# “Exchange rate volatility and manufacturing exports in South Africa”


| | |
|---|---|
| **AUTHORS** | Arnauld Ishimwe<br>Harold Ngalawa http://orcid.org/0000-0002-1946-3983 |



| | |
|---|---|
| **ARTICLE INFO** | Arnauld Ishimwe and Harold Ngalawa (2015). Exchange rate volatility and manufacturing exports in South Africa. *Banks and Bank Systems*, *10*(3), 29-38 |
| **RELEASED ON** | Tuesday, 17 November 2015 |
| **JOURNAL** | "Banks and Bank Systems" |
| **FOUNDER** | LLC “Consulting Publishing Company “Business Perspectives” |


| NUMBER OF REFERENCES | NUMBER OF FIGURES | NUMBER OF TABLES |
|---|---|---|
| 0 | 0 | 0 |

Arnauld Ishimwe (South Africa), Harold Ngalawa (South Africa)

# Exchange rate volatility and manufacturing exports in South Africa


## Abstract

The primary objective of this study is to investigate the impact of exchange rate volatility on South Africa's manufacturing exports to the United States for the period 1990Q1 to 2014Q1. The study employs the EGARCH model to measure exchange rate volatility, and the ARDL bounds tests as developed by Pesaran, Shin and Smith to determine the long-run and short-run effects of exchange rate volatility on the country's manufacturing exports. The study also carries out a Granger causality test between real exchange rates and exports of manufactured products. The study results show that an increase in exchange rate volatility has a significant positive effect on manufacturing exports in the long run. However, the results are insignificant in the short run. It is also found that real exchange rates Granger cause manufacturing exports. Manufacturing exports, however, do not Granger cause real exchange rates.


**Keywords:** exchange rate volatility, EGARCH, ARDL bounds tests.
**JEL Classification:** F10, F31, F41.

## Introduction

The relationship between exchange rate fluctuations and international trade has been a subject of debate for many years (Obi et al., 2013). It has generally been argued that a rise in exchange rate risk causes economic agents to invest in less risky assets and raises the level of risk to trade, which in turn reduces the level of trading activity (Ndung'u, 1999; Walters and de Beer, 1999; Bah and Amusa, 2003). The literature, however, presents confusing and contradictory theoretical and empirical outcomes on this issue (see Sekantsi, 2011), which prompted Klaassen (1999) to argue for the necessity of more empirical studies, especially in less developed countries where deficient time series have been blamed for the lack of adequate studies (Vergil, 2002; Takaendesa et al., 2006; Sekantsi, 2011).

Different studies on the relationship between exchange rate volatility and manufacturing exports have obtained different results (see, for example, Hook and Boon, 2000; Kumar and Dhawans, 1991; Arize et al., 2000; De Vita and Abbott, 2004; Morgenroth, 2000). In the case of South Africa, there are a few studies that have been carried out on the subject. Using ARCH and GARCH frameworks, Bah and Amusa (2003) found a statistically significant inverse relationship between exchange rate fluctuations and exports from South Africa to the United States of America (hereafter the US) during the period 1990Q1 to 2000Q4. Takaendesa et al. (2006) extended this study by using quarterly data from 1992 to 2004. Employing the exponential general autoregressive conditional heteroskedasticity (EGARCH) approach, they found similar results to those of Bah and Amusa (2003). Sekantsi (2011) used higher frequency (monthly) data for the period January 1995 to February 2007, to analyze the same relationship. Using the autoregressive distributed lag (ARDL) bounds test approach, Sekantsi (2011) found that real exchange rate volatility influences exports significantly and negatively, consistent with Bah and Amusa (2003) and Takaendesa et al. (2006).

However, Todani and Munyama (2005) found positive relationships in some instances and insignificant results in others when they investigated the impact of exchange rate volatility on aggregate exports (goods, services and gold exports) of South Africa for the period 1984 to 2004. The conflicting findings underscore the absence of consensus on the relationship between exchange rate fluctuations and manufacturing exports in South Africa. This study, therefore, contributes to the literature by attempting to provide more updated empirical research to the debate. The study employs the EGARCH model to measure exchange rate volatility, and the Pesaran et al. (2001) ARDL bounds tests to determine the long-run and short-run effects of exchange rate volatility on the country's manufacturing exports to the US for the period 1990Q1 to 2014Q1. The study also carries out a Granger causality test between real exchange rate instability and South Africa's manufactured exports to the US.

Following this introduction, the rest of the paper is structured in five sections. Section 1 is a discussion of South Africa's exchange rate fluctuations and trading with the US. A review of the literature of exchange rate volatility and export performance of manufactured goods is carried out in Section 2. Section 3 presents the methodology. Estimation results are discussed in Section 4 followed by a summary and conclusion in final Section.

## 1. Exchange rate behavior and manufacturing export performance in South Africa: 1990-2014

In order to cope with economic and political crises the country faced after the end of apartheid in 1994, South Africa dedicated its efforts to stabilization


Arnauld Ishimwe, MCOM (Economics), School of Accounting, Economics & Finance, University of KwaZulu-Natal, Westville Campus, Private Bag X54001, Durban, South Africa.
Harold Ngalawa, Ph.D., Senior Lecturer, School of Accounting, Economics & Finance, University of KwaZulu-Natal, Westville Campus, Private Bag X54001, Durban, South Africa.

measures in the domestic foreign exchange market (Van der Merwe, 1996). This was done through many changes in the exchange rate regime. In the post-apartheid era, three main exchange rate regimes have been adopted by South Africa, as presented in Table 1.

