EXCHANGE RATE VOLATILITY AND TRADE IN SOUTH AFRICA*

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Abstract

This paper investigates the impact of exchange rate volatility on trade and exports in South Africa using time-series and gravity equations models. The results show no evidence of a robust, first-order detrimental effect of exchange rate volatility on aggregate exports or bilateral trade flows. Therefore, the evidence does not justify policy actions motivated by the aggregate consequences of this volatility, but actions oriented towards easing access to hedging instruments could reduce possible distributional effects.

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1. INTRODUCTION

In June 2001 the exchange rate between the South African Rand and the U.S. dollar was eight; in December 2001 it was twelve. In six months the Rand depreciated 50 percent against the U.S. dollar and also depreciated importantly against many other currencies. Episodes like this, although extreme, have become common in South Africa, where exchange rate volatility has steadily increased since the early 1990s. This raising trend in volatility is apparent in Figure 1, which shows the evolution of the rolling one-year standard deviation of South Africa's real effective exchange rate for the period 1990-2006. A less marked, but similar pattern is also present in the evolution of the nominal exchange rate against the U.S. dollar.

This volatility has not gone unnoticed and has caused important concern among policymakers and market participants, to the extent that President Thabo Mbeki created the *Myburgh Commission* to investigate the causes of the acute depreciation of late 2001. More recently, the Economist Intelligence Unit's country report for South Africa remarks that the Rand "remains one of the most volatile of emerging market currencies, and is prone to sharp movements" (Economist Intelligence Unit (2007)). South African firms share these concerns, as revealed by the World Bank (2007)'s South Africa Investment Climate Assessment, where concern about the exchange rate is rated the second most serious constraint to enterprise operations and growth for a representative sample of South African firms.

The concern with exchange rate volatility is neither particular to South Africa nor recent years. Since the end of the Gold Standard, several arrangements have emerged around the world to deal with exchange rates fluctuations, the most famous probably being the Bretton Woods agreement among industrial countries. Most recently, the creation of the European Monetary Union (EMU) has been at least partly based on the idea that exchange rate volatility is detrimental for trade. This idea seems to find some anecdotal support among the results of the South Africa's Investment Climate Survey (ICS), where the fraction of firms that reported macroeconomic volatility as a major or very severe obstacle was significantly higher among exporter than non-exporter firms (World Bank (2007)).

In contrast to the typical view of policymakers, in the academic world there is much less consensus on the costs of exchange rate volatility, especially on its impact on trade. On the theoretical front, different models predict opposite relations between exchange rate volatility and trade volumes (see McKenzie (1998)), and this theoretical ambiguity has not been solved by looking at the data, where diverging estimates for the sign and significance of the exchange-rate-volatility and trade relation have been obtained (for a summary, see Clark and others (2004)).

This paper studies whether the concerns with exchange rate volatility in South Africa are consistent with its impact on the activity of the exporting sector. It first estimates the time-series relation between the volatility of the South African real effective exchange rate and the country's total exports using an autoregressive distributed lag model and monthly data for the 1975-2007 period. Since time series methods have well known shortcomings, such as their focus on aggregate trade and exchange rate across all trading partners, their lack of structural foundations, and their potential for endogeneity, the estimation also follows the recent empirical literature that uses the gravity model of trade to study the impact of exchange rate volatility on trade and estimate a standard version of this model using annual data on bilateral trade flows between South Africa and 148 other countries during the period 1975-2000.

The results do not support the hypothesis that exchange rate volatility has a significant, first order negative effect on South African trade flows. Results from time series analysis indicate a weakly positive long run relation and no consistent short run relation between total exports and exchange rate. Estimates from the gravity model suggest at most a weak detrimental effect of bilateral real exchange rate volatility on bilateral trade flows and exports. A liberal estimate of its magnitude indicates that an increase in volatility of 2.3 percentage points (similar to the largest increases in volatility observed in the country) would reduce trade only by three percent. This finding is similar to the economically small magnitude obtained in other papers that apply the gravity model to this question in different and broader samples of countries.

The lack of evidence of a significant impact of exchange rate volatility on trade both at the aggregate or bilateral level suggests that the concern with exchange rate stability is either misplaced or due to distributional effects on some sectors particularly affected by it. Properly testing this hypothesis requires studying sectoral trade flows, which is beyond the scope of this paper and left for future research, but the analysis of the degree of concern about macroeconomic stability revealed by different South African firms surveyed in the World Bank's Investment Climate Survey provides some anecdotal evidence on this regard. Using standard econometric techniques (OLS, Ordered Logit, Logit) I analyze South African firm's responses to a question that asks them to rank their degree of concern about macroeconomic stability and relate their answers to various firm's characteristics that the literature links to their degree of exposure to exchange rate risk. The results indicate that a higher participation in international markets, either as an exporter or as an importer results in a higher degree of concern about macro stability, but the simultaneous participation as exporter and importer reduces these concerns. This is a sign that the simultaneous exposure on income and cost provides firms with a natural hedge against terms of trade fluctuations. The probability of reporting macroeconomic volatility as a major concern is 9 percent larger for a firm that exports 30 percent than for a firm that exports only 10 percent of its output (the 75th percentile and median level of exports respectively) when both import 20 percent of their inputs (the average level of imports), but only 6 percent when they import 35 percent of their inputs (the 75th percentile of imports). Also larger firms that are more likely to have access to financial hedge against exchange rate risk are typically less concerned about volatility; a ten million dollar increase in total assets (approximately equal to the difference in size between the firms at the 75th and 25th percentile of the South African ICS sample) reduces the probability of reporting concern with the macroeconomic environment in 1 percent. These results do not offer definite proof but are consistent with a scenario where despite exchange rate volatility having a small aggregate effect, it affects importantly some firms, especially those exposed to currency risk and lacking means to hedge it.

From a policy perspective, the weak negative effect of exchange rate volatility on total trade flows in South Africa offers little support for strong policy actions aimed to dealing with this volatility. Based on this evidence, policy action would have to be based on the consequences that the volatility might have for particular types of firms exposed to currency risk without the ability to privately hedge it. The results on the degree of concern with macroeconomic volatility of different firms obtained from the Investment Climate Surveys provide some circumstantial evidence that these types of heterogeneous effects could be present but require further support and are silent on whether firms have appropriate access to hedging instruments. Although the available data indicates that South Africa's forex derivatives market is large compared to other developing countries and probably appropriate in terms of transaction volume, gathering detailed information on the characteristics and composition of the supply and demand of these derivatives would be crucial to to determine the most appropriate policies to further foster the development of foreign exchange derivatives markets at various maturities and help firms deal with their exposure to exchange rate risk.

The rest of this article is structured as follows. Section 2 presents some stylized facts about South Africa's exchange rate market. Section 3 briefly discusses the theoretical and empirical literature on the link between exchange rate volatility and trade. Section 4 presents the evidence for the relation between volatility and trade in South Africa. Section 5 relates the theoretical literature to the concerns of different firms regarding exchange rate volatility reported in the South Africa's investment climate survey. Section 6 discusses some areas of future research to inform policy options based on the existing evidence and the characteristics of exchange rate markets in South Africa. Section 7 concludes.

2. THE SOUTH AFRICAN EXCHANGE RATE MARKET

The Rand is one of the most actively traded emerging market currencies. Its daily global turnover volume in 1999 was about 9.5 billion dollars, only below the Brazilian Real (10.8 billion dollars) among emerging market currencies (Galati (2000)). In April 2005 the South African Rand accounted for 0.4 percent of global foreign exchange transactions (with an average daily turnover of 10 bn dollars) and was at the same level than other larger emerging markets such as Mexico, according to the Central Bank Survey of the Bank for International Settlements (2005).

This high turnover can be partly explained by the trading of countries in the Common Monetary Area formed by Lesotho, Swaziland and Namibia. It also can be the result of foreign exchange speculation in international markets. According to Bloomberg (2007), the Rand is a currency that many investors trade as a proxy for their risk appetite.

Among emerging markets, South Africa has a comparatively active market for foreign exchange derivatives. In April 2004, the average daily turnover of over the counter (OTC) derivatives of foreign exchange in South Africa was about 8 billion dollars, which was about the same size of the average daily turnover of foreign exchange markets in the country and much larger than other emerging markets such as Mexico and Chile (Bank for International Settlements (2005)). Also, in addition to the OTC forwards and swaps available for hedging currency risks in some emerging economies, the Johannesburg Stock Exchange recently started trading exchange rate futures in maturities ranging up to a year. These types of standard foreign exchange derivatives are uncommon among emerging markets. In section 6 it will be argued that the availability of these instruments is important to assess the ability of South African firms to hedge currency risk.

Since the early 1990s the Rand has exhibit a tendency to depreciate against the currencies of South Africa's main trading partners. Against the U.S. dollar, the Rand depreciated from an initial level of about 2.5 Rand/U.S. dollar in 1990 to about 7 Rand/U.S. dollar in 2007. The tendency to depreciation is shown in Figure 2. The continuous line shows the evolution of the Rand against the dollar during 1990-2007, and the broken line shows the evolution of South Africa's real effective exchange rate during the same period.

Figure 2 also shows that the trend to the depreciation has not been smooth and has been accompanied by wide fluctuations in the Rand/dollar and the real effective exchange rate. For instance, between January and December 2001, the Rand experienced 70 percent depreciation against the U.S. dollar, with the exchange rate rising from a level of 7 to 12 Rand/U.S. dollar, and then an appreciation that took the exchange rate back to about 8 Rand/U.S. dollar by the end of 2002. In fact, the depreciation experienced by the Rand during this period was one of the largest among emerging markets, being only exceeded by Turkey that suffered a full blown financial crisis (Myburgh Comission (2002)).

Although the 2001 episode is extreme, other instances of relatively large fluctuations in the South African exchange rate are common, to the point that market analysts such as the Economist Intelligence Unit (2007) remark that the Rand is one of the most traded and most volatile of the emerging market currencies. In fact, although it is true that many emerging market currencies weakened against the dollar after the Asian Crisis, the volatility of the South Africa's real effective exchange rate (REER) during the period 2000-2007 was almost three times as large as that of a typical emerging market.[1] This is shown in Figure 3, which plots the one-year rolling standard deviation of the monthly growth of South Africa's real effective exchange rate and the median volatility of the same variable among emerging markets and other Sub-Saharan African countries during 1990-2007. The figure clearly shows the comparatively higher volatility of the Rand including its spike in volatility in 2001 and other episodes of high volatility during this period.[2]

The progressive depreciation of the Rand, as well as the large fluctuations it experienced since the mid 1990s, occurred during and after the debt standstill imposed on South Africa by the international community in 1985 and that lasted until mid 1994. South Africa's lack of access to international debt markets during this period resulted in the South African Reserve Bank (SARB) accumulating a large net open forward position (NOFP) through the use of the "forward book" to provide forward cover to corporation's use of international trade credit. Even after the end of the sanctions, the lack of reserves of the SARB derived from its large NOFP and the bank's decision to reduce this open position contributed to the progressive depreciation of the Rand and to

[1] This includes all countries that are included in Morgan Stanley's Emerging Markets Index with data on real effective exchange rate in the IMF's International Financial Statistics, namely Chile, China, Colombia, Czech Republic, Hungary, Israel, Malaysia, Morocco, Pakistan, Philippines, Poland, and Russia. The statement compares the average monthly volatility during the period in South Africa (3.5%) with the median of this statistic across Emerging Markets (1.3%).

