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International Fisher Effect and Purchasing Power Parity: The case of the South African Rand and US Dollar

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International Fisher Effect and Purchasing Power Parity: The case of the South African Rand and US Dollar

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WITS Business School

Thesis presented in partial fulfilment for the degree of Master of Business Administration to the Faculty of Commerce, Law and Management, University of the Witwatersrand

March 2021

DECLARATION

I, Ricardo de Beer, declare that this research report entitled 'International Fisher Effect and Purchasing Power Parity: The case of the South African Rand and US Dollar' is my own unaided work. I have acknowledged, attributed and referenced all ideas sourced elsewhere. I am hereby submitting it in partial fulfilment of the requirements of the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. I have not submitted this proposal before for any other degree or examination to any other institution.

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ABSTRACT

This study aims to investigate the presence of the International Fisher Effect (IFE) and Purchasing Power Parity (PPP) in the case of the South Africa Rand (ZAR) and the United States Dollar (USD) using monthly data that span from January 2014 to December 2019. The study adopted an ordinary least square (OLS) model and the Granger causality econometric technique to achieve the stated objectives. Based on the IFE and PPP assumptions, the OLS results indicate an insignificant positive relationship between the inflation differentials in South Africa and the United States of America. The model revealed that a 1% increase in the inflation differential between the two countries will trigger an increase in the South African interest rate which will furthermore cause an appreciation of the exchange rate in the long run. The model revealed the presence of the IFE and PPP between the ZAR and the USD. The pass-through effect of the IFE and PPP adjustment is incomplete in the analysis due to the peculiarities of the South African economy (reliance on community and its volatile effect on the country's foreign earnings, corruption, civil unrest, concern around political instability, etc.). In light of the above, the study recommended policy measures that focus on diversifying the foreign earning source of the country and policies that enhance the level of political stability in the country to further increase the level of confidence foreign investors have in the stability and monetary policy of the country.

Keywords: South Africa, International Fisher effect, Purchasing Power Parity, Interest Rate Parity, Exchange Rate, Capital Flows.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributed Lag
CPI	Consumer Price Index
ECM	Error Correction Model
EMH	Efficient Market Hypothesis
FDI	Foreign Direct Investment
FED	Federal Reserve Bank
IFE	International Fisher Effect
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Square
PP	Phillips-Perron
PPP	Purchasing Power Parity
SA	South Africa
SARB	South African Reserve Bank
UIP	Uncovered Interest Parity
USA	United States of America
USD	United States Dollar
ZAR	South African Rand

1 INTRODUCTION TO THE RESEARCH

1.1 Background and context

Making investment decisions entails contrasting the risk and returns profile of investment opportunities with alternative investment options (El Khawaga, Esam & Hamman, 2014). The higher the risk-adjusted return on investment opportunities, the higher the level of satisfaction potential investors may derive from such investments. This concept also applies to the international exchange rate market where investors/arbitrageurs are constantly searching for opportunities to exploit potential violations of the parity conditions in the market.

Exchange rate differentials can change the pay-off profile of potentially profitable international investment opportunities. Besides, the globalisation of trade and investment and the development of financial technology has deepened the level of the interdependency of foreign trade and the flow of financial capital among countries; in turn, this calls for further coverage and a review of the exchange rate market.

Numerous studies have analysed the extent to which parity exists in the exchange rate forward market (Alagidede & Ibrahim, 2017; Salas-Ortiz & Gomez-Monge, 2015; Shalishali, 2012). The objectives of these studies have largely been to ascertain if the forward market is truly an unbiased predictor of the future spot exchange rate, especially in the flexible exchange rate regime.

The IFE has often been used in addition to uncovered interest rate parity to gauge the extent to which the spot exchange rate converges towards the projected future spot exchange rate. The uncovered interest rate parity theory highlights the efficiency in the forward rate market. This implies that if country A with a relatively low interest rate is compared to country B with a high interest rate, the currency of country A should appreciate against the currency of country B. This implies that the difference between the interest rates of the two countries is an important factor driving parity in the forwards market and this differential will often be similar to the movement in the ex-post exchange rate.

If this assumption of parity holds, then the differential between the interest rates of the two countries can be used to estimate the expected future spot exchange rate, thereby making it an unbiased predictor of the future spot exchange rate. This, therefore, serves as the central element of examination for this dissertation.

1.2 Research conceptualisation

1.2.1 The research problem statement

The strength of a country's exchange rate is a significant factor in determining foreign direct investment (FDI) and foreign portfolio investment (FPI) inflows, price stability and sustained economic growth (Al-Samara, 2009). Exchange rate fluctuation could significantly impact the competitiveness of a nation in terms of trade export, FPI and FDI.

The South Africa currency (ZAR) and the exchange rate have experienced significant levels of volatility and it has oftentimes been argued that the level of information asymmetry in the forward exchange rate market for underdeveloped and developing markets is higher compared to developed markets (Chmelarova & Schnabl, 2006; Disyatat & Galati, 2005). This is obviously a violation of the uncovered interest rate parity condition, which in turn creates an arbitrage opportunity to earn an economic return from the inflation and interest rate differentials of the two countries.

Other factors that often impact exchange rate parity are political and administrative hurdles, frictions in the financial market and capital control measures by the monetary authority; these factors are all prevalent in developing and underdeveloped nations (Disyatat & Galati, 2005). The above is posited to impede the assumptions of long-run parity championed by PPP, covered interest rate parity, uncovered interest rate parity and the IFE.

Given the fact that South Africa has a history of political instability, foreign exchange market intervention, the tendency of the Reserve Bank to step in when necessary and the above-highlighted impediments that are peculiar to developing countries, some of the structural impediments highlighted so far exist and will impact the ZAR exchange rate either positively or negatively.

To this end, this dissertation will attempt to establish if the IFE and PPP hold between the ZAR and USD.

1.2.2 The research objectives and questions

Given the above background, this dissertation aims to address the following key objectives:

- To establish whether the International Fisher Effect drives exchange rate parity between the ZAR and USD.
- To ascertain the direction of causality between the South African and US inflation differentials and the ZAR exchange rate.

In so doing, answers will be sought for the following questions:

- Does the International Fisher Effect drive parity between the ZAR and USD exchange rate?
- Do South African and US inflation differentials cause changes in the ZAR exchange rate?

1.3 Hypothesis

To satisfy the above objectives and to answer the research questions, the hypotheses listed below will be tested for validity.

Hypothesis 1:

H0: The International Fisher Effect does not drive parity between the ZAR and USD exchange rate.

H1: The International Fisher Effect does drive parity between the ZAR and USD exchange rate.

Hypothesis 2:

H0: South African and US inflation differentials do not cause changes in the ZAR exchange rate.

H1: South African and US inflation differentials cause changes in the ZAR exchange rate.

