1 Chapter 1: Background to the Thesis

1.1 Background to the Thesis

International macroeconomics continues to have a menu of puzzles that require new theoretical and empirical explanations. Obstfeld and Rogoff (2000) have identified 6 major puzzles of international macroeconomics. Three of these relate to exchange rate economics and they are the purchasing power parity puzzle (PPP), the exchange rate disconnect puzzle, and the exchange rate determination puzzle[1].

This Thesis is motivated by the basic recognition that there continues to be a need to find solutions to major exchange rate puzzles mentioned above. In the context of this thesis, the puzzles of interest are the purchasing power parity puzzle (PPP), the exchange rate disconnect puzzle, and the exchange rate determination puzzle.

Since most international studies in exchange rate economics do not include the Southern African Development Community (SADC), this author considered it to be a real contribution to analyse the PPP puzzle in the context of SADC. Currently the SADC is constituted by Angola, Botswana, the Democratic Republic of Congo (DRC), Lesotho, Malawi, Madagascar, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. Owing to a lack of reliable data, four countries have been excluded in the analysis: the DRC, Lesotho, Namibia, and Zimbabwe.

It should be pointed out at the very beginning that this Thesis does not focus on the topics of optimal currency areas in the context of SADC. Nor does it concern itself with issues of macroeconomic convergence, which would typically include budget deficit ratios, inflation rates, public debt ratios, external balance, exchange rates and interest rates. In the context of PPP analysis, this study only seeks to identify dollar-based mean-reversion in the SADC.

[1] For the purposes of this thesis, we have excluded the forward premium puzzle, which has been discussed extensively by Meredith and Ma (2002). In brief, the forward premium puzzle represents the finding that forward rates in the foreign exchange markets are biased predictors of future spot

An analysis of SADC exchange rates within and beyond the PPP hypothesis generally faces several conceptual hurdles and possible pitfalls. First, outside South Africa, capital markets are less advanced and less liquid, and cross-border capital flows tend to be limited, making the real interest rate differentials as fundamentals less likely to play a significant role in equilibrium. Second, low-income SADC countries tend to be heavily indebted, with debt service and/or official grants constituting a significant fraction of gross domestic product (GDP), a situation that likely influences the real exchange rate determination more than the market forces. Also, low-income SADC countries tend to be commodity exporters with only a small share of manufacturing exports. Thus, the preponderance of world prices of certain commodities is likely to affect both the external current account of the balance of payments and the equilibrium real exchange rate. Additional pitfalls in respect of PPP analysis have been discussed in detail by Taylor (2000).

That said, it is not clear how these institutional factors affect the statistical properties of the real exchange rate time series.

1.2 A brief overview of the foreign exchange markets in the SADC

Generally speaking, an analysis of SADC foreign exchange markets has hardly been done in a coherent manner. This subsection is dedicated to a brief overview of the SADC foreign exchange markets. It uses information obtained from the Secretariat of the Committee of Central Bank Governors (CCBG) in SADC. The locus of concern is the exchange rate environment of the 10 countries appearing in the analysis.

Within the SADC there are members of the Common Monetary Area (CMA): South Africa, Namibia, Lesotho and Swaziland. Within the CMA, all member countries apply the same exchange control regulations. All foreign exchange transactions are to be routed via authorised dealers. Foreign exchange earnings by member states' enterprises have to be brought into the CMA within three months of exports. The foreign exchange acquired by the authorised dealers has offshore limits, which they

rates. Furthermore, it has been found that currencies that command a forward premium tend to depreciate, while those that command a forward discount tend to appreciate.

can hold as a balance with their external correspondent banks. The prudential requirements on currency risk containment in terms of their foreign assets and liabilities, allow commercial banks to have an open position, limited to 15 per cent of each bank's capital and reserves.