[2] The second most volatile emerging market during this period is Colombia that experienced a large depreciation in late 2001, but it surpasses the volatility of the Rand only in that episode.

episodes of speculative activity. During this period, even though the access to international capital markets was restored, the SARB had to resort to the forward book to fence attacks on the currency in 1996 and 1998, but the NOFP was considerably reduced from a level of US$22bn to US$ 9.5bn in the year 2000. Other important changes experienced by South Africa since 1994, such as the end in 1995 of the dual exchange rate regime reintroduced in 1985 and the partial lifting of capital controls on residents undoubtedly had some impact on its exchange rate.[3] All this indicates that an important part of the earlier trend and fluctuations in the Rand are probably the result of the structural transformations experienced by South Africa's capital markets during the last 30 years. Understanding the determinants of South Africa's exchange rate fluctuations during these decades is beyond the scope of this paper. Instead, as it is explained in detail below, the more modest goal pursued here is to determine the impact of this volatility on trade flows regardless of the causes of this volatility.

3. EXCHANGE RATE VOLATILITY AND TRADE

The literature on the economic effects of exchange rate volatility has focused almost exclusively on its impact on trade flows, where a large literature started in the 1970s after the collapse of the Bretton Woods agreement on exchange rates. Despite many years of research, there is little consensus on the trade consequences of this form of volatility. On the theoretical front, the literature has produced a large number of models with various predictions for the relation between these variables. Earlier models based on the case of an exporter that takes production decisions before knowing the realization of exchange rates and cannot hedge this source of risk predicted that an increase in volatility negatively affected a risk adverse exporter (Clark (1973)). This result, however, relied importantly on the inability of firms to hedge the currency risk and was challenged by Ethier (1973) who allowing firms to hedge derived the so-called separation theorem that only the expected exchange rate that has an effect on trade volumes; the variance affects only the amount of hedging undertaken by a firm. Other papers relaxed different assumptions of the earlier models and obtained opposite results for the relation between exchange rate volatility and trade. De Grauwe (1992) relaxed the assumption that inputs (and thus production) cannot be adjusted at the time that exchange rate uncertainty is realized, thereby effectively taking the uncertainty largely off the model, and predicted that an increase in volatility would benefit exporters. Franke (1991) also overturned the negative relation between volatility and trade by giving exporting firms the default option of selling their products in domestic markets.

[3] See Cross (2002)

More recent papers relaxed the focus of earlier models on a single trading firm and emphasized the nature of the firm as a determinant of the real effect of exchange rate volatility. One potential source of heterogeneity is that different types of firms may have different capacities to diversify exchange rate risk. For instance, multinationals that produce and sell in several markets may be better able to diversify exchange rate risk that firms operating and selling in a single market (Broll (1994)). Similarly, exporting firms that rely on imported inputs are better hedged against exchange rate risk than exporters that rely exclusively on domestic inputs (Clark (1973)). Other papers have considered the nature of the product as a relevant source of heterogeneity and distinguished between firms that export homogeneous and differentiated goods (Broda and Romalis (2003), Clark et al., (2004)). The basic premise is that because of the differential ability of these two types of firms to switch markets because of movements in bilateral exchange rates, firms producing homogeneous goods are better able to protect themselves from fluctuations in exchange rate risk than those producing differentiated products for specific markets. A different source of heterogeneity lies directly on the nature of the firm. Wolf (1995) showed that exchange rate risk affected negatively the activity of import agents, and a similar result was found for risk-adverse traders that buy goods in one market to sell it in other by Gagnon (1993).

Although most of the models in this literature are partial equilibrium, there are some general equilibrium analyses that take into account the structural shocks that generate exchange rate movements and how they affect other aspects of the firm's problem. These more complex models shadow even more doubts into the existence of an unambiguous relation between real exchange rate volatility and trade. For instance, Bacchetta and Van Wincoop (2000) study a two-country, general equilibrium model with uncertainty derived from fiscal, monetary, and technological shocks and show that depending on consumers's preferences on the trade-off between consumption and leisure, as well as the monetary policy rules followed in each country, trade can be higher or lower under either fixed or floating exchange rates.

The overall message that emerges from reviewing the theoretical literature is that there is no unambiguous relation between exchange rate volatility and trade. The relation potentially depends on the nature of the firm, the nature of the market in which it operates, and the types of shocks that result in exchange rate volatility, and ideally one would like to control and condition any potential test on these types of characteristics.

Given the ambiguous predictions of the theoretical literature, it is tempting to conclude that the sign of the relation between exchange rate volatility and trade is an empirical issue.

However, not surprisingly, the empirical literature has not been able to document a robust relation between these variables. Some earlier papers, such as Hooper and Kohlhagen (1978) found no significant effect of nominal exchange rate volatility on aggregate trade volumes or prices, while Cushman (1988), extending Hooper and Kohlhagen sample to a later period and using a measure of real exchange rate volatility found evidence of negative effects on some bilateral trade flows between the U.S. and five other developed countries but positive effects on other of these flows. Other earlier papers in this tradition extended the analysis to different sets of countries and also disaggregated trade flows not only by partner country, but also by type of good. The results across papers also exhibit considerable variation in terms of the sign of the estimated relation. McKenzie (1999) provides a comprehensive review of this earlier literature.

While earlier empirical papers estimated time-series export (and import) equations, recent papers have used the gravity model to explore the relation between bilateral exchange rate volatility and bilateral trade flows. This approach, however, has also lead to ambiguous results. Dell'Ariccia (1999) and Rose (2000) estimate small but significantly negative effects of exchange rate volatility on trade, but Tenreyro (2007) argues that the standard estimation of gravity equations suffer from problems that when properly addressed results in no significant effect of volatility on trade. Going beyond the standard aggregate gravity equations, Broda and Romalis (2003) compare the impact of exchange rate volatility on homogeneous and differentiated products. Their basic premise, which they embed in a model, is that exchange rate volatility affects only the exports of differentiated products, but that the exports of all products affect real exchange rate volatility. Thus, the asymmetry in the relation between exchange rate volatility and trade across types of products is what gives identification. They find evidence for their hypothesis in a panel of bilateral trade flows separating by class of product. However, Clark et al. (2004) show that this result is not robust to the inclusion of country-period fixed effects.

Although not directly dealing with the issue of exchange rate volatility, a recent literature has focused on the impact that persistent appreciations can have on exporting firms facing financial constraints, and how the presence of these constraints can lead to exchange rate volatility in the form of overshooting (Caballero and Lorenzoni (2007)). This suggests that the large exchange rate volatility observed in emerging markets can be the result of periods of persistent appreciations that lead to systematic bankruptcies of exporting firms in financially underdeveloped markets. The models also indicate that, during the appreciation phase, exporting firms that are more financially constrained should be more likely to disappear.

4. EXCHANGE RATE VOLATILITY AND TRADE IN SOUTH AFRICA

I now turn to the analysis of South African data to determine whether the concerns about exchange rate volatility respond to the impact that this volatility has on the operations of firms that engage in international transactions. As discussed above, the empirical literature has not produced robustly consistent results supporting the hypothesis that volatility is bad for trade and on several occasions has provided support for the alternative hypothesis that volatility is good for trade. Since one potential concern with these analyses is that they have not focused on the particular case of South Africa, I first review the existing evidence of the relation between volatility and trade for South Africa. Then I present new estimations using time-series and gravity equations.

4.1 Existing Evidence for South Africa

Todani et al. (2005) is the only paper that has studied the relation between exchange rate volatility and trade in South Africa. This paper estimates a time-series model based on a demand equation relating exports to the income of trading partners, the real exchange rate, and its volatility applying the autoregressive distributed lags (ARDL) bounds testing approach of Pesaran et al. (2001) to quarterly data on disaggregated exports during the period 1980-2004. Their results indicate that exchange rate volatility has either a positive or no relation with trade, depending on the specific measure of volatility considered. These results do not seem to support the concern of South African firms with exchange rate volatility as they would indicate that, if anything, volatility is good for trade.

4.2 New time series evidence

This section estimates the time-series relation between exchange rate volatility and aggregate exports in South Africa using monthly data for the period 1975-2007 and also look separately at the sub-period 1990-2007. The underlying export equation follows McKenzie (1997) and relates South Africa's (log) real exports (*EXP*) to its (log) real effective exchange rate (*REER*), its index of economic activity (*Y*), the index of economic activity in trading partners (*Y**), and the volatility of the real effective exchange rate (*SDREER*), through an autoregressive distributed lag model detailed next.

The data come from the International Monetary Fund (2007), International Financial Statistics CD and include South Africa's exports (FOB in U.S. dollars), nominal exchange rate (Rand/U.S. dollar), index of manufacturing production, real effective exchange rate (expressed in such a way that an increase represents an appreciation), consumer price index (CPI), and the U.S. index of industrial production. Real exports are constructed as the product of the exports and the nominal exchange rate (to express the exports in Rand) deflated by South Africa's CPI. This procedure is standard in the literature and renders a series that is highly correlated with the export volume index available from the Economist Intelligence Unit for the later part of the sample. The data on real effective exchange rate is used to construct two measures of exchange rate volatility. The first is the one-year rolling standard deviation of the growth rate of the real effective exchange rate:

$$SDREER1_t = \left(\frac{1}{11} \sum_{i=0}^{11} \left(g(REER)_{t-1} - \bar{g}(REER)_{t,t-11} \right)^2 \right)^{1/2} \tag{1}$$

where $g(REER)_t = \log(REER)_t - \log(REER)_{t-1}$ is the monthly growth rate of the real effective exchange rate, and $\bar{g}(REER)_{t,t-\tau}$ is the average of the monthly growth rate between t and $t-\tau$. This manner of measuring volatility is standard in the literature and has been used by Clark et al. (2004) and Tenreyro (2007) among others.[4] The second measure of volatility (*SDREER2*) is obtained from the estimation of a generalized autoregressive conditional heteroskedaticity (GARCH) model for the change in the log of the real effective exchange rate (i.e. its growth rate). This approach models the change in the log of the real exchange rate as

$$\Delta \log(REER)_t = \sum_{j=1}^{p} \alpha_j \Delta \log(REER)_{t-j} + \varepsilon_t \tag{2}$$

$$E_t[\varepsilon_t^2] = SDREER2_t^2 = \sum_{j=1}^{q} \beta_j \varepsilon_{t-j} + \gamma SDREER2_{t-1}^2 \tag{3}$$

where the use of the change in the log real effective exchange rate is due to the presence of a unit root according to standard ADF tests. Lag selection tests indicate using six lags in both equations (p=q=6). The ARCH LM test rejects the hypothesis of no ARCH terms against the GARCH(6, 1) specification.

Before estimating the export equation, I test for the order of integration of the different variables included in the model to determine whether it should be estimated in levels, differences, or in error correction form. The Augmented Dickey-Fuller (ADF) test cannot reject the hypothesis of a unit root for *EXP, REER, Y, Y*,* and for the rolling version of the standard deviation (*SDREER1*), but it strongly rejects the presence of a unit root in the ARCH estimate of the standard deviation (*SDREER2*). This implies that all variables are *I*(1) in the version that uses

[4] Results obtained using 2-year rolling standard deviations are similar (not reported).