1.4 Expected methodology

The central objective of the research is to empirically ascertain if the IFE and PPP held in the case of the ZAR and USD for the period from January 2014 to December 2019. The econometric model relating to this study is adopted from the work of Salas-Ortiz and Gomez-Monge (2015). This model hinged on testing the IFE and PPP effect on the Mexican Pesos (MXN) and the USD. This model is thus adopted here for similar purposes. The mathematical econometric model is presented below:

$$\frac{S_{t+1} - S_t}{S_t} = \alpha_0 + \alpha_1 \left\{ \frac{(i_h - i_f)}{(1 - i_f)} \right\} + \varepsilon_t$$

Where $(S_{t+1} - S_t) / S_t$ = Changes in the home exchange rate

i_h = Home country nominal interest rate

i_f = Foreign country nominal interest rate

ε_t = Error terms

The model will allow a careful examination of how the differential in interest rates between the two countries influences the exchange rate of the home country. With this, whether the parity condition holds between the concerned currencies (ZAR and USD) can be proved or not. Exchange rate and interest rate data for South Africa will be sourced from the South African Reserve Bank while similar data for the USA will be sourced from the Federal Reserve Bank. Further details on methods are presented in Chapter 3.

1.5 Delimitations and assumptions of the research study

The scope of this study is limited to a six-year period (January 2014 to December 2019) representing 72 monthly data sets and can be referred to as a short-term analysis. This research will therefore benefit from additional long-term analysis to further demystify the level of parity between the ZAR and USD as promoted by the IFE and PPP.

1.6 Significance of the research study

Despite numerous researches that have been carried out to test the IFE theory and PPP on the ZAR, no studies have been found to test this effect over the past six years,

despite the record of significant changes in the ZAR exchange rate against major currencies (especially the USD). On the back of the above, this study will focus on breaching the identified research gap by enhancing the existing body of knowledge on the IFE theory and PPP between the ZAR and USD.

1.7 Preface to the research report

Chapter 1 presents the background and the foundation of the study, while Chapter 2 focuses on the review of past publications on the exchange rate, PPP and the IFE. Chapter 3 will focus on detailing adopted methods, including a review of the theoretical framework and measurement techniques that will be used. Chapters 4 and 5 will focus on the analysis, conclusions and recommendations of the study.

2 LITERATURE REVIEW

The objective of this study is to ascertain if the IFE and PPP hold in the case of the ZAR and the USD. This chapter deals with the review of theoretical and empirical research conducted on interest rate and exchange rate parity to identify past trends and also to improve on them.

2.1 Purchasing power parity

The PPP which is rooted in the basic assumption of the law of one price is a theory that attempts to explain movement in the exchange rate. Essentially, PPP theory states that exchange rates adjust over time to offset divergent prices (Ray, 2012).

Two versions of PPP – absolute and relative – have been discussed over time. Absolute PPP explains that goods with equal shape and form must sell at the same price across countries. In other words, products comply with the assumption of one price. Relative PPP, on the other hand, postulates that the exchange rate between countries will reflect the changes in general price levels (inflation) between concerned countries (Solnik, 2000). The PPP under the relative version is written below:

$$(C_{t+1} - C_t) = \frac{(Inf_h - Inf_f)}{(1 + Inf_f)}$$

Or

$$\frac{(C_{t+1} - C_t)}{C_t} = (Inf_h - Inf_f)$$

Where:

C_t = The value of foreign currency in domestic currency at time t

C_{t+1} = The spot exchange rate at time t+1

Inf_h = Current level of inflation rate in the home country

Inf_f = Current level of inflation rate in the foreign country

The above equation tries to explain the relationship between exchange rate volatility and inflation, signifying that the exchange rate differential between the focused countries will be offset by the inflation differential of those countries. Thus, an increase in country A's inflation expectations will result in the depreciation of its currency (Shapiro, 1998).

To substantiate the long-run view of PPP, Manzur (1990) provided evidence over an average of a five-year period that PPP is a long-run phenomenon. On the other hand, several authors are of the view that the Balassa-Samuelson effect will always offset the PPP effect, thereby limiting the holding ability of PPP. The Balassa-Samuelson effect explains that high-income countries with productive advantage in the production of tradeable goods will produce at a relatively lower cost compared with low-income countries with a lower productive advantage.

The presence of the law of one price ensures parity in the price of these tradeable goods across different countries, while the price of non-tradeable goods will be lower in countries with a low level of income. The above conclusion confirms the presence of systemic deviation from PPP in the short and long run. In addition to the Balassa-Samuelson effect, Neary (1988) emphasises the presence of other factors that cause potential long-term deviations from PPP.

Neary (1988) identified 'Dutch Disease' – where a sudden improvement in the price of non-renewable resources leads to the neglect of other sectors of the economy – as another source of long-run deviation in PPP. This price change often causes deviation in the real exchange rate of a country. The author further highlighted terms of trade and government fiscal deficit, especially external debt, as other possible explanations for PPP not holding in the long run.

Furthermore, Al-Gasaymeh and Kasem (2015) revealed that the PPP approach works better for countries experiencing a higher level of inflation and hyperinflation. Short-term studies have shown the tendency of random walk between the real exchange rate and the equilibrium exchange rate in the short run; a low level of reversion was however observed using long-run data. Rogoff (1996) affirms that it takes around three to five years for half of the exemptions to be lifted; he termed this the 'PPP Puzzle'.

Inflationary experience has been described as one of the major characteristics to be considered in the exchange rate variability of a country. The long-run PPP relationship has been perceived as an equilibrium condition of money neutrality in the global market. If monetary shocks dominate price movement, parity reversion is most likely to prevail.

PPP often holds for countries with high inflation (Frenkel, 1976; McNown & Wallace, 1989).

Drine and Rault (2005) examined the robustness of the PPP concept across 80 countries divided into five groups (Latin America, Asia, Middle East, Africa and North Africa) and another set of 22 Organisation for Economic Co-operation and Development (OECD) developed countries between 1970 and 1989, and 1990 and 1997, respectively. The authors calculated the average inflation for the concerned countries and the ones with considerable variation in average inflation between the two sub-periods were excluded from the sample. Hence, the focus of the research was on countries with stable average inflation.

Drine and Rault (2005) verified the presence of strong PPP for OECD countries and the opposite, weak PPP, for Middle East/North Africa countries. They, however, observed a weak and irrelevant presence of PPP in Central and Eastern European countries and Latin America. The authors also concluded that the validity of PPP in a particular country is not conditioned by the reigning exchange rate regime.

