Exchange Rate Volatility and its Effect on Macroeconomic Management in Swaziland

Final Report

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Abstract

The major objective of this paper is to assess the effect of exchange rate volatility on macroeconomic performance in Swaziland from 1990 to 2013. The generalised autoregressive conditional heteroscedasticity GARCH (1, 1) approach was used to estimate the real exchange rate volatility, which was found to be quite persistent. The threshold GARCH (TGARCH) approach was used to capture leverage effects and the results reveal evidence of leverage effects and indicate that positive shocks increased the volatility of the real exchange rate more than negative shocks. The Hodrick Prescott filter was used to separate positive and negative volatilities to estimate different models. The Augmented Dickey Fuller stationarity test, with the exception of the real exchange rate volatility, found all variables to be I(1). The Johansen cointegration test was performed to establish the existence of a long run relationship among the variables, results of which show the existence of such a relationship. Granger causality test results show that there is a unidirectional causality from CPI to real exchange rate volatility and from reserves to public investment. The Structural VAR was estimated and structural exogenous shocks were identified by the Cholesky decomposition. Variance decomposition and impulse response functions for some macroeconomic variables to positive one standard deviation were estimated for three models (real exchange rate volatility, positive, and negative volatilities). Variance decomposition results showed that a significant percentage of the variation in real exchange rate volatility is largely accounted for by its own innovations in a 24 month horizon. On the asymmetry, results show that positive shocks have more effect than negative shocks in explaining variations in the exchange rate volatility. Impulse response functions shows that a negative response is observed for GDP and public investment arising from a positive shock to exchange rate volatility while a positive response in the same variables is observed for a negative shock to exchange rate volatility. This paper recommends that authorities maintain a low and stable inflation rate by setting the interest rate at the right level and further improve on reserve management.

Key Words: Volatility, Economy, Johansen, SVAR, Granger causality, GARCH
CHAPTER 1

INTRODUCTION

1.0 Background

The Kingdom of Swaziland is a landlocked and mountainous country situated in the south-eastern part of the African Continent, bounded by the Republic of South Africa on the north, west and south and by the Republic of Mozambique to the east. The country covers a land area of 17,364 km², with a population of 1.02 million according to the 2007 census. Swaziland is highly dependent on South Africa, not only is the Swazi Lilangeni pegged to the South African Rand but South Africa accounts for over 90 percent of Swaziland’s imports, over 60 percent of its exports, and about 80 percent of its electricity. Most importantly the Southern Africa Customs Union (SACU) which account for an average of 60 percent of total government annual revenue. Exchange rate policy in Swaziland cannot be viewed in isolation of the Common Monetary Area (CMA) for the basic reason that by her membership to the CMA Swaziland surrenders monetary and exchange rate policy to the South African monetary authorities.

The features of the CMA have evolved from the monetary union tightly based on the ZAR to a situation where Lesotho, Namibia and Swaziland have issued their own currencies, obtaining a certain degree of independence. Given the parity peg of the Lilangeni to the Rand and the free mobility of capital, Swaziland, with a small economy compared to that of South Africa, acts as a price taker of interest rates from South Africa and surrenders its exchange rate policy to the South African authorities as monetary and exchange rate policies in Swaziland under this configuration mirror that of South Africa. The main feature that distinguishes the status quo to that before independence is that the small states can issue their own currency through the local monetary authority, which is formally responsible for monetary policy within the respective country. (Central Bank of
Swaziland (CBS) Annual Report, 2008). It is in that backdrop that Swaziland’s exchange rate volatility is widely explained by exchange rate developments in South Africa as the biggest economy in the CMA region.

1.1 Exchange Rates Developments in Swaziland

Volatility in the exchange rate has varying economic consequences. The first of these is the negative impact exchange rate volatility has on confidence as it makes investment planning and decision making difficult. Swaziland is a small open economy and its economic growth is export led. Maintaining a healthy export sector over a long period of time requires maintaining an appropriately competitive and sustainable exchange rate, which is not possible for Swaziland because of the parity status of the domestic currency with the South African rand. On the face of it, exporters are clear gainers when depreciation of a currency occurs because it enhances the competitiveness of the country’s exports in world markets. Figure 1 illustrates the movement in nominal exchange rates of the local currency (Lilangeni) to the US dollar from 1980 to 2013. During the period under review the exchange rate of the Lilangeni was consistently depreciating up to 2002 when the local currency was at its lowest (around 10.45 to the dollar), until it started declining in 2004 when the lilangeni appreciated.

**Figure 1: Nominal exchange rates movements from 1990 to 2013**

![Nominal exchange rates movements from 1990 to 2013](image)

Source: Central Bank of Swaziland
The currency depreciation can lead to improvement in the trade balance of the country. However, this improvement depends also on responses to price changes, that is, on the price elasticities of demand for exports and imports respectively. For a small country like Swaziland whose well-being is closely tied to export performance, the economic significance of the domestic currency stems from its ability to influence export performance above everything else.

1.2 Foreign Direct Investment (FDI) into Swaziland

Sodersten (1994) defines FDI as the act of purchasing an asset and at the same time acquiring control of it (other than the ability to resell it). In a study of the determinants of FDI inflows in Swaziland Masuku and Dlamini (2009) explain that the importance of foreign direct investment in developing countries like Swaziland has been viewed as a significant factor to economic growth through capital accumulation and or facilitating the use of new inputs and technologies in the production process. This in turn translates to exports growth, technological advancement and skills transfer.

The Government of Swaziland continues to intensify its effort to attract FDI into the country. Despite the intensified efforts, FDI inflows to the country remain low to counter the challenges of high unemployment and the general decline in economic activity in the country. The country remains with the challenge to work even harder to attract the necessary FDI that will spur economic growth and development in the future (CBS, 2011). The government embarked on promoting the country through the establishment of the Swaziland Investment Promotion Authority (SIPA) in 1998. The mandate for SIPA is to attract, promote and facilitate foreign investment in Swaziland.

However, the role of FDI in developing countries remains controversial and depends crucially on the motive for such investment. If the motive behind FDI is to capture domestic market (tariff-jumping type investment); it may not contribute to export growth. On the other hand, if the motive is to tap export markets by taking advantage
of the country's comparative advantage, then FDI may contribute to export growth. Figure 2 shows that FDI in Swaziland has been consistently increasing before 1994. However, after that period fluctuations were experienced in foreign direct investment resulting from the tight competition for FDI in the region mainly on account of the gaining of independence by South Africa.

Thus, whether FDI contributes to export growth or not depends on the nature of the policy regime. By now it is well known that an outward-oriented regime encourages export-oriented FDI while an inward-oriented policy regime attracts FDI mainly to capture domestic rather than export markets (World Bank, 1993). Competition for FDI in the Southern African region remains very high and this means that Swaziland should continue intensifying its effort to attract new FDI by creating a more conducive environment for business. Further, efforts need to be made to retain existing investors in the Swaziland economy to make it worthwhile for them to retain their profits and expand their domestic businesses.

**Figure 2: Trends in FDI Stock and Export Earnings from 1990 to 2013**

![Graph showing trends in FDI Stock and Export Earnings from 1990 to 2013](source: Central Bank of Swaziland)
The slow and fragile recovery of the global economy continues to undermine FDI inflow into the country. This makes it difficult for investors to look for opportunities for expansion because of the slow GDP growth experienced globally which in turn limits the profitability of the companies located abroad because of the low level of the demand for the produced products. This is because high GDP growth rates are associated with high profits for companies, which then translates to increases in incomes needed to purchase the goods and services produced by multinational corporations and hence more expansions to other parts of the world for further production and investments (CBS, 2011).

1.3 Swaziland GDP Structure
During the 1980s Swaziland recorded high economic growth rates, driven by an influx of foreign direct investment (FDI) arising from sanctions imposed on South Africa, which propelled the relocations of some enterprises into Swaziland. The high levels of foreign direct investment caused an economic upturn in the manufacturing sector, which became the main growth engine, which in turn encouraged rapid growth in supporting sectors such as construction. This also generated additional revenue which permitted the consequent expansion of government services. Apart from the inflows into the manufacturing sector, the growth performance was also aided by more conventional external stimuli, such as improved export prices for sugar, reinforced by the real depreciation of the lilangeni.

The manufacturing sector is mostly characterized by firms that are foreign-owned, export-oriented and have strong backward and forward linkages with agriculture. Manufacturing entities range from small factories engaged in light industry to large ones endowed with the latest technology and producing highly sophisticated goods which, given the small size of the domestic market, are destined mainly for the export market. The sector’s contribution to export earnings has improved recently, currently standing above 60 percent of total exports. The contribution to employment by the
manufacturing sector has been declining over the years as firms became more capital intensive in their line of production. However, this was offset by the entrance of Asian enterprises, which are more labour intensive in the production of textile commodities.

The small size of the domestic market and the relatively narrow resource base has stifled further development in the manufacturing sector. Hence prospects for the manufacturing sector depend on the country’s ability to retain the preferential trade treatment under the African Growth and Opportunity Act (AGOA). This Act was signed into law on May 18, 2000 as Title 1 of The Trade and Development Act of 2000. It offers tangible incentives for African countries to continue their efforts to open their economies and build free markets. Not only does this arrangement present a solid and significant opportunity, but it also presents substantial new trade and investment flows for the African countries.

The agricultural sector is the most important sector in the Swaziland economy given its contribution to employment (about 70 percent), foreign exchange, food, and its linkages with other sectors of the economy. Despite the declining volumes of output, the agricultural sector remains indispensable for the majority of Swazi people (especially the rural households) who continue to derive their livelihood and income by engaging in this sector’s activities, which include the production of maize, cotton, sugar, fruits, vegetables, citrus and livestock. Moreover, the sector plays a role in providing substantial support to the manufacturing sector in terms of providing the necessary inputs required by the largely agro-based manufacturing firms. The agricultural sector is constrained by factors such as limited credit facilities, poor storage facilities and marketing service, inappropriate pricing policies to mention just a few. Thus, the overall performance of this sector has been steadily deteriorating over the review period with 8.4 percent recorded in 2010 as the sector’s contribution to GDP. Figure 3 shows trends in the country’s overall GDP growth and inflation, where both show a declining trend.
The transportation and communication systems play a vital role in the service sector of the Swazi economy. This sector has continued to grow strongly and has become the second most significant sector in secondary production. The road network constitutes the most predominant mode of transport of people and goods. The railway infrastructure provides an important regional link between Swaziland and other countries in the region as well as countries in the northern Africa via the ports of Durban and Richards Bay in South Africa. This helps in the facilitation of the export business in the region through the accessibility of ports since Swaziland is a landlocked country. The country’s telecommunication industry is now fully digital, although some challenges in its regulation are still present. The other sectors of the Swaziland economy include construction, banking and insurance (Central Statistical Office, 2010).