SDREER1, and it is necessary to test for the presence of cointegration among them. The cointegration tests using the Johansen method indicate the presence of at most one cointegrating equation; the hypothesis of no versus at least one cointegrating equation (trace test) is rejected at standard confidence levels, but the hypothesis of zero against one cointegrating equation (max-eigenvalue test) is rejected only at the 11 percent confidence (and higher levels for other pairwise tests). Since the evidence of cointegration is ambiguous the model was estimated including and excluding an error correction specification. The error correction specification is the following:

$$\Delta EXP_t = \alpha_0 + \alpha_1 (EXP_{t-1} - \beta_0 - \beta_1 REER_{t-1} - \beta_2 Y_{t-1} - \beta_3 Y^*_{t-1} - \beta_4 SDREER1_{t-1}) + \sum_{j=1}^{6} (\alpha_{2j} \Delta EXP_{t-j} + \alpha_{3j} \Delta REER_{t-j} + \alpha_{4j} \Delta Y_{t-j} + \alpha_{5j} \Delta Y^*_{t-j} + \alpha_{6j} \Delta SDREER1_{t-j}) + \varepsilon_t \tag{4}$$

where the lag length of 6 was determined following a general to specific approach, a la Hall (1990). Removing the terms associated with α_1 from equation (5) and adding the contemporaneous change in each explanatory variable yields the specification without error correction.

The estimated coefficients for both specifications including and excluding the error correction component are reported in Table 1. Column 1 reports the results obtained for the error correction specification using the first measure of volatility (*SDREER1*). The cointegration relation reported in Panel A, at the top-half of the table shows that the coefficients for the real effective exchange rate, the activity of trade partners, and local activity have the expected signs but none is significant at the 5 percent level. The only significant coefficient is the one for exchange rate volatility (*SDREER1*), which has a positive sign. This indicates that, in the long run, exchange rate volatility increases exports. Panel B displays the coefficients of the short run dynamics. The coefficient of the error correction term is significantly negative, which means that a level of exports above its long run value triggers a downward adjustment in exports. The significant coefficients for the various lags of the differences of the variables of the error correction model indicate that appreciations of the real effective exchange rate reduce exports, higher activity of trading partners increases exports in the short run but reverses after three months, and a raise in local activity increase exports but not significantly. The coefficients for the short run effects of the volatility of the real effective exchange rate suggest a more nuanced pattern, but only those with positive signs are significant at the 10 percent level, suggesting also a positive short run relation between exchange rate volatility and exports.

The coefficients obtained for the specification without error correction, reported in column 2, show a similar picture than those reported in column 1: a real appreciation reduces exports, an increase in U.S. activity increases exports in the short run, local activity weakly increases exports, and the volatility of the real effective exchange rate significantly increases exports with a lag of 3 months.

Columns 3 and 4 show the coefficients estimated using the ARCH estimate of volatility (*SDREER2*) (again including and excluding the error correction term). The cointegration tests in this case do not indicate the presence of co-integration, so the error correction results are reported only for completeness. The conclusions are similar to those obtained with the rolling standard-deviation measure of volatility. There is a positive long run relation between exchange rate volatility and trade and a weak but significantly positive short run relation (at 4 lags). When using this measure of volatility, however, it is also possible to consider an alternative specification in that relates the changes of the variables that are $I(1)$ against the level of the volatility measure (which is $I(0)$), which are all stationary. The coefficients obtained for this specification are reported in column 5. This is the only specification that exhibits a significantly negative coefficient associated with exchange rate volatility (lag 6), although the significance of the coefficient is sensitive to the inclusion of further lags.

Results for the same specifications reported in columns 1 and 3 but obtained using data from the post 1990 and post 1995 periods are reported in columns 1 to 4 of Table 1B. For reasons of space the table only reports the cointegration vector and the error correction component associated with real exchnge rate volatility. Only in one of the specifications corresponding to the post 1995 period there is evidence of a significant negative long run relation between real exchange rate volatility and trade, but the statistical significance of tests in this sample has to be taken with care because of the short length of the sample, as it is known that the Johansen procedure used to estimate the cointegration vector does not perform well in small samples.

Overall, the time series evidence does not robustly support the hypothesis that exchange rate volatility reduces exports. If anything, the data indicates that aggregate exports increase with exchange rate volatility. This finding is consistent with those of Todani et al. (2005), who also found a positive relation between exchange rate volatility and trade using a different time period, frequency, and estimation method. One possible explanation for this result is that it is driven by the exports of commodities. There are, however, four reasons for this not to be the case in South Africa. First, a recent paper by Cashin et al. (2004) that studies the existence of a relation between commodity prices and real exchange rate does not classify South Africa as a “commodity currency".[5] Second, the impact of commodities exports should manifest on the level of the exchange rate instead of its volatility. Third, estimates by Todani et al. (2005) that separate gold exports from other goods yield similar results to those reported here. Fourth, while commodity exports do not currently represent the majority of South African exports, results for the period 1990-2007 yield similar results to those for the whole 1975-2007 period. Nevertheless, despite these arguments, it would be important to estimate these models using only manufacturing exports, which is left for future research.

4.3 Evidence from the gravity model for South Africa

Recent papers have studied the impact of exchange rate volatility on trade using the gravity model of Frankel and Rose (1998). The standard version of this model explains bilateral trade flows as a function of the products of the size and distance of a pair of countries and a series of other variables capturing their cultural similarity and associations with various trade-promoting institutions. To this standard version, several papers (see Rose (2000), Del Ariccia (1999) and Clark et al. (2004), among others) have added measures of the bilateral exchange rate volatility for each pair or trading partners to test the hypothesis that this volatility affects trade flows. In contrast to these papers that look at a large cross section of countries, this section estimates this model focusing only on the case of South Africa, which would address the criticism that the lack of robustly significant effects documented in the literature could be the result of parameter heterogeneity across countries.

The gravity equation I estimate is the following

$$Trade_{j,t} = \alpha_0 + \alpha_1 GDP_{j,t} + \alpha_2 GDPPC_{j,t} + \alpha_3 BOTHIN_{j,t} + \alpha_4 SDREX_{j,t} + \theta_j + \theta_t + \varepsilon_{j,t} \quad (5)$$

where $Trade_{j,t}$, $GDP_{j,t}$, $GDPPC_{j,t}$, are the log real bilateral trade, the log product of real GDP, and the log product of real per capita GDP between South Africa and country j in year *t*, respectively. The variable $BOTHIN_{j,t}$ is a dummy taking the value 1 if both South Africa and country *j* are members of the General Agreement on Tariffs and Trade (GATT) in year *t,* and $SDREX_{j,t}$ is the volatility of the bilateral real exchange rate between South Africa and country *j* in year *t*.[6] Finally, θ_j and θ_t are country and year fixed effects, respectively. All the variables except for the volatility of the bilateral real exchange rate are standard in the literature and are

[5] This view is not shared by many South African analysts that consider the Rand a commodity currency (see, for instance, Myburgh Comission (2002), part B, page 11).

[6] Using two or three (rolling) years to compute the volatility measures do not affect significantly the results.

described in Rose (2004). The volatility of the bilateral exchange rate was computed as the within year standard deviation of the monthly growth of the bilateral real exchange rate between South Africa and country *j* (the ratio of the nominal exchange rates against the U.S. dollar to the ratio of CPIs).

I estimated the parameters of equation (6) using data on bilateral trade flows between South Africa and 148 other countries during the period 1975 to 2000, obtained from Rose (2004). From the discussion in section 2, one problem with this sample period is that during these decades South African went through different exchange rate regimes, capital controls, and international sanctions. The assumption in the specification above is that those time varying structural features affect only the level of trade with all countries but not the relative composition of bilateral trade, so that their impact is captured in the time fixed effects θ_t. This assumption is important to increase the power of the estimation, but not crucial for the qualitative results.[7]

The results obtained using OLS are reported in Table 2. Using only country *j* fixed effects (column 1) there is a negative coefficient for exchange rate volatility, which indicates that this volatility reduces trade. The coefficient, however, is only significant at the 10 percent level and its economic magnitude is small. A 2.3 percent increase in volatility, equivalent to an increase from the 25th to the 75th percentile, reduces trade by only 3 percent. In historical terms, an increase in volatility of this size is similar to the one observed from 2000 to 2001 for the bilateral real exchange rate between the rand and the dollar. Column 2 shows that adding year fixed effects reduces both the size and significance of the coefficient associated with exchange rate volatility. This indicates that the identification in column 1 comes mainly from the time variation of the data, that is, periods in which bilateral trade with most countries declines and the bilateral exchange rates become more volatile. Columns 3 to 6 report regressions that control for the potential influence of outliers. Columns 3 and 4 exhibit similar regressions to columns 1 and 2 after using the Hadi method to exclude outlier observations corresponding to 1 percent of the sample. The coefficients are again negative but none of them is statistically significant, which indicates that observations with unusually large values of the volatility are driving the significance. Columns 5 and 6 use a robust regression procedure to weight the different observations.[8] In this case the coefficients are similar to those in columns 1 and 2, but significant

[7] Results for the post 1990 period (available upon request) exhibit the same patterns described below although most OLS coefficients are not statistically significant, and the IV procedures tend to yield implausible large coefficients because of the weakness of the instruments in this smaller sample.
[8] I obtain the weights using the rreg command in Stata.

at the 10 percent level. This is consistent with the previous findings, since the observations with unusually large values of the volatility are not down-weighted by this procedure.

The small and weak contemporaneous effect of volatility on trade may indicate that volatility takes time to affect trade flows, but Table 3 shows that this is not the case. The regressions reported in this table add the lagged value of volatility to the regressions reported in Table 2 to account for potential delays in the trade effect of volatility. Adding lagged volatility does not increases its overall effect on trade flows and weakens the contemporaneous coefficients.[9]

The direction of causality in the relation between bilateral volatility and trade is a concern because pairs of countries that trade relatively more may take steps to stabilize their bilateral exchange rate. To the extent that this source of reverse causality is purely cross-sectional it should be captured by the country *j* fixed effect (which amounts to a country-pair fixed effect), but this would not be the case if changes in trade flows resulted in increasing attempts for stabilization. The literature has dealt with this concern by using instrumental variables. Three types of instruments have been used. Frankel and Wei (1993) use the volatility of relative money supplies, Del'Ariccia (1999) uses the spread between the forward and spot exchange rates, and Tenreyro (2007) uses an estimated probability of two countries pegging their currencies to the same anchor (among 5 potential anchor currencies). Among these three approaches, only the one used by Frankel and Wei (1993) can be applied to the estimation of equation (5). The instruments used by Del'Ariccia (1999) require information on the forward exchange rates of the currencies of countries under analysis; no such data are available for a comprehensive sample of countries in the case of South Africa (Del'Ariccia (1999) focused on G7 countries). The instrument built by Tenreyro (2007) cannot be used because South Africa is an anchor county. Based on these considerations, I follow the approach of Frankel and Wei (1993) and use the within year standard deviation of the monthly growth of bilateral money supplies to instrument for the volatility of bilateral exchange rates. The results obtained using two stages least squares are reported in Table 4. The various columns of the table show weaker results than under OLS. In fact, the coefficients for the regressions estimated in the whole sample and after dropping outliers using the Hadi method (columns 1 to 4) change signs and become statistically insignificant. These results may be partly due to weak instruments, but they are also consistent with other findings in the literature

[9] Using 2 and 3 year rolling standard deviations as measures of volatility does not change the results importantly.