Table 1. South Africa's exchange rate regimes since 1985

| Episode | Period | Exchange rate regime |
|---|---|---|
| I | Sept 1985 – Feb 1995 | Two-tier system is re-established, with commercial and financial Rand. |
| II | Mar 1995 – Jan 2000 | Unitary exchange rate: managed float in Rand. |
| III | Feb 2000 – present | Unitary exchange rate: free floating Rand with inflation targeting framework of monetary policy. |

Source: Mtonga (2011).

The financial sanctions imposed on apartheid South Africa in the 1980s and 1990s forced the South African Reserve Bank (SARB) to enter the foreign exchange market as an active participant with direct control measures to regulate capital flows and mo-netary reserves (Van der Merwe, 1996). Van der Merwe (1996) affirms that South Africa took steps in the development of a forward market in the first two years of the post-apartheid era (1994-1995) as part of financial reforms. This happened with progressive relaxation of foreign exchange controls and a decline in SARB's involvement in the foreign exchange market.

From March 1995 to September 2000, South Africa adopted a unitary exchange rate under a managed floating Rand. This development occurred following South Africa's political reconciliation in 1994 that not only heralded a political transition from the apartheid regime to inclusive democracy, but also ended the country's economic isolation. Aron et al. (2000) argue that this change of regime was a huge step toward the liberalization of South Africa, which reinstated the country into the global economy. The financial liberalization resulted in the removal of exchange rate control regulations (Mtonga, 2011). Under this regime, SARB neither set the fixed rate to be quoted by banks nor predetermined its own rate of buying and selling dollars. Nattrass et al. (2002) state that the administered float allows the currency to fluctuate and the Reserve Bank to intervene and diminish the market's short-run fluctuations.

In February 2000, South Africa adopted inflation targeting, which was followed by implementation of a free floating exchange rate. The current monetary policy framework is employed to allow market forces to determine the exchange rate without interfering in the market (South African Reserve Bank (SARB), 2012). The Reserve Bank, however, still has authority over the foreign exchange rate by participating in the market through purchases and sales of foreign currency, even though it stopped the control of foreign exchange rate directly (Mtonga, 2011).

Figure 1 in the Appendix shows trends of the real exchange rate of the South African Rand per US Dollar from 1990Q1 to 2014Q1. The figure shows a peak in 2002Q1. According to the Myburgh Commission of Inquiry, the 2002 depreciation of the Rand against the US Dollar was caused by (1) a continuous slowdown in global economic activity; (2) contagion from events in Argentina; (3) a worsening in the current account of the balance of payments in 2001Q3; and (4) a complete shift from a surplus position in the financial account of the balance of payments in 2001Q3 to a deficit in 2001Q4 (Bhundia and Gottschalk, 2003).

Since 1994, there has been a significant increase in exports of South African goods to its major trading partners such as Germany, US, China, and Japan (see Figure 2 in the Appendix). Figure 2 shows that the US has been the largest importer of South African manufactured exports, followed by Japan and Germany, in that order. It is also observed that there has been a considerable increase in exports to China, especially since 2002.

Figure 3 in the Appendix shows that there is an apparent inverse relationship between manufacturing exports and volatility. The periods of low volatility in the exchange rate tend to be followed by an increase in South Africa's exports to the US. However, we also observe that higher exchange rate volatility (i.e., in 1998, 2001 and 2002, 2008) appears to be positively related to an increase in exports to the US. This represents the ambiguity regarding the relation between exchange rate fluctuations and manufactured exports.

## 2. Literature review

Exchange rate fluctuations are largely explained by macroeconomic variables. A high demand for South African exports relative to its imports, for instance, may increase the country's terms of trade, which in turn may lead to an appreciation of the South African Rand against other currencies. Conversely, if the price of South African exports increase compared to its imports, the Rand may depreciate relative to foreign currency, as it is expected to be on high demand compared to other trading currencies

(Coudert et al., 2008). The rate of interest is another determinant of exchange rate variation, and the two are positively correlated (see Hnatkovska et al., 2008). This means, for example, that an increase in South Africa's interest rates will attract capital inflows, which may lead to an appreciation of the Rand. Money supply changes operating through interest rates also influence exchange rate movements. A rise in money supply is expected to put downward pressure on interest rates, consequently leading to a decrease in the rate of return on domestic financial assets and a fall in the value of the domestic currency (see Krugman and Obstfeld, 2006). According to Kandil and Mirzaie (2003), a devaluation of the domestic currency has a positive effect on the demand for domestic goods by foreigners. This occurs because a depreciation of the domestic currency increases the value of foreign currency which allows foreigners to buy more of domestic goods since they are cheaper (in foreign currency) compared to foreign goods.

Several studies have been carried out on the relationship between exchange rates and export performance. Many of these have found an inverse relationship between exchange rate fluctuations and trade (see, for example, Hook and Boon, 2000; Kumar and Dhawans, 1991; Arize et al., 2000); several have found an insignificant relationship between the two variables (see, for example, De Vita and Abbott, 2004; Morgenroth, 2000); some have shown that an increase in exchange rate uncertainty increases trade flows (see, for example, Todani and Munyama, 2005); and others show that the correlation between exchange rate fluctuations and trade is poor (see, for example, Musonda, 2001; Adubi and Okumadewa, 1999).