1.4 Trends in Swaziland's Export
Swaziland’s membership in the Southern African Customs Union (SACU) and the CMA are important determinants of Swazi trade patterns. The parity status of the lilangeni to the rand has, amongst other things, facilitated cross-border trade with CMA member
countries, in particular South Africa (the country’s major trading partner), attracted tourism from South Africa and guaranteed continued profitability and competitiveness of its export sector. This has manifested itself in the steady growth of exports to South Africa over the past years. At least half of Swaziland’s total fiscal revenue is generated from SACU receipts. Although this association has its advantages, such membership prevents the country from developing its own monetary and trade policies, thus making it virtually impossible for the country to either protect potential domestic industries or follow an independent exchange rate policy. Swaziland is also a member of a number of other trading blocs, such as COMESA and SADC, which provide Swazi products with preferential access to a market consisting of more than 320 million people (Skosana, 2013).

**Figure 4: Trends in Exports and nominal exchange rates from 1990 to 2013**

![Graph showing trends in exports and nominal exchange rates from 1990 to 2013.](image)

*Source: Central Bank of Swaziland*

Furthermore, Swaziland’s products currently enjoy preferential access to European Union (EU) markets while the African Growth and Opportunity Act (AGOA) has opened up duty free access for some of her products to the United States (US) market. Under the Generalized System of Preferences (GSP), Swaziland’s exports have access to markets in
countries such as the US, Australia, Japan and Canada. Figure 3 shows the trends of the value of exports, and exchange rates from 1980 to 2013. Export earnings have been moving in tandem with the depreciation in the exchange rate of the Lilangeni until 2003 when exports in emalangeni terms declined in line with the local currency gaining strength against the dollar. The last two years 2012 and 2013, however, were characterized by increases in exports as shown in Figure 4 (CBS, 2013).

Traditionally, developing countries have been suppliers of primary commodities (minerals and some tropical agricultural products) to the industrialized world (Gowland and Helm, 1985). Likewise, Swaziland’s export sector, like many other developing countries, is dominated by exports of agricultural and manufacturing commodities which include soft drinks concentrates, sugar, wood pulp which formed part of exports until 2009 when Sappi closed down its pulp production. Other commodities include citrus and canned fruits, coal, textiles, and raw iron ore. Soft drink concentrates account for more than 50 percent of the total export earnings followed by sugar. About 60 percent of Swaziland’s exports are destined to the South African market (Skosana, 2013).

1.5 Inflation Trends in Swaziland
The Central Bank of Swaziland has, as its ultimate goal, inflation management to create an environment conducive to economic growth. The monetary authorities in the country basically use the discount rate to control inflation but subservient to the movements in the discount rate in South Africa. Figure 3 further show the trend in Swaziland’s inflation 1990 to 2013, which depicts a falling trend.

Besides controlling inflation by discouraging borrowing through higher interest, imported component of inflation is curbed by a strong Rand on the back of higher interest rates. Swaziland is also affected by South Africa’s imported inflation through imports from South Africa. A stronger Rand therefore means lower imported inflation by Swaziland via South Africa.
1.6 Statement of the problem

The Swaziland economy, like most African countries, is highly dependent on trade, with sugar and sugar concentrates being the most export earner, followed by the agricultural products. Any shock to the export sector, affects both employment and foreign exchange earnings. Hence, it is important to investigate the impact of exchange rate volatility on major macroeconomic variables. The research question driving the study therefore is: What is the impact of exchange rate volatility on the macroeconomic variables in Swaziland and how does the risk of such volatility affect the economy as a whole. The study seeks to assist in formulating the best policies, which would address the economic disturbances created by the exchange rate volatility in order to promote and boost the overall economic performance of the Swazi economy. Exchange rate volatility is known to create two effects; deficiency in domestic markets and the riskiness, which exporters encounter due to such volatility. These are finally transmitted into the economy by means of trade imbalances which could affect the economic growth of the country.

1.7 The Purpose of the Study

This study will examine the effects of exchange rate volatility, or the variability of exchange rates, on the macroeconomic variable in Swaziland in the period (1990 – 2013). It assesses whether the variability of exchange rate had an impact on the performance of the country’s economy as a whole.

The specific objectives of this work are:

(1) To assess econometrically, the impact of exchange rate volatility on the macroeconomic variables in Swaziland.

(2) To suggest policies for the amelioration of the impact of such volatilities on the domestic economy.
1.8 Limitations

The major limitation of the study is the unavailability of high frequency time series data on most of the macroeconomic variables in Swaziland. That is very important because analyzing volatility requires data of very high frequency. However, that will be ameliorated by interpolating the available data into monthly series, although this has implications on the interpretation of the results.
CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Substantial increase of the degree of variability of exchange rate movements since the beginning of the generalized floating has led policymakers and economists to investigate the nature and extent of the impacts of such movements on several macroeconomic variables. Theoretical analysis suggests that uncertainty generated by greater exchange rate volatility may induce risk averse agents to behave differently during periods of volatile exchange rates. Two types of exchange rate volatility can be distinguished: volatility and misalignment. Volatility refers rather to short-term (day-to-day or month-to-month) fluctuations of nominal or real exchange rates. Since the collapse of Bretton-Woods system, volatility has increased substantially. Another type of exchange rate volatility mentioned above is so called misalignment. Contrary to volatility which is a short-term phenomenon, misalignment refers to persistent departures (under- or overvaluation) of real exchange rates from their equilibrium values, i.e. values consistent with their macroeconomic fundamentals.

In spite of the abundant literature on the effects of exchange rate volatility on macroeconomic variables, studies that specifically focus on the Swazi economy are scanty. However, this paper will make use of other empirical studies that have been undertaken worldwide.

2.2 Foreign exchange rate volatility

The issue of volatility in financial time series including exchange rate has received considerable attention from both researchers and relevant practitioners and policy makers alike. Despite this phenomenal growth in research efforts, the choice of a modelling framework has remained inconclusive both theoretically and empirically. The Engle (1982) paper is the first notable work on volatility modelling of financial time
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The paper develops an Autoregressive Conditional Heteroscedasticity (ARCH) model to capture probable statistically significant correlations between observations that are large distance apart and time varying. After the seminal paper of Engle (1982), several extensions have emerged to improve on the latter. Among these extensions are the ARCH in Mean (ARCH-M) by Engle, et al (1987), the Generalized ARCH (GARCH) developed by Bollerslev (1986) and the GARCH family. The latter includes the integrated GARCH (IGARCH) model by Engle and Bollerslev (1986), the multivariate GARCH models (MGARCH) developed by Baba, et al (1990) and extended by Engle and Kroner (1995) and asymmetric GARCH models; exponential GARCH (EGARCH) proposed by Nelson (1991), GJR-GARCH by Glosten, et al, (1993), and asymmetric power GARCH (APGARCH) model by Ding, et al (1993). Several extensive applications of these dimensions of volatility models in relation to modelling of exchange rate volatility exist in the literature.

Salisu (2012) analysed the extent of volatility in exchange rate in Nigeria covering the sustainable democratic transitions between 1999 and 2011 using daily returns. The main innovation of his paper is that it evaluates the volatility under each democratic regime of four years namely 05/29/1999 – 05/28/2003 (SUB1); 05/29/2003 – 05/28/2007 (SUB2); and 05/29/2007 – 05/28/2011 (SUB3). The findings from the empirical analysis appear mixed and in particular, there is evidence of inconsistent leverage effects and persistence of shocks. Large depreciations were recorded during SUB1 and SUB3 compared to SUB2. Thus, monetary policy strategies seem more effective in the latter period than the two former periods. Comparatively, the TGARCH (1,1) model gave the best fit under SUB2 and SUB3 while the GARCH (1,1) was preferred under SUB1. The results obtained from the TGARCH (1,1) model revealed evidence of strong leverage effects. These effects indicate that positive shocks increased the volatility of exchange rate more than negative shocks of the same magnitude. Thus, good news in the foreign exchange market has the potential of increasing volatility in the exchange rate than bad news.

Swarey (2006) utilised three univariate ARCH-type models (GARCH, TGARCH, and
EGARCH) to empirically examine persistence and asymmetry in volatility of prices of primary agricultural commodities produced in Sub-Saharan Africa. Maximum likelihood estimation results of the three models ranked the GARCH version as the best statistical fit, lending support for hypothesis of persistence, symmetry and variability.

In order to measure the overvaluation of rupiah during the Asian crisis in 1997, Saxena (2002) studied the exchange rate dynamics in Indonesia over 1980:1 to 1997:4. This study used the cointegration method, unobserved component model and structural vector auto regression (SVAR) model to analysis the exchange rate policy in Indonesia. Empirical results show that exchange rate is positively related to the term of trade and government expenditure. Lastly, the unobserved component model carry out that Indonesia trade balance increase when exchange rate devaluation.

2.3 Foreign Exchange Rate Volatility and Growth

Evidence of the link from exchange rate volatility to growth is less than conclusive. While Ghosh et al. (1997) found no relationship between observed exchange rate volatility and economic growth for a sample of 136 countries over the period 1960-1989, Bailliu et al. (2001) reported a positive association between the degree of exchange rate flexibility and economic growth. That this association is positive rather than negative leads one to suspect that this result reflects the influence of other factors correlated with both exchange rate flexibility and growth: political stability, institutional strength, financial market development, for example. A further problem with much of this literature is that it focuses on the nominal rather than the real exchange rate. Dollar (1992) does report evidence of a negative OLS relationship between real exchange rate variability and growth in a sample of 95 developing countries covering the period 1976-85.