In the case of Botswana, the national currency is Pula, which is pegged to a weighted basket of currencies comprising Special Drawing Rights currencies of the IMF and the South African rand. According to CCBG (2006), a crawling band exchange rate mechanism was introduced in Botswana in May 2005, with the objective of avoiding the need for periodic discrete large adjustment of the exchange rate to maintain real effective exchange rate stability. At the same time the foreign exchange trading margin of the Bank of Botswana for foreign exchange transactions was increased from ± 0.125 per cent around the central rate to ± 0.5 per cent in order to encourage trading on the interbank market.

Mauritius has a managed floating exchange rate regime with no pre-announced path for the exchange rate. The foreign exchange market is totally liberalised: foreign exchange dealers and money-changers transact foreign exchange. From time to time the Bank of Mauritius intervenes in the market to smooth out seasonal and cyclical fluctuations.

Since 1994, Madagascar adopted the floating exchange rate system and established the foreign currency interbank market where the national currency rate, the ariary, is traded against major foreign currencies such as the euro and the US dollar.

Tanzania practices a managed float exchange rate system. The foreign exchange market is a daily interbank foreign exchange market. The Bank of Tanzania intervenes by selling and buying only to smooth fluctuations. The Tanzanian currency (the shilling) is not convertible outside East Africa. In the spirit of East African co-operation, a currency convertibility agreement was reached in 1995. Under the agreement, commercial banks and foreign exchange bureaux in the region are allowed to buy and sell regional currencies just like the other convertible currencies.

In Zambia the foreign exchange market has been liberalised since 1992. The exchange rate is fully market-determined depending on supply and demand conditions.

1.3 The evolution of South Africa's foreign exchange system

It is important to note that South Africa had a dual exchange rate during the years 1961-1995 (excluding a two-year period between 1983 and 1985). According to Barnard and de Clerk (2007), the system comprised a commercial- and blocked rand (1961-1976), with the commercial rand remaining unaltered ever since. However, the blocked rand was subsequently substituted by the securities rand in 1976. This duality remained in place until 1979 when it was once again renamed the financial rand. According to the authors, the financial rand continued to remain in place during the periods 1979-1983 and 1985-1995, alongside the commercial rand. The reintroduction of a dual exchange rate in 1985 was necessitated by the pressure on the SA rand and the gold and foreign exchange reserves of the country, which at the time coincided with the introduction of a foreign debt standstill to foster political change. The financial rand was finally abolished in March 1995 after the first democratic election in South Africa the preceding year.

1.4 Objectives of the Thesis

The Thesis focuses on finding solutions to the 3 major exchange rate puzzles mentioned above. The objectives of the thesis regarding the puzzles are discussed in sections 1.5 to 1.8.

1.5 Resolving the mean reversion version of the PPP puzzle

To test for the long-run purchasing power parity relation, this study uses SADC country real exchange rate data to undertake Bayesian unit root tests, Augmented Dickey-Fuller tests, as well as nonlinear nonstationarity tests associated with smooth

transition autoregressive (STAR) family of models. In addition, this research goes further to deal with the issue of long-memory in real exchange rates. In this context, the Thesis uses "a class test of fractional integration" pioneered by Hinich and Chong (2007). This test is able to determine whether a series is a long memory process or not.

1.6 Resolving the half-life version of the PPP puzzle

The study relies on Rossi (2005a) to calculate confidence intervals of half-life deviations from equilibrium. Rossi uses several methods, some of which are robust for highly persistent data.

1.7 Resolving the exchange rate determination puzzle

The study relies on market microstructure approaches to find the short run and long-run determinants of the nominal rand-dollar exchange rate. In this context, the thesis utilises autoregressive distributed lag (ARDL) model of cointegration to address the exchange rate determination puzzle. ARDL models have the benefit that they avoid the issue of verifying whether a variable is $I(0)$ or $I(1)$. They rely instead on bounds testing.

1.8 Resolving the exchange rate disconnect puzzle

The current literature on the exchange rate disconnect puzzle is in a state of flux. Since there has yet to be a detailed survey of DSGE models in respect of the disconnect puzzle, the study surveys competing theoretical dynamic general equilibrium approaches that attempt to make the disconnect less of a puzzle. We critically review the usefulness of the models and indicate which models are likely to gain popularity.