There are four studies on the effect of exchange rate fluctuation on trade in South Africa that we are aware of. These are Bah and Amusa (2003), Todani and Munyama (2005), Takaendesa et al. (2006), and Sekantsi (2011). Bah and Amusa (2003) investigated the effect of exchange rate volatility on South African exports to the US. Using quarterly data from 1990Q1 to 2000Q4 in ARCH and GARCH models, they found that both in the long run and the short run, real exchange rate fluctuations tend to have a negative and statistically significant effect on exports. Takaendesa et al. (2006) extended the Bah and Amusa (2003) study to 2004Q4, although the starting period is also moved forward to 1992Q1. Using the EGARCH model of Nelson (1990) to measure exchange rate volatility, they found similar results to Bah and Amusa (2003).

Todani and Munyama (2005) investigated the impact of exchange rate fluctuations on aggregate exports of South Africa to the rest of the world using quarterly data from 1984 to 2004 using the ARDL bounds testing model. To measure exchange rate volatility, they used the GARCH (1, 1) and the moving average standard deviation. Todani and Munyama (2005) found a positive but insignificant correlation between exchange rate fluctuations and the exports of manufactured products from South Africa using different measures of exchange rate variability. Sekantsi (2011) examined the impact of real exchange rate volatility on South Africa's exports to the US for the period 1995 to 2007. Using the GARCH model to measure exchange rate volatility, the study also estimated long-run coefficients using the ARDL model. Sekantsi (2011) found that exchange rate fluctuations are significantly and inversely related to exports.

## 3. Methodology

**3.1. Model specification.** Following Savvides (1992), Todani and Munyama (2005) and Sekantsi (2011), the estimated exports equation is given by:

$$exp_t = \alpha_0 + \alpha_1 gdp_t + \alpha_2 rer_t + \alpha_3 dummy_t + \alpha_4 vol_t + \varepsilon_t, \quad (1)$$

where $exp_t$ represents South Africa's manufacturing exports to the US, $gdp_t$ is real income of the foreign country (the US), $rer_t$ is the exchange rate of the South African Rand to the US Dollar, $vol_t$ is exchange rate volatility, $dummy_t$ is a dummy variable representing the African Growth and Opportunity Act (AGOA) bilateral trade agreement with the US signed in 2000, $a_0$ is a constant and $\varepsilon_t$ is a white noise error term. The variables $exp_t$, $gdp_t$ and $rer_t$ are expressed in natural logarithms.

**3.2. Definition of variables, data and sources of data.** The study uses quarterly data covering the period 1990Q1 to 2014Q1. Data on South Africa's EXPORTS to the US were collected from the US Census Bureau and are expressed in US Dollars. In order to generate real exports, we follow Vergil (2002) and Takaendesa et al. (2006) who deflated the nominal value of South Africa's exports to the US with the consumer price index of the US. Though demand theory proposes that the volume rather than the value of manufacturing exports be used, this study uses manufacturing exports values for easy comparability with previous studies (see, for example, Bay and Amusa, 2003; Todani and Munyama, 2005; Takeandesa et al., 2008; and Sekantsi, 2011).

Real income data of the foreign country, which is proxied by the real GDP of the US, was obtained from International Financial Statistics (IFS), a database of the International Monetary Fund (IMF). The bilateral real exchange rate was computed using the formula:

$$rer = \frac{NER * CPI_{US}}{CPI_{SA}}, \tag{2}$$

where $CPI_{US}$ is the consumer price index for the US, $CPI_{SA}$ is the consumer price index for South Africa and $NER$ is the nominal exchange rate in Rands per US Dollar. Data for the nominal exchange rate were obtained from the South African Reserve Bank (SARB). The CPI data of both countries were obtained from the Organization for Economic Cooperation and Development (OECD) statistics.

**3.3. Measuring exchange rate volatility.** The autoregressive conditional heteroscedasticity (ARCH) model, the general ARCH (GARCH) model, and the exponential GARCH (EGARCH) model are some common measures of exchange rate volatility (see Engel, 1982; Bollerslev, 1986; Todani and Munyama, 2005; Takaendesa et al., 2006; Sekantsi, 2011). This study adopts the EGARCH method of Nelson (1990), consistent with Takaendesa et al. (2006) and Su (2010). The variance specification of the EGARCH model can be presented as:

$$ln\left(\sigma_t^2\right) = \tau_0 + \theta_1 ln\left(\sigma_{t\text{-}1}^2\right) + \gamma \frac{\omega_{t\text{-}1}}{\sigma_{t\text{-}1}^2} + Æ\left|\frac{\omega_{t\text{-}1}}{\sigma_{t\text{-}1}^2}\right|, \tag{3}$$

where $\tau_0$ is the intercept term and $\theta_1$ $\gamma$, $\emptyset$ are parameters to be estimated. The $\theta_1$ parameter measures persistence in conditional volatility in the economy; the term $\omega_{t\text{-}1}$ symbolizes the ARCH term and measures fluctuations in the previous period; and $\sigma_{t-1}^2$ is the GARCH term which represents the variance of the previous period estimate.

One of the advantages of the EGARCH specification is that even though the parameters are negative, $\sigma_t^2$ would be positive. Accordingly, there would be no violation of the positive variance conditions. In addition, unlike the GARCH specification, the $\gamma$ parameter measures the leverage effect or the asymmetric order (see Brooks, 2002; Su, 2010; Takaendesa et al., 2006). If $\gamma = 0$, the EGARCH model is symmetric because the $\emptyset$ parameter denotes the symmetric or magnitude effect of the model. If $\gamma < 0$, there are positive shocks in the economy that produce less fluctuations than negative shocks. However, when $\gamma > 0$, the opposite applies, meaning positive shocks are more threatening than negative shocks (Su, 2010).

