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**Purchasing Power Parity and Reserve Bank Intervention in the
Foreign Exchange Market**

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Purchasing Power Parity and Reserve Bank Intervention in the Foreign Exchange Market

Goran Unkovski

This paper tests the behaviour of the PPP relationship in South Africa between 1993 and 2003 using cointegration techniques. The period under review is divided into two sub-phases. The first, from January 1993 to May 1998, encompasses the changing political situation and the initial effects of global integration for South Africa. It is found that the PPP relationship holds during this time frame. The second phase, between June 1998 and December 2003, starts with the severe depreciation of the rand during the Asian contagion and encompasses the change of the operational regime at the SARB and the 2001 rand freefall. The findings of the study point to the failure of the PPP hypothesis during this latter period. A further objective of the study is to discuss the differing approaches of the Reserve Bank to the 1998 and the 2001 rand crashes. It is during the 1998 crash that the repercussions of Reserve Bank intervention in the foreign exchange market are most clearly seen. The paper examines the effect of this intervention in light of the PPP hypothesis, and compares it to the non-interventionist stance of the Bank during the 2001 depreciation.

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1. Introduction

Purchasing power parity (PPP) is a theory of exchange rate determination. In its simplest form, it states that the exchange rate change between two currencies over any period of time is determined by the change in the two countries' relative price levels (Dornbusch, 1985). In other words, in the absence of government intervention (trade barriers), an internationally traded basket of similar goods should sell for an approximately equal effective price when converted into the same currency. If PPP holds, it implies that inflation differentials between South Africa and her major trading partners are offset by exchange rate changes which therefore keeps the real exchange rate constant (Barr and Kahn, 1995).

The validity of PPP (or whether or not the real exchange rate remains constant) has important implications for the competitiveness and prosperity of South African industry. For example, an appreciating real exchange rate renders exports less competitive and leads to cheaper imports. Sustained appreciation of the real exchange rate could therefore have serious negative consequences on the tradeable goods sectors. If deviations from PPP are highly variable, this variability of the real exchange rate will increase the uncertainty facing manufacturing exporters about the future profitability of their exports (Barr and Kahn, 1995).

More generally, highly variable deviations from PPP are an indication of the risk associated with an economy. The more fragile the economy, and the lower the investor confidence, the more severe will the capital outflows be during times of uncertainty surrounding global and domestic events, and the more variable the exchange rate. Thus, the robustness of an economy is exemplified by the behaviour of the exchange rate – the closer the exchange rate to its long-run PPP trend, the more robust the economy.

The primary objective of this study is to examine the empirical validity of PPP in South Africa between 1993 and 2003 using a cointegration approach. More specifically, the focus of the paper is on the 1998 and 2001 rand crashes and their impact on the PPP

relationship. The period under review is divided into two sub-phases. The first, from January 1993 to May 1998, encompasses the changing political situation and the initial effects of global integration for South Africa. It is found that the PPP relationship holds during this time frame. The second phase, between June 1998 and December 2003, starts with the severe depreciation of the rand during the Asian contagion and encompasses the change of the operational regime at the SARB and the 2001 rand freefall. The findings of the study point to the failure of the PPP hypothesis during this latter period.

The secondary objective of the study is to discuss the differing approaches of the Reserve Bank to the 1998 and the 2001 rand crashes. It is during the 1998 crash that the repercussions of Reserve Bank intervention in the foreign exchange (FX) market are most clearly seen. The paper examines the effect of this intervention in light of the PPP hypothesis, and compares it to the non-interventionist stance of the Bank during the 2001 depreciation.

The remainder of the paper is organised as follows. The following section provides a brief literature review on research into the PPP hypothesis. Section 3 list events in the South African foreign exchange market between 1979 and 2003, and section 4 discusses the risk associated with the South African economy. Section 5 provides theoretical background on the methodology used to test the PPP relationship. Section 6 describes the data used in the PPP tests. Section 7 discusses the estimation procedure and the results obtained, section 8 analyses the PPP results with reference to Reserve Bank intervention, and section 9 discusses the recent commodity price boom and its implications for future rand volatility. Finally, conclusions are given in section 10.

2. Empirical Background

Although straightforward in theory, real world factors such as trade barriers, differentiated products, tastes, and costly information, complicate the concept of PPP. Therefore, in testing the validity of PPP, results from economic literature have been mixed. There has been little (if any) support for the theory in the short-run while the results on PPP in the long-run have been more varied. Results in support of the existence of PPP have predominantly been conducted during hyperinflationary periods and in the presence of transaction costs [Frenkel (1980), Hakkio (1984), Davyutan and Pippenger (1985), Taylor (1988), McNown and Wallace (1989), Phylaktis (1992), Dockery and Georgellis (1994), and Geppert (1997)].

More recently, results of tests using cointegration techniques have been more favourable to the notion that PPP holds as a long-run equilibrium relationship. For example, Ramirez and Khan (1999) have found supportive evidence for PPP in Germany, the United Kingdom, Japan, Canada, and France – such results differ substantially from other time series studies which found evidence against long-run PPP [Krugman (1978), Dornbusch (1980), and Frenkel (1981a, 1981b)].

Issues related to whether PPP holds in South Africa have been examined in various papers. Tsikata (1998) and Subramanian (1998) show that the effective nominal depreciation of the rand during the 1990s is almost fully reflected in higher prices of imported goods, although an important caveat is that results are extremely sensitive to the choice of price aggregates and sample period. A study by Aron, Elbadawi, and Kahn (1997), states that the real exchange rate in South Africa during 1970-1995 is nonstationary, implying the breakdown of strict PPP. The same study shows, however, that real exchange rate fluctuations can be explained by variations in a set of economic “fundamentals” such as trade liberalisation, terms of trade, government expenditures, capital flows, and official reserves. This is to some degree consistent with the findings of the Barr and Kahn (1995) paper which shows that PPP breaks down during periods of

real shocks but appears to hold constant in periods where there are relatively few shocks and where monetary and exchange rate policies are more consistent.

Until the mid-1980s, econometric analyses to determine the validity of the PPP theory were carried out using the ordinary and generalised least squares methods (Isard, 1995). However, results based on these methods are not reliable because they fail to incorporate the fact that the data used are nonstationary. According to Granger and Newbold (1974), regressions involving nonstationary variables using the classical methods are spurious. Variables need to be appropriately differenced to render them stationary. But Hendry and Mizon (1978), amongst others, have shown that differencing removes the ability to infer long-run steady state relationships between variables. Engle and Granger's (1987) cointegration technique provides a statistical solution to this problem.

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3. Historical Overview

3.1 The Validity of PPP during the 1979-1992 period

Barr and Kahn (1995) tested the behaviour of the PPP relationship in South Africa between 1979 and 1992 using cointegration techniques. They divided the dataset into three sub-periods, to take account of the various shocks to the economy and the changes in the policy regime.

Their results pointed out that the PPP in South Africa broke down between 1979 and 1988. This breakdown was expected, considering that the period was characterised by variability of the gold price, severe political shocks and the debt crisis. Changes in the Reserve Bank's exchange rate and monetary policy were also notable over this period.

Barr and Kahn found that the PPP held between 1988 and 1992. The real exchange rate was stable, and there were relatively few real shocks and the macroeconomic policies were far more consistent and stable.

It follows from the Barr and Kahn study that PPP breaks down during periods of real shocks but appears to hold in periods where there are relatively few shocks and where monetary and exchange rate policies are more consistent.

3.2 Description of South African Exchange Rate Movements

January 1993 – December 2003

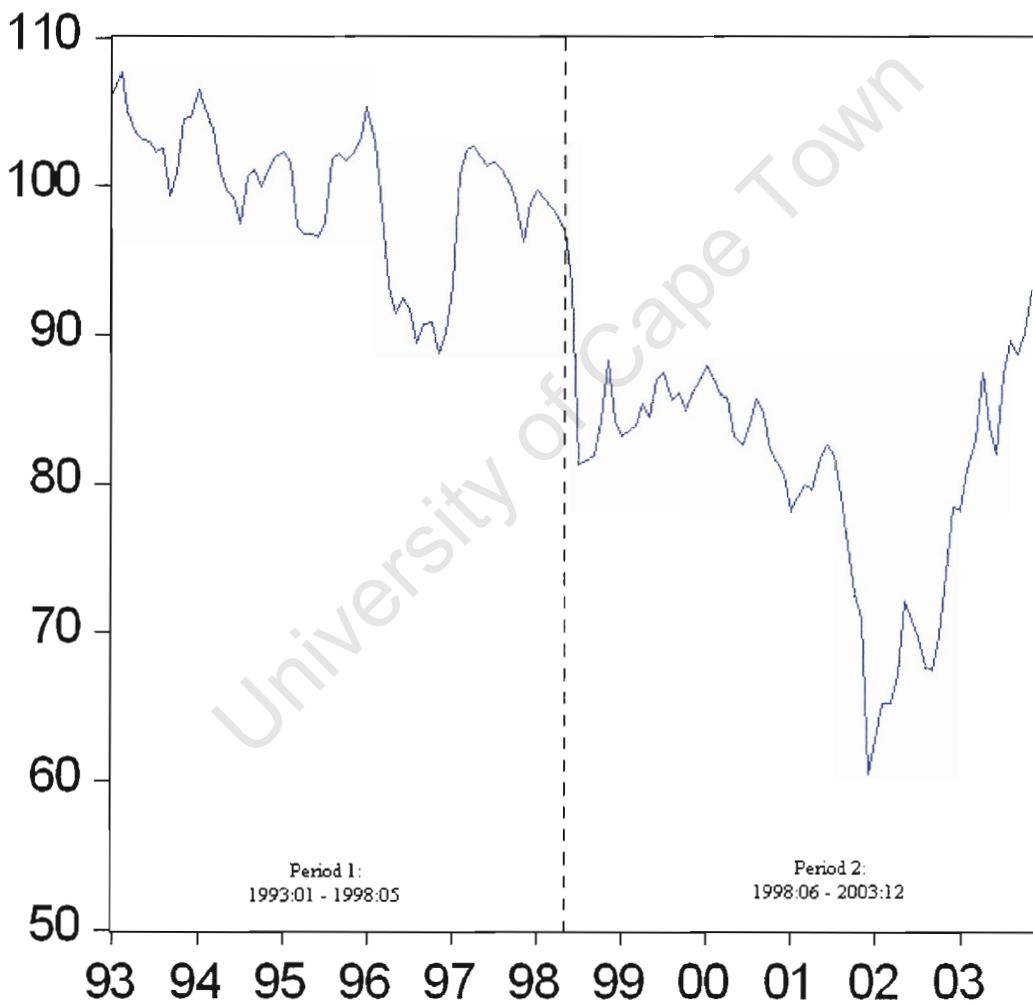
Prior to 1992, the South African economy was not sufficiently open for the exchange rate to play a significant role in monetary policy (De Wet, 2002). The economy was insulated from external events by the sanctions imposed during the latter half of the 1980s. But political uncertainty after 1992 began to put increased pressure on the exchange rate. From January 1993 to mid-1994, the nominal effective exchange rate depreciated by approximately 18%, and as this exceeded the inflation differential between South Africa and her major trading partners, it implied a real effective depreciation of about 10% over the period, thus countering the real appreciation from 1988 (Aron, Elbadawi and Kahn, 1997, p.4).