1.9 Contributions of the Thesis to economic literature

Concerning the contributions of the Thesis to economic literature, the author believes the Thesis represents an earnest effort to find solutions to the main puzzles of exchange rate economics using SADC data and the latest econometric techniques. The Thesis uses nonlinear tests of nonstationarity with high power (an approach representing hypothesis testing when nuisance parameters exist only under the alternative hypothesis), Bayesian unit root tests, fractional integration tests, point estimates and confidence intervals for exchange rate half-life deviations from PPP, and ARDL form of cointegration.

1.10 The structure of the Thesis

Having discussed the background to this study, the rest of the thesis is organised such that chapter 2 introduces the puzzles. Chapter 3 covers recent theoretical and empirical developments. Chapter 4 presents empirical results pertaining to PPP using SADC dollar-based exchange rates. Chapter 5 presents the results of half-life deviations from PPP in the SADC. Chapter 6 undertakes tests of long memory regarding the PPP puzzle and presents the results of frequency domain fractional integration tests. Chapter 7 cover the results of the microstructure approach to the determination puzzle. Conclusions and implications are found in Chapter 8.

2 Chapter 2: Introducing the puzzles

2.1 Introduction

Chapter 2 introduces the puzzles that were identified by Obstfeld and Rogoff (2000). Three of these relate to exchange rate economics and they are the purchasing power parity puzzle (PPP), the exchange rate disconnect puzzle and the exchange rate determination puzzle.[2]

Below we provide a brief overview of each puzzle. For convenience, the thesis treats them as independent puzzles.

2.2 The PPP puzzle: mean-reversion

This subsection borrows from Mokoena (2006, 2007), among other sources. An ordinary definition of absolute purchasing power parity (PPP) is that the latter represents the exchange rate between two currencies multiplied by the relative national price levels. The relative form of this hypothesis is that PPP exists when the rate of depreciation of, say, the home currency relative to the foreign currency matches the difference in aggregate price inflation between the two countries in point (Sarno and Taylor, 2002).

The PPP hypothesis implies that the real exchange rate should be constant such that any deviations from equilibrium should be transitory. Yet most studies have found that real exchange rates exhibit a large degree of volatility and that their deviations from equilibrium are highly persistent.

Formally, the relative form of PPP admits the following logarithmic representation:

[2] For the purposes of this thesis, we have excluded the forward premium puzzle, which has been discussed extensively by Meredith and Ma (2002). In brief, the forward premium puzzle represents the finding that forward rates in the foreign exchange markets are biased predictors of future spot rates. Furthermore, it has been found that currencies that command a forward premium tend to depreciate, while those that command a forward discount tend to appreciate.

$$y_t \equiv s_t - p_t + p_t^*, \tag{2.1}$$

where y_t is a measure of deviation from PPP, s_t is the nominal exchange rate, p_t denotes the domestic price level, and p^*_t represents the foreign price level.

From a historical perspective, real exchange rates play an important role in establishing parities and in estimating national income levels for comparative purposes (Taylor, Peel and Sarno, 2001). In addition, there are policy implications in determining the degree of persistence of real exchange rates. For instance, if the real exchange rate is highly persistent or near unit root, its adjustment is likely to impact upon the real side of the economy -- productivity and tastes. By contrast, a low level of persistence is associated with shocks on the aggregate demand.

Today it is still a matter of debate whether the PPP relation holds in both the long-run and the short run. At the level of theoretical discussion, the violation of PPP in the short run can be explained through the theory of exchange rate overshooting, in which the PPP deviations are expected to occur as explained by Dornbusch (1976). However, in the long-run, for the PPP to hold, it must admit mean reversion. So, empirically speaking, an econometrician would like to see the real exchange rate remain stationary, while the alternative hypothesis would suggest that the exchange rate was a unit root process or a random walk. Formally, a manifestation of mean-reversion implies that, under the assumption of linearity, the following relation from (2.1) should hold:

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t, \qquad 0 < \rho < 1. \tag{2.2}$$

When $\rho = 1$, equation (2.2) becomes a unit root process. It means the process does not allow the system to come back to equilibrium. An implication of a real exchange rate with a unit root is that, among other things, it limits the usefulness of the PPP exchange rates used for policy purposes.