(see Clark et al. 2004). Lacking better instruments, the hypothesis that the weak negative effect of volatility on trade documented in Table 2 may be due to reverse causality cannot be rejected.

A recent criticism to the estimation of gravity equations has emphasized that they typically exclude zero bilateral trade flows because of the use of a logarithmic transformation of the data. Tenreyro (2007) has shown that this transformation can lead to biases in the coefficients estimated for the parameters of the model because of sample selection and the correlation that may appear between the log of the residuals and other explanatory variables arising from Jensen's inequality. To address these problems Tenreyro (2007) proposes using a Poisson regression to estimate the parameters of the model directly in its exponential form and also shows how to address potential endogeneity concern within this framework. Regressions in Table 5 use these procedures to estimate the parameters of the main specifications. Columns (1) and (2) show the results obtained using simple Poisson regressions with and without year fixed effects, while columns (3) and (4) use the IV procedure. For the reason outlined above, this estimation uses Frankel and Wei (1993)'s instruments instead of Tenreyro (2007)'s. The coefficients obtained using Poisson regressions are larger than those estimated through traditional methods but still imply a quantitatively small effect of exchange rate volatility on trade, especially when including year fixed effects.

Following the gravity equation literature, the previous regressions estimated the impact of exchange rate volatility on bilateral trade flows (the average of exports and imports to and from each country in a given pair). This departs from the approach taken in section 5.2 that followed the time series literature and examined the impact of exchange rate volatility on exports. To ease comparison Tables 6 and 7 report OLS and IV regressions estimating the parameters of the gravity model using (log) real exports from South Africa to country *j* as the dependent variable. The results are very similar to those reported for the case of bilateral trade flows. The OLS regressions report a negative coefficient for the impact of exchange rate volatility on exports that is marginally significant when using only country fixed effects, and typically insignificant when year fixed effects are added. The coefficient is also similar to the one reported for total trade and economically small. The IV regressions in the whole sample and dropping outliers reverse the sign of the main coefficient and those using robust regression weights become statistically insignificant. Results obtained applying Poisson regression methods to the export gravity equations are similar to those obtained with traditional methods (not reported).

4.4 Exchange rate volatility and trade in South Africa: Where do we stand?

The evidence can be summarized as follows: time series regressions tend to suggest a weakly positive relation between aggregate real exchange rate volatility and exports. The estimation of cointegration equations indicates a positive long run relation between these variables and the short run dynamics in the error correction and standard ARDL models also tend to produce some significantly positive coefficients. Despite its long tradition, the time-series approach suffers from several problems, mainly the lack of structural foundations of the estimated relations and the clear potential for endogeneity. For these reasons, the most recent literature has turned to the gravity model as a benchmark on which to estimate the trade effects of exchange rate volatility. The existing results for broad samples of countries are contradictory and tend to indicate either the absence or the presence of economically small effects of exchange rate volatility on trade. Estimating the relation for the specific case of South Africa yields similar patterns to those obtained in the broad literature and document at most an economically small negative effect of volatility on trade, which seems to be inflated by the presence of endogeneity. Taking stock, the evidence does not support the presence of a strong, first-order aggregate trade-reducing impact of exchange rate volatility in South Africa.

5. WHO CARES ABOUT EXCHANGE RATE VOLATILITY? EVIDENCE FROM INVESTMENT CLIMATE SURVEYS

Although the evidence on the impact of exchange rate volatility on South African trade flows does not reveal and important negative relation, some firms in particular sectors may be specially affected by it. The theoretical and empirical literature discussed in section 3 indicates that exchange rate volatility should be mainly a concern for firms that are linked to international markets and therefore exposed to currency risk. It also suggests that other firm characteristics, such as whether the firm belongs to a multinational, is financially constrained, or produces differentiated goods could determine the disruption that the volatility causes on its activity. Properly testing this hypothesis would require analyzing sectoral trade flows and goes beyond the scope of this paper, but I next provide some circumstantial evidence in its favor based on the analysis of the responses of South African firms to the World Bank's Investment Climate Survey.

The World Bank (2007) Investment Climate Assessment for South Africa documented that a large fraction of exporter firms lists macroeconomic volatility as a major obstacle to its operations. I further use the Investment Climate Survey data for South Africa to test whether firms that report the highest concern about macroeconomic stability are those the theory predicts to be more exposed to exchange rate risk by estimating the relation between a firm's concern with macroeconomic stability and variables capturing the degree of exchange risk. The benchmark specification, estimated by OLS, is the following:

$$Obstacle_i = \alpha_0 + \alpha_1 Size_i + \alpha_2 Multinational_i + \alpha_4 Export_i + \alpha_5 Imports_i + \alpha_6 External\ Dependence_i + \alpha_7 Homogeneous_i + \varepsilon_i \quad (6)$$

where *Obstacle* is the reported value of the degree to which macroeconomic volatility is perceived as an obstacle by a firm (ranging from 0 = no obstacle, to 4 = severe obstacle), *Size* is a firm's assets (in billions of Rands), *Multinational* is a dummy variable that takes the value 1 for a firm that is part of a multinational corporation (and zero otherwise), *Exports* is the fraction of a firm's sales that are exported either directly or indirectly, *Imports* is the fraction of a firm's inputs that are imported directly or indirectly, *External Dependence* is the external dependence of the 3-digit ISIC (revision 2) industry to which a firm belongs according to Rajan and Zingales (1998), and *Homogeneous* is a measure of whether the industry to which a firm belongs produces homogeneous or differentiated products according to Rauch (1999), finally ε is an error term that in some specifications contains an industry fixed effect. This specification exploits the increasing relation between the value of the left hand side variable and the degree of concern reported by a firm and just models the conditional mean of a firm's reported degree of concern with macroeconomic stability.[10] To capture the theoretical view that firm's characteristics such as the degree of financial constraints or the type of product should be especially important for firms that trade in international markets (those with high exports or imports), and that, for a given level of exports, a larger fraction of imported inputs offers a natural hedge against exchange rate fluctuations, I added a series of interaction terms between the main variables to this benchmark specification.

Finally, since the left hand side variable takes discrete values I also directly model the probability of a firm reporting that macroeconomic stability is a major concern as a function of the same determinants of equation (6) and estimate the parameters of the model using and ordered logit model that exploits the whole variation of answers (ranging from 0 to 4), and a standard bivariate logit specification that groups the answers given by firms in two groups depending on whether there is or not an important degree of concern for macroeconomic stability (answers with values 3 and 4 versus the rest).[11] For the simple bivariate logit model I also estimate the role of

[10] A recent paper by Clarke et al. (2007) estimates a similar specification and reaches analogous conclusions.

[11] I classify these answers as indicating a major degree of concern based on the wording of the questionnaire and on the results of the ordered logit model that indicate a clear difference in the marginal effects associated with those answers against the rest. As the results will show, this simple specification

interactions among variables but restrict the set of interactions to include only the one between the level of imports and exports because of the model's complexity.[12]

The results of the estimation of the benchmark specification (eq. [6]), reported in Table 8, indicate that larger firms are less concerned about macroeconomic stability. The coefficient associated with a firm's level of assets is negatively significant in the baseline specification (column 1) and in the specification including industry fixed effects (column 2). This sign is consistent with theory to the extent that the level of assets captures the ability of a firm to hedge and diversify risks. This is likely to be the case because larger firms are probably less financially constrained.

The regressions also indicate that a higher exposure to exchange rate risk resulting from a higher level of exports or from the use of imported inputs significantly increases a firm's concern with macroeconomic volatility. However, neither a firm's industry degree of external dependence nor the extent to which it produces differentiated goods seems to have any direct influence on its concern with macroeconomic volatility (see column 1, in column 2 these measures that are constant for a given industry are absorbed by the fixed effect).[13] Finally, and somewhat surprising, firms with operations in other countries seem to be more concerned with macroeconomic volatility than purely domestic firms. This coefficient, however, becomes insignificant when controlling for industry fixed effects, so it may just be capturing differences across industries.

Table 9 reports the results for the regressions that add interaction terms among the main variables to the baseline specification. The results confirm that firms with higher levels of exports or imported inputs are significantly more concerned with macro volatility. Interestingly, all regressions consistently show that the interaction term between a firm's level of exports and imported inputs is significantly negative. This means that, for a given level of exports, an increase in a firm's use of imported inputs reduces its concern with macro volatility and is consistent with the idea that the use of imported inputs provides exporting firms with a natural hedge against exchange rate fluctuations.

The coefficients associated with a firm's size and multinational operations are similar to those reported in the baseline specification. These regressions also suggest that adding interaction

yields the same qualitative results as the ordered model but the interpretation of its marginal effects is simpler.

[12] Results obtained using Probit models are similar. The focus on logit models is motivated by the possibility of incorporating industry fixed effects in this setting.

[13] Similar results are obtained using sales instead of assets as a proxy for a firm's size.

effects uncovers a role for external dependence and product homogeneity. When interactions are added, the coefficient for external dependence becomes positive, indicating that more dependent industries are more concerned with macro stability and that this effect is weaker among importing firms. In the case of the measure of product homogeneity the results indicate that the concern about macro volatility is weaker among importing firms producing homogeneous goods but there is no significant coefficient associated with firms exporting homogeneous goods, as expected from theory. These results are suggestive, but must be taken with caution because of the lack of mean effect observed in Table 8 and the noise in these variables resulting from translating them from their original industrial classification (ISIC Rev 2 and SITC) to the classification used in the survey.

Overall, the robust pattern of the data is the relation between participation in international markets and concern for macro volatility, and the natural hedge associated with the use of imported inputs by exporting firms.

The logit estimation produces similar conclusions to the linear model. The results of this estimation are reported in Table 10, which reports the coefficients estimated for the various models.[14] The first column presents the ordered logit regression replicating the baseline specification and shows that an increase in a firm's assets reduces the probability that a firm is concerned with volatility. A ten million dollar increase in total assets reduces the probability of reporting concern with the macroeconomic environment in 1 percent. On the other hand, the existence of multinational operations and the participation in international markets as an exporter or importer increase this probability. The external dependence or the homogeneity of the goods produced by a firm's industry does not seem to affect the probability of reporting macroeconomic volatility as a major concern. Similar results are reported in column 2, which presents the coefficients of the simple bivariate logit model. Column 3 shows that the introduction of industry fixed effects weakens importantly the relevance of size and multinational operations (as in the benchmark case) but not the relevance of the variables associated with the participation in international markets. It is well known that the logit model has non-linearities embedded in its structure, thus, in principle it is not necessary to include interaction terms in the linear component of the model. However, not including interaction terms leaves the cross derivatives completely driven by the model's structure and can yield incorrect results. This can be seen at the bottom of column 2, which reports the cross derivative of the probability function with respect to total

[14] The marginal effects associated with these coefficients are available upon request. They are not reported because the ordered logit estimation has four different marginal effects associated with the probabilities of each of the possible states.

exports and imported inputs evaluated at the means (marginal effect). The estimated cross-derivative is positive and statistically significant. In contrast, column 4 explicitly includes the cross-derivative in the linear structure of the model. It can be seen that the coefficient on the cross-derivative is negatively significant. Moreover, the cross-derivative of the probability function (the derivative of the marginal effect of Total exports with respect to total imports) properly computed (i.e. incorporating all the terms) is negatively significant when evaluated at the means.[15] Since the model estimated in column 4 embeds the one in column 2, the estimation of the cross-derivative produced by the former is the one that should be considered. The evidence thus indicates that the use of imported inputs by exporting firms reduces the probability of being concerned about macro volatility. The probability of reporting macroeconomic volatility as a major concern is 9 percent larger for a firm that exports 30 percent than for a firm that exports only 10 percent of its output when both import 20 percent of their inputs (the average level of imports), but only 6 percent when they import 35 percent of their inputs (the 75th percentile of imports).