Alba and Papell (2007) rationalise their analysis of Africa and Latin America by bucketing countries in the same region due to exposure to similar macroeconomic environments; they believe PPP has a higher chance of holding among them. Their efforts to analyse long-term PPP led to the rejection of the unit root hypothesis for panels of countries nearer to the United States of America (USA) but failed to reject the null hypothesis at a 10% significant level for countries that are farther from the USA. Their analysis is in line with the argument that PPP is negatively correlated with distance.

2.2 The International Fisher Effect

The IFE is an extension of the Fisher effect. The major conclusion of the theory is that country A with an interest rate relatively higher than country B should see the currency of country A depreciating in value; this decline is attributed to the implied higher inflation expectation in country A. Effectively, the potential loss in the value of the currency in country A should lead to a lower demand for its currency which thus drives the currency back to its sustainable level. The question worth asking is: can the

inflation/interest rate differential between two currencies help in predicting future currency movement?

Observed evidence by Hill (2004) revealed mixed results in the case of PPP while the long-run relationship between the interest rate differentials and subsequent changes in the spot exchange rate was observed to be stable. The model, however, became inconsistent under closer short-term examination. The IFE has been established to be an unreliable predictor of short-term movement in the spot exchange rate (Cumby & Obstfeld, 1981).

To further corroborate the above, Siti and Eno (2009) utilised the quarterly and yearly data on inflation rate differentials and interest rates over a five-year period (2003–2008) in their analysis of Japan, the USA, the UK and Singapore, while using Indonesia as the home country. They observed an insignificant positive relationship between the interest rate differential and the exchange rate for Singapore, the UK and the USA relative to Indonesia, while also observing a significant negative relationship between changes in the exchange rates for Japan and Indonesia.

The IFE theory postulates that volatility in the spot exchange rates between countries must be equal to nominal interest rate differences (Goddard, 1994). For instance, the Naira exchange rate will witness a depreciation against the USD for an increase in the level of the inflation rate in South Africa relative to the USA.

Foreign speculative investors in the future spot exchange rate often move capital from low-interest rate countries to high-interest rate countries for the sake of making arbitrage profit. The mobility of capital would affect exchange rate volatility, wiping off all the return opportunities for countries with capital control measures.

Demirag & Goddard (1995) infer that nominal interest rate differentials are an unbiased predictor of future changes in the spot exchange rate. However, inconsistency in exchange rate policies, demand and supply forces, speculation, external reserve, capital control measures, the balance of payment position and rising inflation all have some form of impact on the exchange rate movement between two currencies.

Thomas (1985) examined the validity of the IFE theory by focusing on the result of a long position in future contracts on currencies with relatively high interest rates and also a form of discount, vis-à-vis a short position in the future contract on currencies with a low interest rate that is priced with some form of premium. Thomas's finding contradicts the conclusion of the IFE, as around 57% of the transactions created using this strategy generated arbitrage profit and the average gain was higher than the average loss.

If the IFE holds, some form of depreciation in currencies with high interest rates should be observed and some form of appreciation should be witnessed in currencies with a low interest rate, thereby limiting the arbitrage opportunity. Abuaf and Jorion (1990), Adler and Lehman (1983) and Mishkin (1984) all observed some form of variation in the relationship between the exchange rate and inflation differential among multiple countries.

In support of the above, Hakkio (1986) found an imperfect relationship between the inflation rate differential and the exchange rate over a long-term period and concluded that the inflation differential is an integral part of long-run exchange rate forecasting.

2.3 Relationship between exchange rate and interest rate

Two basic approaches are utilised to measure the relationship between nominal exchange rate volatilities and interest rate differentials in the literature (El Khawaga et al., 2014). Frenkel (1976) introduced an approach that reveals the elastic and perfect flexibility of prices. Frenkel implies that the expected inflation rate is influenced by the nominal interest rate, which in turn impacts the demand for domestic currency. The author also revealed a strong positive correlation between the nominal interest rate differential and exchange rate volatility.

Similarly, Dornbusch (1976) adopted a different approach which tracked the exchange rate adjustment to the differentials in interest rate over a certain period. Also, Frankel (1976) established that the real interest rate and the inflation rate are influenced by the nominal interest rate. The author further asserted that the real interest rate differential model comprised the relationship between the real interest rate differential and exchange rate volatilities. Frankel added the inflation expectations element of the

flexible price model to the stable price assumption of the Dornbusch model and concluded that the real interest rate differential is negatively related to the nominal exchange rate but positively associated with the differential in long-run expected inflation.

Friedman (1953) opined that instability in the exchange rate may be a symptom of instability in the macroeconomic environment; the author concluded that a positive relationship exists between macroeconomic growth and exchange rate variability. To corroborate this, Burdekin and Burketi (1996) argued that a passive response of money supply to inflationary pressure can exacerbate inflationary pressure in the economy. In this case, depreciation in the country's exchange rate can help to assuage inflationary pressure regardless of whether the process is initiated by internal or external factors.

Similarly, Cooper (1971), in his analysis of 19 developing countries over an eight-year period, observed a positive relationship between exchange rate devaluation and the trade balances of the concerned countries in the short run; he explained further that the economic activity of the focused countries decreased thereafter as the inflation level rose beyond the target level.

In their study in China, Lu and Zhang (2003) observed a short-run positive correlation between changes in the exchange rate, interest rate and general price level. The findings provided some form of clarity around China's exchange rate policy reform, which was targeted at correcting the country's overvalued currency.

Agénor (1991), using a sample of 23 developing countries, adopted an autoregressive time series model by analysing economic growth using its lag series and government spending, interest rate money supply and exchange rate. The result revealed a short-run positive impact of exchange rate depreciation on economic growth, followed by a medium-term growth reversal.

Canetti and Greene (1991) adopted a vector autoregression approach in their analysis to isolate the impact of money supply and interest rate on exchange rate changes in Africa. The authors, however, observed a strong influence of monetary expansion and exchange rate movement on the level of inflation in several Sub-Saharan African

countries. Specifically, the authors established the presence of strong causality between inflation and exchange rates in Tanzania, Congo and Sierra Leone. Kamas (1995) observed an insignificant relationship between exchange rate variations, the interest rate and inflation rate in Colombia. The author highlighted that the major factor fuelling the exchange rate and interest rate variation in the country was demand shocks.

2.4 Empirical review of the International Fisher Effect

Ersan (2008) investigated the applicability of the IFE among G5 countries (Germany, France, Japan, the USA and the UK) over a 23-year period (1985–2007). By adopting the Johansen cointegration approach, he observed the long-run relationship between exchange rate volatilities and nominal interest rate differentials among the focused countries. He also observed that the IFE theory held for Turkey when it was incorporated as a home country against the remaining G5 countries. However, the IFE theory broke down under close examination for other country pairs (excluding Germany and France).

Ersan (2008) concluded that perfect capital mobility may not have been in existence during the period of research among the focused countries. In addition to the above, currency risk, political risk and transaction costs that affect investment decisions were also highlighted as additional reasons behind the IFE breakdown.