On balance, evidence on the long-term PPP, while in some cases is supportive of the relation, is influenced by the techniques used by researchers. For instance, the current literature focuses on linear and nonlinear tests of nonstationarity, linear and nonlinear cointegration tests, and panel data studies, to name a few.

As far as panel data techniques are concerned, Abuaf and Jorion (1990) analysed a system of 10 $AR(1)$ regressions for real dollar exchange rates. They tested the null hypothesis that the real exchange rates were jointly nonstationary for all the 10 series over the sample period 1973 to 1987. Their results indicated a positive support for the stationarity of real exchange rates at conventional levels of significance, suggesting that there was evidence in favour of PPP. Other panel data studies include Levin and Lin (1992), who tested the null hypothesis that each individual series was an $I(1)$ against the alternative that all the series as a panel were stationary. Frankel and Rose (1995), Wu (1996) and Oh (1995) have relied on Levin and Lin(1994) panel unit root test to establish mean reversion in real exchange rates.

There are other studies utilising univariate approaches and multivariate methods and these are surveyed extensively by Sarno and Taylor (2002).

Moreover, as shown in Bailie and Kapetanios (2005), exchange rates seem to harbour neglected nonlinearities of unknown form. A detailed discussion concerning nonlinear mean-reversion is found in Taylor, Peel, and Sarno (2001). In the latter study the authors provide evidence of nonlinear mean reversion in a number of major real exchange rates during the post-Bretton Woods period. The study undertakes multivariate unit root tests with high power to reject the null hypothesis of unit root behaviour in exchange rates.

Moreover, there is a growing realisation that, due to their lack of power, the standard tests of nonstationarity in the univariate context are unable to provide a strong foundation for inference that reduces the high probability of committing type 2 error in the PPP studies.

More formally, traditional unit root tests involve testing the null hypothesis of

$z_t = z_{t-1} + \varepsilon_t$ against equation (2.2). This leads to the application of an augmented Dickey-Fuller test statistic:

$$\Delta z_t = \phi_0 + \phi_1 t + \phi_2 z_{t-1} + \sum_{i=1}^{n-1} \beta_i \Delta z_{t-i} + v_t \ . \qquad (2.3)$$

The poor power performance of the standard unit root tests has been reported by many studies, including Balke and Fomby (1997), Pipenger and Goering (1993), Diebold and Rudebusch (1991), and Taylor, Peel and Sarno (2001).

Due to the problems mentioned above, the resolution of the PPP will require fairly robust tests of nonstationarity and nonlinearity. The details of the empirical results are found in Chapter 4.

2.3 The half-life version of the PPP puzzle

Following Rossi (2005a), consider that a real exchange rate follows an autoregressive process of order one such that $y_t - y_0 = \alpha + \rho(y_{t-1} - y_0) + \varepsilon_t$, where y_0 is the long-run equilibrium value and ε_t is white noise. At horizon h the percentage deviation from equilibrium is ρ^h. Then the half-life deviation is the smallest h such that $h = \frac{\ln(1/2)}{\ln(\rho)}$. Traditionally half-life deviations have been used for AR(1) processes. For higher orders the process may become cyclical and half-lives may become meaningless.

The half-life version of the PPP puzzle is that a high degree of exchange rate volatility is generally associated with an implausibly slow speed of mean reversion. According to sticky price theories, a half-life of an exchange rate is supposed to be less than 3 years. However, according to Rogoff (1996), the consensus is that the speed of mean reversion is between three and five years. Other authors such as Grilli and Kaminski (1991) and Lothian and Taylor (1995)) have used approximately 100 years of annual data to find evidence of significant mean reversion, with an average half life across these studies being around 4 years. Diebold, Husted and

Rush (1991) also used long time spans of annual data, ranging from 74 to 123 years, to analyse the real exchange rates of 6 countries using a fractional integration framework. They found evidence that PPP held as a long-run concept, generally reporting half-lives of around 3 years.