In summary, the analysis of South African firms' responses to the question of whether macroeconomic stability is an obstacle for growth indicates that firms with higher exposure to exchange rate risk because of their participation in international markets as exporters or importers of inputs are those most concerned with macroeconomic volatility, and that the simultaneous participation of a firm as exporter and imported reduces its concerns, which is consistent with the fact that this simultaneous exposure provides the firm with some natural hedge. These results are consistent with some of the theories that link the nature of firms with their sensitivity to exchange rate volatility.

There are two issues that deserve some further discussion before proceeding. The first is that the Investment Climate Survey records the firm's perceptions about the importance of a given type of problem. It is well known that these types of data are subject to perception bias and do not necessarily provide comparable information across units. For example, it may well be the case that macroeconomic instability is a bigger problem for domestic than multinational firms in terms of the distortion of production, but that domestic firms also face other more pressing problems that do not affect multinationals (for instance, lack of human capital) that leads them to assign lower importance to macro instability than multinational firms. This type of potential bias should be considered when dealing with perception data. However, except for the coefficients obtained for multinationals (which can be rationalized) the results reported above conform to

[15] The cross-derivative is also negatively significant in most of the sample.

theoretical expectations and are reassuring that the problem of perception data is probably not a major concern for this particular question. The second issue is more idiosyncratic and has to do with the timing of the survey. The ICS was performed in South Africa in 2003 just after the spike in exchange rate volatility the country experienced during 2001-2002. This may have clearly lead firms to give more weight to macro volatility than what could be justified by the relevance that it has for their operations in normal times. Finally, the ICS question asks firms about macroeconomic instability in general, including inflation and exchange rates. So it is impossible to tell whether the answer given by firms reflects their concern about inflation or exchange rate volatility, both of which were high around the time of the survey. However, the findings that firms that are a-priori more exposed to exchange rate risk seem to be more concerned about macro volatility suggests that they are probably reacting to exchange rate volatility. Also, firms that participate in external markets are probably concerned about real exchange rate volatility, so the separation between inflation and currency risk is probably artificial, as both types of risks would affect their operations.

6. DEALING WITH EXCHANGE RATE VOLATILITY

The existing evidence for broad samples of countries and the evidence reported in this paper for the case of South Africa do not support the hypothesis that exchange rate volatility has an unambiguous first order negative impact on South Africa's aggregate trade. From this perspective, the existing evidence does not provide support for policy action.

This conclusion, however, assumes that the only reason to worry about exchange rate volatility is its impact on aggregate trade flows. This may nott be the case for at least two reasons. First, exchange rate volatility may affect production of non-tradable firms if they borrow in foreign currency and therefore manifest in other dimensions of real activity beyond trade flows. Second, since this paper has not looked at disaggregated data, it may still be the case that exchange rate volatility has a detrimental effect for some types of firms.

Considering the lack of aggregate consequences, further evidence for the presence of distributional effects would be required to justify any form of intervention. The results on the degree of concern with macroeconomic volatility of different firms obtained from the Investment Climate Surveys provide some circumstantial evidence that these types of heterogeneous effects could be present but require further support and are silent on whether firms have appropriate access to hedging instruments. With these caveats in mind, the rest of this section discuss some possible lines for further research and policy action that can inform and help deal with the distributive consequences of exchange rate risk.

Since the consequences of exchange rate volatility are intimately tied to the exposure to currency risk, policies aimed to facilitate the hedging of such risk are the appropriate response. South Africa seems to be at an advantage with respect to other emerging economies in this regard because of the degree of development of its markets for foreign exchange derivatives. As mentioned in Section 2, the turnover of the South African derivatives market is similar to the turnover of its foreign exchange market, which indicates that at least in terms of volume there are ample possibilities for hedging currency risks. Also, in addition to the forwards and swaps typically available OTC in emerging markets, the Johannesburg Stock Exchange recently created a market for foreign exchange futures, where maturities ranging up to a year that are regularly traded. Although there is no available information on the maturities of the OTC instruments, they tend to be longer than those of standard products, so hedging opportunities for maturities beyond a year are probably available in the market.

With these considerations, the immediate question is whether there is a role for the government in easing access to hedging instruments. The magnitudes discussed above suggest that in terms of size, the supply of foreign exchange derivatives by private markets (banks and stock exchanges) seems to be adequate, although of course this merits serious further quantification.[16] It is, however, particularly important to gather further information on the characteristics of this supply to determine whether it is appropriate in terms of its distribution of risk and maturity. Regulatory restrictions to the participation in foreign exchange derivatives only to firms with real hedging needs (i.e. mainly importers and exporters) tend to increase the difficulty of finding counterparts to OTC contracts and may end up with banks absorbing part of the currency risk. Also, the maturities observed in futures markets seem appropriate to deal with short run fluctuations in exchange rate affecting the domestic value of invoices but not with persistent appreciations that may jeopardize the survival of a financially constrained firm, as highlighted by Caballero and Lorenzoni (2007). Keeping in mind that long term currency derivative contracts are uncommon even in financially developed markets, further understanding the maturities that are required for firms exposed to exchange risk, determining the extent to which they are offered by financial institutions, and whether there is any excessive tilt towards the short term are necessary steps before determining whether intervention by the government or international financial institutions is required.

[16] Our conjecture comes from the similarity of the turnover in foreign exchange markets and foreign exchange derivatives.

Another aspect that requires further analysis to inform policy is determining who is on the demand side of the derivatives markets, whether it is domestic firms or foreign portfolio investors exposed to exchange rate risk. If domestic exporters/importers are found not to be hedging their currency risk it is important to determine whether it is for lack of information (financial literacy), access to credit, or expectations of potential bailouts in the form of exchange rate interventions.

A final aspect that relates to the impact of exchange rate volatility is the degree of currency mismatches among non-tradable firms resulting from lack of appropriate access to credit in domestic currency in appropriate maturities. However, liability dollarization does not seem to be pervasive in South Africa. The average level of dollarization for the period 1991-2004 was only 2.3 percent, much lower than countries with similar levels of per-capita income such as Costa Rica and Argentina (39 and 45 percent, respectively).[17] Thus, there seems to be little scope for concern or action in this dimension.

In summary, South Africa is nowadays an economy that is open to trade and capital flows, with a floating exchange rate, and inserted and dependent on international markets. For such an economy, exchange rate volatility is unavoidable and has some important benefits in reducing the real consequences of terms of trade shocks.[18] Considering the evidence on the impact of this volatility on aggregate trade presented in this paper, a strong policy action aimed to reduce this volatility seems unjustified. However, gathering information to asses the availability and adequacy of hedging options for South African firms exposed to currency risk and, if necessary, taking measures to improve their access to hedging by further fostering the development of the foreign exchange derivatives market and the availability of credit in local currency of appropriate size and maturities are important steps to help South African firms deal with exchange rate risk. Further research on the distributional consequences of the volatility and the characteristics of the supply and demand of the derivative market in South Africa would be required to provide more precise guidance for these policies.

7. CONCLUDING REMARKS

Motivated by the increasing exchange rate volatility observed in South Africa in recent years and the concerns that this volatility has raised among policymakers and firms, this paper has investigated whether there is evidence that exchange rate volatility has a negative impact on trade and exports. Using both time series analysis and gravity equations, I find no robust evidence of a

[17] See Cowan, Levi-Yeyati, and Sturzenegger (2006).
[18] See Broda (2004).

strong, first-order trade-reducing impact of volatility on aggregate exports and bilateral trade flows. Thus, the evidence on the aggregate consequences of this volatility does not offer support for strong policy actions. The limited scope of the paper, however, does not allow me to dismiss the possibility that some particular types of exporting firms could be importantly affected by exchange rate volatility as a result of limited possibilities of hedging currency risk. If this were the case, policy options targeted towards facilitating access to hedge instruments for these particular groups, along the lines of fostering the supply of hedging instruments of appropriate maturities, would be appropriate.

These findings highlight several avenues for further research. First, the reduced impact of exchange rate volatility on aggregate trade flows indicates that a detailed analysis at the disaggregated level of the distributional impact of exchange rate volatility for different types of firms and sectors is necessary to assess whether particular industries or groups of firms are being specially affected by exchange rate risk and provide more precise guidance for the targeting of policies. Second, gathering detailed information on the characteristics of the supply and demand of financial instruments for hedging exchange rate risk is crucial to determine whether firms are constrained in their access to appropriate risk mitigation and left excessively exposed to exchange rate fluctuations. A detailed analysis of the amounts and types of instruments available both in the market and over the counter is a required first step, and a firm survey of usage of hedging instruments like the one implemented by the Australian Bureau of Statistics would be an important tool to assess the dimensions where the access of firms to forex markets could be strengthened.

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Table 1
Real Exports and Exchange Rate Volatility. Time-Series Evidence

The results of the cointegration relations and the short run dynamics are reported in Panel A and B, respectively. Columns (1) and (3) report the coefficients for the cointegration equations, and Columns (2), (4), and (5) report the coefficients of ARDL specifications without error correction. The dependent variable is the change in (log) real exports. In Panel A, *REER* is the real effective exchange rate built in such a way that an increase indicates an appreciation, *Y** is the index of economic activity in the U.S., *Y* is South Africa index of economic activity, and *SDREER1* is the volatility of the real effective exchange rate corresponding to the one-year rolling standard deviation of the monthly growth of the real effective exchange rate in Column (1) and to the ARCH(1,1) estimate in Column (3). In Panel B, Δ*REER* is the change in the log real effective exchange rate built in such a way that an increase indicates an appreciation, Δ*Y** is the change in the index of economic activity in the U.S., Δ*Y* is the change in South Africa's index of economic activity, and Δ*SDREER1* is the change in the volatility of the real effective exchange rate corresponding to the one-year rolling standard deviation of the monthly growth of the real effective exchange rate in Columns (1) and (3), and to the ARCH(1,1) estimate in Columns (2), (4), and (5). In Column (5) the measure of volatility is included in levels but is reported in the same rows as the measures in differences for reasons of space. Standard errors reported in parentheses. *, ** denote significance at 10 and 5 percent, respectively.