Straub and Tchakarov (2004) laid out an empirical and a theoretical model to analyze the effects of non-fundamental exchange rate volatility on economic activity and welfare in Canada, Germany and UK. In the first part of the paper, the GARCH-SVAR model was applied to measure empirically the effect of the conditional exogenous exchange rate
volatility on the conditional mean of the endogenous variables in our open economy VAR. The results for Canada, Germany and UK indicate that the effects of exchange rate uncertainty are small empirically. In the second part, they investigate the effect of non-fundamental exchange rate volatility in a stochastic open economy model. The second order approximation method of Sims et al [2003] was applied to the model equilibrium conditions. They show that in a model with habit persistence, even non-fundamental exchange rate volatility that generate only small variation in the unconditional mean of the variables might induce economically significant welfare changes.

Using different measures and country samples, Bosworth et al. (1995) and Hausmann et al. (1995) report similar results. Belke and Kaas (2004) found the same results focusing on employment growth in the Central and Eastern European transition economies. Two other studies exploring the relationship between real exchange rate variability and growth in different developing country samples, Ghura and Grennes (1993) and Bleaney and Greenaway (2001) found little evidence of a relationship. Potential explanations include different country samples, different periods, different controls, different ways of measuring the real exchange rate, and different degrees of omitted-variables and simultaneity bias.

Chukwu (2007) and Adubi & Okunmadewa (1999) concluded that foreign exchange rate is a determinant of export trade and economic growth in Nigeria. Similarly, Lama & Medina (2010) observed a coincidence in exchange rate appreciation with a contraction of 3 percent in the country’s gross domestic product in the manufacturing sector; with a 2 percent average decline in manufacturing GDP over a 20 year period characterized by foreign exchange rate appreciation. Although, carrying attendant risks, foreign exchange rate movement are monetary policy instruments to achieve export growth, economic growth and development of any nation.

Other scholars argue that with growth variable entering the equation, there is a negative
relationship between productivity growth and exchange rate volatility in less financially developed countries and there is no link between the two in developed countries (Aghion et al., 2006). In close connection to the above mentioned, Schnabl (2007) shows that exchange rate stability exerts a negative influence on growth in developing states because it doesn’t allow them to react flexibly to real shocks and stimulates speculative capital inflows. On the other hand, it carries a positive influence on economic growth as it leads to lower transaction costs in international trade, decreases the uncertainty of capital flows and stimulates international macroeconomic stability.

### 2.4 Foreign Exchange Rate Volatility and Export Performance

Foreign exchange fluctuations whether positive or negative are not desirable to producers of export products as it has been found to increase risk and uncertainty in international transactions which discourages trade (Adubi and Okunmadewa, 1999). Findings by the IMF (1984) revealed that these fluctuations induce undesirable macroeconomic phenomena called inflation. Similarly, Caballero and Corbo (1989) observed positive effect of exchange rate fluctuations on export trade in European Union countries. Accordingly, Walsh and Yu (2010) noted that low exchange rate favour the importation of production machinery, and favours production and exports in periods of high foreign exchange rate. Lama and Medina (2010) opined that different open economies experience different episodes of exchange rate appreciation in response to different types of stocks, contending that an appreciation in exchange rate induces a contraction of the exporting manufacturing sector. Maintenance of export performance to them require the depreciation of the real exchange rate of a country’s currency, achievable through monetary injections; noting that a policy of exchange rate depreciation can successfully prevent a contraction of export output, having an allocative effect in the economy.

Arize et al. (2000) investigated real exchange rate volatility on the exports of 13 less
developed countries with quarterly data series for the period 1973-1996 using Johansen’s multivariate procedure for long-run and error correction model to analyze the short-run dynamics. Their study reveals a significant negative impact of volatility on export flows. Broda (2004) examined the panel data of 75 developing countries covering periods between 1973 and 1996 using the VAR model. He found that there exists substantial impact of real shocks, such as shocks to terms of trade of a country, on real GDP in the short term. He also suggested that negative shocks lead to larger real exchange rate changes in countries with flexible exchange rate regimes.

Bakhromov (2011) did a study that estimates the effect of exchange rate volatility on the international trade in Uzbekistan during the 1999-2009 period. Results showed that the real exchange rate volatility has a substantial impact on the exports and imports of the country during the given period. Furthermore, using Johansen’s cointegration framework, he tested for the presence of unique cointegrating vectors linking series such as exports (imports), foreign (domestic) income, relative export (import) prices (proxied by real exchange rate) with the volatility of the real exchange rate in the long run. Results showed that increases in the volatility of the real exchange rate have significant negative effects on equations of exports and imports in the long-run dynamics. It was also observed that improvements in the terms of trade, as represented by declines in the real exchange rate, positively affect exports. Overall, the findings suggest that trade can be further increased as a result of sound macroeconomic policies directed to achieve and maintain a stable real exchange rate.

Rahman and Serletis (2006) did a study on the effects of exchange rate uncertainty. In this paper they used United States data to examine the effects of exchange rate volatility on exports and output, in the context of a multivariable framework in which a structural vector autoregression (SVAR) was modified to accommodate multivariate GARCH-in-mean errors. The model took into account the possible interaction between conditional means and variances and was able to handle the problem of heteroscedasticity. They
observed evidence that exchange rate volatility has significant negative effects on exports. The study also analyzed the effects of shocks to the various variables, using an analytic expression for the impulse response function of the multivariate GARCH-in-mean VAR, analogous to the impulse response function of an orthogonalized VAR.

2.5 Foreign Exchange Rate Volatility and Inflation

Analyzing the performance of floating exchange rate regimes combined with inflation targeting versus fixed exchange rate regimes, Gali and Monacelli (2004) showed that the price paid by the adherents of the first category for the simultaneous stabilization of the output gap and inflation was a higher exchange rate volatility, both in nominal and real terms. In close connection with this, Bleaney and Francisco (2008) show that inflation targeting reduces the volatility of real exchange rate expectations, given the tendency of associating it with floating exchange rate regimes. Taking a look at the issue from the opposite angle, namely the influence of exchange rate volatility on inflation performance, the cross-country research conducted by Edwards (1993) showed that developing countries that have adopted a fixed rate regime obtained better inflationary performances than countries that practice schemes characterized by greater flexibility. Inflation is much lower and less volatile in peg regimes.

According to a study by Sachs (1985), the indirect effects of exchange rate fluctuations are divided into the competition effect and the wage inflation effect. The competition effect takes place when there are shifts in the demand for domestic output due to exchange rate fluctuations. An exchange rate appreciation leads to an increase in export prices and fall in import prices. Given unchanged domestic costs, domestic producers have to react to lower import prices by cutting their own prices and profits margins due to lower competitors’ prices. On the other hand, exchange rate depreciation is likely to lead to an increase in the domestic demand for substitutes due to the rising import prices, thus putting upward pressure on prices of such products and causing consumer prices to rise. At the same time depreciation of the domestic currency makes exports more competitive.
on the world market. The rising demand of exports leads to an upward pressure on the price of domestic tradable goods which also contribute to the rise in consumer prices. The last channel is the wage inflation effect. The wage inflation effect works through the determination of nominal wages which has a direct impact on production costs. Exchange rate depreciation increases the price of imported consumption goods leading to a fall in purchasing power of workers. To compensate for the fall in purchasing power, employers are forced to increase nominal wages and this leads to an increase in the cost of production which is consequently passed through into higher output prices.

Ragoobur and Chicooree (2012) did a study on exchange rate volatility in Mauritius. The aim of this study was to analyse the effect of exchange rate volatility pass-through on import price, producer price index and consumer price using quarterly data from 1999 to 2010. The VAR analysis enabled the researchers to analyse the effect of exchange rate volatility along the distribution chain. From the analysis of impulse response functions, it suggested that the degree of pass-through to the exchange rate shock varies across different price indices. It was observed that the effect of exchange rate volatility is the largest on import price index then PPI and the smallest on CPI.

2.6 Foreign Exchange Rate Volatility and FDI

Alaba (2003) is one of the very few studies that have attempted to bridge the gap on the exchange rate volatility-FDI nexus for SSA countries. The study aimed at determining the magnitude and direction of the effects of exchange rate movements and its volatility on FDI flows to agriculture and manufacturing sectors in Nigeria. Employing the GARCH measure of volatility, the error correction methodology was used for the empirical investigation in testing the effects of both the official and parallel market exchange rates on FDI flows to agriculture and manufacturing. While the results show that the official market exchange rate movement significantly reduces FDI inflows to agriculture, the same is, however, insignificant for the manufacturing FDI. For the volatility coefficients, official market exchange rate volatility was not found to be significant for FDI inflows to
both manufacturing and agriculture. Conversely, the estimated parallel market exchange rate coefficients suggest that both systematic movement of the exchange rate and its volatility are significant for flow of FDI to both agriculture and manufacturing in Nigeria with the parallel market rates, yielding both negative and positive signs for exchange rate volatility in the two sectors. The emerging conclusion was that while exchange rate volatility attracted investment in agriculture, it rather deterred FDI in the manufacturing sector, thus suggesting ambiguity on the effects of exchange rate movements and its volatility on FDI inflows.

Ruiz and Pozo (2008) stated in their study that if the purpose of FDI were either to serve other markets or bring production back to the home country, a negative relationship between FDI and exchange rate uncertainty would likely arise. There are a lot of studies which are compliant with this argument, for example, Kiyota and Urata (2002) investigated the relationships between exchange rate volatility and FDI coming from USA and Japan to their partner countries and they found out that volatility observed in exchange rate affect FDI from both countries negatively. Moreover, the empirical study of Dorantes and Pozo (2010), was distinctive than previous works in a sense that they considered the non-stationary series and took advantage of conditional variance rather than unconditional variance. But they still drew the same conclusion with Kiyota and Urata (2002) in the effect of exchange rate uncertainty on FDI inflows for USA.