**3.4. Autoregressive distributed lag bounds testing approach.** This paper adopts the autoregressive distributed lag (ARDL) bounds test approach proposed by Pesaran et al. (2001). Among its many advantages, this approach permits examining the presence of cointegration without the need to recognize whether the variables are stationary in levels, integrated of order one or mutually cointegrated (Todani and Munyama, 2005). In addition, this procedure has small-sample properties which are better than what is obtained in Johansen (1991, 1995) and Engle and Granger (1987) approaches (see Sekantsi, 2011). Following Todani and Munyama (2005) and Pesaran et al. (2001), equation (1) can be rewritten as:

$$\begin{aligned}\Delta exp_t &= \theta_0 + \theta_1 t + \Pi_1 exp_{t\text{-}1} + \Pi_2 \mathrm{gdp}_{t\text{-}1} + \Pi_3 rer_{t\text{-}1} + \Pi_4 vol_{t\text{-}1} \\ &+ \Pi_5 dummy_{t\text{-}1} + \sum_{i=1}^{n} \vartheta_i \Delta exp_{t\text{-}i} + \sum_{k=0}^{m} \gamma_k \Delta gdp_{t\text{-}k} + \sum_{k=0}^{p} \delta_k \Delta rer_{t\text{-}k} + \\ &+ \sum_{k=0}^{q} \varphi_k \Delta vol_{t\text{-}k} + \sum_{k=0}^{v} \Theta_k \Delta dummy_{t\text{-}k} + \mu_t,\end{aligned} \tag{4}$$

where $\theta_0$ and $\theta_1 t$ are the constant and trend components, respectively, $\mu_t$ is a white noise error term and the remaining variables are similar to the variables in equation (1). De Vita and Abbott (2004) and Sekantsi (2011) argue that the nonexistence of serial correlation in the residuals is explained by the formation of the first difference explanatory variables. The parameters $\Pi_2$, $\Pi_3$, $\Pi_4$, and $\Pi_5$ represent long-run coefficients that affect manufacturing exports.

In order to estimate equation (4), the starting point is to determine the lag length that specifies the final ARDL by using the general-to-specific approach (Shin and Yu, 2006). The next step is to test if manufactured export products and the explanatory variables are cointegrated. This is done by carrying out a joint test for cointegration. After the model is found to be cointegrated, the normalized long-run relationship resulting from equation (4) is given by (see Pesaran and Shin, 1999):

$$exp_t = \beta_1 + \beta_2 t + \beta_3 gdp_t + \beta_4 rer_t + \beta_5 dummy_t + \beta_6 vol_t + \xi_t, \quad (5)$$

where $\beta_1 = -\theta_0/\Pi_{1;2} = -\theta_1/\Pi_{1,3} = -\Pi_2/\Pi_{1,4} = -\Pi_3/\Pi_{1,5} = -\Pi_5/\Pi_{1,6} = -\Pi_5/\Pi_1$ and $\xi_t$ is an error term which is assumed to be white noise. These long-run coefficients (3, 4, 5 and 6) correspond to the estimated coefficients ($\alpha_1$, $\alpha_2$, $\alpha_3$ and $\alpha_4$) in equation (1) respectively.

**3.5. Granger causality.** This study uses the Granger causality test to determine the direction of causality between manufacturing exports and the real exchange rate. According to Mousavi and Leelavathi (2013), to carry out the Granger causality test, the variables of interest must be stationary. Akaike and Schwarz Information Criteria are used to find the optimal number of lags.

## 4. Estimation results

**4.1. Exchange rate volatility.** The Lagrange Multiplier (LM) – ARCH test shows that the value of the test statistic ($R^2$ * (number of observations = 3.75998)) is greater than the probability of the chi-squared value (0.1526), revealing the presence of ARCH effect in the real exchange rate series. This prompts us to use the EGARCH model. The anti-cipated conditional variance of the exchange rate volatility in the EGARCH model is summarized as follows:

$$ln\left(\sigma_t^2\right) = -0.2877 + 0.908 ln\left(\sigma_{t-1}^2\right) + 0.1503\frac{\omega_{t-1}}{\sigma_{t-1}^2} - 0.3068\left|\frac{\omega_{t-1}}{\sigma_{t-1}^2}\right| \quad (6)$$

$$P\text{-}value\ (0.0016) \quad (0.0000) \quad (0.0000) \quad (0.0021).$$

In equation (6), all coefficients are statically significant at 1%. The coefficient of the measure of persistence $[ln(\sigma_{t-1}^2)]$ shows that exchange rate volatility does not die instantaneously following a shock. The asymmetric parameter (0.1503) reveals that positive shocks are more threatening than negative shocks (see Su, 2010). To ascertain the robustness of the exchange rate volatility estimates, we check if there is any ARCH effect remaining in the EGARCH residuals. A summary of the ARCH effect test is presented in Table 2.

Table 2. Heteroskedasticity test: ARCH

| | | | |
|---|---|---|---|
| F-statistic | 0.035321 | Prob. F (1.93) | 0.8513 |
| Obs*R-squared | 0.036067 | Prob. chi-square (1) | 0.8494 |

The Table shows that the F-statistic and Chi-square statistic are insignificant. We, therefore, conclude that there is no ARCH effect remaining in the exchange rate fluctuation. Next we carried out unit root tests of the data using the Augmented Dickey-Fuller (ADF) and the Phillips Peron (PP) tests. The results show that all variables are integrated of the first order, except for exchange rate volatility, which is stationary in levels for both ADF and PP tests. These findings provide further justification for using the ARDL bounds test approach (see Table A1 in the Appendix).