Panel A Cointegration Equation

	(1)	(2)	(3)	(4)	(5)
REER	-0.055	--	-0.171	--	--
	(0.225)		(0.200)		
Y*	0.384	--	0.218	--	--
	(0.301)		(0.270)		
Y	0.550	--	0.715*	--	--
	(0.411)		(0.372)		
SDREER1	6.307***	--	5.548***	--	--
	(1.459)		(1.164)		
Constant	14.712	--	15.225	--	--

Panel B Short Run Dynamics

	(1)	(2)	(3)	(4)	(5)
Cointegration equation	-0.098**	--	-0.125***	--	--
	(0.045)		(0.043)		
ΔEXP(-1)	-0.608***	-0.727***	-0.597***	-0.732***	-0.726***
	(0.067)	(0.055)	(0.065)	(0.055)	(0.055)
ΔEXP(-2)	-0.419***	-0.503***	-0.420***	-0.520***	-0.514***
	(0.077)	(0.069)	(0.074)	(0.067)	(0.067)
ΔEXP(-3)	-0.165**	-0.236***	-0.149*	-0.241***	-0.239***
	(0.079)	(0.073)	(0.076)	(0.072)	(0.072)
ΔEXP(-4)	-0.155**	-0.212***	-0.139*	-0.217***	-0.211***
	(0.078)	(0.071)	(0.076)	(0.071)	(0.071)
ΔEXP(-5)	-0.067	-0.085	-0.069	-0.096	-0.093
	(0.070)	(0.066)	(0.070)	(0.066)	(0.066)
ΔEXP(-6)	-0.041	-0.062	-0.051	-0.075	-0.076
	(0.056)	(0.054)	(0.056)	(0.054)	(0.054)

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Table 1

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	(1)	(2)	(3)	(4)	(5)
ΔREER	--	-0.627***	--	-0.610***	-0.601***
		(0.167)		(0.168)	(0.168)
ΔREER(-1)	-0.332*	-0.153	-0.359**	-0.224	-0.228
	(0.175)	(0.175)	(0.175)	(0.173)	(0.173)
ΔREER(-2)	-0.505***	-0.431***	-0.513***	-0.483***	-0.489***
	(0.179)	(0.174)	(0.177)	(0.175)	(0.175)
ΔREER(-3)	-0.016	-0.094	0.034	-0.080	-0.078
	(0.180)	(0.175)	(0.182)	(0.178)	(0.177)
ΔREER(-4)	0.100	0.095	0.107	0.073	0.132
	(0.179)	(0.174)	(0.181)	(0.177)	(0.172)
ΔREER(-5)	0.135	0.095	0.090	0.029	0.014
	(0.179)	(0.175)	(0.176)	(0.171)	(0.169)
ΔREER(-6)	0.280	0.230	0.323*	0.202	0.202
	(0.175)	(0.170)	(0.168)	(0.165)	(0.165)
ΔY*	--	0.141	--	0.272	0.238
		(0.306)		(0.307)	(0.306)
ΔY*(-1)	0.748**	1.013***	0.779**	1.163***	1.126***
	(0.321)	(0.339)	(0.319)	(0.338)	(0.337)
ΔY*(-2)	0.831**	1.002***	0.842**	1.101***	1.088***
	(0.367)	(0.353)	(0.364)	(0.353)	(0.352)
ΔY*(-3)	-0.837**	-0.583	-0.851**	-0.572	-0.562
	(0.382)	(0.357)	(0.375)	(0.357)	(0.357)
ΔY*(-4)	-0.577	-0.477	-0.627*	-0.533	-0.541
	(0.378)	(0.356)	(0.371)	(0.355)	(0.355)
ΔY*(-5)	-0.766**	-0.592*	-0.802**	-0.641*	-0.704**
	(0.368)	(0.346)	(0.363)	(0.348)	(0.344)
ΔY*(-6)	-0.194	-0.174	-0.173	-0.161	-0.216
	(0.323)	(0.311)	(0.321)	(0.313)	(0.310)
ΔY	--	0.993***	--	1.043***	1.023***
		(0.252)		(0.249)	(0.248)
ΔY(-1)	-0.156	0.295	-0.180	0.321	0.294
	(0.264)	(0.287)	(0.261)	(0.282)	(0.281)
ΔY(-2)	0.521*	0.575**	0.421	0.491*	0.495*
	(0.296)	(0.289)	(0.291)	(0.285)	(0.285)
ΔY(-3)	0.507*	0.396	0.416	0.259	0.280
	(0.299)	(0.289)	(0.297)	(0.289)	(0.288)
ΔY(-4)	0.252	0.256	0.315	0.249	0.241
	(0.301)	(0.290)	(0.298)	(0.288)	(0.287)
ΔY(-5)	0.395	0.288	0.533*	0.424	0.419
	(0.301)	(0.288)	(0.294)	(0.286)	(0.286)
ΔY(-6)	0.467*	0.240	0.536**	0.351	0.382
	(0.264)	(0.256)	(0.261)	(0.254)	(0.253)
ΔSDREER1	--	0.830	--	-0.182	-0.092
		(0.995)		(0.350)	(0.356)
ΔSDREER1(-1)	-1.266	-0.389	-0.395	0.033	0.172
	(1.035)	(1.004)	(0.399)	(0.348)	(0.502)
ΔSDREER1(-2)	-0.217	-0.495	-0.147	0.164	0.198
	(1.030)	(0.998)	(0.394)	(0.413)	(0.557)
ΔSDREER1(-3)	1.909*	2.017**	0.076	0.458	0.175
	(1.028)	(0.986)	(0.436)	(0.410)	(0.563)
ΔSDREER1(-4)	1.765*	2.221**	0.237	0.540	0.114
	(1.030)	(0.990)	(0.426)	(0.405)	(0.539)
ΔSDREER1(-5)	-0.394	0.347	0.588*	0.778**	0.335
	(1.023)	(0.992)	(0.343)	(0.333)	(0.477)
ΔSDREER1(-6)	0.405	0.210	-0.155	0.209	-0.733**
	(1.010)	(0.981)	(0.351)	(0.339)	(0.337)
Constant	0.006	0.002	0.006	0.002	-0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.010)
R-squared	0.44	0.48	0.45	0.48	0.48
Adj. R-squared	0.39	0.42	0.40	0.43	0.43
Log likelihood	332.32	345.78	336.14	348.42	348.99

Table 1B

Real Exports and Exchange Rate Volatility. Time-Series Evidence for 1990-2007 and 1995-2007

The results of the cointegration relations and the short run dynamics associated with real exchange rate volatility are reported in Panel A and B, respectively. Columns (1) and (3) report the coefficients for the cointegration equations for the two measures of real exchange rate volatility during the period 1990-2007, and Columns (2) and (4) report analogous results for the period 1995-2007. The dependent variable is the change in (log) real exports. In Panel A, *REER* is the real effective exchange rate built in such a way that an increase indicates an appreciation, *Y** is the index of economic activity in the U.S., *Y* is South Africa index of economic activity, and *SDREER1* is the volatility of the real effective exchange rate corresponding to the one-year rolling standard deviation of the monthly growth of the real effective exchange rate in Columns (1) and (3) and to the GARCH(1,1) estimate in Columns (2) and (4). Standard errors reported in parentheses. *, ** denote significance at 10 and 5 percent, respectively.

Panel A: Cointegration Equation

	(1)	(2)	(3)	(4)
LOGREER(-1)	0.659	0.071	-0.549	-0.466
	(0.380)*	(0.219)	(0.054)***	(0.064)***
LOGIIP(-1)	-0.070	0.248	0.296	0.325
	(0.616)	(0.355)	(0.110)***	(0.126)***
LOGLIPI(-1)	0.287	1.249	2.288	2.166
	(0.908)	(0.531)**	(0.135)***	(0.168)***
SD_DLOGREER12(-1)	25.131	11.343	-1.519	0.272
	(5.077)***	(3.220)***	(0.716)**	(1.113)
Constant	-14.085	-11.357	9.592	9.584

Panel B: Short Run Dynamics

	(1)	(3)	(2)	(4)
Cointegration Equation	-0.007	-0.115	-0.984	-0.473
	(0.042)	(0.077)	(0.271)***	(0.246)*
D(SD_DLOGREER12(-1))	0.047	-2.058	1.181	-1.499
	(2.318)	(1.067)*	(2.206)	(0.939)
D(SD_DLOGREER12(-2))	-2.787	-0.110	-0.702	0.331
	(2.329)	(1.122)	(2.275)	(0.947)
D(SD_DLOGREER12(-3))	-0.136	-1.705	0.929	-1.838
	(2.317)	(1.153)	(2.250)	(1.123)
D(SD_DLOGREER12(-4))	-0.381	1.093	0.355	1.469
	(2.323)	(1.161)	(2.242)	(1.133)
D(SD_DLOGREER12(-5))	-0.599	0.393	0.909	0.299
	(2.273)	(0.932)	(2.215)	(0.918)
D(SD_DLOGREER12(-6))	1.620	1.397	3.212	1.750
	(2.251)	(0.797)*	(2.231)	(0.858)**
Constant	0.004	0.006	0.005	0.004
	(0.011)	(0.010)	(0.012)	(0.012)
R-squared	0.50	0.53	0.64	0.62
Adj. R-squared	0.40	0.44	0.53	0.51
Log likelihood	168.97	179.43	126.65	127.84

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2
Gravity equation. Bilateral Trade and Exchange Rate Volatility. OLS regressions

The dependent variable is the log real bilateral trade between South Africa and other countries in each year. *GDP* is the log of the product of real GDP of South Africa and each trading partner, *GDP per capita* (*GDPPC*) is the log product of real GDP per capita of South Africa and each trading partner, *Volatility of bilateral exchange rate* (*SDREX)* is the within year standard deviation of the growth of the bilateral exchange rate between South Africa and trading partner, *Both countries in GATT* is a dummy variable that takes the value 1 if a trading partner was member of GATT at the same time as South Africa. All columns include trading partner fixed effects (effectively a country pair fixed effect), and columns (2), (4), and (6) also add year fixed effects. Columns (1) and (2) report regressions for the whole sample. Columns (3) and (4) report results after dropping the 1 percent of the sample with the highest distances obtained using the multivariate Hadi method. Columns (5) and (6) report weighted OLS regressions where the weights were determined using Stata's robust regression procedure.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
GDP (*GDP*)	2.372***	5.029***	2.376***	5.119***	1.738***	4.136***
	(0.197)	(0.610)	(0.199)	(0.613)	(0.130)	(0.443)
GDP per capita (*GDPPC*)	-2.599***	-4.505***	-2.600***	-4.554***	-1.666***	-3.452***
	(0.381)	(0.580)	(0.388)	(0.585)	(0.254)	(0.389)
Volatility of bilateral exchange rate (*SDREX*)	-1.496*	-1.087	-1.174	-0.924	-1.521**	-1.113*
	(0.825)	(0.857)	(1.424)	(1.676)	(0.625)	(0.675)
Both countries in GATT	-0.430*	-0.648***	-0.417*	-0.636***	-0.366***	-0.528***
	(0.245)	(0.242)	(0.249)	(0.246)	(0.121)	(0.129)
Constant	-30.794***	-93.081***	-30.890***	-95.452***	-23.404***	-78.862***
	(3.803)	(13.812)	(3.816)	(13.917)	(3.024)	(10.620)
Observations	2098	2098	2077	2077	2077	2077
R-squared	0.77	0.79	0.77	0.79	0.86	0.87
Year FE	--	YES	--	YES	--	YES

Table 3
Gravity equation. Bilateral Trade and Exchange Rate Volatility. Adding Lagged Volatility

The dependent variable is the log real bilateral trade between South Africa and other countries in each year. *GDP* is the log of the product of real GDP of South Africa and each trading partner, *GDP per capita* (*GDPPC*) is the log product of real GDP per capita of South Africa and each trading partner, *Volatility of bilateral exchange rate* (*SDREX)* is the within year standard deviation of the growth of the bilateral exchange rate between South Africa and trading partner, *Both countries in GATT* is a dummy variable that takes the value 1 if a trading partner was member of GATT at the same time as South Africa, and *Volatility of bilateral exchange rate(-1)* is the lagged variable of *SDREX*. All columns include trading partner fixed effects (effectively a country pair fixed effect), and Columns (2), (4), and (6) also add year fixed effects. Columns (1) and (2) report regressions for the whole sample. Columns (3) and (4) report results after dropping the 1 percent of the sample with the highest distances obtained using the multivariate Hadi method. Columns (5) and (6) report weighted OLS regressions where the weights were determined using Stata's robust regression procedure.