Similarly, Shalishali (2012) examined the IFE theory between eight emerging economies (Japan, Indonesia, South Korea, Philippines, Malaysia, China, Singapore and India) over a ten-year period (1990–2009). The author's adoption of the time series regression approach revealed a mixed result. The IFE theory held for some countries while the opposite was the case for other countries when used as a home country and foreign countries, respectively and vice versa. The author attributed the failure of the IFE in some of the covered countries to factors such as expectations around the future spot exchange rate which affects the exchange rate volatility outside of interest rate and inflation rate differentials.

To test the reliability of the IFE between the USD and the Egyptian Pound, Al-Nashar (2013) tested for the presence of interest rate parity by adopting the stationarity test on the exchange rate adjusted interest rate differential between the USD and the Egyptian

Pound over the three-month treasury bill rate. The author adopted the Augmented Dickey-Fuller (ADF) test for stationarity which shows that the exchange rate adjusted interest rate differentials for both countries were unstationary over the covered period. The failure of the uncovered interest rate parity, in this case, was attributed to the low degree of integration of the Egyptian financial system into global financial markets.

Furthermore, Al-Nasher (2013) concluded that investors are irrational and that their behaviour differs from that of a risk-neutral investor in the face of their future expectations of the spot exchange rate. Furthermore, the difference decomposition of the interest rate spread between the Egyptian Pound and the USD revealed that inflation expectation differentials were the main factors adding to the differential in the interest rate.

In his study of the USA, Japan, India and Korea, Ray (2012) observed mixed findings in his adoption of the IFE approach. The IFE theory held partially for the USA because both the nominal interest rate and inflation rate exhibited a positive correlation. However, the IFE theory did not hold for the other three countries (Japan, India and Korea). After interchanging the countries from home countries to foreign countries, a similar conclusion was made. The study, however, revealed the presence of a long-run relationship between inflation and interest rate for the concerned countries but the idea of a full IFE was absent in that case.

Asari et al. (2011) tested the IFE using data from the USA and Malaysia. They adopted the Error Correction Model (ECM), Granger causality, Cointegration Test and Impulse-Response Function. The authors observed that inflation Granger causes interest rate while the interest rate Granger causes exchange rate. Based on the above, the authors concluded that a positive relationship exists between the interest rate and the exchange rate in the USA while the opposite was observed in the case of the inflation rate and the exchange rate in Malaysia.

Sundqvist (2002) also tested the IFE theory for the USA economy against five developed countries (Sweden, Japan, the UK, Canada and Germany). The author regressed the interest rate differentials among the countries against the volatility of their exchange rate over 11 years (1993–2003). The regression result showed that the IFE

only holds for the USA against Japan. Therefore, the author concluded that an unstable relationship exists between interest rate differentials and the exchange rate volatilities of the countries (except the USA and Japan).

Ray (2012) tested the Fisher effect by obtaining data on Korea, the United States, India and Japan. The author observed a partial Fisher effect in the USA due to the observed positive correlation between inflation and interest rate. However, the author's findings did not support any presence of the Fisher effect in the case of India, Japan and Korea.

In trying to make sense of the result, Ray (2012) interchanged the dependent variable by making the target countries the home country and the foreign country to reveal the direction of the IFE; the findings were inconclusive in nature. The author observed that the IFE theory holds when some of the focused countries were used as home countries in the analysis, but disproves the theory when those same countries were used as foreign countries, respectively. In summary, the author concluded the presence of a positive long-run relationship between the interest rate and inflation rate but rejected the presence of the IFE for the focused countries.

Similarly, Asari et al. (2011) adopted the Vector ECM, Cointegration Test, Granger causality and Impulse-Response function in their analysis of the USA and Malaysia. They observed that the inflation rate in the USA and Malaysia strongly influenced the interest rate which on the other hand significantly accounted for the large variation in the exchange rate of those countries.

Shapiro (1998) further asserted that countries with higher inflation rates attempt to tame the disruptive effect of the high inflation rate by increasing their interest rate. On the other hand, countries with lower inflation rates consequently try to boost economic activities by reducing the interest rate to prevent the economy from slipping into a depression. This implicitly confirms the presence of the IFE.

On the other hand, Miskin (1992) concluded against the presence of the IFE in the short run. This assertion is further corroborated by Coppock and Poitras (1999) who state that an imperfect relationship exists between inflation and the exchange rate in the focused countries.

Giddy and Dufey (1975) also argued against the presence of the IFE in the short run by stating that the arbitrage opportunities across countries allow for the equalisation of returns in the short run. This view is based on the Efficient Market Hypothesis (EMH) that presumes that the market adjusts to new information and temporary mispricing in the market will be exploited by informed investors, hence, wiping off the short-term opportunity.

Finally, Kane and Rosenthal (1982), in their analysis of the Eurocurrency and focusing on six European countries between 1974 and 1979, concluded that significant evidence to affirm the presence of the IFE in the focused countries exists.

2.5 Research knowledge gap analysis

Despite numerous researches that have been carried out on the testing of the IFE theory across the globe, little is known about the applicability of the IFE theory to the ZAR against other major currencies. The majority of the exchange rate related research has largely been based on how interest rate causes changes in inflationary expectation in South Africa; few have considered how the inflation differential between South Africa and the USA influences the local interest and exchange rates. In consequence, this study will focus on breaching this gap by testing the validity of the IFE theory and PPP between the ZAR and the USD.

3 THEORETICAL FRAMEWORK AND RESEARCH METHODOLOGY

In analysing econometric models, the adopted methodology is one of the most important elements that decomposes the factors underpinning the model and how each variable is intertwined. The conclusions and recommendations resulting from the research are largely dependent on the robustness of the adopted methodology. This chapter will therefore start by examining the theoretical framework and follow with model specification and estimation techniques. Finally, the type, nature and sources of the data will be highlighted.

3.1 Theoretical framework

3.1.1 International Fisher Effect

The Fisher effect, the IFE and PPP are used to determine the level of the exchange rate in a particular country. Shapiro (1998) highlighted that the generalised version of the Fisher effect is built around the assumption that countries experiencing a higher level of inflation should experience a higher level of interest rate to combat the higher level of inflation, while the opposite holds for countries with a lower level of inflation and interest rate.

Fama (1975) established the presence of a relationship between the inflation rate and the nominal interest rate of a country. He went further to assert that the changes in interest rate are a response to changes in inflation expectations among countries.

Miskin (1992) asserts that there is no evidence to support the existence of a Fisher effect in the short run, while Coppock and Poitras (1999) also argue against the assumption of a perfect correlation between inflation and nominal interest rate. On the other hand, the relative version of PPP popularises the view that the price level in each country will be reflected in the overall changes in the exchange rates of those countries. In other words, PPP implies that countries with a higher interest rate will witness depreciation of their currency against countries with lower interest rates (Shapiro, 1998).