**4.2. Estimation of the ARDL bounds test for cointegration approach.** In the estimated equation (4), the optimal lag length was chosen by examining the sequential modified likelihood ratio test statistic (LR), Akaike information criterion (AIC), Schwarz information criterion (SC), final prediction error (FPE), and Hannan-Quinn information criterion (HQ). FPE, AIC and HQ show seven lags and LR and SC show six and three lags, respectively, as the optimal lag lengths (Table of results available on request from authors). Following Shin and Yu (2006), we use the general-to-specific approach, beginning from seven lags (max $n$ = max $m$ = max $p$ = max $q$= max $v$ = 7), then removing all the variables that are insignificant. The long-run estimation results of the model are presented in Table 3.

Table 3. Results of the long-run cointegration equation

| | Manufacturing exports | Constant | Trend | Foreign income | Real exchange rate | Exchange rate volatility | Dummy variable |
|---|---|---|---|---|---|---|---|
| Coefficients | 1.000 | -70.0406 | -0.0198 | 2.9297 | -0.9656 | 44.9146 | 0.2517 |
| Std. error | -0.0840 | 9.5818 | 0.0035 | 0.3493 | 0.1472 | 12.6412 | 0.0509 |
| *t*-statistic | -6.8843 | -4.2287 | -3.2873 | 4.8515 | -3.7978 | 2.0559 | 2.8625 |
| Prob. | 0.000*** | 0.0001*** | 0.0015*** | 0.000*** | 0.0003*** | 0.043** | 0.0053*** |

Note: *, **, *** represent 10%, 5%, and 1% level of significance, respectively.

Using the critical values tabulated by Pesaran et al. (2001), we observe that the F-statistic (10.2807) and chi-square (51.4035) are statistically significant at 5 percent. We observe that the F-statistic (10.2807) is greater than the upper-bound critical values of Pesaran et al. (2001) at all levels of significance, indicating that

there is cointegration between manufacturing exports and the explanatory variables in equation (5).

Table 3 shows that exchange rate volatility is statistically significant and positively related to manufacturing exports. This finding is consistent with De Grauwe (1988), Arize et al. (2003), Todani and Munyama (2005), and Obi et al. (2013). The positive relationship between exchange rate volatility and manufacturing exports might be due to income effects exceeding substitution effects. This relationship may also be a result of the openness of the South African economy (Todani and Munyama, 2005). This might be a situation where exporters are aware that all excess supply may not be consumed by the domestic market in case trading becomes risky as exchange rate volatility increases. Therefore, exporters increase manufacturing exports as exchange rate volatility increases with the intention of avoiding a fall in revenues and an exchange rate risk exposure.

We also observe that the real exchange rate is negatively related to manufacturing exports and statistically significant at 1 percent, which may suggest that the negative effect of a devaluation on net exports in the J-curve is persistent. This is also in line with a structuralist view, which states that the depreciation of a currency might have a negative effect on job creation and production, which in turns negatively affects exports (Acar, 2000). Acar (2000) maintains that this view works mostly for developing countries, where a depreciation raises both costs of domestic productions and imports. The foreign income coefficient is positive, higher than unity and statistically significant. Even though this elasticity is high, it is consistent with other studies (see, for example, Arize et al., 2000; Bah and Amusa, 2003). Coefficients of foreign income mostly range between 2.0 and 4.0 for both developed and developing countries (Riedel, 1988). Riedel (1988, 1989) argues that a high income elasticity shows lack of action from the supply side of exports. Arize (1990), however, states that increased export penetration would result in high income elasticity. Since the AGOA bilateral trade agreement was signed in 2000, South Africa's exports of manufactured products to the US market have increased (Bah and Amusa, 2003). The coefficient of the AGOA bilateral trade agreement was found to be statistically significant and consistent with a priori theoretical expectations.

**4.3. Error correction model.** An error correction model (ECM) was estimated to present the short-term dynamics that exist between South Africa's manufacturing exports to the US and its main determinants (see Table 4 for the estimation results).

Table 4. Error correction model

| Variables | Coefficients | Standard error | *t*-statistic | Probability value |
|---|---|---|---|---|
| Constant | -0.069193 | 0.032028 | -2.160412 | 0.0336** |
| Trend | 0.000493 | 0.000414 | 1.190674 | 0.2371 |
| D (exp (-4)) | 0.267280 | 0.081954 | 3.261323 | 0.0016*** |
| D (gdp) | 4.186642 | 1.318292 | 3.175808 | 0.0021*** |
| D (vol) | 40.29242 | 14.94883 | 1.695356 | 0.1985 |
| D (vol (-1)) | -46.07119 | 14.61612 | -1.152081 | 0.2022 |
| ECM (-1) | -0.483196 | 0.082928 | -5.826681 | 0.0000*** |

The speed of adjustment towards long-run equilibrium is found to be negative (-0.4832) and statistically significant, showing that almost 48 percent of the disequilibrium in the previous quarter are adjusted to their long-run equilibrium in the current quarter. All short-run explanatory variables were found to be statistically significant, except exchange rate volatility.