Liberalisation efforts were intensified following the general elections in 1994, and the financial rand mechanism was terminated in March 1995 and the exchange rate unified. Capital controls on residents were slowly relaxed while virtually all controls on non-residents were removed. Since the unification, there has been greater variability of the real and nominal exchange rates. This variability was further reinforced by the fact that South Africa was only just re-entering the global economic arena. South Africa was especially vulnerable, as a newly emerging market, to the foreign investment flows into and out of the country. These flows were subject to both global and domestic events (De Wet, 2003).

The general stability that had prevailed in the market for foreign exchange in South Africa during 1995 and the first six weeks of 1996 came to an abrupt end in the middle of February. The exchange rates of the rand decreased sharply against all major currencies. Between February and August, the nominal effective exchange rate lost 19.5% (Quarterly Bulletin, 1996). This was due to rumours that the South African economy was struggling with global integration, and that her trading partners were benefiting from increased capital flows on the back of the 1990's stock-market boom. This led to fears that the rand had become overvalued (De Wet, 2003). Additionally, downward pressure on the

exchange rate was brought about by the deficit on the current account of the balance of payments that was not fully matched by a net inflow of capital from abroad. Between the end of 1995 and the end of 1996, the overall decline of the nominal effective exchange rate was 21.9%.

Figure 1: Real Effective Exchange Rate 1993.01 - 2003.12 (1995=100)



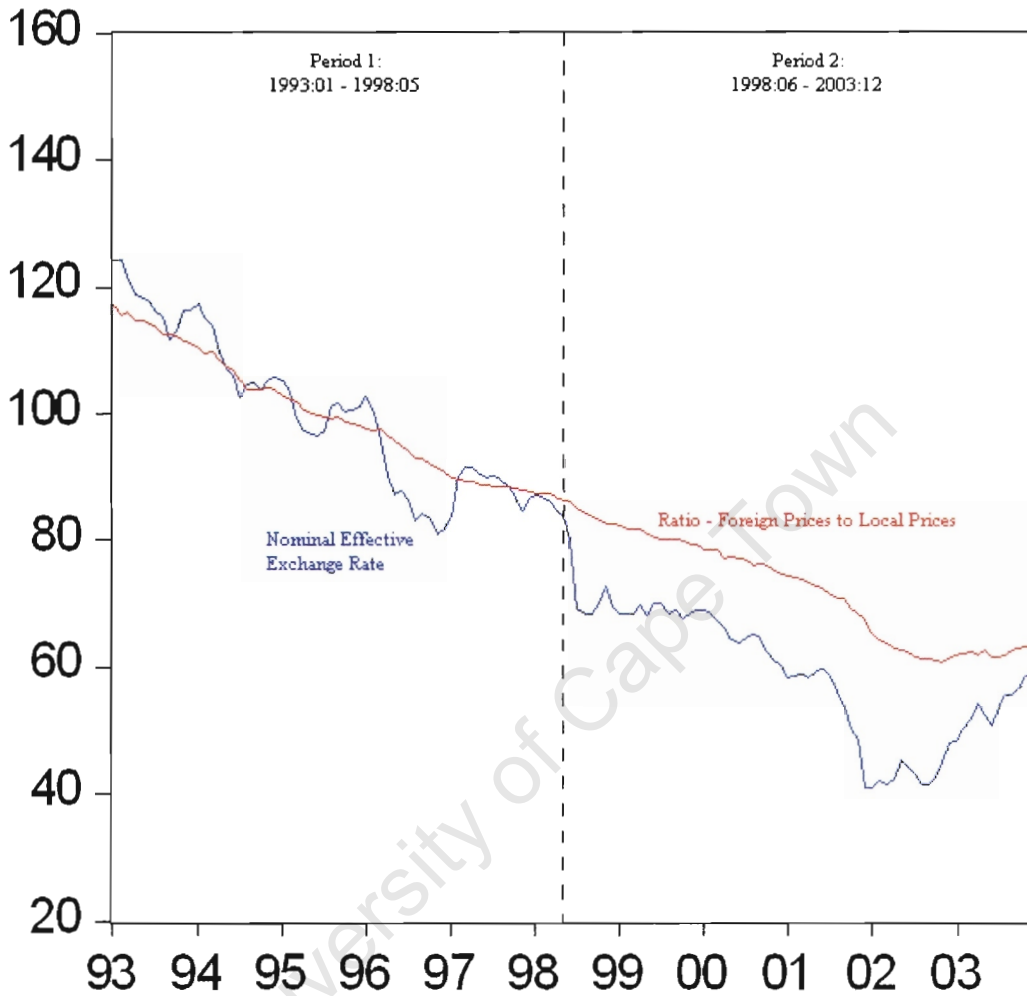
Note that the Real Effective Exchange Rate in Figure 1 is defined such that an increase represents an appreciation and a falling value a depreciation

This period was followed by the strengthening of the rand in the first quarter of 1997, as sentiment in the market responded to the improvement in the foreign trade balance and a retarding money and credit growth in the final quarter of 1996. The nominal effective exchange rate gained 10.9% between November 1996 and March 1997, and the real effective exchange rate increased by approximately 9.5% over the same period (Quarterly Bulletin, 1997a, 1997b).

During the rest of 1997, the nominal effective exchange rate gradually declined, while the developments in the international exchange markets were profoundly influenced by events in a number of Southeast Asian economies. The recessionary conditions in Asia (especially as Japan – the largest economy in the region moved into recession), and the financial crisis in Russia during the second quarter of 1998, facilitated a general move to quality. International investors moved their funds out of emerging markets into the US (especially US Treasury bonds) and Europe (Schaling and Schoeman, 1999).

The severe effects of the subsequent rand depreciation began to unfold in May 1998 with massive outflows from the bond market. A mismatch between the rates in the money market and the rates in the forward market opened up an arbitrage gap. What ensued can best be described as a battle between the Reserve Bank and speculators, as the Reserve Bank intervened in the foreign exchange market by using reserves to buy forward contracts guaranteeing the rand's exchange rate against the dollar. With the use of the forward book, the net open forward position (NOFP) increased to USD 23 billion. Figuratively speaking, the Reserve Bank left the battle bloodied and defeated. Chris Stals, then Governor of the Reserve Bank, generated a huge NOFP in the forward market (effectively a liability for South Africa), and the rand nonetheless depreciated drastically. Between May and August 1998, the nominal effective exchange rate fell by 19% while the real effective exchange rate lost 17%.

Figure 2: Nominal Effective Exchange Rate and Relative Prices (1995=100)



Note that the Nominal Effective Exchange Rate in Figure 2 is defined as the foreign currency price of a unit of local currency so that in the figure a rising value represents an appreciating rand and a falling value a depreciating rand.

In September 1998, the IMF publicly rebuked the Reserve Bank's handling of the crisis. The IMF pointed out that, like other emerging markets, South Africa merely faced a contagion problem from Asia. That is, the herd mentality of investors towards quality was a short-run phenomenon, and would have dissipated on its own. Had the Reserve Bank been less interventionist in the FX market, and less hesitant to raise the repo rate more firmly at an earlier stage in the contagion, the economic fundamentals could have

reasserted themselves once the storm blew over (as had happened following the 1995 investor scare). Instead the Bank had unnecessarily created a South African financial crisis all of its own.

The consequences for the real economy were harsh. By first using FX intervention, instead of increasing the repo (which at that stage in the contagion, according to Schaling and Schoeman, would have been quite effective), the Reserve Bank pushed (perceived) fundamentals down. This created an unstable currency which rendered interest rate policy increasingly ineffective. According to Schaling and Schoeman, the macroeconomic outcome was the worst of all possible worlds. An unstable currency, high inflation, and the persistently high level of interest rates pushed the economy into recession by the end of 1998.

Whereas in 1998 the Reserve Bank intervened in the FX market by using the forward book, the Bank started changing its position under the new leadership of Tito Mboweni¹. A new monetary policy – inflation targeting – was introduced on 6 April 2000. Under this policy, the emphasis was given to domestic price stability². That is, the Reserve Bank wanted to support balanced and sustainable economic growth through lower inflation levels. This was seen as a move away from direct intervention in the FX market.

During 1999, the currency recovered somewhat and its real effective rate actually increased during the first six months of 1999 by more than 5%. However, owing to high interest rates, and widespread insolvencies and liquidations in the private sector (a legacy of the 1998 FX intervention), the rand began a long slide at the turn of the new millennium. Over the period from the beginning of 2000 to mid-2001, the nominal effective exchange rate maintained an almost consistent and fairly well-defined declining trend.

¹ In August 1999, Tito Mboweni took over as the Governor of the South African Reserve Bank.

² The monetary and exchange rate policy has been more focused on balance of payments and inflation considerations since 1988 but inflation-targeting only became explicit in 2000.

Furthermore, the Reserve Bank and the National Treasury had been in the process of actively reducing the NOFP by “buying foreign exchange”. By the end of the first quarter of 2001 the NOFP had been reduced from \$23 billion in 1998 to \$9.4 billion. Although the policy of reducing the NOFP was praised by the IMF, the rating agencies, and the investment banking community, South African experts from the private sector agreed that the Reserve Bank’s commitment to reduce the NOFP by buying US dollars contributed significantly to the perception that the rand was a one-way bet.

After a steady decline earlier in 2001, the rand surprised everyone by appearing to be in freefall in December. The nominal effective exchange rate had lost 32% year-on-year (December 2001-2002), and 16% within the month of December. The real effective exchange rate had lost 25% year-on-year, and 15% within December. The unexpected depreciation in the final months of 2001 led to widespread public concern and confusion among policymakers.

Many experts and analysts would describe the overall macro-economic position in South Africa during the first three quarters of 2001 as being characterised by “sound fundamentals”. That is, the rapid rand depreciation happened in spite of falling inflation, a manageable current account deficit, disciplined monetary and fiscal policies, and a growing economy in the face of a global slowdown.