Ruiz and Pozo (2008) analysed the impact of exchange rate uncertainty on US foreign direct investment into seven Latin American countries. They also decomposed uncertainty into temporary (short-run) and permanent (long-run) components by employing GARCH estimation. They concluded that exchange rate volatility affects FDI inflows to Latin America from USA negatively. They also touched the timing aspect of uncertainty in exchange rate such that they argued that the persistency in exchange rate volatility deter FDI inflows more than transitionary uncertainty.
Ullah et al (2012) investigated the relationship of FDI with exchange rate and exchange rate volatility in Pakistan using data between 1980-2010. Variables used in this study were FDI, inflation, trade openness, exchange rate and exchange rate volatility. Econometric techniques including volatility analysis, co-integration technique, unit root test and causality test were applied for analysis of data. ARCH and GARCH techniques used to calculate the volatility. Findings of the study shows that Rupee depreciation positively relates with the FDI while exchange rate volatility negatively. Inflation affected FDI positively but it was highly insignificant. The paper concluded with the policy recommendation to reduce the exchange rate volatility and maintain the exchange rate in well-suited form.

Chowdhury and Wheeler (2008) used data from four developed countries. The aim of this paper was to check the impact of shocks to exchange rate uncertainty (volatility) on FDI for the sample of four countries Japan, Canada, US, UK by applying GARCH and VAR model approach. They took FDI as dependent variable and real output, price level, volatility of real exchange rate, interest rate, real exchange rate as independent variables. The result showed that exchange rate volatility has positive and significant impact on FDI. The effect was found to be positive and significant in Canada, Japan and US. Chaduhary et al (2012) again took the annual data from 1980 to 2010. The objective of this paper was to examine the effect of volatility of exchange rate on FDI for the sample of Asian economies by applying autoregressive distributed lag, GARCH approach, ARCH/GARCH mixed modelling approach. They took FDI as dependent variable and volatility exchange rate as explanatory variables. The result shows that there is positive and significant relationship between FDI and volatility exchange rate. The result shows the existence of long run and short run effect of volatility exchange rate and FDI in Asian economies.
2.7 Foreign Exchange Rate Volatility and Public Investment

Campa and Goldberg (1995) report that the effect of the exchange rate on investment can change as patterns of external exposure shift over time. While U.S. manufacturing sectors were primarily export-exposed in the 1970s, they became predominantly import-exposed by the early 1980s. Consequently, exchange rate appreciations reduced investment in durable goods sectors in the 1970s but stimulated investment after 1983. While exchange rate volatility depressed investment, the effects were small. Campa and Goldberg (1999) extended these results and estimated their model for the two-digit manufacturing sectors of the United States, the United Kingdom, Canada, and Japan. They found that, across countries, exchange rates tend to have insignificant effects on investment rates in high markup sectors. However, investment responsiveness to exchange rates is fairly strong in low markup sectors. Surprisingly, there is no significant effect for either low or high markup industries for Canada.

2.8 Volatility and Asymmetries

Although there is vast literature that investigates the effects of exchange rate volatilities on the real economy, there are relatively few studies that investigate the asymmetric effect of such volatilities on economic activities, in developing economies. Most studies focussed on oil price volatility than exchange rate volatility when investigating asymmetries.

Lee, et al. (1995) modelled oil price asymmetry using a univariate generalized autoregressive conditional heteroscedasticity (GARCH, 1, 1) model. They calculate an oil price shock variable, reflecting the unanticipated component as well as the time-varying conditional variance of oil price changes, introduced it in various vector autoregression (VAR) systems, and found that oil price volatility is highly significant in explaining economic growth. They also establish evidence of asymmetry, in the sense that positive shocks have a strong effect on growth while negative shocks do not. A disadvantage of the Lee, et al. (1995) approach, however, is that oil price volatility is a generated
Rahman and Serletis (2008) investigate the asymmetric effects of uncertainty on output growth and oil price changes as well as the response of uncertainty about output growth and oil price changes to shocks using general bivariate framework in a modified vector autoregression. They employ simulation methods to calculate Generalized Impulse Response Functions (GIRFs) and Volatility Impulse Response Functions (VIRFs) to trace the effects of independent shocks on the conditional means and the conditional variances, respectively, of the variables. They find that bivariate, GARCH-in-mean, asymmetric VAR-BEKK model embodies a reasonable description of the monthly U.S. data, over the period from 1981:1 to 2007:1. They show that the conditional variance-covariance process underlying output growth and the change in the real price of oil exhibits significant nondiagonality and asymmetry, and presents evidence that increased uncertainty about the change in the real price of oil is associated with a lower average growth rate of real economic activity.

Keikha, et al (2013) investigated the positive and negative effects of oil price volatilities (asymmetric effect) on GDP, consumer price index, imports, government expenditure and money stock using quarterly data through the Structural VAR approach and using Impulse Response Function and Variance Analysis. Results of Impulse Response Function and Variance Analysis indicated that the economy of Iran is sticky to the oil income. The effect of oil shocks on studied macroeconomic variables is as expected and asymmetric and was divergent for most variables. This effect is not adjusted even in the twenty seasons. Oil shocks (especially positive shocks) had serious and significant role in volatilities of other variables in long-term.
CHAPTER 3

METHODOLOGY

3.1 Exchange Rate Volatility

Exchange rate volatility is a measure that intends to capture the uncertainty faced by exporters due to unpredictable fluctuations in the exchange rates. Clearly, this is an unobservable variable and thus its measure is a matter of serious contention. Consequently the literature is not unanimous as to which measure is most appropriate. It should be noted that different methods have been identified in literature to estimate foreign exchange rate volatility. In the work of Anderton and Skudelny (2001), quarterly variance of the weekly nominal exchange rate was used to measure exchange rate volatility. While Zubair and Jega (2008) used moving average standard deviation to measure the exchange rate volatility, Gujarati (2003) measure exchange rate volatility in terms of mean-adjusted and the squared deviation of variance of each series in a sample. Another measure of exchange rate volatility is the conditional variance of the first difference of the log of the exchange rate. Both the autoregressive conditional heteroscedasticity (ARCH) by Engel (1982) and the generalized conditional heteroscedasticity (GARCH), proposed by Bollerslev (1986), which is the generalization of ARCH model, can be used to measure exchange rate volatility. This paper follows recent literature and uses the measures derived from the GARCH model as a measure of exchange rate volatility from 1990:01 to 2013:12.

The choice between using the real or nominal exchange rate in empirical analysis of this issue has been prominently discussed in literature. Due to sticky prices, it has been argued that the real and nominal exchange rate volatilities should be the same in the short to medium run. However, in the presence of high inflation, nominal exchange rate volatility is expected to be higher than real exchange rate volatility (Clark, P. et al. 2004). For this
reason, the empirical analysis in this paper will use the real exchange rate volatility (RERV).

### 3.1.1 ARCH and GARCH Models

The measure of volatility is the autoregressive conditional heteroscedasticity (ARCH) proposed by Engel, (1982) and the generalized conditional heteroscedasticity (GARCH) proposed by Bollerslev, (1986). The ARCH is defined in terms of the distribution of errors of a dynamic linear regression model. Assuming that a dependent variable $x_t$ is generated by the autoregressive process:

$$p_t = \beta_0 + \sum_{i=1}^{k} \beta_i p_{t-i} + \varepsilon_t.$$  

To generate the ARCH ($p$) process, we express the conditional variance of the above equation as a function of its past values squared:

$$\varepsilon_t \mid \Omega_{t-1} \sim N(o, \sigma_t^2),$$

$$\sigma_t^2 = \mu_0 + \sum_{i=1}^{p} \mu_i \varepsilon_{t-i}^2,$$

Where $\sigma_t^2$ denotes the conditional variance of the information set $\Omega_{t-1}$ that is available at time $t-1$, and $\mu_i \geq 0$ for all $i = 1, 2 \ldots p$ and $\mu_1 + \mu_2 + \ldots + \mu_p < 1$ are necessary to make $\varepsilon_t^2$ positive and covariance stationary.

According to Engle (1995), one of the drawbacks of the ARCH specification was that it looked more like a moving average specification than an autoregression. Hence a new idea was to include the lagged conditional variance terms as autoregressive terms, hence the GARCH, proposed by Bollerslev (1986) came into being. It takes the form:
\[ \sigma_t^2 = \mu_0 + \sum_{i=1}^{p} \gamma_i \sigma_{t-i}^2 + \sum_{j=1}^{q} \mu_i \epsilon_{t-i}^2, \]

which says that the value of the variance \( \sigma_t^2 \) now depends both on past values of the shocks, which are captured by the lagged squared residual terms, and on past values of itself, which are captured by the lagged \( \sigma_t^2 \) terms. The autoregressive root which governs the persistence of volatility shocks is the sum of \((\mu+\gamma)\). In many applied settings this root is close to unity, so that shocks die out rather slowly.

### 3.2 Threshold for exchange rate volatility

A major restriction to the ARCH and GARCH specifications is the fact that they are symmetric, meaning what matters is the absolute value of the innovation and not its sign. Therefore in ARCH/GARCH models a big positive shock will have exactly the same effect in the volatility of the series as a big negative shock of the same magnitude. However, for equities it has been observed that negative shocks (or ‘bad news’) in the market have a larger impact on volatility than positive shocks (or ‘good news’) of the same margin. Glosten, Jaganathan and Runkle (1993) introduced the Threshold GARCH (TGARCH) model whose main target is to capture asymmetries in terms of negative and positive shocks. The model simply adds to the variance equation a multiplicative dummy variable to check whether there is statistically significant difference when shocks are negative. The TGARCH model takes the general form:

\[ \sigma_t^2 = \mu_0 + \sum_{i=1}^{p} (\mu_i + \gamma_i d_{t-i}) \epsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2, \]

Where \( d_t \) takes the value of 1 for \( \epsilon_t < 0 \), and 0 otherwise. That makes ‘good news’ and ‘bad news’ to have different impacts. Good news has an impact \( \mu \), while bad news has an impact \( \mu + \gamma \). If \( \gamma > 0 \) we conclude that there is asymmetry, while if \( \gamma = 0 \) the news
impact is symmetric. The Exponential GARCH (EGARCH) model, which was first developed by Nelson (1991), will be used as to further support the results obtained from the TGARCH model. Just like the TGARCH, the EGARCH model allows for the testing of asymmetries or leverage effects. These asymmetric effects of the exchange rate volatility will further be analysed for both negative and positive shocks. The Hodrick-Prescott (HP) filter will be applied in the separation of the cycle and the trend. The cycle will further be separated to show series for both positive and negative shocks.