*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
GDP (*GDP)*	2.079***	4.377***	2.095***	4.378***	1.481***	3.837***
	(0.197)	(0.634)	(0.198)	(0.634)	(0.141)	(0.497)
GDP per capita (*GDPPC*)	-2.226***	-3.922***	-2.291***	-3.944***	-1.239***	-3.036***
	(0.406)	(0.589)	(0.415)	(0.589)	(0.295)	(0.434)
Volatility of bilateral exchange rate (*SDREX*)	-1.325	-0.947	-1.310	-0.852	-1.356*	-0.958
	(0.876)	(0.914)	(1.345)	(1.594)	(0.695)	(0.755)
Both countries in GATT	-0.529***	-0.665***	-0.520***	-0.653***	-0.233*	-0.377***
	(0.158)	(0.170)	(0.160)	(0.172)	(0.130)	(0.139)
Volatility of bilateral exchange rate(-1)	-0.664	0.072	-0.757	0.090	-0.736	-0.141
	(0.618)	(0.656)	(0.718)	(0.795)	(0.494)	(0.561)
Constant	-26.234***	-79.917***	-25.683***	-79.593***	-21.409***	-78.208***
	(4.101)	(14.950)	(4.140)	(15.071)	(3.376)	(12.673)
Observations	1876	1876	1861	1861	1864	1864
R-squared	0.81	0.83	0.81	0.83	0.87	0.88
Year FE	--	YES	--	YES	--	YES

Table 4
Gravity equation. Bilateral Trade and Exchange Rate Volatility. 2SLS regressions

The dependent variable is the log real bilateral trade between South Africa and other countries in each year. *GDP* is the log of the product of real GDP of South Africa and each trading partner, *GDP per capita* (*GDPPC*) is the log product of real GDP per capita of South Africa and each trading partner, *Volatility of bilateral exchange rate* (*SDREX)* is the within year standard deviation of the growth of the bilateral exchange rate between South Africa and trading partner, *Both countries in GATT* is a dummy variable that takes the value 1 if a trading partner was member of GATT at the same time as South Africa. A two stage least squares approach is applied for estimation using the within year standard deviation of the monthly growth of bilateral money supplies to instrument for the volatility of bilateral exchange rates. All columns include trading partner fixed effects (effectively a country pair fixed effect), and Columns (2), (4), and (6) also add year fixed effects. Columns (1) and (2) report regressions for the whole sample. Columns (3) and (4) report results after dropping the 1 percent of the sample with the highest distances obtained using the multivariate Hadi method. Columns (5) and (6) report weighted OLS regressions where the weights were determined using Stata's robust regression procedure.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
GDP (*GDP*)	2.540***	4.507***	2.533***	4.567***	1.862***	3.964***
	(0.220)	(0.729)	(0.229)	(0.733)	(0.143)	(0.537)
GDP per capita (*GDPPC*)	-2.638***	-4.040***	-2.464***	-3.997***	-1.669***	-3.275***
	(0.421)	(0.685)	(0.462)	(0.700)	(0.277)	(0.467)
Volatility of bilateral exchange rate (*SDREX*)	1.321	0.816	14.459	8.007	-1.122	-1.765
	(3.331)	(2.265)	(9.819)	(5.907)	(2.779)	(1.931)
Both countries in GATT	-0.490*	-0.707**	-0.352	-0.639**	-0.461***	-0.616***
	(0.296)	(0.286)	(0.316)	(0.293)	(0.149)	(0.152)
Constant	-45.736***	-66.011***	-32.641***	-68.925***	-33.906***	-61.888***
	(5.050)	(13.088)	(4.590)	(13.197)	(3.925)	(10.213)
Observations	1749	1749	1731	1731	1729	1729
R-squared	0.73	0.76	0.71	0.75	0.82	0.84
Year FE	--	YES	--	YES	--	YES

Table 5
Gravity equation. Bilateral Trade and Exchange Rate Volatility. Poisson regressions

The dependent variable is the log real bilateral trade between South Africa and other countries in each year. *GDP* is the log of the product of real GDP of South Africa and each trading partner, *GDP per capita* (*GDPPC*) is the log product of real GDP per capita of South Africa and each trading partner, *Volatility of bilateral exchange rate* (*SDREX)* is the within year standard deviation of the growth of the bilateral exchange rate between South Africa and trading partner, *Both countries in GATT* is a dummy variable that takes the value 1 if a trading partner was member of GATT at the same time as South Africa. A two stage least squares approach is applied for estimation using the within year standard deviation of the monthly growth of bilateral money supplies to instrument for the volatility of bilateral exchange rates. All columns include trading partner fixed effects (effectively a country pair fixed effect), and Columns (2), (4), and (6) also add year fixed effects. Columns (1) and (2) report the results of standard Poisson regressions, while Columns (3) and (4) report results obtained after instrumenting the volatility of bilateral real exchange rate with the volatility of relative money supplies.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	Poisson Regression		IV Poisson Regression	
	(1)	(2)	(3)	(4)
GDP (*GDP)*	1.284***	2.947***	1.518***	3.791***
	(0.100)	(0.237)	(0.104)	(0.321)
GDP per capita (*GDPPC*)	-1.044***	-2.242***	-0.955***	-2.989***
	(0.199)	(0.248)	(0.212)	(0.355)
Volatility of bilateral exchange rate (*SDREX*)	-2.062***	-1.767***	-4.593***	-1.250
	(0.478)	(0.602)	(1.010)	(3.305)
Both countries in GATT	0.245***	0.120	0.467**	-0.115
	(0.091)	(0.093)	(0.204)	(0.215)
Constant	-12.646***	-58.608***	-23.329***	-56.661***
	(1.762)	(6.056)	(2.206)	(5.345)
Observations	2107	2107	2037	1757
Year FE	--	YES	--	YES

Table 6
Gravity equation. Bilateral Exports and Exchange Rate Volatility. OLS regressions

The dependent variable is the log real exports from South Africa to other countries in each year. *GDP* is the log of the product of real GDP of South Africa and each trading partner, *GDP per capita* (*GDPPC*) is the log product of real GDP per capita of South Africa and each trading partner, *Volatility of bilateral exchange rate* (*SDREX)* is the within year standard deviation of the growth of the bilateral exchange rate between South Africa and trading partner, *Both countries in GATT* is a dummy variable that takes the value 1 if a trading partner was member of GATT at the same time as South Africa. All columns include trading partner fixed effects (effectively a country pair fixed effect), and columns (2), (4), and (6) also add year fixed effects. Columns (1) and (2) report regressions for the whole sample. Columns (3) and (4) report results after dropping the 1 percent of the sample with the highest distances obtained using the multivariate Hadi method. Columns (5) and (6) report weighted OLS regressions where the weights were determined using Stata's robust regression procedure.

*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
GDP (*GDP*)	2.214***	5.493***	2.239***	5.593***	1.431***	4.190***
	(0.211)	(0.701)	(0.213)	(0.702)	(0.138)	(0.490)
GDP per capita (*GDPPC*)	-2.364***	-4.778***	-2.422***	-4.862***	-1.116***	-3.181***
	(0.408)	(0.643)	(0.413)	(0.645)	(0.278)	(0.425)
Volatility of bilateral exchange rate (*SDREX*)	-1.672**	-1.282	-2.225*	-1.879	-1.288**	-0.907
	(0.805)	(0.842)	(1.189)	(1.374)	(0.593)	(0.629)
Both countries in GATT	-0.342	-0.569**	-0.345	-0.568**	-0.179	-0.354**
	(0.224)	(0.223)	(0.228)	(0.227)	(0.135)	(0.141)
Constant	-28.944***	-105.203***	-28.809***	-107.282***	-21.728***	-85.609***
	(4.300)	(16.300)	(4.306)	(16.363)	(3.368)	(11.959)
Observations	1992	1992	1974	1974	1979	1979
R-squared	0.77	0.79	0.77	0.79	0.85	0.86
Year FE		YES		YES		YES

Table 7
Gravity equation. Bilateral Exports and Exchange Rate Volatility. 2SLS regressions

The dependent variable is the log real exports from South Africa to other countries in each year. *GDP* is the log of the product of real GDP of South Africa and each trading partner, *GDP per capita* (*GDPPC*) is the log product of real GDP per capita of South Africa and each trading partner, *Volatility of bilateral exchange rate* (*SDREX)* is the within year standard deviation of the growth of the bilateral exchange rate between South Africa and trading partner, *Both countries in GATT* is a dummy variable that takes the value 1 if a trading partner was member of GATT at the same time as South Africa. A two stage least squares approach is applied for estimation using the within year standard deviation of the monthly growth of bilateral money supplies to instrument for the volatility of bilateral exchange rates. All columns include trading partner fixed effects (effectively a country pair fixed effect), and Columns (2), (4), and (6) also add year fixed effects. Columns (1) and (2) report regressions for the whole sample. Columns (3) and (4) report results after dropping the 1 percent of the sample with the highest distances obtained using the multivariate Hadi method. Columns (5) and (6) report weighted OLS regressions where the weights were determined using Stata's robust regression procedure.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
GDP (*GDP*)	2.406***	5.154***	2.389***	5.258***	1.560***	4.080***
	(0.237)	(0.842)	(0.246)	(0.839)	(0.153)	(0.594)
GDP per capita (*GDPPC*)	-2.382***	-4.472***	-2.229***	-4.506***	-1.075***	-3.032***
	(0.459)	(0.766)	(0.520)	(0.781)	(0.312)	(0.514)
Volatility of bilateral exchange rate (*SDREX*)	0.936	0.375	9.487	3.075	-0.356	-1.024
	(3.250)	(2.272)	(9.104)	(5.593)	(2.686)	(1.883)
Both countries in GATT	-0.477*	-0.694***	-0.368	-0.662**	-0.287*	-0.448***
	(0.278)	(0.268)	(0.304)	(0.277)	(0.166)	(0.168)
Constant	-33.431***	-78.932***	-46.825***	-124.242***	-31.671***	-73.828***
	(4.771)	(15.561)	(6.077)	(23.181)	(4.405)	(11.695)
Observations	1655	1655	1638	1638	1642	1642
R-squared	0.73	0.76	0.72	0.76	0.82	0.83
Year FE		YES		YES		YES