In support of Shapiro, Gailliot (1970) concludes that long-run changes in exchange rates are driven largely by changes in general price levels. To wrap up his work, Shapiro (1998) concluded that higher currency depreciation is prevalent in countries with higher inflation. Many studies have proven that PPP holds largely in the long run, hence, making it an ineffective exchange rate determinant in the short-run (Demirag & Goddard, 1995).

On the other hand, the IFE asserts that the profitability of an investment in a foreign market will be influenced by the changes in local and foreign markets. Appreciation or depreciation of both the foreign and domestic markets can positively or negatively affect the total return realised on investment opportunities. Given this uncertainty around the exchange rate, the IFE concluded that the exchange rate equalisation effect will kick in to ensure that an investor who partakes in foreign investment opportunities will earn a return like those of domestic investment to eliminate any arbitrage opportunity. This approximation is achieved by combining equations 1 and 2 below to give equation 3:

$$\frac{(r_{ht}-r_{ft})}{(1+r_{ft})} = \pi_f + \pi_h \qquad (1)$$

Where, r_h and r_f are nominal interest rates in the home and foreign countries, while π_f and π_h represent foreign and domestic inflation rates, respectively.

Equation 1 implies that in an efficient market (both domestic and foreign) with free mobility of capital, investors will perceive investment in the home and foreign countries to be equal and hence, will invest in a market with higher perceived value and returns. Because of the free mobility of capital, interest rates among countries will converge and equalise to eliminate arbitrage opportunities, thereby forcing the nominal interest rate to mimic the inflation expectation of those countries.

The PPP approach to exchange rate determination has been described as a long-term phenomenon and is built around the law of one price which states that identical goods should trade for the same price in different countries, barring the presence of trade barriers, transaction and transportation costs, etc. Evidence of short-run imperfections in financial markets that makes the absolute version of PPP unsuitable for short-run market analysis has been noted.

On the other hand, the relative version of PPP highlights the perfect correlation that exists between price and the exchange rate, thereby maintaining the purchasing power of the currencies. In consequence, relative PPP holds that countries with relatively higher inflation differentials should increase their interest rate and exchange rate to maintain the constant relationship between the price and exchange rate of the countries.

$$\frac{(S_{t+1}-S_t)}{S_t} = \pi_f + \pi_h \qquad (2)$$

Where, s_t and s_{t+1} are the spot exchange rate and expected spot exchange rate, while π_f and π_h represent foreign and domestic inflation rates, respectively.

PPP purports that an increase in the general price level in the domestic market will reduce the purchasing power of the country's currency and will thus lead to the depreciation of the domestic currency.

The combination of equations 1 and 2 gave birth to the IFE which is presented in equation 3.

$$\frac{(S_{t+1}-S_t)}{S_t} = \frac{(i_h-i_f)}{(1+i_f)} \qquad (3)$$

Where, s_t and s_{t+1} are the spot exchange rate and expected spot exchange rate, while i_f and i_h represent foreign and domestic interest rates, respectively.

The Fisher effect maintains that investment return should be equal across domestic and foreign investment opportunities and, hence, a long-run increase in interest rate will be followed by an equivalent level of depreciation in its currency to neutralise any arbitrage opportunities. On the other hand, an investment in a lower interest rate country will be compensated by the appreciation of the country's exchange rate which also neutralises the presence of arbitrage opportunity (carry trade).

Equation 3 can be graphically presented as follows:

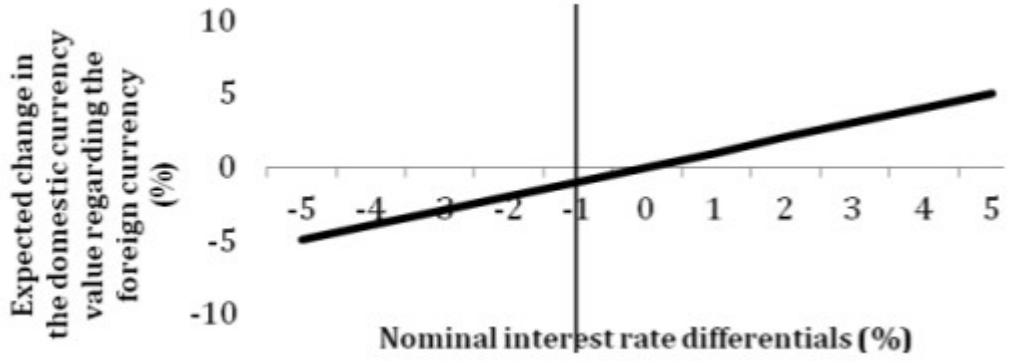


Figure 3.1. Graphic representation of equation 3
Source: Shapiro (1998); Salas-Ortiz & Gomez-Monge (2015).

The graph in Figure 3.1 reveals the expectations around exchange rate changes between domestic and foreign currency (MXN and USD) on the vertical axis, while the nominal interest rate differential is presented on the horizontal axis of the graph.

Based on the figure, an increase in the domestic interest rate will lead to the appreciation of the domestic currency against the foreign currency. The opposite is expected to be the case in the event of a higher foreign interest rate vis-à-vis a lower domestic interest rate. However, the assumption of parity implied by the above statement and figure has been disproved by Aliber and Stickney (1975) who tested the validity of the assumption in their study of 13 underdeveloped and developed countries over a six-year period (1966–1971).

Aliber and Stickney (1975) concluded that the IFE is only applicable in the long run, as the observed short-run deviations were too large to meet this effect. Similarly, Giddy and Dufey (1975) and Robinson and Warburton (1980) both concluded that the IFE is more effective in the long run. These authors also argued that the short-run deviation, as highlighted by Aliber and Stickney (1975), creates a short-run arbitrage opportunity between two countries. In their conclusion, they assert that higher returns are achievable

in the short run and thus confirm the presence of a short-run arbitrage opportunity using the IFE. In support of the IFE, Kane and Rosenthal (1982) obtained sufficient evidence to support the IFE's position in their analysis of six major European countries between 1974 and 1979.

3.2 Research methodology

The variables captured in the model are time series in nature (i.e., secondary data) and range from January 2014 to December 2019; they involve the interest rates and exchange rates of the focused countries.