3.3 Effect of exchange rate volatility on macroeconomic variables

The review of literature on the effect of exchange rate volatility on macroeconomic performance had shed some light on the linkage between the macroeconomic management and exchange rate volatility. The review also helped in suggesting a suitable model for analysing the impact of exchange rate volatility on major macroeconomic variables in Swaziland. This chapter therefore develops a simple empirical model for this estimation. There are a large number of macroeconomic variables which affect macroeconomic performance besides the exchange rate. They include; investment, consumption, government spending, trade, foreign direct investment, inflation, balance of payment, among others. The study will cover a period of 23 years (1990-2013). In this study the structural vector autoregressive model (SVAR) is adopted to estimate the effects of exchange rate volatility on macroeconomic variables, and extends to the granger causality tests, impulse response, and variance decomposition. The Johansen (1988) cointegration test will be used to test for a long run cointegration relationship among the variables. Despite the large number of macroeconomic variables, in this study, focus variables are real exchange rate volatility (REXV), which measures uncertainty associated with fluctuations in the exchange rate, real Gross Domestic Product (GDP), public investment (PINV), Foreign Direct Investment (FDI), Consumer price Index (CPI), reserves (RR), and exports (EX). The Augmented Dickey Fuller (ADF) was used to test for the stationarity or otherwise of the variables. The minimum of the Akaike Information
Criterion (AIC) and the Schwarz Bayesian Criterion (SBC) was used for lag length selection.

### 3.4 Structural VAR Estimation

A structural VAR uses economic theory to sort out the contemporaneous links among the variables (Bernanke, 1986; Blanchard and Watson, 1986; Sims, 1986). Structural VARs require “identifying assumptions” that allow correlations to be interpreted causally. These identifying assumptions can involve the entire VAR, so that all of the causal links in the model are spelled out, or just a single equation, so that only a specific causal link is identified. This produces instrumental variables that permit the contemporaneous links to be estimated using instrumental variables regression. There is no consensus on the number of variables required in a SVAR model to provide a plausible interpretation of an economy. Dungey and Pagan (2000) included eleven variables in analysing the Australian economy while Kim and Roubini (2000) argued that seven variables are enough for smaller economies.

The basic structural VAR model in our study contains seven endogenous variables as previously stated. The matrix form of the equation of the VAR model is selected as follows:

\[
AY_t = \sum_{i=1}^{p} B_i Y_{t-i} + \epsilon_t
\]

(1)

Where;  
- \( Y \) is the vector containing the seven endogenous variables.  
- \( A \) is a square matrix of coefficients to be estimated.  
- \( \epsilon \) is a vector of serially uncorrelated, and mutually orthogonal structural disturbances.  
- \( p \) is the number of lags.
The structural model represented by the above system must be identified for the purpose of policy analysis and must be given economic interpretation (Leeper et al., 1996). The fundamental problem is that the model is not directly observable, hence cannot be directly estimated to derive the true values of the coefficient vectors. A reduced form of the model, which is obtained by multiplying both sides by \( A^{-1} \), is specified as follows:

\[
Y_t = A^{-1} \sum_{i=1}^{p} B_i Y_{t-i} + e_t
\]

where \( e_t \) is a vector of serially uncorrelated, but not necessarily orthogonal, reduced form disturbances. In that regard, the relationship between the reduced form VAR residuals \( (e_t) \) and structural shocks \( (\varepsilon_t) \) can be expressed as follows:

\[
e_t = A_0 \varepsilon_t
\]

Based on the Cholesky decomposition of the reduced form VAR, we have to impose \( n(n-1)/2 \) (= 21 in our model) constraints that define matrix \( A_0 \) as a lower triangular matrix. The lower triangularity of \( A_0 \) implies a recursive scheme (structural shocks are identified through reduced form VAR residuals) among variables (the Wald chain scheme) that has clear economic implications and has to be empirically tested as any other relationship. Identification scheme of the matrix \( A_0 \) implies that particular contemporaneous interactions between some exogenous shocks and some endogenous variables are restricted reflecting causal chain of interaction transmission. Therefore the Wald causal chain is incorporated via convenient ordering of the variables. Thus, the order of the variables is as follows: real GDP, real exchange rate volatility, consumer prices index, FDI, exports, reserves and public investment. The matrix form of the SVAR model can be expressed as follows:
Exchange Rate Volatility and its Effect on Macroeconomic Management in Swaziland

\[
\begin{bmatrix}
\varepsilon_{\text{GDP}_t} \\
\varepsilon_{\text{REXV}_t} \\
\varepsilon_{\text{CPI}_t} \\
\varepsilon_{\text{FDI}_t} \\
\varepsilon_{\text{RR}_t} \\
\varepsilon_{\text{EX}_t} \\
\varepsilon_{\text{PINV}_t}
\end{bmatrix} =
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & a_{21} & 1 & 0 & 0 & 0 & 0 \\
0 & a_{31} & a_{32} & 1 & 0 & 0 & 0 \\
0 & a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\
0 & a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 \\
0 & a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\
0 & a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1
\end{bmatrix}
\begin{bmatrix}
\varepsilon_{\text{GDP}_t} \\
\varepsilon_{\text{REXV}_t} \\
\varepsilon_{\text{CPI}_t} \\
\varepsilon_{\text{FDI}_t} \\
\varepsilon_{\text{RR}_t} \\
\varepsilon_{\text{EX}_t} \\
\varepsilon_{\text{PINV}_t}
\end{bmatrix}
\]

Where the left hand side of the equation contains a vector of residuals in the reduced form, and in the right hand side is the squared matrix \((A_0)\) of coefficients associated with lagged variables and structural shocks through the column vector \((\varepsilon)\).

Correct identification of the exogenous structural shocks reflecting Cholesky ordering of the variables denotes the following assumptions:

- Real output does not contemporaneously respond to the shock from any other endogenous variable of the model.
- Real exchange rate volatility contemporaneously responds to the shock from CPI, but not other variables.
- CPI contemporaneously respond to exchange rate volatility and output shocks, but not to the other endogenous variables.
- FDI contemporaneously respond to GDP, public investment, and export shocks, but not the other variables.
- Reserves contemporaneously respond to GDP, exchange rate volatility, public investment, and export shocks, but not CPI and FDI.
- Exports contemporaneously respond to all the variables with the exception of CPI.
- Public investment contemporaneously responds to all the shocks from the endogenous variables.

In that regard, 3 models were estimated in order to further accommodate the asymmetric effect of real exchange rate volatility on macroeconomic variables in Swaziland. In undertaking this analysis, three structural VAR models were estimated utilising monthly data over the sample 1990:01 – 2013:12 for the vector series;
\[ Y_1 = [\text{REXV}, \text{GDP}, \text{PINV}, \text{FDI}, \text{CPI}, \text{RR}, \text{EX}, \text{DUM2010}] \]
\[ Y_2 = [\text{POSTV}, \text{GDP}, \text{PINV}, \text{FDI}, \text{CPI}, \text{RR}, \text{EX}, \text{DUM2010}] \]
\[ Y_3 = [\text{NEGTV}, \text{GDP}, \text{PINV}, \text{FDI}, \text{CPI}, \text{RR}, \text{EX}, \text{DUM2010}] \]

Where POSTV and NEGTV are positive and negative shocks respectively obtained from the HP filter, and all other variables are as previously explained.

### 3.5 Data Sources

All the data used in this study are secondary data obtained from monthly statistical bulletins of the Central Statistics Office (CSO) and the Central Bank of Swaziland (CBS) annual and quarterly reports. The data are monthly and cover the period from 1990 to 2013. In the case of variables with annual and quarterly data, these data sets will be interpolated to generate monthly series.

#### 3.5.1 Real exchange rates

Nominal exchange rate of the Lilangeni to the dollar will be deflated with the corresponding CPIs to get the real exchange rate using the formula:

\[ \text{Real Exchange rate} = \text{Nominal exchange rate} \times \frac{\text{Swaziland CPI}}{\text{US CPI}}. \]

Data for US CPI will be sourced from the World Bank data base.

#### 3.5.2 Exports

Data for exports will be obtained from the CBS.

#### 3.5.3 Real GDP at constant prices

Data for real GDP was obtained from the CSO. GDP can be measured in both constant and current prices. This study uses real GDP at constant prices so that inflation is factored out.

#### 3.5.4 Public Investment
Data on public investment will be obtained from the CSO, which is on the expenditure side of GDP.

3.5.5 Foreign Direct Investment
Data on FDI will be obtained from the Central Bank of Swaziland quarterly reports.

3.5.6 Consumer Price Index
Data for CPI will be obtained from the CSO.

3.5.7 Gross Official Reserves
Data on reserves will be obtained from the Central Bank of Swaziland quarterly reports.

3.5.8 US dollar exchange rate
Data on USD will be obtained from the Central Bank of Swaziland quarterly reports.

3.5.9 Dummy 2010
This variable captures the financial crisis faced by the country in 2010/11.
CHAPTER 4

DISCUSSIONS AND FINDINGS

4.1 Real Exchange rate volatility

The major objective of this paper is to assess the effect of exchange rate volatility on macroeconomic performance in Swaziland. As an open and lower middle income country, Swaziland considers exchange rate as a key macroeconomic policy instrument that ensures export promotion and economic growth. Swaziland, through its monetary policy, maintains the pegging of the lilangeni to the South African rand. It is in that regard that the exchange rate volatility of the Lilangeni is widely explained by the South African economy. However, this paper explores the impact of such volatility to macroeconomic variables in Swaziland.

It is that regard that this chapter begins with the application of the GARCH (1, 1) approach to estimate the real exchange rate volatility of the Lilangeni against the US dollar. The real exchange rate was calculated based on the formula presented in section 3.4.1 under the data sources. Results for the real exchange rate volatility are presented in the Table 1.