The sentiment surrounding South Africa during most of 2001 (prior to the rand freefall) could be personified partially by Moody’s upgrading the investment grade sovereign risk ratings afforded to the country in November 2001. With reference to the FX market, this sovereign risk rating upgrade was tantamount to stating that the exchange rate was regaining stability. This indicates just how unexpected the freefall in December 2001 really was.

As a result of the concern and confusion surrounding the events of the freefall, the President of South Africa set up the Commission of Enquiry to investigate the rapid depreciation of the rand in 2001.

The Commission's final report (2002) concluded that several macroeconomic factors contributed to the rand depreciation.

The Commission analysed the circumstances surrounding specific transactions and whether the rand's depreciation was due to speculative behaviour. Speculative behaviour is necessary for the effectiveness of the price mechanism, but in thin (less liquid) markets, such behaviour can have an exaggerated impact, even with very small transactions. The Commission predominantly focused on the Wakeford Allegations³, which involved allegations about specific share transactions that could have triggered the 2001 rand freefall, but concluded that the information submitted was either inaccurate or inconclusive. Although these and other transactions most probably contributed to the rapid depreciation, the Commission did not find any illegal behaviour by market participants, and could not deem such transactions as openly unethical.

The Commission furthermore considered the slowdown in global economic activity (dominated by the events following 11 September attack on New York) and contagion effects (mainly from Argentina and Zimbabwe), but concluded that these factors alone could not explain the depreciation. However, the Commission hypothesised that these factors generated a pervasive negative sentiment and when this was coupled with the issues surrounding the FX market, i.e.: the discrepancy between a current account deficit and net outflow of foreign investment capital, the thinner FX market after mid-October 2001⁴, and the Reserve Bank's policy of non-intervention – panic set in and “herd mentality” prevailed. Although there was no evidence of collusion or acting in concert, the rand depreciation became a self-fulfilling prophecy and the impact was grave. This was a conclusion reached by a number of experts⁵. What remains puzzling, however, is that the sharp depreciation only materialised in the final months of the year and yet there

³ Possible dubious share placement transactions between Deutsche Bank AJ on the one hand, and Sasol, Nampak, M-Cell, and Billiton on the other

⁴ Following 14 October Reserve Bank's announcement that foreign exchange control rulings were to be policed more rigorously

⁵ Taken from the experts' conclusions given to the Commission of Enquiry; the experts included: Mr Gouws, Dr Stals, Dr Abedian, Mr Bruce-Brand, Mr Mboweni, Ms Ramos, Dr O'Neill, and the Standard Corporate and Merchant Bank.

was no singular, equally abrupt, factor that could be stated as a definite decisive trigger for the rand freefall.

De Wet (2003) proposes that factors such as historically low interest rates and high money supply could have contributed towards the sharp depreciation in the currency, stating that this especially applies in the light of a stable international economic environment at the time.

Bhundia and Gottschalk (2003) use a historical decomposition analysis to argue that nominal disturbances explain most of the fluctuation in the rand in the latter half of 2001 and first quarter of 2002. This is not to say that real disturbances did not contribute or have an effect, but rather that they were not a sufficient condition for the sharp depreciation at year-end 2001. This is consistent with the Commission's findings. Bhundia and Gottschalk found that financial market developments were the most likely source of the depreciation, but their deduction is, like the Commission's, inconclusive.

In his conclusion, stated to the Commission, Dr Abedian⁶ gave three possible trigger scenarios for the rand's December depreciation:

- a. A perfectly legitimate large transaction by one of the major market players might have led to the emergence of a herd mentality resulting in the run on the rand.
- b. It is technically possible that one may execute a deal fully aware of the full-scale domino effects and one does so in order to benefit via a major deal already in contract. Such a situation was particularly more feasible when the pure speculators were driven out of the market by November 2001.
- c. There were uncoordinated numerous market transactions that culminated in a self-fulfilling prophecy leading to a severe overshooting in valuation of the currency. Deals of this kind might well have had no motive other than well-considered business logic, yet the impact or outcome was identical to either of scenarios a and b. (Commission of Enquiry, 2002)

⁶ Doctor Iraj Abedian is a South African Economist and a Professor at the University of Cape Town.

Whatever the causes of the rand's depreciation in 2001, the reversal in the rand's fortunes since around the second quarter of 2002 has been equally remarkable. During 2002, the nominal effective exchange rate appreciated by 17%, followed by a further 22% appreciation during 2003. The real effective exchange rate appreciated by 25% in 2002, and 19% in 2003.

Although the Reserve Bank was widely criticised at the time for its non-interventionist stance in 2001, it seems that the policy of reducing the NOFP over the course of 2000-onwards, paid off. It is probable that the Reserve Bank contributed to the depreciation of the rand in the short-run, but non-intervention seems to have been instrumental in the rapid recovery of the rand. Mboweni himself stated to the Commission of Enquiry: "Given the losses on the forward book and negative perceptions from market participants and commentators on the one hand, and the potential impact on the currency of reducing the forward book on the other, the Bank had a difficult choice to make. In the long-term interest of South Africa, it was decided to place emphasis on reducing the NOFP." (Commission of Enquiry, 2002)

4. Investment Risk of the South African Economy

The 1990s saw the opening up of the South African economy and more freedom for capital flows into and out of the country. Economic theory stresses many benefits arising from free capital flows, but the complications associated with such freedom are given, in particular, by the evidence from emerging markets. The events in Mexico (1994), Thailand (1997), and Malaysia (1997), are clear examples of the excessive foreign exchange volatility that can arise from free international capital flows (Abedian and Biggs, 1998). South Africa herself is a perfect example of the correlation between freer capital flows and more volatile exchange rate movement.

The analysis given in the previous section indicates just how volatile the exchange rate has been to different forms of domestic or international risk. However, the recovery of the exchange rate over the past two years seems to indicate that the economy is much more robust.

It could be argued that the effect of unanticipated news or events on asset prices is a possible indication of the risk associated with an economy. A promising measure for the risk associated with the South African economy, therefore, could be given by international credit ratings. An international credit rating is an opinion by a rating agency of the future ability, legal obligation, and willingness of a bond issuer or other obligor to make full and timely payments due to investors. In other words, this rating indicates the “default (risk) premium”. The default premium reflects the financial health (solvency) of the borrower under consideration and compensates for the risk that he/she “defaults”, i.e., is unable (or unwilling, in the case of a government) to service his/her debt. Moreover, if the borrower in question is the government itself, the default risk premium, or the country risk premium, is called the “sovereign risk premium” or simply “sovereign risk”.

One would therefore expect that when a measure of “sovereign risk” is optimistic, this will reflect sentiment that an economy (characterised by its government) is robust and thus the FX market and the exchange rate are less susceptible to news and events that generate negative sentiment.

Table 1 (Grandes and Peter, 2004) below shows the history of credit ratings for South Africa, by two main USA-based rating agencies, Moody’s Investor Service, and Standard & Poor’s. These ratings are a measure of “sovereign risk” and are graded relative to other countries’ risk profiles.

Table 1: History of Credit Ratings for South Africa (until May 31, 2003)

Date	Standard & Poor’s		Date	Moody’s	
	Local Currency Credit Rating	Foreign Currency Credit Rating		Domestic Currency Bond Rating	Foreign Currency Bond Rating
	Long Term / Outlook			Long Term / Outlook	
May 7, 2003	A / stable	BBB / stable	Feb 26, 2003	A2 / stable	Baa2 / positive
Nov 12, 2002	A- / positive	BBB- / positive	Nov 29, 2001	A2 / stable	Baa2 / stable
			Oct 12, 2001	Baa1 / rev. for up	Baa3 / rev. for up
Feb 25, 2000	A- / stable	BBB- / stable	Feb 7, 2000	Baa1 / positive	Baa3 / positive
			Oct 2, 1998	Baa1 / stable	Baa3 / stable
Mar 6, 1998	BBB+ / stable	BB+ / stable	Jul 17, 1998	Baa1 / rev. for down	Baa3 / rev. for down
			Mar 7, 1997	Baa1 / negative	Baa3 / negative
Nov 20, 1995	BBB+ / positive	BB+ / positive	Nov 20, 1995	Baa1	-----
Oct 3, 1994	-----	BB / positive	Oct 3, 1994	-----	Baa3

The foreign currency rating columns in the above table show the perceived riskiness of South Africa's FX market on the given date. Relative to the October 1994 ratings, the most recent ratings of both agencies are considerably more positive. Moody's rates the foreign currency bonds as Baa2 / positive, indicating a medium grade obligation, i.e. bonds that are neither highly protected nor poorly secured. Such bonds lack outstanding investment characteristics and in fact have speculative characteristics as well. Standard & Poor's rates the foreign currency credit as BBB / stable, indicating adequate capacity to meet financial commitments but with the threat that adverse economic conditions or changing circumstances could weaken such capacity by the obligator.

The general movement of the ratings between 1994 and 2003 has been in an upward direction, indicating a more robust economy and optimism for future stability of the exchange rate. Following the 2001 depreciation, Moody's upgraded the foreign currency bond rating outlook from stable to positive in February 2003. The positive outlook indicates that a rating may be raised. Between 2002 and 2003, Standard & Poor's increased the foreign currency rating from BBB minus to BBB only.

The agencies (Guest, 2003) stated the following reasons as positive factors behind their upgrading rationale:

- Consistent record of sound economic policies and ongoing reform implementation, in spite of external shocks
- Tax reforms have permitted greater fiscal flexibility, allowing tax cuts and infrastructural investment
- Gradual removal of exchange controls and elimination of the Reserve Bank's net open forward position
- Dedication to reducing inflation
- Well-developed domestic capital market

On the other hand, factors that could act as long-term rating constraints are:

- External liquidity is relatively modest and reserves cover only 70% of gross financing needs
- Low domestic savings and investment levels
- Labour market rigidities
- Social challenges, such as crime, HIV/Aids and unemployment

The upgrades provide cautious optimism concerning the robustness of the South African economy but nonetheless, the ratings given to South Africa's foreign currency obligations are medium grade and possible future runs on the currency cannot be ruled out. The recovery of the exchange rate over the past two years is nonetheless indicative of lower perceived riskiness associated with the FX market.

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5. Theoretical Background

5.1 Statistical Testing of PPP

The absolute version of PPP defines the “law of one price” in an integrated, competitive market. Abstracting from all and any frictions, the price of a given good will be equal in all locations when quoted in the same currency:

$$P_t^d = S_t * P_t^f \quad , \text{ where}$$

P_t^d is the domestic price level at time t , P_t^f is the foreign price level at time t , and S_t is the exchange rate at time t expressed in local currency units per foreign currency unit.

