	(0.033)	(0.016)	(0.037)	(0.016)	(0.033)	(0.016)	(0.033)	(0.022)	(0.036)
ln(RER) x (mkt share)	0.198*	-0.467**	0.225*	-0.408+	-0.001	-0.362*	0.206+	-0.537**	0.064	-0.323
	(0.085)	(0.173)	(0.107)	(0.230)	(0.081)	(0.147)	(0.109)	(0.199)	(0.112)	(0.214)
ln(destination imports)			0.007	0.081**						
			(0.005)	(0.015)						
ln(RER) x ln(distance)					0.148**	-0.085				
					(0.037)	(0.080)				
Constant	3.693+	0.903	5.398**	4.046	3.045+	1.601	4.267+	-0.323	7.225**	-0.607
	(2.088)	(4.892)	(1.986)	(5.021)	(1.789)	(4.525)	(2.295)	(5.259)	(1.791)	(4.643)
Observations	1,113,364	1,113,364	932,028	932,028	1,113,368	1,113,368	812,823	812,823	173,006	173,006
Adj. R2	0.772	0.755	0.778	0.765	0.772	0.755	0.753	0.685	0.760	0.827

Notes: standard errors clustered at country-year level, reported in brackets. Classification of products into differentiated and homogenous based on Rauch (1999). Variable destination imports denote total imports at the HS four-digit level by destination country from low- and middle-income countries in each year. Data from UN Comtrade. Distance is bilateral distance from South Africa to export destination, obtained from CEPII. All estimates include firm-product-destination fixed effects and year fixed effects, with exception of first two columns, which contain HS two-digit by year fixed effects. ** p<0.01, * p<0.05, + p<0.1.

Source: authors' calculations using data from SARS-NT panel, WDI database, CEPII, and UN Comtrade.