Table 1: Dependent Variable: REAL_EXCH_RATES
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.007069</td>
<td>0.004356</td>
<td>1.622989</td>
<td>0.1046</td>
</tr>
<tr>
<td>REAL_EXCH_RATES(-1)</td>
<td>1.004919</td>
<td>0.002262</td>
<td>444.2099</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
Exchange Rate Volatility and its Effect on Macroeconomic Management in
Swaziland

Variance Equation

<table>
<thead>
<tr>
<th></th>
<th>Coefficient 1</th>
<th>Coefficient 2</th>
<th>Coefficient 3</th>
<th>Coefficient 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>5.18E-05</td>
<td>3.32E-05</td>
<td>1.560146</td>
<td>0.1187</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>0.595403</td>
<td>0.066890</td>
<td>8.901233</td>
<td>0.0000</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>0.635381</td>
<td>0.032849</td>
<td>19.34260</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared 0.992449  Mean dependent var 4.841731
Adjusted R-squared 0.992423  S.D. dependent var 2.880033
Durbin-Watson stat 1.628164

From the results in Table 1, the lower part of output refers that the sum of the ARCH parameters (RESID(-1)^2) correspond to $\mu$ and the GARCH(-1) parameter which corresponds to $\gamma$ is 1.23 and close to one, indicating that volatility shocks of Swaziland’s real exchange rate are quite persistent. Figure 5 shows graphical results of the real exchange rate volatility of the Lilangeni.

**Figure 5: Lilangeni/US Dollar real exchange rate volatility**

Source: Author’s calculations

As shown in Figure 5, there is evidence of volatility of the lilangeni in the periods between 1998, 2001 and 2002, and 2008 and 2010. Ever since South Africa adopted the flexible exchange rates system in the mid 1990’s, the rand/lilangeni has been very
volatile. Furthermore, recent studies show that inflation targeting regimes are associated with more currency volatility, which is likely the case with South Africa, which adopted this framework in the last decade.

4.2 Threshold for exchange rate volatility
The threshold GARCH (TGARCH) model’s main target is to capture asymmetries, or leverage effects, in terms of negative and positive shocks. The model simple adds to the variance equation a multiplicative dummy variable to check whether there is statistically significance difference when shocks are negative or positive, that is whether negative shocks (or ‘bad news’) in the market have a larger impact on volatility than positive shocks (or ‘good new’) of the same margin. The TGARCH (1, 1) is an extension of the GARCH (1, 1) results presented in 4.1 in this chapter where the persistency of real exchange rate volatility was observed. The results of the TGARCH model are presented in Table 2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.005415</td>
<td>0.004482</td>
<td>1.208172</td>
<td>0.2270</td>
</tr>
<tr>
<td>REAL_EXCH_RATES(-1)</td>
<td>1.007984</td>
<td>0.002719</td>
<td>370.7226</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Variance Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>4.98E-05</td>
<td>2.85E-05</td>
<td>1.746634</td>
<td>0.0807</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>0.695992</td>
<td>0.089604</td>
<td>7.767430</td>
<td>0.0000</td>
</tr>
<tr>
<td>RESID(-1)^2*(RESID(-1)&lt;0)</td>
<td>-0.484219</td>
<td>0.121509</td>
<td>-3.985039</td>
<td>0.0001</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>0.703887</td>
<td>0.034673</td>
<td>20.30091</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared 0.992445 Mean dependent var 4.841731
Adjusted R-squared 0.992418 S.D. dependent var 2.880033
Durbin-Watson stat 1.632193

Central Bank of Swaziland, 2014
The results obtained from the TGARCH (1, 1) model reveal evidence of leverage effects as evidenced by the significant coefficient of -0.48 for the TGARCH. These effects indicate that positive shocks increased the volatility of exchange rate more than negative shocks of the same magnitude during the sample under consideration. Thus, good news in the foreign exchange market has the potentiality of increasing volatility in the exchange rate than bad news. These results were further confirmed by the exponential GARCH (EGARCH) which yielded the same conclusion that indeed positive shocks have the tendency of aggravating the real exchange rate volatility in the foreign exchange market.

After obtaining the above results, the next step was to separate the cycle from the trend in the real exchange rate volatility series. The HP filter was used in this process and the results are shown in Figure 6.

**Figure 6: The cycle and trend separated by the HP filter**

The cycle was further separated into positive and negative shocks in order to capture their effect on macroeconomic variables distinctively. The results of such separation are shown in Figure 7.
4.3 Test for stationarity

According to Granger (1969), stationarity tests are the pre-tests for avoiding spurious regressions. They are the starting point in any cointegration analysis as well as regression analysis. In non-stationary series, the order of integration is therefore determined by the number of times it has to be differenced to attain stationarity. If two or more series are integrated of the same order, there exists the possibility to estimate a linear relationship between them (Engle and Granger, 1987). In this study, as previously stated, the Augmented Dickey Fuller (ADF) test was used to test for unit roots. As with most time series data, all the variables were not stationary at their levels, save for real exchange rate volatility, inclusive of positive and negative, were found to be I(0). Results for stationarity tests are presented in Table 3.

Table 3: Unit root test results (first difference)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Constant</th>
<th>Constant and trend</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPORTS</td>
<td>-2.648***</td>
<td>-2.851</td>
<td>-1.616</td>
</tr>
<tr>
<td>GDP</td>
<td>-4.509*</td>
<td>-4.599*</td>
<td>-1.456</td>
</tr>
<tr>
<td>PUB INV</td>
<td>-4.753*</td>
<td>-4.759*</td>
<td>-4.348*</td>
</tr>
</tbody>
</table>
4.4 Cointegration test results

After determining the order of integration of the variables, the next step is to determine whether there is cointegration between the variables. This is to establish if the linear relationship of the variables is stationary. If the null hypothesis of no cointegration is rejected then the linear combination of the variables is stationary, hence a non-spurious long-run relationship exists between the variables and as such, consistent estimates of the long run relationship is evident. To test for cointegration between these variables, the Johansen test is applied. The inclusion of the stationary exchange rate volatility series in our estimation is not an issue, and Johansen (1995) states that there is little need to pre-test the variables in a VAR system to establish their order of integration. The first step in conducting the test was to identify the optimal lag length, whose results are shown in Table 4.

Table 4: VAR Lag Order Selection Criteria

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1122.296</td>
<td>NA</td>
<td>7.95e-13</td>
<td>-7.994950</td>
<td>-7.903845</td>
<td>-7.958404</td>
</tr>
<tr>
<td>2</td>
<td>5778.006</td>
<td>310.6071</td>
<td>5.15e-27</td>
<td>-40.66671</td>
<td>-39.30013*</td>
<td>-40.11851*</td>
</tr>
<tr>
<td>3</td>
<td>5845.037</td>
<td>123.4894</td>
<td>4.53e-27*</td>
<td>-40.79596*</td>
<td>-38.79164*</td>
<td>-39.99193*</td>
</tr>
<tr>
<td>5</td>
<td>5913.362</td>
<td>41.12012</td>
<td>5.65e-27</td>
<td>-40.58324</td>
<td>-37.30344</td>
<td>-39.26756</td>
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<tr>
<td>7</td>
<td>5958.378</td>
<td>35.13452</td>
<td>8.40e-27</td>
<td>-40.20343</td>
<td>-35.64814</td>
<td>-38.37609</td>
</tr>
<tr>
<td>8</td>
<td>5984.129</td>
<td>40.98020</td>
<td>1.01e-26</td>
<td>-40.03677</td>
<td>-34.84374</td>
<td>-37.95360</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion.
The minimum of the Akaike Information Criterion (AIC) and the final Prediction Error (FPE) showed a lag order of 3 while that of the Schwartz Bayesian Criterion (SBC) and Hannan Quinn (HQ) showed a lag order of 2 as the optimal lag length. With these conflicting results and from literature, results of the AIC and FPE were used which showed 3 as the optimal lag length. The second step is to choose the appropriate model, and the Pantula (1989) principle, which involves the estimation of the three most relevant models and the presentation of the results from the most restrictive hypothesis, was applied as shown in Table 5.

### Table 5: Johansen Cointegration test results

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace statistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>190.9519*</td>
<td>156.2770*</td>
<td>194.9835*</td>
</tr>
<tr>
<td>At most 1</td>
<td>121.6061*</td>
<td>89.97021</td>
<td>123.0518*</td>
</tr>
<tr>
<td>At most 2</td>
<td>71.39789</td>
<td>59.69506</td>
<td>69.24517</td>
</tr>
<tr>
<td>At most 3</td>
<td>43.48248</td>
<td>31.97682</td>
<td>40.43735</td>
</tr>
<tr>
<td>At most 4</td>
<td>27.23692</td>
<td>17.80880</td>
<td>23.62959</td>
</tr>
<tr>
<td>At most 5</td>
<td>15.72714</td>
<td>8.037103</td>
<td>11.54534</td>
</tr>
<tr>
<td>At most 6</td>
<td>7.538572</td>
<td>0.136733</td>
<td>3.203736</td>
</tr>
<tr>
<td>Maximum Eigenvalue statistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>69.34580*</td>
<td>66.30675*</td>
<td>71.93166*</td>
</tr>
<tr>
<td>At most 1</td>
<td>50.20819*</td>
<td>30.27515</td>
<td>53.80667*</td>
</tr>
<tr>
<td>At most 2</td>
<td>27.91541</td>
<td>27.71824</td>
<td>28.80782</td>
</tr>
<tr>
<td>At most 3</td>
<td>16.24556</td>
<td>14.16802</td>
<td>16.80776</td>
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<tr>
<td>At most 4</td>
<td>11.50978</td>
<td>9.771694</td>
<td>12.08426</td>
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<tr>
<td>At most 5</td>
<td>8.188567</td>
<td>7.900370</td>
<td>8.341601</td>
</tr>
<tr>
<td>At most 6</td>
<td>7.53857</td>
<td>0.136733</td>
<td>3.203736</td>
</tr>
</tbody>
</table>

Source: Authors own calculations  
* denotes rejection of the hypothesis at the 0.05 level

As seen in Table 5, conflicting results are found. Both the trace test and the maximum
eigenvalue test select Model 2 and 4 as having two cointegrating vectors, as expected since the real exchange rate variable entered the model at its levels. Model 3 presented one cointegrating vector in each test. Irrespective of the conflicting results, and for the purpose of this study as we are not interested in the long run coefficients, we conclude the existence of a long run relationship among the variables. That is despite that the real exchange rate volatility entered the model at its levels.