3.2.1 Model specification

The models that will be used for the evaluation of the hypotheses of this research are adopted from the work of Salas-Ortiz and Gomez-Monge (2015) which is based on the fundamental theory of the exchange rate and the factors responsible for variation in the exchange rate.

$$\frac{S_{t+1}-S_t}{S_t} = \alpha_0+\alpha_1 \left\{\frac{(i_h-i_f)}{(1-i_f)}\right\} + \varepsilon_t$$

Where:

$(S_{t+1} - S_t)/S_t$ = Changes in the ZAR exchange rate

i_h = South African inflation rate

i_f = USA inflation rate

ε_t= Error terms

3.3 Estimation technique

A time series econometric approach will be utilised to analyse the impact of the IFE and PPP on the ZAR and the USD exchange rates over a six-year period (January 2014 to December 2019); the OLS technique will be specifically implemented for this purpose. Historically, time series analysis was often based on the view of stationarity of series variables, which also lends credence to the conclusions and recommendations of this research.

However, a number of time series datasets suffer from this same stationarity problem due to the random walk effect which causes large deviations from the mean. To confirm the presence of stationarity or the extent of random walk in time series data, the ADF and Phillips-Perron (PP) tests are often conducted.

3.3.1 Stationarity test (Augmented Dickey-Fuller and Phillips-Perron)

As mentioned above, the essence of a stationarity test using the ADF and PP approaches is often triggered by the presence of random walk which reveals the presence of trend between two or more variables over a specified period. Without correcting for this anomaly, the output of the regression result may give a false conclusion and recommendation on the back of significant T-statistics and an extremely high coefficient of determination (R^2); hence, the presence of random walk indicates the violation of the asymptotic analysis. The focus is often to reject the null hypothesis of no stationarity and, hence, the outcome of the ADF and PP tests often determines this; failure to reject the null hypothesis will lead to the test for cointegration.

3.3.2 Cointegration test

The failure to reject the null hypothesis from the ADF and PP tests will lead to the test for long-run cointegration among the variables. Several estimation approaches to cointegration analysis, such as the Bound test and Johansen test, have been adopted historically to estimate the presence of cointegration among the focused variables and, as such, the Johansen test for cointegration will be adopted for this work.

The choice of this model is due to the limitation of non-stationarity at the second difference (I2) imposed by the Bound test. Similarly, the Bound test is often adopted alongside the autoregressive distributed lag (ARDL) model which is not the preferred estimation technique for this thesis.

3.3.3 Causality test

Due to the peculiarity of this thesis, it is important to determine the direction of causality between the interest rate differentials of the focused countries and how they influence the future spot exchange rate. The Granger causality test will be adopted for this purpose to determine the direction of causality among the focused variables.

3.3.4 Ordinary least square model

The OLS estimation technique will be used to analyse the specified models. The focus is to estimate the impact of the independent variable on the dependent variable over the specified period.

3.4 Types of data, definitions and sources

The data to be utilised for this research work are secondary in nature and will be sourced from the South African Reserve Bank and the US Federal Reserve publication. The data range from January 2014 to December 2019, which shows that the variables are time series in nature.

Both descriptive and inferential statistical measures will be used as measures of estimation in this research work. The descriptive statistics measure to be adopted is trend analysis which will help reflect the trends in inflation across the two countries. On the other hand, inferential statistical analysis adopts regression analysis using the OLS technique to estimate the parameters in question. The E-views statistical package will be used to analyse the relationship between the IFE and PPP and how they impact the nominal exchange rate in South Africa.

The data used in this research were sourced from public sources, specifically, the US interest rate (Fed Rate) and inflation rates sourced from the Board of Governors of the Federal Reserve System (US) and the US Bureau for Labour Statistics, respectively. The South African interest rate and the inflation rate will be sourced from the South African Reserve Bank and Statistics South Africa. The data will be recorded in a Microsoft Excel sheet to ensure proper presentation and clarity of analysis.

3.4.1 Ethical considerations when collecting research data

The data utilised in this analysis are largely secondary data sourced from public sources, eliminating potential ethical issues that often accompany primary data collection. Also, no permission will be required for the required data sets as they are available from public sources.

4 PRESENTATION OF RESEARCH RESULTS

This section presents the data set used for the analysis. The data used in this study are time series in nature and span from January 2014 to December 2019. As stated in Chapter 3, the study was able to source the data (inflation and interest rate) across the focused countries without any problem as the data were readily available and obtained from public sources.

The analysis of the sourced data will begin with a descriptive analysis as presented in section 4.1. Section 4.2 presents the stationarity test using the ADF and PP tests, while section 4.3 presents the Johansen test for cointegration. Section 4.4 presents the results of the regression analysis (OLS) and its implication for the stated objectives. Sections 4.5 and 4.6 present the Granger causality test and the summary of the findings and the chapter.

4.1 Presentation of results

4.1.1 Trend analysis

The diagram in Figure 4.1 reveals the trend in South Africa's exchange rate and inflation rate as well as the trend in US inflation (represented by CPI) for the chosen six-year period (2014–2019).

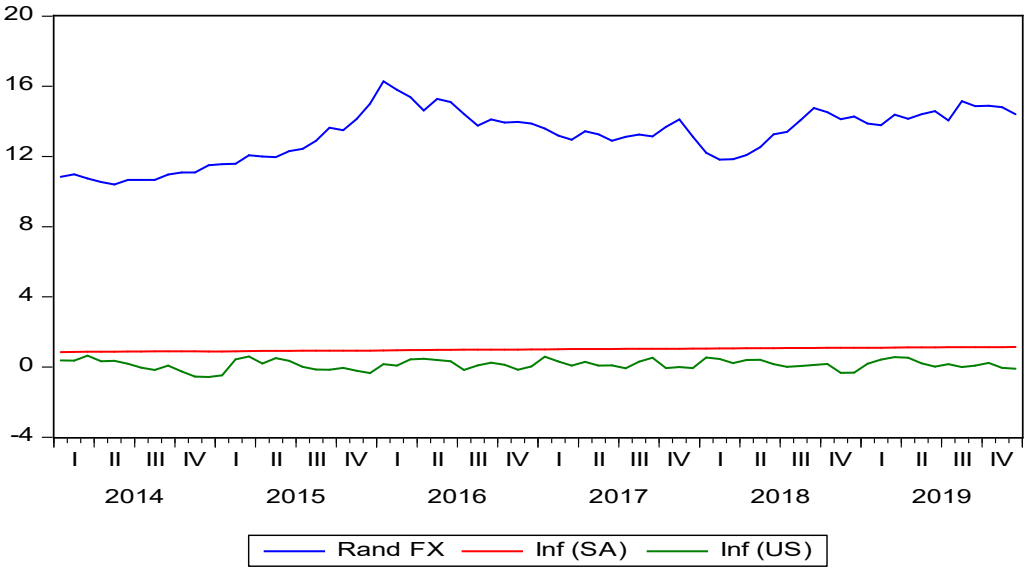


Figure 4.1. Trend for six-year South African exchange rate period

Source: Statistics South Africa

The objective of this analysis is to reveal the trend in the variables over the covered period. The trend in South Africa's exchange rate (Rand FX) was volatile over the covered period, peaking in October 2014, March 2015, September 2015 and January 2016 before experiencing a downward trend thereafter. The inflation rate in South Africa as represented by CPI maintained its uptrend all through the covered period, rising from 85.1 in January 2014 to 113.8 in December 2019, while a volatile trend was observed in the case of the CPI in the USA over the covered period.