**4.4. Diagnostic tests.** The model was tested for normality, serial correlation, autoregressive conditional heteroscedasticity and stability. Results of the diagnostic tests show that there is no serial correlation in the model, the error terms have equal variance and the residuals are normally distributed (see Table 5).

Table 5. Residual diagnostic test results

| Test | Null hypothesis | *t*-statistic | Probability value |
|---|---|---|---|
| Breusch-Godfrey LM-test | No serial correlation | 0.3561 | 0.7015 |
| White test (Chi-sq) | No conditional heteroscedasticity | 0.7395 | 0.8419 |
| Jarque-Bera(JB) | There is a normal distribution | 1.9574 | 0.3758 |

**4.5. Granger causality test.** The test of causality between manufacturing exports and the real exchange rate is carried out using the Granger causality test. Table 6 presents the results of the test.

Table 6. Granger causality test results

| Dependent variable: manufacturing exports | | | |
|---|---|---|---|
| Excluded | Chi-sq | Df | Prob. |
| Real exchange rate | 8.658541 | 2 | 0.0132 |
| All | 8.658541 | 2 | 0.0132 |
| Dependent variable: real exchange rate | | | |
| Excluded | Chi-sq | Df | Prob. |
| Manufacturing exports | 4.129443 | 2 | 0.1269 |
| All | 4.129443 | 2 | 0.1269 |

The Table shows a probability value of 0.0132 in a test of whether the exchange rate Granger causes manufacturing exports. We, therefore, conclude that the real exchange rate Granger causes manufacturing exports at 5%. Testing if manufacturing exports Granger cause real exchange rates, a probability value of 0.1269 reveals that we cannot reject the null hypothesis. We, therefore, conclude that manufacturing exports do not Granger cause exchange rates.

## Summary conclusions and policy implications

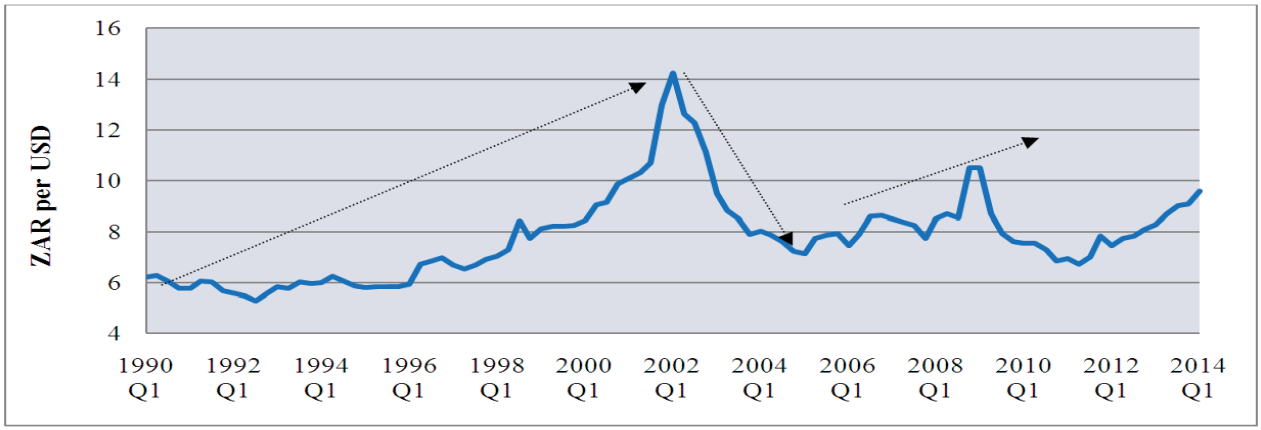
The primary objective of this study was to examine the long-run and short-run relationship between exchange rate volatility and manufacturing exports in South Africa, covering the period of 1990Q1 to 2014Q1. The study also analyzes the causality between exchange rates and manufacturing exports from South Africa to the US. Using the EGARCH model to determine the volatility of exchange rates and the ARDL bounds test approach for cointegration, it has been found that exchange rate volatility and manufacturing exports are positively related in the long run. However, the real exchange rate and export of manufactured products are observed to be negatively associated. In the short run, the results of exchange rate volatility and foreign income were found to be insignificant. It is also established that the speed of adjustment to equilibrium is nearly 50 percent and statistically significant. Thus, the study finds no evidence that exchange rate volatility adversely affects manufacturing exports in South Africa. Therefore, central bank intervention in the South African foreign exchange market to smoothen exchange rate movements cannot be justified on the basis that it encourages manufacturing exports.