4.5 Granger causality test

The model that was estimated in the previous section was used in order to examine the causal relationships between the variables under examination. The variables which were significant in the long run were selected in order to test for causality between them. As a testing criterion the F statistic was used. No causal relationship was found between exports and CPI, public investment and CPI, as well as reserves and CPI. The results relating to the existence of Granger causal relationships between the remaining variables are presented in Table 6.

<table>
<thead>
<tr>
<th>Table 6: Pairwise Granger Causality Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>LEXCHV does not Granger Cause LCPISD</td>
</tr>
<tr>
<td>0.00084</td>
</tr>
<tr>
<td>0.9770</td>
</tr>
<tr>
<td>LCPISD does not Granger Cause LEXCHV</td>
</tr>
<tr>
<td>10.8476</td>
</tr>
<tr>
<td>0.0011*</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>LEXCHV does not Granger Cause LEX</td>
</tr>
<tr>
<td>0.19935</td>
</tr>
<tr>
<td>0.6556</td>
</tr>
<tr>
<td>LEX does not Granger Cause LEXCHV</td>
</tr>
<tr>
<td>19.5426</td>
</tr>
<tr>
<td>1.E-05*</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>LPUBINV does not Granger Cause LEX</td>
</tr>
<tr>
<td>23.2446</td>
</tr>
<tr>
<td>2.E-06*</td>
</tr>
<tr>
<td>LEX does not Granger Cause LPUBINV</td>
</tr>
<tr>
<td>3.10262</td>
</tr>
<tr>
<td>0.0792***</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>LRR does not Granger Cause LEX</td>
</tr>
<tr>
<td>12.4901</td>
</tr>
<tr>
<td>0.0005*</td>
</tr>
<tr>
<td>LEX does not Granger Cause LRR</td>
</tr>
<tr>
<td>4.72919</td>
</tr>
<tr>
<td>0.0305**</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>LPUBINV does not Granger Cause LEXCHV</td>
</tr>
<tr>
<td>8.93045</td>
</tr>
<tr>
<td>0.0031*</td>
</tr>
<tr>
<td>LEXCHV does not Granger Cause LPUBINV</td>
</tr>
<tr>
<td>6.51202</td>
</tr>
<tr>
<td>0.0112**</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>LRR does not Granger Cause LEXCHV</td>
</tr>
<tr>
<td>6.10129</td>
</tr>
<tr>
<td>0.0141**</td>
</tr>
<tr>
<td>LEXCHV does not Granger Cause LRR</td>
</tr>
<tr>
<td>3.75942</td>
</tr>
<tr>
<td>0.0535***</td>
</tr>
</tbody>
</table>
The results show that there is a unidirectional causality from CPI to real exchange rate volatility but not vice versa. This was expected since we believe that the real exchange rate volatility arises from the CPI in Swaziland. Exports were also found to cause exchange rate volatility, not vice versa which was expected. Bi-directional causality was found between public investment and exports, reserves and exports, public investment and exchange rate, and reserves and exchange rate. However, there was a unidirectional causality from reserves to public investment, which was expected as the government draws down on reserves for investment purposes.

4.6 Structural VAR results

Having established the existence of cointegration and some causality among the variables, we proceed to estimate the short run SVAR in order to capture the accounting innovations (variance decomposition and impulse response) among the variables. We start by applying various diagnostic tests to our models to test for stability. The results for the LM test for serial correlation in all the models indicate that there is generally no evidence of serial correlation. The p-value for the heteroscedasticity test in the first model is 0.8465 > 0.1, which suggests that there is no problem of heteroscedasticity. For the positive volatility model the p value is 0.8566 > 0.1 while for the negative volatility model the p value is 0.9697 > 0.1, indicating that there is no problem of heteroscedasticity in both models. All the models failed the normality tests, indicating that the residuals are not normally distributed. As noted by Harris (1995:83), non-normality in the residuals is acceptable if some of the variables are weakly exogenous. Figure 8 to 11 reports the inverse roots of the characteristic autoregressive polynomials of each of the three models. According to Lütkepohl (1991) the estimated VAR is stable.
(stationary) if all roots have modulus less than one and lie inside the unit circle. If the VAR is not stable, results such as impulse response standard errors are not valid.

**Figure 8: Stability condition for the first model (both positive and negative effects)**

![Inverse Roots of AR Characteristic Polynomial](image1)

Source: Author’s calculations

**Figure 9: Stability condition for the second model (positive effects)**

![Inverse Roots of AR Characteristic Polynomial](image2)

Source: Author’s calculations
Over and above the results of the diagnostic tests, the models seem to be stable because the inverted roots lie inside the unit circle in all the models.

### 4.7 VARIANCE DECOMPOSITION ANALYSIS

Variance decomposition separates the variations in the endogenous variable into component shocks in the SVAR. This implies that it determines the percentage of error variance in the system that is explained by the dependent variable and its determinants. Table 7 presents the variance decomposition results for real exchange rate volatility.

#### Table 7: Variance decomposition for real exchange rate volatility

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LGDP</th>
<th>REAL_EXCH_VOL</th>
<th>LCPISD</th>
<th>LFDI</th>
<th>LEX</th>
<th>LRR</th>
<th>LPUBINV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>99.83743</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>1</td>
<td>0.001146</td>
<td>0.162569</td>
<td>1.146972</td>
<td>0.749860</td>
<td>1.357399</td>
<td>0.206290</td>
<td>2.442962</td>
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</tr>
<tr>
<td>4</td>
<td>0.003039</td>
<td>0.990555</td>
<td>93.10596</td>
<td>1.850651</td>
<td>3.985116</td>
<td>0.336655</td>
<td>4.227457</td>
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</tr>
<tr>
<td>8</td>
<td>0.005183</td>
<td>2.634807</td>
<td>86.06637</td>
<td>0.898944</td>
<td>3.985116</td>
<td>0.336655</td>
<td>4.227457</td>
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</tr>
<tr>
<td>12</td>
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<td>3.650207</td>
<td>82.36189</td>
<td>1.805502</td>
<td>1.662688</td>
<td>5.948008</td>
<td>0.331544</td>
<td>4.240157</td>
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</table>
Exchange Rate Volatility and its Effect on Macroeconomic Management in Swaziland

<table>
<thead>
<tr>
<th></th>
<th>LGDP</th>
<th>REAL_EXCH_VOL</th>
<th>LGDP_S</th>
<th>REAL_EXCH_VOL_S</th>
<th>LGDP_CPI</th>
<th>REAL_EXCH_VOL_CPI</th>
<th>LGDP_FDI</th>
<th>REAL_EXCH_VOL_FDI</th>
<th>LGDP_LPCID</th>
<th>REAL_EXCH_VOL_LPCID</th>
<th>LGDP_LER</th>
<th>REAL_EXCH_VOL_LER</th>
<th>LGDP_LRR</th>
<th>REAL_EXCH_VOL_LRR</th>
<th>LGDP_LPUBINV</th>
<th>REAL_EXCH_VOL_LPUBINV</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>0.008148</td>
<td>3.908995</td>
<td>80.56566</td>
<td>1.763384</td>
<td>2.208975</td>
<td>7.069721</td>
<td>0.332286</td>
<td>4.150984</td>
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</tr>
<tr>
<td>20</td>
<td>0.009210</td>
<td>3.922053</td>
<td>79.80525</td>
<td>1.751711</td>
<td>2.360529</td>
<td>7.663831</td>
<td>0.387154</td>
<td>4.109467</td>
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<td></td>
</tr>
<tr>
<td>24</td>
<td>0.010108</td>
<td>3.902699</td>
<td>79.43941</td>
<td>1.749473</td>
<td>2.364858</td>
<td>7.952026</td>
<td>0.501423</td>
<td>4.090107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cholesky Ordering: LGDP REAL_EXCH_VOL LCPI SD LFDI LEX LRR LPUB INV

Source: Authors own calculations

The second column labelled S.E. presents the forecast of error of the variable at the 24 months forecast horizon. The S.E. shows the variation in current and future values of innovations to each endogenous variable in the SVAR. It is interesting to note that a significant percentage of the variation in real exchange rate volatility is largely accounted for by its own innovations from the first to the twenty fourth period. As shown in Table 7 the error variance in the twenty fourth period for real exchange rate volatility is 79.44 percent, down from 99.84 percent in the first period. The twenty fourth period shows very low results with regard to the other explanatory variables contribution, recording the lowest percentage are reserves at 0.50 percent, with exports recording the highest at 7.95 percent. GDP, FDI, CPI and public investment each contributes to 3.90 percent, 2.36 percent, 1.75 percent, and 4.09 percent of the variations on the real exchange rate volatility in the twenty fourth period. Combined, these variables explain 20.56 percent of variations in the real exchange rate in the twenty fourth period. The fact that exports recorded a higher percentage in the twelfth period is in par with economic theory that exchange fluctuations can be attributed to the demand for tradable goods in the economy. However the low percentages on the overall macroeconomic variables to explaining variations in exchange rate volatility can be attributed to the pegging of the local currency to the South African Rand, leaving the local variables to explain only the real part of the volatility, which is minimal.

Since one of the major objectives of this paper is assess whether the thresholds of the volatility on the exchange rate is disruptive or not, results from the TGARCH (1, 1) model reveal evidence of leverage effects. These effects indicate that positive shocks increased
the volatility of exchange rate more than negative shocks of the same magnitude during the sample under consideration. In that regard, the variance decomposition results were obtained from the second and third models for positive and negative real exchange rate volatility series respectively. From the results presented in Tables 8 and 9 for positive and negative shocks respectively, it can be seen that positive shocks account for 83.54 percent of its own innovations in the twenty fourth period, higher than the 79.26 percent for negative shocks. Although the negative shock explains most of its innovations, at 99.98 percent, than the positive shocks at 99.91 percent in the first month, this changes in the twenty four month horizon as the positive shocks end up explaining themselves more than the negative shocks.