Table 8
Concern for Macroeconomic Volatility and Firm Characteristics

The dependent variable is the reported value of the degree to which macroeconomic volatility is perceived as an obstacle by a firm (ranging from 0 = no obstacle, to 4 = severe obstacle), *Size* is firm's assets (in billions of Rands), *External dependence* is the external dependence of the 3-digit ISIC (revision 2) industry to which a firm belongs, *Homogeneous* is a measure of whether the industry to which a firm belongs produces homogeneous or differentiated products, *Multinational* is a dummy variable that takes the value 1 for a firm that is part of a multinational corporation (and zero otherwise), *Export* is the fraction of a firm's sales that are exported, and *Import* is the fraction of a firm's inputs that are imported. Column (2) includes industry fixed effects. Heteroskedasticity robust standard errors reported in parentheses.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)
Size	-0.129***	-0.142*
	(0.038)	(0.077)
External dependence	0.001	--
	(0.262)	--
Homogeneous	0.053	--
	(0.212)	--
Multinational	0.455**	0.345
	(0.182)	(0.214)
Export	1.156***	1.040***
	(0.312)	(0.390)
Import	1.123***	0.911***
	(0.222)	(0.265)
Constant	1.278***	1.368***
	(0.150)	(0.092)
Observations	551	566
R-squared	0.10	0.27

Table 9
Concern for Macroeconomic Volatility and Firm Characteristics. Adding Interaction Effects

The dependent variable is the reported value of the degree to which macroeconomic volatility is perceived as an obstacle by a firm (ranging from 0 = no obstacle, to 4 = severe obstacle), *Size* is firm's assets (in billions of Rands), *External dependence* is the external dependence of the 3-digit ISIC (revision 2) industry to which a firm belongs, *Homogeneous* is a measure of whether the industry to which a firm belongs produces homogeneous or differentiated products, *Multinational* is a dummy variable that takes the value 1 for a firm that is part of a multinational corporation (and zero otherwise), *Export* is the fraction of a firm's sales that are exported, and *Import* is the fraction of a firm's inputs that are imported. The product of two variables denotes the interaction between them. Columns (2) and (4) include industry fixed effects. Heteroskedasticity robust standard errors reported in parentheses.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)
Size	-0.095	-0.066	-0.126***	-0.115
	(0.074)	(0.296)	(0.035)	(0.075)
Multinational	0.521*	0.446	0.428**	0.313
	(0.282)	(0.319)	(0.178)	(0.211)
Export	1.823**	2.435**	1.983**	2.458**
	(0.832)	(1.148)	(0.786)	(1.009)
Import	2.485***	2.727***	2.410***	2.626***
	(0.517)	(0.636)	(0.508)	(0.616)
Size*Multinational	0.062	0.038	--	--
	(0.239)	(0.337)		
Size*Export	-0.197	-0.894	--	--
	(0.655)	(1.139)		
Size*Import	-0.058	0.171	--	--
	(0.350)	(0.450)		
Multinational*Export	0.367	0.474	--	--
	(0.813)	(0.982)		
Multinational*Import	-0.609	-0.828	--	--
	(0.565)	(0.639)		
Export*Import	-1.926*	-2.297**	-2.056**	-2.401**
	(1.082)	(1.051)	(1.023)	(1.033)
External dependence	0.634*	--	0.644*	--
	(0.381)		(0.378)	
Homogeneous	0.381	--	0.413	--
	(0.308)		(0.301)	
Homogeneous*Export	1.365	1.175	1.205	1.115
	(1.269)	(1.938)	(1.203)	(1.717)
Homogeneous*Import	-1.652*	-2.848**	-1.691*	-2.814**
	(0.915)	(1.107)	(0.902)	(1.104)
External dependence*Export	-0.994	-2.284	-1.149	-2.300
	(1.456)	(2.162)	(1.391)	(1.998)
External dependence*Import	-1.758**	-2.168**	-1.731**	-2.107*
	(0.871)	(1.099)	(0.867)	(1.089)
Constant	0.907***	1.285***	0.907***	1.297***
	(0.189)	(0.099)	(0.187)	(0.093)
Observations	551	551	551	551
R-squared	0.12	0.28	0.12	0.27

Table 10
Concern for Macroeconomic Volatility and Firm Characteristics. Ordered Logit and Standard Logit Regressions

The dependent variable is a dummy variable that takes the value 1 if a firm reports macroeconomic volatility to be a major or severe obstacle. *Size* is the level of firm's assets (in billions of Rands), *External dependence* is the external dependence of the 3-digit ISIC (revision 2) industry to which a firm belongs, *Homogeneous* is a measure of whether the industry to which a firm belongs produces homogeneous or differentiated products, *Multinational* is a dummy variable that takes the value 1 for a firm that is part of a multinational corporation (and zero otherwise), *Export* is the fraction of a firm's sales that are exported, and *Import* is the fraction of a firm's inputs that are imported. The product of two variables denotes the interaction between them. *Cross derivative* is the cross derivative of the probability of reporting a severe obstacle with respect to the fraction of exports and imports evaluated at the means of the values of all variables. The coefficients reported in column 3 were obtained using conditional fixed-effects. Heteroskedasticity robust standard errors reported in parentheses.
*, **, and *** denote significance of the 10%, 5% and 1%, respectively.

	(1)	(2)	(3)	(4)
Size	-0.168***	-0.357**	-0.417	-0.342**
	(0.061)	(0.146)	(0.339)	(0.150)
Multinational	0.592**	0.628*	0.531	0.620**
	(0.247)	(0.321)	(0.325)	(0.313)
Export	1.718***	1.668***	1.516***	2.994***
	(0.447)	(0.493)	(0.584)	(0.646)
Import	1.524***	1.688***	1.401***	2.253***
	(0.359)	(0.387)	(0.395)	(0.423)
External dependence	0.062	-0.325	--	--
	(0.279)	(0.389)		
Homogeneous	0.267	-0.100	--	--
	(0.292)	(0.389)		
Export*Import		--	--	-4.338***
				(1.393)
Constant		-1.205***	--	-1.517***
		(0.244)		(0.131)
Cross derivative		0.230***	--	-0.620**
		(0.070)		-0.26
Observations	551	551	483	566
Industry FE	--	--	YES	--

Figure 1
Exchage Rate Volatility in South Africa

The figure displays the evolution of the one year rolling standard deviation of the monthly growth rate of South Africa's real effective exchange rate (y-axis) during the period January, 1990 to June 2007 (x-axis).

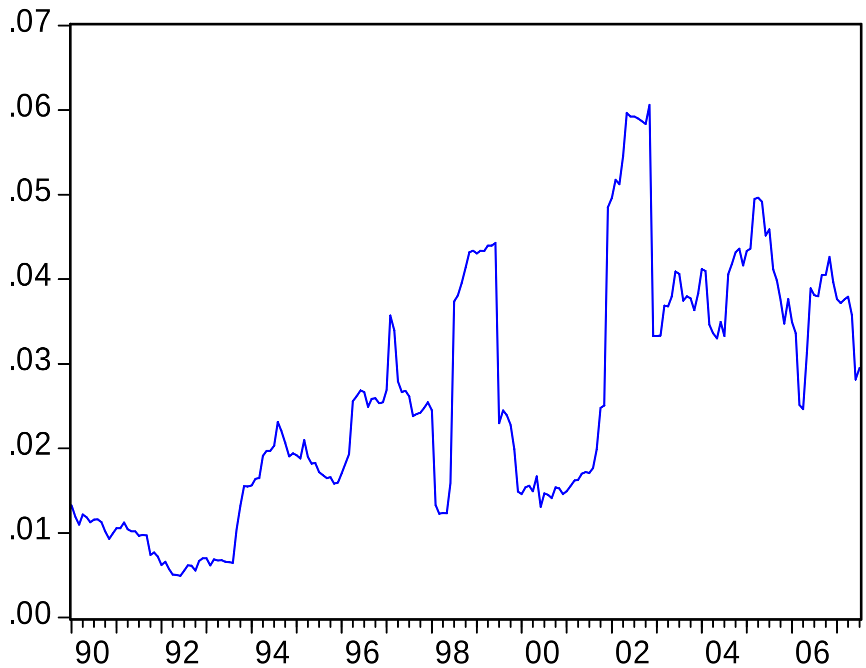

Figure 2
Evolution of the Rand/U.S. dollar and Real Effective Exchange Rates

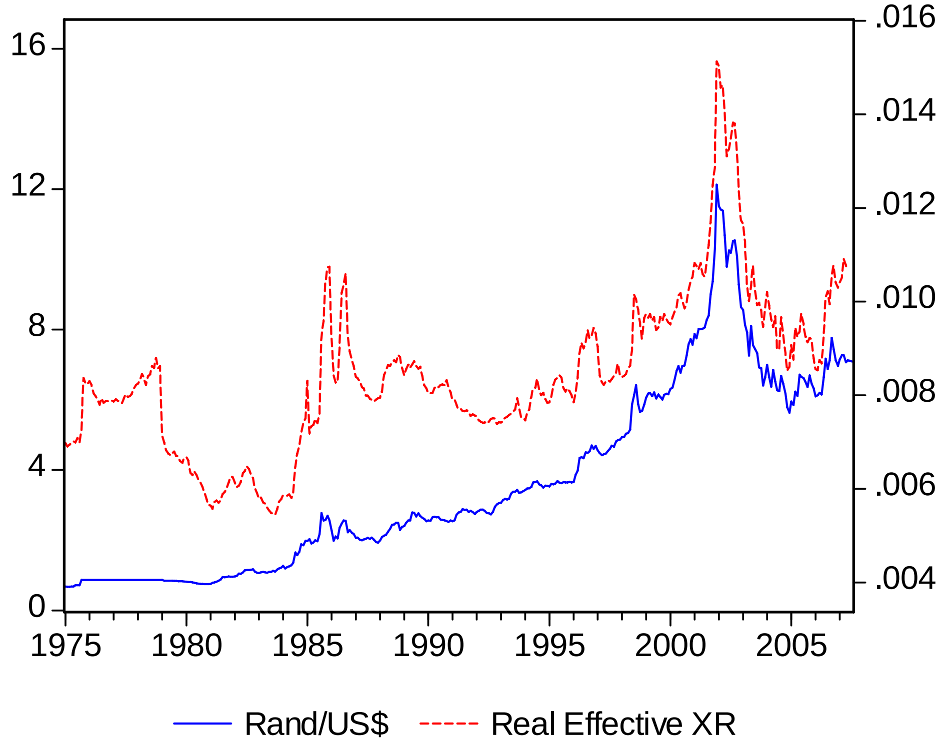

Figure 3

Evolution of Real Effective Exchange Rate, South Africa and Other Groups of Countries

The figure displays the evolution of the one year rolling standard deviation of the monthly growth rate of South Africa's real effective exchange rate and the average of the same standard deviation among emerging markets and other Sub-Saharan African countries (y-axis) during the period January, 2000 to June 2007 (x-axis).