The absolute version of PPP cannot be interpreted as an empirical condition. Since there is no clear notion as to when the PPP relationship actually holds, one cannot assess what constitutes deviations from such a relationship. The PPP relationship is thus tested most generally over a particular period in an incremental sense (relative PPP) by considering deviations over a period of time. The simplest regression form is:

$$\nabla(\ln S_t) = \alpha + \beta \nabla(\ln(P_t^d / P_t^f)) + e_t \quad , \text{ where}$$

∇ denotes the difference operator, \ln is the natural log, and e_t is a random process with constant mean and variance. The estimate of β can then be tested for significant deviation from 1.0 using standard regression tests, after checking that the standard regression assumptions have been satisfied.⁷

The relative PPP is tested using differenced data (as opposed to data in levels) to avoid the “spurious regression” results one gets when time-series data is non-stationary. In a famous paper Granger and Newbold (1974) introduced the notion of a spurious regression. They warned that researchers had ignored the significance of very high serial

⁷ Alternatively test the real exchange rate ($\frac{S_t * P_t^f}{P_t^d}$) for stationarity. If the real exchange rate is stationary then the PPP will hold for that period.

correlation among the residuals in conventional regression models. They said that macroeconomic data was in general non-stationary (or integrated) and that in regressions involving levels of variables, the significance tests were usually misleading. The conventional t and F tests would tend to reject the hypothesis of no relationship even if there was, in fact, none.

In a Monte-Carlo study, Granger and Newbold (1974)⁸ created two non-stationary random walks x and y that were uncorrelated with each other. They regressed y on x and found that in 75% of cases, the t-test on the beta coefficient rejected the null that the coefficient was zero. So in 75% of the cases, a spurious significant relationship was found. Granger and Newbold concluded that when regressions of this sort were performed:

- The R^2 tended to be high
- Low DW statistics were observed
- The t-tests were very misleading

Although it has become standard econometric practice to ensure that the time-series data is appropriately differenced before inter-relationships can be meaningfully measured, there has been criticism in the literature that it is impossible to infer long-run steady state solutions from variables in differenced form (Hendry and Mizon (1978), Davidson *et al.* (1978)). Subsequently, Granger and Weiss (1983) argued that a vector of non-stationary variables may have linear combinations which are stationary. Engle and Granger (1987) formalised these ideas by introducing the notion of cointegration – a particular statistical interpretation of long-run equilibrium between non-stationary variables which abstracts from short-run deviations.

⁸ See Appendix for analysis of a Monte-Carlo simulation using Eviews econometric software

5.2 The Cointegration Approach

A series is said to be integrated of order d , denoted $I(d)$, if it contains d unit roots. Such a series must be differenced d times to render it stationary. If we consider two series y_t and x_t , which are both $I(d)$, then any linear combination of the two will also be $I(d)$ (e.g., the disturbance term from regressing y_t on x_t). It is possible, however, that a vector β exists, such that the disturbance term from the regression $e_t = y_t - \beta x_t$ is of lower order of integration, $I(d-b)$. Then Engle and Granger (1987) define y_t and x_t as cointegrated of order (d,b) . Thus, if y_t and x_t were both $I(1)$, and $e_t \sim I(0)$, then the two series would be cointegrated of order $CI(1,1)$.

The economic explanation of cointegration is that if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (i.e., be non-stationary), they will nevertheless move closely together over time and the difference between them will be stable (i.e., stationary) (Harris, 1995).

In the context of this paper, the stable (constant) difference referred to in the above paragraph can be represented by the real effective exchange rate in the PPP hypothesis. That is, if the weighted relative price index variable representing inflation differentials is cointegrated with the nominal effective exchange rate variable representing exchange rate changes, then PPP will hold since the two series will move closely together over time, thus implying that the difference between them (i.e., the real effective exchange rate) will be stable (constant).

Since the link between identification of cointegration and equilibrium can be made, it follows that long-run insight can be gained from regressions involving non-stationary variables. It must be stressed, however, that the definition of cointegration is a necessary condition for applying cointegration analysis to a particular problem, but it is not sufficient. In many cases, this technique is used where a coherent argument cannot be made that y_t and x_t are in a long-run relationship. For cointegration to be used, it is necessary to fulfil the requirement of sound theoretic reasoning for cointegrating the series in question. Statistical analysis without grounded economic interpretation is bound to be of limited (if any) use. The theory of PPP is well established and the use of cointegration analysis to examine the PPP relationship is thus justified.

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5.3 Unit Root Tests

In order to test for the possibility of y_t and x_t being cointegrated, it must be established that y_t and x_t have the same order of integration.

A possible testing strategy for unit roots is proposed:

1. Graph the series. Is it trending (exhibit growth)? What does economic theory tell us?
2. If the series is not trending, include an intercept in the model for testing a unit root.
3. If the series is trending, include an intercept and a trend.
4. Alternatively, use the intercept and a trend model as a “highly powerful” statistical model at 5% level, and the intercept-only model as a “moderately powerful” statistical model at 5% level.
5. Decide on how many augmentation terms to include, either via significance of the lag terms or via an automatic lag selection criterion.
6. Carry out the test. Reject the null hypothesis if the t value is a sufficiently large negative value or the p-value is less than the significance level. Conclude the process is stationary (or trend stationary); there is no unit root.
7. If the null hypothesis is not rejected, perform the test again, with the series expressed in first differences (include an intercept only if both an intercept and trend were included when testing the levels, otherwise include neither). Rejection of the null hypothesis suggests that the process is $I(1)$. The series has a unit root but is stationary after differencing once. [If the first differences exhibit a unit root, carry out the test with the series expressed in second differences. In almost all cases the second difference will be stationary and there will be no need to proceed any further.]

The most general test for the existence of a unit root is taken to be Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981). In terms of first differences we may write:

$$\nabla y_t = \psi y_{t-1} + \sum_{i=1}^{p-1} \psi_i \nabla y_{t-i} + \mu + \gamma t + \varepsilon_t$$

where $\psi = (\rho - 1)$, and the level series y_t will have a unit root if $\rho = 1$ or $\psi = 0$.

The ADF test in the Eviews software package provides an ADF statistic as well as critical values for the 1%, 5%, and 10% levels. The statistic relates to the null hypothesis of unit root, $H_0 : \psi = 0$. H_0 can be rejected when the absolute value of the ADF statistic is greater than the absolute value of the 1%, 5%, or 10% critical level.

In the case where $|\text{ADF statistic}| < |\text{critical value}|$, it would lead the acceptance of the null of a unit root.

However, accepting the null of unit root does not automatically imply that the first difference of y_t will be stationary. The ADF test must be applied on the difference of y_t and the null of unit root rejected to conclude that the level series is in fact $I(1)$. In this case the ADF test takes the form:

$$\nabla^2 y_t = \psi \nabla y_{t-1} + \sum_{i=1}^{p-2} \psi_i \nabla^2 y_{t-i} + \mu + \varepsilon_t$$

where the null hypothesis is $H_0 : \psi = 0$ (unit root). If H_0 can be rejected using the critical values, it can be concluded that the first difference series is stationary $I(0)$ and therefore the level series is $I(1)$.

6. Data Description

The data required to test PPP were obtained from the online South African Reserve Bank database⁹. Two time series variables were used for this purpose: the nominal effective exchange rate of the rand consistently excluding Zimbabwe (NOM), and the real effective exchange rate of the rand consistently excluding Zimbabwe (REAL). Both NOM and REAL are defined as the foreign currency price of a unit of local currency (rand). The data is in a monthly format, with the index 1995=100, and spans from January 1993 until December 2003.

By definition, the real effective exchange rate is the nominal effective rate adjusted for relative price differences between South Africa and her trading partners. That is:

$$REAL = NOM * \left(\frac{P^d}{P^f}\right), \text{ or}$$

$$\frac{P^f}{P^d} = RELATIVE = \frac{NOM}{REAL}$$

The relative price variable (RELATIVE) was thus created by dividing the nominal effective exchange rate by the real effective exchange rate¹⁰.

The nominal effective (or trade weighted) basis of depicting trends and calculating exchange rate movements is a superior measure to using a single currency comparison such as the dollar. Using a nominal effective rate ensures that relative cross-currency movements become less important. The real effective exchange rate measure also eliminates exchange rate movements solely owing to inflation rate differentials. For instance, should the rand show a weakening against the dollar, this may be, partly or even entirely, owing to a strengthening of the dollar against most other currencies (ABSA, 2003).

⁹ www.resbank.co.za

¹⁰ The reason for defining relative prices as NOM/REAL as opposed to REAL/NOM stems from the fact that the variables NOM and REAL are both defined as the foreign currency price of a unit of local currency, and not as the local currency price of a unit of foreign currency.

The nominal effective exchange rate is based on trade in and consumption of manufactured goods between South Africa and thirteen currencies (representing the most important trading partners) and excludes Zimbabwe due to the recent socioeconomic developments in that country. The real effective exchange rate is the nominal effective rate adjusted for relative price differences (using producer price indices).

In Section 9, the real effective exchange rate of the Australian dollar was obtained from the Australian Reserve Bank website¹¹, and the various commodity price indices from the IMF World Database website¹². The quarterly GDP figures were retrieved from the South African Reserve Bank database.

Version 3.1 of the Eviews software package was used to organise and manipulate the time series data. All quantitative output presented in this study was generated using this package (Eviews, 1999).

¹¹ www.rba.gov.au

¹² www.imf.org/external/np/res/commod

7. Testing for the Purchasing Power Parity Relationship

If RELATIVE is cointegrated with NOM, then PPP will hold since the two series will move closely together over time, thus implying that the difference between them (REAL) will be stable (constant).

The test for cointegration between NOM and RELATIVE thus comprises two parts:

- a) Test each time series for the *same* order of integration. In the case of economic time series $I(1)$ is the most common representation.
- b) Test the residuals of the cointegrating regression for a *reduction* in the order of integration established in a) above. In the case of economic time series this will thus usually be a test of whether $e_t \sim I(0)$. This test comprises of a standard unit root test (ADF test), except that there is no time trend adjustment and no intercept term. This is because the residuals e_t have a zero mean over the sample.

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7.1 Testing the Series for Unit Roots

Three series were tested for stationarity (unit roots). These comprised:

1. The natural log of the nominal effective exchange rate (LNOM)
2. The natural log of the weighted relative price index, using producer prices (LRELATIVE)
3. The natural log of the real effective exchange rate (LREAL)

The tests were performed on periods:

1. January 1993 – May 1998, to examine the initial stages of South Africa's global integration and the changing nature of the socioeconomic landscape.
2. June 1998 – December 2003, to examine the period during which two major rand depreciations occurred.