Taylor (2000) has noted possible pitfalls associated with the calculation of half-lives, the main problem being a downward bias in the magnitude of point estimates. Some of the problems have to do with the linearity assumption, the choice of sample frequency, and the treatment of nonlinearities. Clearly therefore the calculation of half-lives that are free of biases is challenging.

The latest approaches are associated with, among others, Kim, Silvapulle and Hyndman (2006), Norman (2007) and Rossi (2005a). In the light of problems identified by Rossi (2005a), Kim, Slivapulle and Hyndman (2006) use the highest density region (HDR) approach to propose a bias-corrected bootstrap procedure for the estimation of half-life in the context of point and interval estimation. The authors report that their approach generates accurate point estimators and tight confidence intervals with superior coverage properties to those of its alternatives. Norman (2007) uses nonlinear impulse response analysis and Monte Carlo integration methods (MCIM) in the context of STAR models to assess how well nonlinear mean reversion solves the PPP puzzle. Rossi (2005a) uses local-to-unity asymptotic theory in the context of $AR(p)$ processes to construct confidence intervals that are robust to high persistence in the presence of small sample sizes.

Chapter 5 relies on Rossi (2005a) to determine the extent to which the half-life puzzle can be resolved. The promising approach of Kim, Silvapulle and Hyndman (2006) is left for future research due to software availability and programming issues.

2.4 The exchange rate disconnect puzzle

For the last 30 years of floating exchange rates, academic economists have not had consensus regarding the impact of exchange rate fluctuations on real economic variables, such as exports and output. Indeed, if we accept the premise that an exchange rate is one of the significant “prices” in an economy such as South Africa’s,

then to an economist an exchange rate would seem likely to have a wide-ranging impact on a number of economic variables, and therefore seem likely to have a strong connection with the real economy. In some economic models regarding South Africa,[3] an expansionary monetary policy is supposed to raise domestic demand while lowering the exchange value of the rand. This implies the existence of a correlation between exchange rate changes and business-cycle expansions and contractions. However, in real life, it is debatable whether such a strong relationship exists. Moreover, in international studies that examined data at the aggregate or macroeconomic level, it has been generally found that there is a small or an insignificant effect of exchange rate fluctuations on the real variables. In particular, Stockman and Baxter (1989) showed that the exchange rate volatility seems to have no systematic impact on macroeconomic variables. Moreover, empirical work by Mussa (1986), and Flood and Rose (1995), have found that high exchange rate volatility is not related to high volatility of other macroeconomic variables. This lack of association between real quantities and the exchange rate is called the "exchange rate disconnect puzzle," a conundrum discovered by Meese and Rogoff (1983).

The exchange rate disconnect puzzle is particularly important for policymakers. For instance, if central bankers, in particular, do not have a clear understanding of how exchange rates affect the economy or the monetary transmission mechanism, they are likely to make mistakes when they have to respond to historically high and unexpected currency volatility. This is an important issue for less-developed countries, where capital markets may be underdeveloped, and the exchange rate volatility can cause significant welfare losses to the economy. In addition, exchange rate volatility can trigger welfare-inefficient resource allocations across sectors of the country in point.

2.5 The exchange rate determination puzzle

The exchange rate determination puzzle suggests that the exchange rate has 'a life of its own' and there are hardly reliable determinants of the exchange rates in the short run. In recent years the market microstructure approaches to the exchange rate

[3] See Smal and de Jager (2001) and Aron and Muellbauer (2000a and 2000b).

determination puzzle have gained popularity because they have identified order flow or the imbalances between 'buyer-initiated and seller-initiated trades' in foreign exchange markets as indicative of the transmission link between exchange rates and fundamental determinants of exchange rates (Vitale, 2006).

2.6 Conclusion

This chapter discussed the three main exchange rate puzzles, namely, the PPP puzzle, the disconnect puzzle and the exchange rate determination puzzle. These puzzle are studies empirically in subsequent chapters, focusing on the data from the SADC region.