4.2 Stationarity test (Augmented Dickey-Fuller and Phillips-Perron)

The results of the stationarity test (Table 4.1) as reported using the ADF test for stationarity revealed that the variables were stationary at level for ΔEXC and INFDif (South Africa and the USA). The result from the PP test also followed a similar pattern as both variables were stationary at level.

Table 4.1 Stationarity test

	ADF (Trend & Intercept)		PP (Trend & Intercept)	
Variables	**T-Stat**	**Order of Integration**	**T-Stat**	**Order of Integration**
ΔEXC	-6.8820*	I(0)	-6.8879*	I(0)
INFDif (SA & US)	-5.2304*	I(0)	-7.4283*	I(0)

* Denotes significance at 1% level.

The computed value of the T-statistic for all the variables is greater than the Mackinnon DF absolute critical value at 1% for all the variables under the ADF and PP tests, respectively. The conclusion from the stationarity test is the rejection of the null hypothesis that the variables are not stationary. Due to the rejection of the null hypothesis and the conclusion that the variable is stationary, the OLS analysis will be applied against the initial process of testing for the presence of a unique long-run relationship among the variables.

4.3 Ordinary least square

In the OLS analysis (Table 4.2), the coefficient of the determination value of 1.9% indicates the limited explanatory power of the model. This is largely due to the short life-span of the investigation (2014–2019).

Table 4.2 Ordinary least square

ΔEXC = c + INFDif(SA & US)

Dependent Variable: ΔEXC				
Method: Least Squares				
Date: 03/10/21 Time: 12:43				
Sample: 2014M01 2019M12				
Included observations: 72				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002720	0.006751	-0.402855	0.6883
INFD (SA & US)	0.007125	0.006176	1.153746	0.2525
R-squared	0.018661	Mean dependent var		0.003712
Adjusted R-squared	0.004642	S.D. dependent var		0.032391
S.E. of Regression	0.032315	Akaike info criterion		-3.999162
Sum Squared Resid	0.073100	Schwarz criterion		-3.935921
Log Likelihood	145.9698	Hannan-Quinn criterion		-3.973985
F-statistic	1.331129	Durbin-Watson stat		1.659381
Prob (F-statistic)	0.252529			

This marginal explanatory power was expected due to the peculiarities of the South African nation, the primary dependence of the global trend in commodity prices and domestic unrest which distorted the explanatory power of the independent variables.

However, the Durbin-Watson statistic at 1.66 reveals the presence of a marginal positive serial correlation problem which means that error terms from prior periods are not correlated with the error term of the current period. This implies that this regression analysis is statistically reliable to satisfy the assumptions of the BLUE OLS estimate.

The model which measures the effect of the inflation differential between South Africa and the USA on changes in the ZAR exchange rate reveals an insignificant positive relationship between the variables. Specifically, the model reveals that a 1% increase in the inflation differential between the two countries (higher inflation in South Africa) will

cause the interest rate to rise which, on the other hand, will also cause the Rand exchange rate to appreciate by 0.71% against the USD. This observation is in line with the positive a priori expectation.

The implication of the above is that the inflation differential as a result of higher inflation in South Africa over the covered period influences the policies of the South African Reserve Bank (the monetary authority) to raise the interest rate.

The rise in the interest rate, on the other hand, assuages the Rand depreciation over the covered period. This simply means investors who invested in ZAR assets between January 2014 and December 2019 experienced around 0.7% currency gain at the time of repatriation. In line with the first objective that tests for the presence of the IFE between the ZAR and USD, the result reveals the presence of the IFE between the ZAR and USD over the covered period.

The level of currency exposure and risk revealed by the models is however incomplete as regular civil unrest, commodity price volatility, corruption and concern around political instability distorts the true level of the exchange rate adjustment and currency risk exposure of foreign investors in South Africa.

These findings are in line with those of Salas-Ortiz and Gomez-Monge (2015) who observed a positive relationship between the Mexico interest rate and the inflation differential between the USA and Mexico. The IFE and PPP advocate for a total pass-through of the effect of the inflation differential on the interest rate of the focused country and, finally, its exchange rate. This observation was observed in the case of South Africa and the USA which further lends credence to the presence of the IFE and PPP between the ZAR and USD.

4.4 Granger causality test

To satisfy the second objective of this study, the Granger causality test was conducted to capture the direction of causality between the variables (Table 4.3).

Table 4.3 Granger causality test

Null Hypothesis:	Obs	F-Statistic	Prob.

INFDif (SA & US) does not Granger Cause ΔEXC	69	0.16870	0.9171
ΔEXC does not Granger Cause INFDif (SA & US)		0.91833	0.4373

* Denotes causality at 1% level.

The probability value suggests the absence of direct causality between changes in South Africa's exchange rate (ΔEXC) and the inflation differential between South Africa and the USA. This finding opposes the general expectation that the inflation differential between the two countries should cause changes in the Rand exchange rate.

4.5 Summary

The major finding of this thesis is the presence of the IFE and PPP between the ZAR and USD. Also, this analysis revealed the absence of causality between the USD and ZAR inflation differential and change in the ZAR exchange rate. The positive relationship observed between the Mexican interest rate and the inflation differential between the USA and Mexico by Salas-Ortiz and Gomez-Monge (2015) supports the findings for South Africa and the USA.

The pass-through of the inflation differential has however not been fully established in this study as other factors have been highlighted as exogenous variables in the inflation differential story of South Africa and the USA and are not captured by the inflation differential of the two countries.

5 SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

5.1 Summary

The objective of this study was to examine if the IFE and PPP hold between the ZAR and the USD during the period from January 2014 to December 2019. The objectives of this thesis were to establish whether the IFE drives exchange rate parity between the ZAR and USD and to ascertain the direction of causality between the inflation differential of the two countries and the Rand exchange rate.

The exchange rate practice in South Africa has been a free float of the ZAR system in the post-apartheid era. This policy has been backed by the stability in foreign earnings which relies on the stability of commodities (the major source of foreign earnings for the country) prices on the international market. Instability in commodity prices, political unrest, high levels of inflation and corruption impacted negatively on the stability of the ZAR over the covered period, with periods of depreciation dominating periods of appreciation.

During the research, literature on the IFE, PPP, interest rate and exchange rates was reviewed to establish the root of the thesis in the literature. The study reviewed the IFE model as well as the PPP, combining them to create a working model that focuses on the impact of the inflation differential between the two focused countries on the interest rate parameters and exchange rates of the primary country (South Africa).