The testing strategy for unit roots proposed previously was employed.

Table 2 below shows the values for the ADF tests performed on the three series over the three periods.

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Table 2: Values of the t-statistic for the ADF unit root test

Series	93.01-98.05	Lags	98.06-03.12	Lags
LNOM; C	-1.3833	1	-2.0061	1
LNOM; T	-3.0662	1	-1.8768	8
LRELATIVE; C	-1.0948	0	-1.2962	3
LRELATIVE; T	-2.4327	6	-1.8755	3
LREAL; C	-2.9423 **	1	-1.8043	0
LREAL; T	-3.2778 *	1	-1.1966	0

* - significant at the 10 % level,

** - significant at the 5 % level,

*** - significant at the 1 % level, using the tables of MacKinnon (1990)

The suffix C infers that an intercept term was included.

The suffix T infers that a time trend and an intercept were included.

The lag formulation used was determined by systematically dropping lagged values (from an initial set of 8 lags) until the last was statistically significant, using a 5 % t-test.

Table 2 above implies that all the series over both periods, with the exception of the real exchange rate¹³ over the period 93.01-98.05, are non-stationary with at least one unit root. To confirm that the series are in fact $\sim I(1)$ and possess only one unit root, the same test is applied to first differences of the series. Table 3 shows the results of the ADF test performed on the first differences.

¹³ The tests were performed on both the REAL variable and its logarithmic (natural) transformation LREAL. The resulting statistics do not differ significantly however, and lead to the same conclusions. Therefore only output for LREAL is presented here.

Table 3: Values of the t-statistic for the ADF unit root test on the first differences

Series	93.01-98.05	Lags	98.06-03.12	Lags
D(LNOM); C	-5.3658 ***	0	-5.9165 ***	0
D(LNOM); T	-5.3447 ***	0	-6.1944 ***	0
D(LRELATIVE); C	-8.2912 ***	0	-5.8377 ***	0
D(LRELATIVE); T	-8.3544 ***	0	-5.9681 ***	0
D(LREAL); C	-5.6082 ***	0	-6.7420 ***	0
D(LREAL); T	-5.5742 ***	0	-7.0021 ***	0

- * - significant at the 10 % level,
- ** - significant at the 5 % level,
- *** - significant at the 1 % level, using the tables of MacKinnon (1990)

The suffix C infers that an intercept term was included.

The suffix T infers that a time trend and an intercept were included.

The lag formulation used was determined by systematically dropping lagged values (from an initial set of 8 lags) until the last was statistically significant, using a 5 % t-test.

From Table 3 it follows that the first differences of both LNOM and LRELATIVE are $\sim I(0)$ for the two periods, indicating that the level series are $\sim I(1)$. Since LNOM and LRELATIVE are both integrated of the same order, i.e., $\sim I(1)$, they are potential candidates as a pair of cointegrated variables over the two periods.

The real effective exchange rate LREAL is non-stationary $\sim I(1)$ between 1998.06 and 2003.12, but is stationary $\sim I(0)$ over the 1993.01-1998.05 sub-period.

7.2 Testing the nominal effective exchange rate (LNOM) and the relative price index (LRELATIVE) for cointegration

Following from the fact that LNOM and LRELATIVE are both $\sim I(1)$, one may now proceed to test the two series for a cointegrating relationship. As discussed above, this requires that the residuals of a cointegrating regression are tested for stationarity so that it may be established that the residuals are $\sim I(0)$. The cointegrating regression may either be one where LNOM is regressed against the LRELATIVE variable and a constant term, or where LRELATIVE is regressed against the LNOM variable and a constant term. The generated residual series of either regression should lead to the same conclusions. The following formulation was adopted in this paper:

$$LNOM_t = \alpha + \beta LRELATIVE_t + e_t$$

Table 4 below shows the values of the ADF t-statistic for the residual of the cointegrating regression for the two periods.

Table 4: Values of the ADF t-statistic for the residual of the cointegrating regression

Series	93.01-98.05	Lags	98.06-03.12	Lags
LNOM & LRELATIVE	-3.4331***	1	-1.2108	0

* - significant at the 10 % level,

** - significant at the 5 % level,

*** - significant at the 1 % level, using the tables of MacKinnon (1990)

The lag formulation used was determined by systematically dropping lagged values (from an initial set of 8 lags) until the last was statistically significant, using a 5 % t-test.

On the basis of this analysis it can be concluded that:

- a) LNOM and LRELATIVE are cointegrated over the sub-period 93.01-98.05
- b) LNOM and LRELATIVE are not cointegrated over the sub-period 98.06-03.12

With reference to (a) above, the result obtained from the cointegration analysis is consistent with the result testing the stationarity of the real exchange rate (REAL) over the same sub-period. It was found that REAL was stationary over the same sub-period. It can therefore be concluded that PPP held between 1993.01 and 1998.05.

With reference to (b) above, the result obtained from the cointegration analysis is consistent with the result testing the stationarity of the real exchange rate (REAL) over the same sub-period. It was found that REAL was not stationary over the same sub-period. It can therefore be concluded that there was a breakdown of the PPP relationship in South Africa between 1998.06 and 2003.12.

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8. PPP and FX Market Intervention

Between 1993 and 1998, PPP held on the back of a stable rand post-1988. Although the initial stages of global integration impacted on the economy, there was only one substantial real shock over this period and the FX market quickly recovered from the investor scare of 1995. The nominal effective exchange rate and the inflation differential moved together statistically and this rendered the real exchange rate constant during the period.

The results of the statistical tests show that there was a breakdown of the PPP relationship in South Africa between 1998 and 2003. This is an intuitive result since two major rand depreciations occurred within this period. The intervention in the foreign exchange market during the 1998 crisis did not have the desired effect and is a probable cause for the exchange rate's failure to adjust back to the long-run PPP trend over the next couple of years. The perceived riskiness of South Africa during these years, coupled with the detrimental factors pointed out by the Commission of Enquiry, culminated in the exchange rate crash in December 2001. Therefore, before the fundamentals could be re-established and lead to the long-run adjustment of the exchange rate back to the PPP, the second crash occurred and led to a further deviation away from PPP.

It can be argued that a significant difference between the handling of the 1998 and 2001 crises was the Reserve Bank's stance towards intervention. As was pointed out by the IMF, South Africa merely faced a contagion problem from Asia in 1998, and the economic fundamentals of all emerging markets deteriorated. This deterioration in fundamentals was however a short-run phenomenon, and had the Reserve Bank been less interventionist, the fundamentals would have reasserted themselves on the back of a functioning price mechanism. Instead, the Bank's intervention resulted in distortions that prevented price mechanism correction and a perception was created that South African fundamentals would continue being weak. Thus, the nominal effective exchange rate could not recover before the 2001 crash. Between 1998 and 2001, the nominal effective exchange rate did not correct back towards the long-run PPP trend, and it followed the

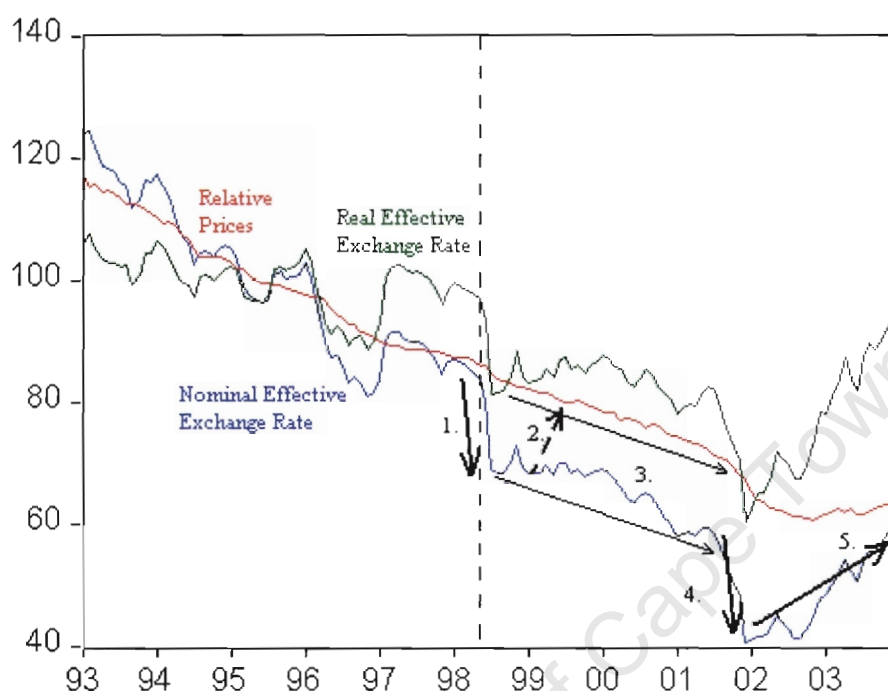
relative prices in parallel (see Figure 3). The depressed fundamentals had created an environment of low investor confidence and increased uncertainty.

Conversely, the handling of the 2001 freefall by the Reserve Bank can be praised in retrospect. Although the non-interventionist stance contributed to the uncertainty surrounding the rand at the time, the long-run effect of non-intervention in the FX market was the creation of an environment where the price mechanism could reassert the economic fundamentals.

A question of whether the Reserve Bank could have been more active in trying to limit the extent of the depreciation in 2001 remains. The impulse analysis conducted by Bhundia and Gottschalk shows that, in principle, monetary policy can be very effective with regard to the nominal exchange rate. However, leaning against depreciation would have required a substantial tightening of the monetary policy stance, and it is not clear that this would have been appropriate in an environment of slowing economic growth and muted inflationary pressures. Furthermore, their impulse response analysis shows that the effects of a nominal disturbance on the real exchange rate are fairly short lived, from which it follows that there is less need for strong interventions (of the 1998 kind) in the FX market, since the real effects of the depreciation should subside relatively quickly.

The recovery of the nominal effective exchange rate towards the PPP trend is evident from Figure 3. One should therefore expect that in the absence of future shocks, once the “mean path” is reached, the real effective exchange rate will move according to economic fundamentals, while the nominal effective exchange rate will reflect the changes in both the real effective rate and relative prices. The apparent robustness of the economy at the moment should not be taken for granted however. A myriad of socio-economic problems remain, and the future stability of the rand is uncertain. According to Moody’s, one of the ways that the Reserve Bank could aid rand stability is to buy more foreign currency to boost its foreign reserves which covered only some two and a half months of imports at the end of September 2003.