## References


1. Acar, M. (2000). Devaluation in Developing Countries: Expansionary or Contractionary? *Journal of Economic and Social Research*, 2 (1), pp. 59-83.
2. Adubi, A. and Okumadewa, F. (1999). Price, Exchange Rate Volatility and Nigeria's Agricultural Trade Flows: A Dynamic Analysis, African Economic Research Consortium Research Paper No. 87.
3. Arize, A. (1990). An Econometric Investigation of Export Behavior in Seven Asian Developing Economies, *Applied Economics*, 22, pp. 891-904.
4. Arize, A.C., Osang, T. and Slottje, J.D. (2000). Exchange Rate Volatility and Foreign Trade: Evidence from Thirteen LDC's, *Journal of Business and Economic Statistics*, 18 (1), pp. 10-17.
5. Arize, A.C., Osang, T. and Slottje, J.D. (2003). *Exchange Rate Volatility in Latin America and its Impact on Foreign Trade*. Retrieved from: http://faculty.smu.edu/tosang/pdf/latin.pdf.
6. Aron, J., Elbadawi, I., and Kahn, B. (2000). *Determinants of the Real Exchange Rate in South Africa*. Centre for the Study of African Economics. Working paper number WPS/97-16.
7. Bah, I. and Amusa, A. (2003). Real Exchange Rate Volatility and Foreign Trade: Evidence from South Africa's Export to United State, *African Finance Journal*, 5 (2), pp. 1-20.
8. Bhundia, A. and Gottschalk, J. (2003). *Source of Nominal Exchange Rate Fluctuation in South Africa.* IMF Working Paper No. WP/03/252.
9. Bollerslev, T. (1986). Generalised Autoregressive Conditional Heteroscedasticity, *Journal of Econometrics*, 31, pp. 307-327.
10. Brooks, C. (2002). *Introductory Econometrics for Finance*. Cambridge: Cambridge University Press.
11. Coudert, V., Couharde, C., and Mignon, V. (2008). *Do Terms of Trade Drive Real Exchange Rates? Comparing Oil and Commodity Currencies?* Centre d'Etude Prospectives et d'Inforamtion International Working Paper No. 32.
12. De Grauwe, P. (1988). Exchange Rate Volatility and the Slowdown in Growth of International Trade, *IMF Staff Papers*, 35 (1), pp. 63-84.
13. De Vita, G. and Abbott, A. (2004). The Impact of Exchange Rate Volatility on UK Exports to EU Countries, *Scottish Journal of Political Economy*, 51 (1), pp. 63-81.
14. Engel, R. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of the United Kingdom Inflation, *Econometrica*, 50, pp. 987-1007.
15. Engle, R.F. and Granger, C.W.J. (1987). Co-integration and Error Correction: Representation, Estimation, and Testing, *Econometrica*, 2 (55), pp. 251-276.