Table 8: Variance decomposition for positive real exchange rate volatility

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LGDP</th>
<th>POSTV</th>
<th>LCPISD</th>
<th>LFDI</th>
<th>LEX</th>
<th>LRR</th>
<th>LPUBINV</th>
</tr>
</thead>
<tbody>
<tr>
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<td>99.91361</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>4</td>
<td>0.003084</td>
<td>0.389613</td>
<td>91.97159</td>
<td>1.060713</td>
<td>1.676442</td>
<td>1.143469</td>
<td>0.639103</td>
<td>3.119067</td>
</tr>
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<td>1.234609</td>
<td>87.02388</td>
<td>1.527222</td>
<td>1.982139</td>
<td>2.688631</td>
<td>0.934612</td>
<td>4.608905</td>
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<td>2.760978</td>
<td>3.518846</td>
<td>0.977455</td>
<td>4.588297</td>
</tr>
<tr>
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<td>1.757929</td>
<td>84.05182</td>
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<td>3.234374</td>
<td>3.915931</td>
<td>0.977161</td>
<td>4.546050</td>
</tr>
<tr>
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<td>83.71076</td>
<td>1.543511</td>
<td>3.382043</td>
<td>4.092384</td>
<td>0.987465</td>
<td>4.529780</td>
</tr>
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<td>24</td>
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<td>1.764989</td>
<td>83.54302</td>
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<td>4.522751</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LGDP POSTV LCPISD LFDI LEX LRR LPUBINV

Source: Authors own calculations

Table 9: Variance decomposition for negative real exchange rate volatility

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LGDP</th>
<th>NEGV</th>
<th>LCPISD</th>
<th>LFDI</th>
<th>LEX</th>
<th>LRR</th>
<th>LPUBINV</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>4</td>
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<td>0.032910</td>
<td>97.05872</td>
<td>0.824926</td>
<td>0.345642</td>
<td>0.916947</td>
<td>0.620840</td>
<td>0.200012</td>
</tr>
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<td>4.176876</td>
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<td>4.535188</td>
<td>0.698397</td>
<td>0.330213</td>
</tr>
</tbody>
</table>

Central Bank of Swaziland, 2014
In analysis of the other variables, it can be seen that positive shocks have more effect. All the other variables combined explains 16.45 percent of the variation in the positive shock in the twenty fourth period, with public investment contributing the highest at 4.52 percent and reserves recording the lowest at 1.05 percent. On the other hand, the variables combined accounted for 27.11 percent of the variations in the negative shock in the twenty fourth period, with CPI recording the highest at 8.20 percent while public investment recorded the lowest at 0.30 percent. The results show that the effect of positive shocks is greater than negative shocks as the other variables show a degree of stickiness to variations of positive shocks than negative shocks.

4.8 IMPULSE RESPONSE FUNCTIONS
An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. In our case, the shock will be on the real exchange rate volatility and we observe the responsiveness of volatility to its own shock and that of the other endogenous variables. Figure 11 shows the response of the macroeconomic variables to a one time shock on the real exchange rate volatility in the twenty four month horizon.

Figure 11 shows that the response of real exchange rate to its own innovations starts at a high level and declines rapidly in the first six months, and then decline steadily approaching zero towards the twenty fourth month. GDP and public investment decline...
in the first twelve months and GDP then moves constantly while public investment shows signs of reverting back to zero. FDI and CPI respond first by going down in the first few months, with CPI responding negatively, they then increase rapidly in the next two months, then fall steady surpassing zero in the sixteenth and twentieth months respectively. Exports show a positive response in the whole forecast horizon and approaches zero in the twenty fourth period. Reserves respond negatively in the first period and goes positive in the whole forecast horizon, approaching zero in the twenty fourth period.

**Figure 11: Impulse response of the endogenous variables to One-standard deviation real exchange rate shock**

![Impulse response graphs]

*Source: Author’s calculations*
Figure 12 and 13 show a comparison of the impulse response functions for the asymmetric shocks. The response for both positive and negative shocks on its own innovation quickly dies out after the first quarter. A negative response is observed for GDP and public investment arising from a positive shock to exchange rate volatility while a positive response in the same variables is observed for a negative shock to exchange rate volatility, as shown in Figure 8. That is in par with the Keynesian effects in that currency depreciation (negative shock) is associated with increase in output and vice-versa. FDI responds positively from a positive exchange rate shock, but decline steadily and becomes negative after 20 periods. However, for a negative shock, FDI responds positively but quickly goes down and become negative after 6 periods.

**Figure 12: Impulse response of the endogenous variables to One-standard deviation positive real exchange rate shock**

![Graph of impulse response functions]
The contemporaneous effect on prices is negative for both positive and negative shocks, however the positive shock has little effects on prices than the negative shock. Exports show the same response in the first month for both positive and negative shocks, but surprisingly, they stay positive for the positive shock while they go negative in the later months for a negative shock which contradicts economic theory. However in the case of Swaziland exports demand is not entirely driven by the exchange rate since over 70 percent of them goes to South Africa at the rate of one is to one. Foreign exchange reserves shows the same trend in the first few months, however they quickly revert to negative for the positive shock but stays positive in the entire period for the negative shock. That was expected as the reserves increase with currency depreciation (negative shock) and decreases with currency appreciation (positive shock). Overall, the effect of a
negative shock results to an increase in a slight increase in output and reserves in the 24 month horizon, but a fall in the other variables, whereas a positive shock results to a slight fall in output and public investment, and a general rise in the other variables in the 24 month horizon. The impulse response graphs for the total volatility shocks and positive shocks shows the same behaviour on the other variables, where they both depicts a fall in output and public investment, but a general rise on the other variables with prices remaining almost stable. The results confirm those of the TGARCH (1, 1) that positive shocks increased the volatility of exchange rate more than negative shocks of the same magnitude.
CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions
The major objective of this paper was to assess the effect of exchange rate volatility on macroeconomic performance in Swaziland. The GARCH (1, 1) approach was used to estimate the real exchange rate volatility of the Lilangeni against the US dollar. Results indicated that volatility shocks of Swaziland’s real exchange rate are quite persistent. To test for threshold effects, results from the TGARCH (1, 1) model reveal evidence of leverage effects. These effects indicate that positive shocks increased the volatility of exchange rate more than negative shocks of the same magnitude during the sample period. After obtaining the above results, the next step was to separate the cycle from the trend in the real exchange rate volatility series, and further separated positive and negative shocks from the trend, using the HP filter.

All the variables were tested for stationarity using the ADF test and, with the exception of the real exchange rate volatility, were all found to be non-stationary at their levels and had to be differenced to attain stationarity. The Johansen cointegration test was performed to establish the existence of a long run relationship among the variables, results of which show the existence of such a relationship. The Granger causality test was also performed on the variables. The results show that there is a unidirectional causality from CPI to real exchange rate volatility but not vice versa. This was expected since we believe that the real exchange rate volatility arises from the CPI in Swaziland. Exports were also found to cause exchange rate volatility, not vice versa which was expected. Bi-directional causality was found between public investment and exports, reserves and exports, public investment and exchange rate, and reserves and exchange rate. However, there was a unidirectional causality from reserves to public investment, which was
expected as the government draws down on reserves for investment purposes.

Having established the existence of cointegration and some causality among the variables, we proceeded to estimate the short run SVAR in order to capture the accounting innovations (variance decomposition and impulse response) among the variables for the three models; with overall, positive, and negative volatility. All the models passed most of the diagnostic tests and proved to be stable. Variance decomposition results showed that a significant percentage of the variation in real exchange rate volatility is largely accounted for by its own innovations in a 24 month horizon. On the asymmetry, results show that positive shocks have more effect than negative shocks in explaining variations in the exchange rate volatility. All the other variables combined explain 16.45 percent of the variation in the positive shock in the twenty fourth period, 20.56 percent of variations in total real exchange rate, and 27.11 percent of the variations in the negative shock in the same period. That means the other variables show a degree of stickiness to variations of positive shocks than the other shocks, resulting to the conclusion that volatility is driven mostly by positive shocks.

Results from impulse response functions show that a negative response is observed for GDP and public investment arising from a positive shock to exchange rate volatility while a positive response in the same variables is observed for a negative shock to exchange rate volatility. That is in par with the Keynesian effects in that currency depreciation (negative shock) is associated with increase in output. Furthermore, the contemporaneous effect on prices is negative for both positive and negative shocks; however the positive shock has little effect on prices than the negative shock. Foreign exchange reserves shows the same trend in the first few months, however they quickly revert to negative for the positive shock but stay positive in the entire period for the negative shock. That was expected as the reserves increases with currency depreciation (negative shock) and decreases with currency appreciation (positive shock). The impulse response graphs for the total volatility shocks and positive shocks shows the same
behaviour on the other variables, where they both depict a fall in output and public investment, but a general rise on the other variables with prices remaining almost stable. The results confirm those of the TGARCH (1, 1) that positive shocks increased the volatility of exchange rate more than negative shocks of the same magnitude. Overall, the results are in par with Keikha et al (2013) who found that the effect of positive shocks is greater than negative shocks when examining oil price volatilities on macroeconomic variables in Iran. Lee, et al. (1995) also established evidence of asymmetry, in the sense that positive shocks have a strong effect on growth while negative shocks do not.

5.2 Recommendations
This paper has shown that the volatility of the real exchange rate is persistent in Swaziland and yield mixed results to the macroeconomic variables. The findings call for appropriate short and long term policy packages that should focus on stabilizing the real exchange rate volatility in Swaziland. With Swaziland being a member of the CMA, there is practically no control of the nominal exchange rate volatility, but only the real exchange rate volatility, which can be controlled through the CPI. The only option the country has is to maintain a low and stable inflation rate by setting the interest rate at the right level through the Central Bank of Swaziland, and further improve on reserve management to maintain the parity of the Lilangeni to the South African rand.
REFERENCES


CEE Economies. CEPR Discussion Paper 4802.


Exchange Rate Volatility and its Effect on Macroeconomic Management in Swaziland

Growth in Swaziland. Mbabane, Swaziland.


Exchange Rate Volatility and its Effect on Macroeconomic Management in Swaziland

Econometric Theory, 11: 122-150.


Renani H.S. and Mirfatah M. (2012). The Impact of Exchange Rate Volatility on FDI in Iran. Department of Economics, Khorasgan Branch, Islamic Azad University, Isfahan, Iran


Saxena S. C. (2002). Exchange Rate Dynamics in Indonesia: Journal of Asian Economics,


Appendix: Graphs for data used.