Figure 3: Mean-reverting behaviour of the Real Effective Exchange Rate



1. The rand depreciates due to the Asian contagion crisis.
2. The Reserve Bank pushes perceived fundamentals down through intervention in the FX market and the Nominal Effective Exchange Rate is not able to recover back to its long-run trend.
3. The Nominal Effective Exchange Rate moves parallel to the relative prices, i.e., there is no correction towards the trend dictated by relative prices.
4. The rand freefalls in Nov/Dec 2001.
5. From mid-2002 the rand begins its recovery towards the long-run trend dictated by relative prices. The real exchange rate exhibits mean-reverting behaviour.

The recent appreciation of the rand over the past two years is a good argument in favour of long-term adjustment to PPP. One of the key issues surrounding PPP is the length of time it takes the exchange rate to stabilise in light of shocks such as the 1998 and 2001 crashes. This question is beyond the scope of this paper (which is based on the Engle-Granger two-step methodology) and would best be analysed by using a multivariate framework.

More rigorous testing of the cointegrating relationship, including time-adjustment properties, can be based on the cointegration technique developed by Johansen (1988, 1991). The Johansen maximum likelihood approach has been shown to be a more efficient way of analysing the cointegration structure relative to the traditional Engle-Granger methodology (Maddala and Kim, 1998). Allowing modelling in a multivariate framework is one of the most crucial advantages of the Johansen maximum likelihood approach¹⁴.

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¹⁴ Both Aron et al. (1997) and van Staden et al. (2002) use this approach to test the behaviour of South Africa's real exchange rate.

9. The Commodity Price Boom and the Recovery of the Rand

The above thesis is based on the argument that the non-interventionist stance of the Reserve Bank during the 2001 crisis was instrumental in the rapid recovery of the rand.

This may well be true, but although there is general agreement that the vast improvement in the rand is partly owing to the country's stronger external position (as reflected in the elimination of the commitments of the Reserve Bank to sell dollars on the forward exchange account), the recovery of the rand cannot be viewed in isolation from the commodity price boom that has been in effect since 2002.

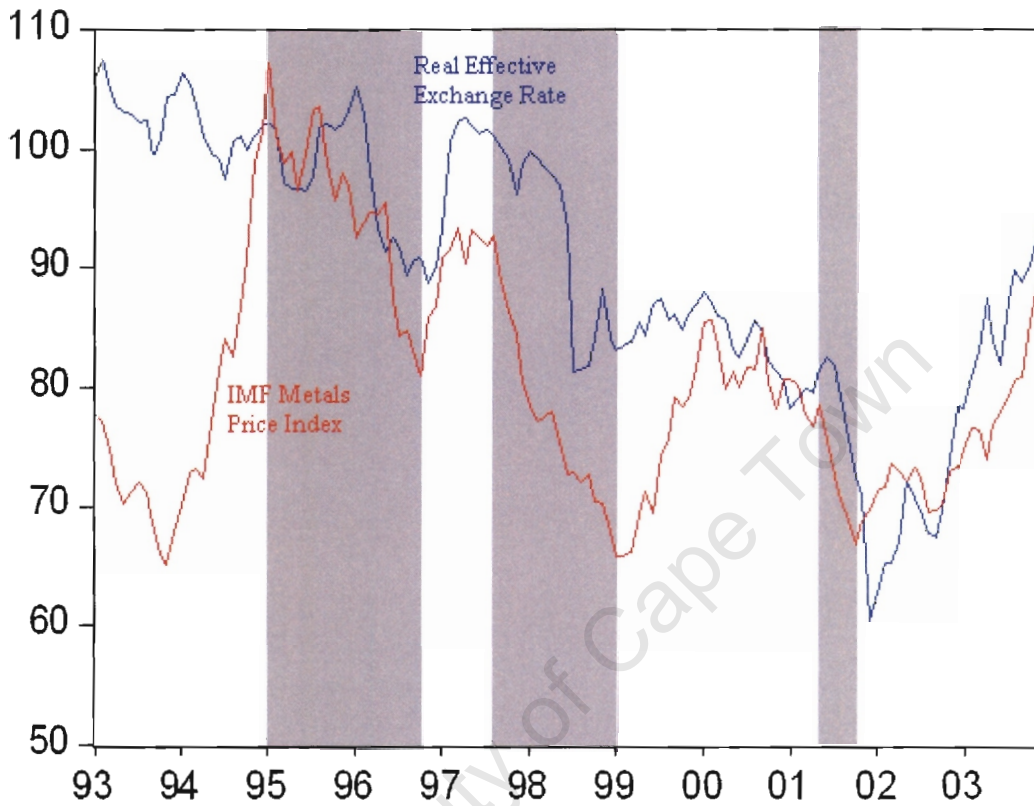
An accepted assumption for developing countries is that variability in real commodity prices has the potential to explain a large share of changes in real exchange rates, given that the majority of developing countries are highly dependent on commodities for the bulk of their export revenues (Cashin *et al.*, 2003). The rand is seen as one of the four¹⁵ main commodity-based currencies in the world, with the bulk of South African exports dependent on gold, platinum group metals, and coal.

As a result of this dependency, the rand was very sensitive to commodity price cycles over the past decades (Nedcor, 2003). In particular, the boom in the prices of precious metals between 1976 and 1980 (the gold price boom) led to a soaring rand. But in contrast to previous commodity cycles, which stemmed from changes in prices of specific commodities (e.g. gold), the current upswing in international commodity prices applies across the board, encompassing base metals, minor metals, precious metals and even certain "soft" commodities (Absa, 2004).

Figure 4 below shows the movement of the real effective exchange rate vis-à-vis the International Monetary Fund (IMF) World Commodity Metals Price Index.

¹⁵ The other three currencies are the Australian, New Zealand and Canadian dollar.

Figure 4: Real Effective Exchange Rate and the IMF World Metals Price Index (1995=100)



Note that the Real Effective Exchange Rate in Figure 1 is defined such that an increase represents an appreciation and a falling value a depreciation

IMF Commodity Metals World Price Index, includes: copper, aluminum, iron ore, tin, nickel, zinc, lead, and uranium prices


 Represents Commodity Downturn

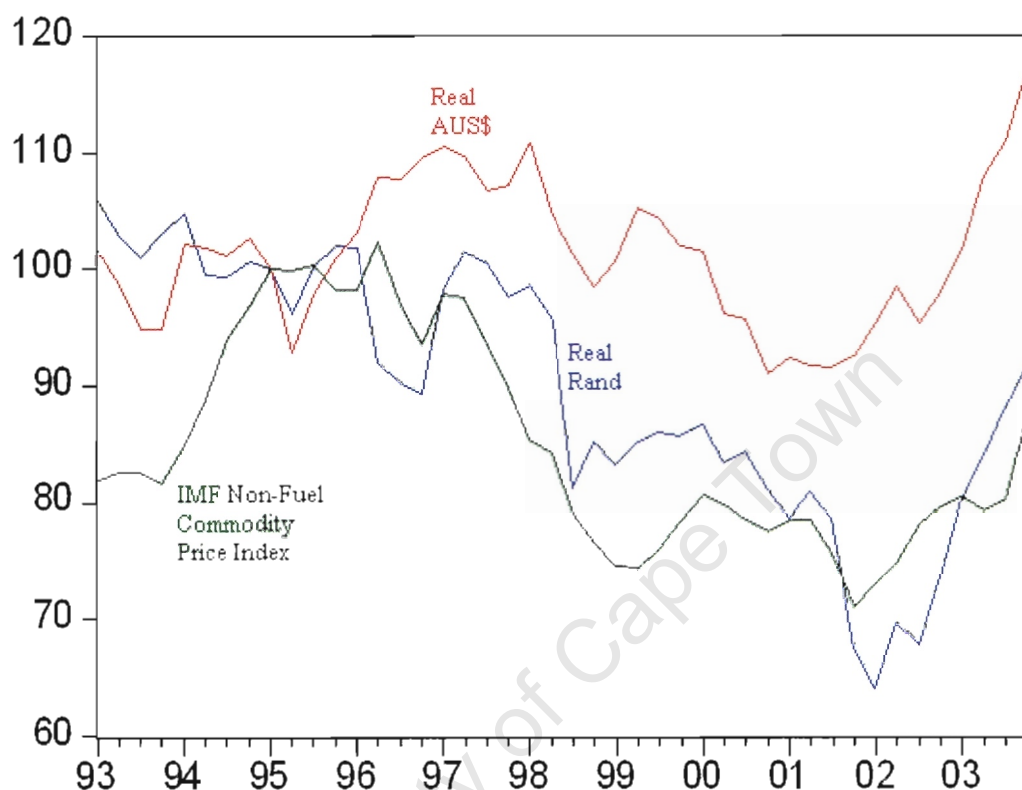
Figure 4 illustrates the rand's sensitivity to the metals' price cycle between 1993 and 2003. Periods of exaggerated movement in the real rand have tended to be associated with rising and falling commodity prices. In each downturn phase (indicated by the shaded area) a substantial real depreciation occurred.

Since 1995, the IMF World Metal Index tracked the rand closely, with the exception of the 1999 to mid-2000 period. The 1999-2000 experience seems to indicate that it is not actual commodity prices that explain currency weakness, but more the expectations about those prices that prevail in investment circles¹⁶. The general downward trend in commodity prices since 1995 and expectations of future deflationary trends made investment in countries that enjoy a comparative advantage in resource and commodity sectors unattractive (similar analysis can be applied to the real Australian (and New Zealand) dollar movement) (Kantor, 2001). In other words, the dynamics of currency movements are indicated by commodity prices, not defined by them. A larger set of factors is at play, but nonetheless, the vulnerability of the rand to commodity cycles is clear.

One explanation for the 2001 freefall includes the fact that the rand is a commodity-based currency, but this proposition does not hold on its own considering that other major commodity-based currencies did not experience a similar rapid decline. To exemplify this, Figure 5 shows how the rand has tracked the Australian dollar (a major commodity-based currency) relatively well during the 1990s (with the exception of the 1996 investor scare), but how the relationship broke down in the final months of 2001. In Figure 5, the two real effective exchange rates are modelled with respect to the IMF Non-Fuel Primary Commodities Price Index.

¹⁶ The negative sentiment of equity investors about resource companies represented on the Sydney and Johannesburg Stock Exchanges.

Figure 5: Real Effective Exchange Rates of the Rand and the Australian Dollar vis-a-vis the IMF Non-Fuel Primary Commodity Prices Index (1995.1=100)



Note that the Real Effective Exchange Rates in Figure 5 are defined such that an increase represents an appreciation and a falling value a depreciation

IMF Commodity Non-Fuel Price Index includes: food and beverages, and industrial inputs price indices

The closeness of the relationship between the rand and the Australian dollar can best be described by calculating the correlations between the two currencies (see Table 5).