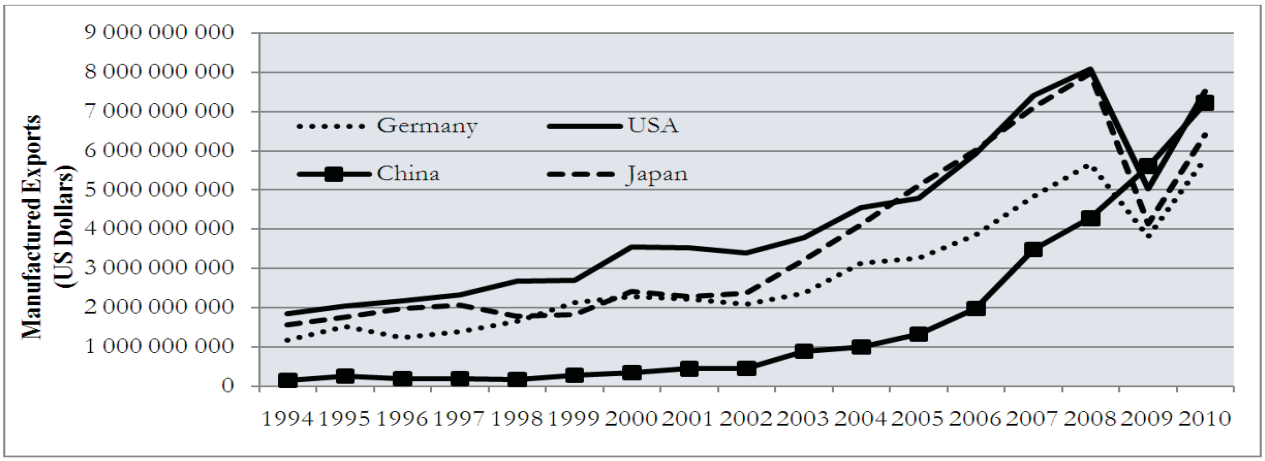
16. Hnatkovska, V., Lahiri, A., Vegh, C.A. (2008). *Interest Rate and the Exchange Rate: A Non-Monotonic Tale.* National Bureau of Economic Research Working Paper No. 13925.
17. Hook, L.S. and Boon, T.H. (2000). Real Exchange Rate Volatility and Malaysian Exports to its Major Trading Partners. University Putra Malaysia Working Paper No. 6.
18. Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, 59 (6), pp. 1551-1580.
19. Johansen, S. (1995). *Likelihood-Based Inference in Cointegration Vector Autoregressive Models.* New York: Oxford University Press.
20. Kandil, M. and Mirzaie, I.A. (2003). The Effect of Exchange Rate Fluctuations on Output and Prices: Evidence from Developing Countries, *International Monetary Fund Working Paper*.
21. Klaassen, F. (1999). Why is it so Difficult to Find an Effect of Exchange Rate Risk on Trade? Retrieved from http://greywww.kub.nl:2080/greyfiles/center/.
22. Krugman, P.R. and Obstfeld, M. (2006). *International Economics: Theory and Policy* (7th Ed.). Boston: Pearson Addison-Wesley.
23. Kumar, R. and Dhawan, R. (1991). Exchange Rate Volatility and Pakistan's Exports to the Developed World: 1974-1985, *World Development*, 19, pp. 1225-1240.
24. Morgenroth, L.W. (2000). Exchange Rate and Trade: The Case of Irish Exports to Britain, *Applied Economics*, 32, pp. 107-110.
25. Mousavi, S., and Leelavathi, D.S. (2013). Agricultural Export and Exchange Rates in India: The Granger Causality Approach, *International Journal of Scientific and Research Publications*, 3 (2), pp. 1-8.
26. Mtonga, E. (2011). Did it matter? Monetary Policy Regime Change and Exchange Rate Dynamics in South Africa, paper presented at the Centre for the Study of African Economies, Oxford.
27. Musonda, A. (2001). Exchange Rate Volatility and Non-Traditional Exports Performance: Zambia (1965-1999), Paper Presented at the AERC Biannual Workshop, Nairobi, May (2001)
28. Nattrass, N., Wakeford, J. and Muradzikwa, S. (2002). *Macroeconomics Theory and Policy in South Africa* (3rd ed.). Cape Town: David Philip.
29. Ndung'u, N. (1999). Monetary and Exchange Rate Policy in Kenya. AERC Research Paper No. p. 94.
30. Nelson, D.B. (1990). Stationarity and Persistence in the GARCH (1, 1) Model, *Econometric Theory*, 6 (3), pp. 318-334.
31. Obi, A., Ndou, P. and Peter, B. (2013). Assessing the Impact of Exchange Rate Volatility on the Competitiveness of South Africa's Agricultural Exports, *Journal of Agricultural Science*, 5 (10), pp. 227-250.
32. Pesaran, M. and Shin, Y. (1999). An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis, in Strom, S. (Ed.), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*. Cambridge: Cambridge University Press.
33. Pesaran, M.H., Shin, Y., and Smith, R.J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships, *Journal of Applied Econometrics*, 16, pp. 289-326.
34. Riedel, J. (1988). The Demand for LDC Exports of Manufactures: Estimates from Hong Kong, *Economic Journal*, 98, pp. 138-148.
35. Riedel, J. (1989). The Demand for LDC Exports of Manufactures: Estimates from Hong Kong: A Rejoinder, *Economic Journal*, 99, pp. 467-70.
36. South African Reserve Bank (SARB) (2012). Inflation Targeting Framework: South African Reserve Bank. Retrieved from: https://www.resbank.co.za/MonetaryPolicy/DecisionMaking/Pages/default.aspx>.
37. Savvides, A. (1992). Unanticipated Exchange Rate Variability and the Growth of International Trade, *Welwirtschaftliches Archives*, 128, pp. 446-463.
38. Sekantsi, L. (2011). The Impact of Real Exchange Rate Volatility on South African Exports to the United States (U.S.): A Bounds Test Approach, *Review of Economic and Business Studies*, 8, pp. 119-139.
39. Shin, Y. and Yu, B. (2006). *An ADRL Approach to an Analysis of Asymmetric Long-Run Co-Integrating Relationships*, Mimeo. Leeds University Business School.
40. Su, C. (2010). *Application of EGARCH Model to Estimate Financial Volatility of Daily Returns: The Empirical Case of China* (Unpublished Master's Degree in Finance Project) University of Gothenburg.
41. Takaendesa, P., Tsheole, T. and Aziakpono, M. (2006). Real Exchange Rate Volatility and its Effect on Trade Flows: New Evidence from South Africa, *Studies in Economics and Econometrics*, 30 (3), pp. 79-97.
42. Todani, K.R. and Munyama, T.V. (2005). Exchange Rate Volatility and Exports in South Africa. Retrieved from: http://www.tips.org.za/files/773.pdf.
43. Van der Merwe, E.J. (1996). Exchange Rate Management Policies in South Africa: Recent Experience and Prospects, *South African Reserve Bank Occasional Paper No.* 9.
44. Vergil, H. (2002). Exchange Rate Volatility in Turkey and its Effect on Trade Flows, *Journal of Economic and Social Research*, 4 (1), pp. 83-99.
45. Walters, S. and De Beer, B. (1999). An Indicator of South Africa's External Competitiveness, *South African Quarterly Bulletin*, 213, September, pp. 54-67.

## Appendix




Source: South Africa Reserve Bank.

**Fig. 1. Trend of the real exchange rate**




Source: Department of Trade and Industry, South Africa.

**Fig. 2. Export products by country of destination 1994-2010**


Source: International Monetary Fund, International Financial Statistics.

**Fig. 3. Manufacturing exports and exchange rate volatility in South Africa**

Table A1. Summary of the augmented Dickey-Fuller and the Phillips Peron test results

| Null hypothesis: *exp*, *gdp*, *rer* and *vol* have unit roots | | | | | |
|---|---|---|---|---|---|
| Exogenous: constant and trend | | | | | |
| | ADF test statistics | ADF test critical values | PP test statistics | PP test critical values | Order of integration |
| Manufacturing exports (*exp*) | -10.38926 | -2.589531*** | -12.94891 | -4.05753*** | I (1) |

Table A1 (cont.). Summary of the augmented Dickey-Fuller and the Phillips Peron test results

| Null hypothesis: *exp*, *gdp*, *rer* and *vol* have unit roots | | | | | |
|---|---|---|---|---|---|
| Exogenous: constant and trend | | | | | |
| Real exchange rate (*rer*) | -7.791884 | -3.500669*** | -7.74961 | -4.05753*** | I (1) |
| Foreign income (*inc*) | -5.898253 | -3.500669*** | -6.69778 | -4.05753*** | I (1) |
| Volatility (*vol*) | -7.58564 | -4.057528*** | -8.5786 | -4.25789*** | I (0) |

Notes: the LS method was used in the ADF test; maximum number of lags was set to 11; *, **, *** represent 10%, 5%, and 1% level of significance, respectively.