The association broke down during the 2001 freefall (indicated by the negative correlation), suggesting that the rand depreciation was influenced by factors other than the commodity cycle.

Table 5: Correlations Between the Real Effective Exchange Rates of the Rand and the Australian Dollar

93:01-95:04	96:01-96:04	97:01-00:04	01:01-01:04	02:01-03:04
0.4038	-0.9756	0.8299	-0.6370	0.9588

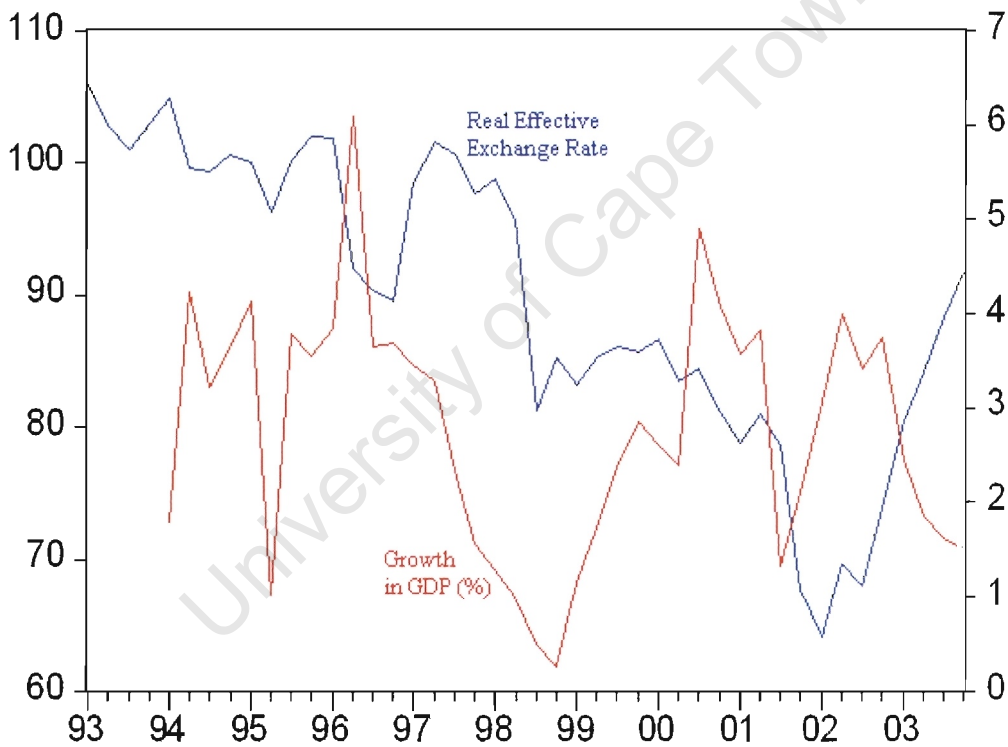
Although the 2001 experience can be attributed to factors other than commodity prices, a case can be made that the commodity price boom that began in 2002 has been highly influential in the real appreciation of many commodity-based currencies.

The latest upswing in the metals price index comes after a prolonged stagnation, and is indicative of a bullish market. The high correlation between the soaring metal prices and the rapid rand appreciation during 2002-2003 stands at approximately 70 percent (see Figure 4).

Moreover, the 2002-2003 real appreciations of both the rand and the Australian dollar were closely matched, with the correlation between the two currencies standing at 96 percent. This relationship started on the back of rising metal prices which began moving upwards in September 2001. The exceptional performance of many commodities in 2003 (more specifically: nickel, lead, copper, tin, zinc, platinum, and gold) came after already impressive gains in 2002. In 2003, four of the five top-performing currencies against the dollar were commodity-based currencies. This rally has occurred against the backdrop of a synchronised upswing in the world economy and fast-growing economies in Asia – especially China (Absa, 2004).

It has already been discussed that the exceptional recovery of the rand since 2002 represents a retraction from the heavily undervalued situation that was brought about by the 1998 and 2001 rapid depreciations. The real appreciation has thus been seen as a movement back towards the long-run trend and probable reestablishment of long-run PPP. But despite the benefits associated with the reestablishment of PPP and international competitiveness, the current commodities boom is not benefiting the South African economy.

Figure 6: Real Effective Exchange Rate and GDP growth



Note that the Real Effective Exchange Rate in Figure 1 is defined such that an increase represents an appreciation and a falling value a depreciation

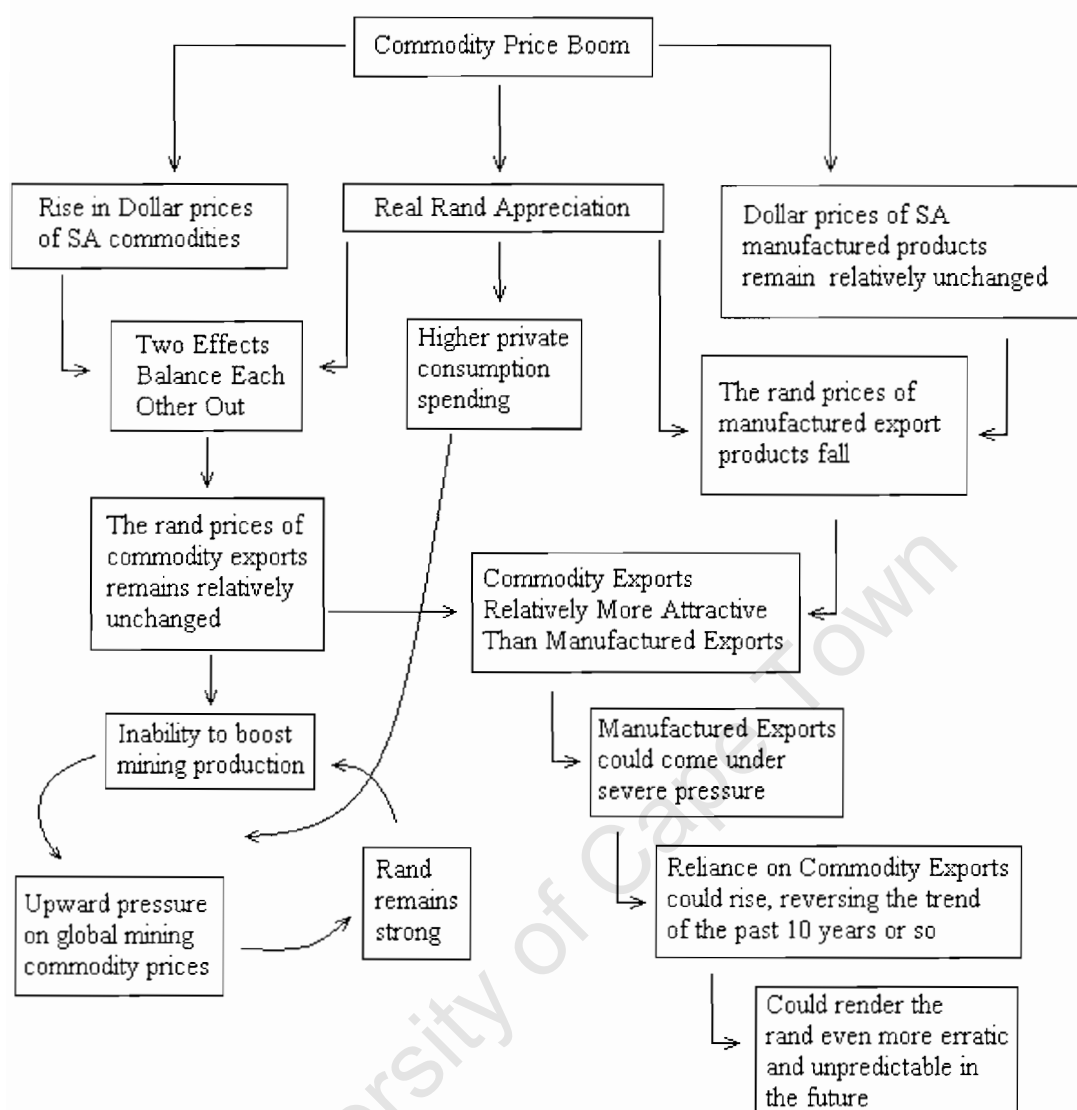
Growth in GDP was calculated year-on-year using quarterly data and constant 1995 prices

The growth in the gross domestic product fell to 1.5 percent in 2003 from 3.5 percent in 2002. The economic windfall of rising commodity prices is not being experienced by South Africa because the US dollar price rises of many commodities have been counterbalanced by the appreciation in the rand. According to Absa (2004), the current advance in commodities is mostly reflected in a stronger rand and lower inflation, although the latter has facilitated a drop in domestic interest rates, which is of benefit to the economy.

Conversely, the strong rand is preventing the manufacturing sector from reaping the benefits of the global economic recovery. The appreciation of the rand has eroded export growth and depressed production in import-competing industries. As a result, overall manufacturing production contracted by 2.3 percent in 2003 compared with 2002 robust growth of 5.2 percent. Furthermore, private consumption spending has risen over the same period.

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Figure 7: "Curse of Commodities"
(also known as the "Dutch Disease")



While the commodity prices in dollar terms have increased significantly during the past two years, the dollar prices of South African manufactured exports have, in general, remained unchanged or risen only marginally. The rand prices of manufactured export products have therefore fallen much more sharply than those of commodity exports. The rand has become more of a commodities-based currency, but the mining sector in South Africa has received no meaningful benefits from the boom because of the huge rand appreciation. This has exerted a depressing influence on mining output. Furthermore, the movement towards commodities poses a significant threat to manufactured exports. The country's reliance on commodity exports could rise, and in turn render the rand more volatile (Absa, 2004).

Such instability would bring into focus the suitability of Reserve Bank's policy of non-intervention. At present the Bank is "creaming off" dollars in the FX market to strengthen its foreign exchange reserves. More importantly, it is doing so to eventually eliminate the NOFP.

On the negative side, the rise in the foreign reserves could precipitate a considerable increase in banking liquidity (as the Bank sells rands to buy dollars), which in turn could pose inflationary dangers. On the positive side, the elimination of the NOFP is bringing about some upward credit assessment by the foreign community, which could lead to improved investment sentiment towards South Africa.

10. Conclusion

The early and mid-1990s were characterised by the opening up of the South African economy to international forces, and gradual liberalisation of the FX market. The PPP held for the period 1993-1998, indicating that inflation differentials between South Africa and her major trading partners were offset by exchange rate changes.

The results of the statistical tests show that there was a breakdown of the PPP relationship in South Africa between 1998 and 2003. During this period, the rand was a weak currency and was negatively affected by a combination of adverse economic circumstances, which resulted in two major rand depreciations. The Reserve Bank intervention during the 1998 crisis failed to protect the rand, and contributed to the further weakening of economic fundamentals, so that the exchange rate was unable to recover before the 2001 freefall. The failure of PPP during this latter period is therefore intuitive.

The recent recovery of the rand, and real exchange rate retraction towards the long-run PPP trend, can partly be attributed to the non-interventionist stance of the Bank during the 2001 crisis. Moreover, it is clear that the commodity price boom that has been in effect since 2002 has played a major role in the rapid rand appreciation. Whereas the 1990s exchange rate experience seemed to be dominated by issues surrounding the reintegration of the South African economy into the international community, and the importance of international sentiment towards economic fundamentals of emerging markets, the situation is now very different.

Political risk factors and social problems still remain, but due to the pronounced international commodity boom, the rand is now in unfamiliar territory. The analysis points to long-term adjustment towards PPP, but the volatility of the rand in the face of increased reliance on commodity exports presents a new threat. If one accepts the proposal that the currency is now almost fairly valued by the PPP measure, a case can be made for policy moves to restrain any renewed rand appreciation. One such policy could involve further liberalisation of exchange controls.

Since the beginning of 2004, the rand has been more stable against the dollar and the dollar prices of commodities have generally still been rising strongly. A whole new positive environment could eventually emerge if this boom stretches over several more years and if the rand maintains its PPP trend. Conversely, the threat to manufactured exports from an appreciating rand could render the exchange rate more volatile and increase uncertainty.

One fact that has emerged from this analysis is that an emerging commodity market, such as South Africa, that has maintained a flexible, and in recent years, a more free and transparent exchange rate regime, will occasionally experience powerful effects (adverse or positive) stemming from international events. It is a question of how the policy makers respond to those forces that will determine the long-run course for the economy.

Goran Unkovski

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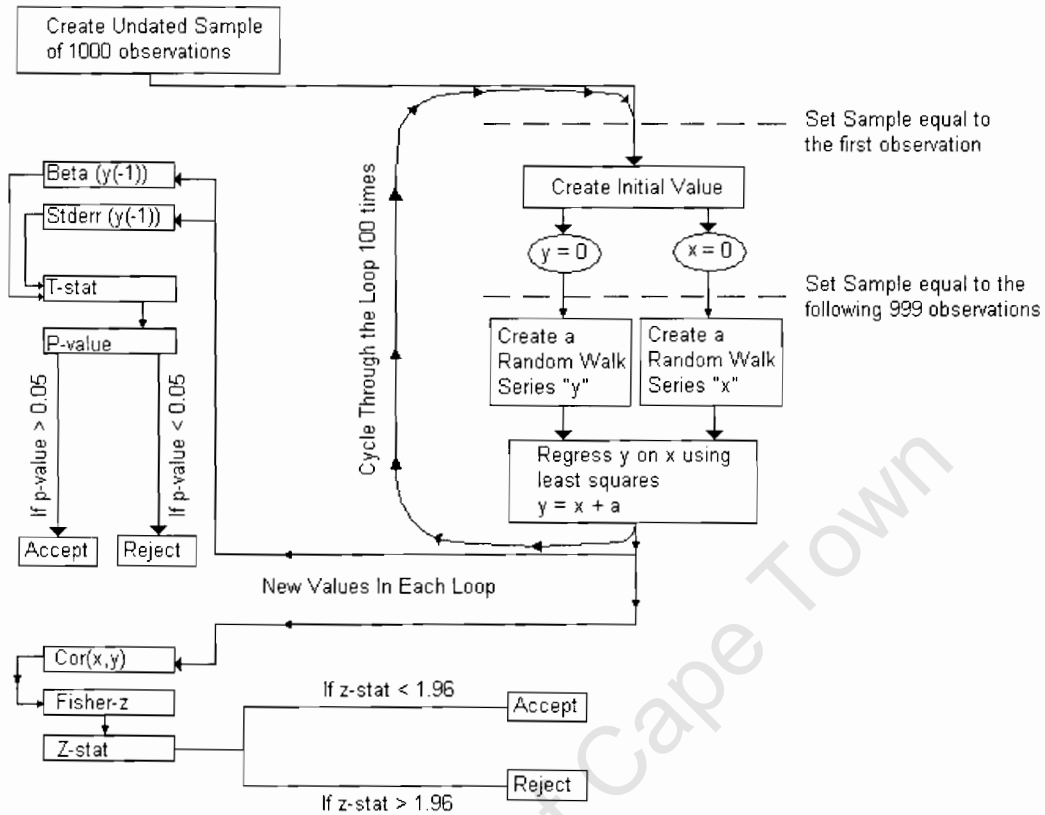
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Appendix: Monte-Carlo Simulation Study

The Program Algorithm for Monte-Carlo Unit Root Testing is given in the diagram below:



A sample of 1000 observations was created and two uncorrelated non-stationary random walks “y” and “x” were generated. “y” was then regressed on “x” using the model: $y_t = \beta_0 + \beta_1 x_t + \varepsilon_t$. In the context of the paper, one could imagine that “y” represents the nominal effective exchange rate, and “x” represents relative prices.

The process of generating “y” and “x”, and regressing one on the other, was looped 100 times, and in each cycle, separate statistics were recorded to compute the t-statistic and the fisher-z.

For the t-statistic, the coefficient and the standard error of β_1 were recorded into separate vectors, and the t-stat and p-value estimated for the null $H_0: \beta_1=0$.

An “if” command was introduced to separate the p-values into those greater than 5% and those less than 5%, and depending on the value generated in a pass through the loop, the value was recorded into the appropriate scalar named “accepttstat” or “rejecttstat”. The program was looped 100 times, so that in total, the two scalars would together contain 100 values.

The Fisher-z value was computed from the correlation (x, y), and a z-statistic obtained by standardizing the Fisher-z to a normal distribution. The z-statistic was then tested for the null that the correlation coefficient is not significantly different from 0, i.e., $H_0: \rho=0$, and an “if” command introduced to separate the z-statistic into those greater or less than 1.96, and depending on the value generated in a pass through the loop, the value was recorded into the appropriate scalar named “acceptcorr” or “rejectcorr”. The program was looped 100 times, so that in total, the two scalars would together contain 100 values.

The above simulation was run 100 times, resulting in an estimated mean value for β_1 of -0.050, and an associated standard error of 0.029 (given a sample size of $T=1000$), thus rejecting the null that $E[\beta_1]=0$. Based on 100 replications, the probability of rejecting the null of no association at the conventional significance level of 0.05 was found to be 0.95 (i.e., in 95 percent of the regressions, values of $|t|>1.96$ were obtained). This was due to the fact that the mean t-statistic obtained from the experiment was -0.05 instead of zero, with an associated standard deviation of 0.685. The non-standard distribution of the t-statistic accounts for the very high rejection rate of the null.

A similar conclusion is obtained by evaluating the significance of the Fisher-z statistic. Based on 100 replications, and a sample size of 1000, the probability of rejecting the null of a correlation coefficient equal to zero at the conventional significance level of 0.05 was found to be 0.95.

By varying the size of the sample T , it was found that the probability of rejecting the (true) null $H_0: \beta_1=0$ will increase with sample size. The rejection rate for the t statistic was 65% for $T=50$, 76% for $T=100$, 91% for $T=500$, and 95% for $T=1000$.

By varying the size of the sample T , the probability of rejecting the (true) null $H_0: \rho=0$ did not increase with sample size. The rejection rate for the normalized z -statistic was 92% for $T=50$, 95% for $T=100$, 96% for $T=500$, and 95% for $T=1000$.

If y_t and x_t are modelled with a drift term (up to now it was assumed that the two series were pure random walks), for each sample size T , the rejection rate is slightly higher than if the two series are modelled without drift.

Furthermore, it was found that the R^2 of a regression of one random walk on another becomes a random variable in a regression of unrelated nonstationary variables, and the likelihood of finding a sizable R^2 in that context is rather large.

In summary, there is often a problem of falsely concluding that a relationship exists between two unrelated non-stationary series. This is especially important when analysing relationships such as the PPP. This problem generally increases with the sample size and it cannot be solved by attempting to detrend the underlying series as would be possible with trend-stationary data. This leads to the question of when it is possible to infer a causal long-run relationship(s) between non-stationary time series, based on estimating a standard regression such as: $y_t = \beta_0 + \beta_1 x_t + \varepsilon_t$?

Demonstrably, OLS does not yield consistent estimates of the true slope parameter in this instance: the case of a spurious regression, as defined by Granger and Newbold (1974). The problem of spurious regressions appears with $I(1)$ variables, so the determination of unit root processes (generally using the Augmented Dickey-Fuller ADF test) is essential. Furthermore, the problem will not arise if the series are cointegrated, so that determining

whether cointegration exists, and whether there is theoretical economic ground for such cointegration, is important as well¹⁷.

EViews PROGRAM CODE

```

new workfile question3 u 1000

scalar acceptcorr=0
scalar rejectcorr=0
scalar accepttstat=0
scalar rejecttstat=0
vector(100) corr_xy
vector(100) fisher_z
vector(100) z_star
vector(100) beta
vector(100) serr
vector(100) t_stat
vector(100) p_value

for !0 = 1 to 100
  smpl 1 1
  gener y = 0
  gener x = 0
  smpl 2 1000
  gener y = y(-1) + nrnd or alternatively for drift component gener y = 0.1*rnd
  + y(-1) + nrnd
  gener x = x(-1) + nrnd or alternatively for drift component gener x = 0.1*rnd
  + x(-1) + nrnd
  equation q3a.ls y c x
  corr_xy(!0) = @cor(x,y)
  fisher_z(!0) = 0.5*(log(1+corr_xy(!0)) - log(1-corr_xy(!0)))
  z_star(!0) = @abs(fisher_z(!0)*@sqrt(997))
  beta(!0) = c(2)
  serr(!0) = @stderrs(2)
  t_stat(!0) = (beta(!0)-0)/serr(!0)
  p_value(!0) = @tdist(t_stat(!0),48)
  if z_star(!0) < 1.96 then
    acceptcorr = acceptcorr + 1
  else
    rejectcorr = rejectcorr + 1
  endif
  if p_value(!0) > 0.05 then
    accepttstat = accepttstat + 1
  else
    rejecttstat = rejecttstat + 1
  endif
endfor
next

```

¹⁷ I would like to thank Professor Graham Barr for his help in clearly explaining the unit root processes in Eviews programming. The technical detail presented in this dissertation would not have been possible without the knowledge, reading material and notes, imparted by Professor Barr during the coursework at the 2003 Financial Time Series Module for Masters Studies at the University of Cape Town.