The study adopted monthly time series data for all of the variables to properly capture the trend and its implications for the study. The data utilised were sourced from the Office for National Statistics, Board of Governors of the Federal Reserve System (US), the US Bureau for Labour Statistics, the International Monetary Fund (IMF) and Statistics South Africa.

The OLS estimation technique was adopted to proffer an answer to the first objective while the Granger causality test was adopted to achieve the second objective of this

research. The ADF and PP tests for stationarity were employed to determine the order of integration.

5.2 Conclusions

The regression analysis showed an insignificant positive relationship between the inflation differentials of South Africa and the USA which means that an increase in the inflation differential between the two countries (caused largely by a higher inflation rate in South Africa) will bring about an increase in the interest rate in South Africa. This, on the other hand, will reverse the negative impact of inflation through appreciation of the ZAR from the initial depreciation caused by the higher inflation rate.

Since the South African currency is largely exposed to volatility in commodity prices, corruption, civil unrest and concerns around political instability, the true impact of these events is not effectively reflected on the Rand exchange rate. The pass-through effect of the IFE and PPP in South Africa against the US dollar is incompletely reflected in the model's assumption of Rand exchange rate appreciation. This simply means foreign investors in South Africa between January 2014 and December 2019 were exposed to frequent volatilities in the Rand exchange rate against the USD. This conclusion aligns closely with the reality in South Africa.

It is also believed that investors, in search of a higher return price for the currency, factor in civil and political risk in their return expectation which at the end of the day contributed to their decision to take on the risk of a Rand investment during the study period. On account of the empirical analysis and the above, this research confirms the presence of the IFE and PPP in South Africa over the covered period but the pass-through effect on the Rand exchange rate is incomplete.

5.3 Recommendations

Based on the output of the analysis vis-à-vis the trends in commodity prices, inflation, civil unrest, corruption and concerns around political instability in South Africa, the following recommendations were made:

- Diversify the foreign earnings sources of the country through the development of other sectors to reduce the reliance on commodities and their price volatility

on the country's foreign exchange earnings and, subsequently, macroeconomic variables (inflation, interest rate and exchange rate) that impact the economy.

- Put in place a resolution mechanism that forestalls instability and prevents frequent civil unrest to avoid their negative impact on the nation's risk-premium priced in by investors and the Rand exchange rate.

5.4 Areas for further research

To deepen the knowledge of the IFE and PPP applicability in the case of South Africa and the USA, further research with data over a longer period will improve the output of the analysis and help to give a clearer picture of the topic.

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Appendices

Appendix 1.1: Data collection instrument(s)

Table A1.1.1 Data

Date	Rand EXC	ΔEXC	Fed Fund Rate	INT (SA)	INF (SA)	INF (US)	INFDif (SA & US)
Jan-14	10.84	0.02	0.07%	5.22%	85.10%	37.20%	34.91%
Feb-14	10.98	0.01	0.07%	5.56%	86.00%	36.98%	35.79%
Mar-14	10.75	(0.02)	0.08%	5.73%	87.20%	64.40%	13.87%
Apr-14	10.55	(0.02)	0.09%	5.74%	87.60%	32.97%	41.09%
May-14	10.40	(0.01)	0.09%	5.74%	87.70%	34.93%	39.11%
Jun-14	10.66	0.02	0.10%	5.79%	88.00%	18.62%	58.49%
Jul-14	10.66	(0.00)	0.09%	6.03%	88.70%	-3.90%	96.36%
Aug-14	10.66	0.00	0.09%	6.01%	89.00%	-16.71%	126.90%
Sep-14	10.97	0.03	0.09%	6.00%	89.20%	7.53%	75.96%
Oct-14	11.09	0.01	0.09%	5.90%	89.20%	-25.12%	152.68%
Nov-14	11.09	0.00	0.09%	5.84%	89.00%	-53.99%	310.82%
Dec-14	11.50	0.04	0.12%	6.04%	88.00%	-56.70%	334.19%
Jan-15	11.56	0.01	0.11%	6.00%	88.90%	-47.06%	256.81%
Feb-15	11.59	0.00	0.11%	5.88%	89.40%	43.43%	32.05%
Mar-15	12.07	0.04	0.11%	5.80%	90.70%	59.52%	19.55%
Apr-15	12.00	(0.01)	0.12%	5.80%	91.50%	20.33%	59.15%
May-15	11.96	(0.00)	0.12%	5.73%	91.70%	50.97%	26.98%
Jun-15	12.30	0.03	0.13%	5.76%	92.10%	35.03%	42.27%
Jul-15	12.44	0.01	0.13%	6.03%	93.10%	0.67%	91.81%
Aug-15	12.90	0.04	0.14%	6.16%	93.10%	-14.16%	124.96%
Sep-15	13.64	0.05	0.14%	6.24%	93.10%	-15.57%	128.70%
Oct-15	13.50	(0.01)	0.12%	6.16%	93.30%	-4.50%	102.40%
Nov-15	14.14	0.04	0.12%	6.33%	93.40%	-21.11%	145.14%
Dec-15	15.01	0.06	0.24%	6.74%	93.70%	-34.17%	194.25%
Jan-16	16.28	0.08	0.34%	6.86%	94.40%	16.53%	66.82%
Feb-16	15.80	(0.03)	0.38%	6.93%	95.70%	8.23%	80.82%
Mar-16	15.39	(0.03)	0.36%	7.04%	96.40%	43.06%	37.29%
Apr-16	14.62	(0.05)	0.37%	7.18%	97.20%	47.41%	33.78%
May-16	15.29	0.04	0.37%	7.16%	97.40%	40.46%	40.54%
Jun-16	15.10	(0.01)	0.38%	7.20%	97.90%	32.84%	48.97%
Jul-16	14.42	(0.05)	0.39%	7.35%	98.70%	-16.18%	137.06%
Aug-16	13.76	(0.05)	0.40%	7.30%	98.60%	9.18%	81.89%
Sep-16	14.11	0.02	0.40%	7.29%	98.80%	24.04%	60.27%

Date	Rand EXC	ΔEXC	Fed Fund Rate	INT (SA)	INF (SA)	INF (US)	INFDif (SA & US)
Oct-16	13.94	(0.01)	0.40%	7.35%	99.30%	12.47%	77.21%
Nov-16	13.97	0.00	0.41%	7.48%	99.60%	-15.55%	136.37%
Dec-16	13.88	(0.01)	0.54%	7.61%	100.00%	3.27%	93.66%
Jan-17	13.59	(0.02)	0.65%	7.46%	100.60%	58.28%	26.74%
Feb-17	13.19	(0.03)	0.66%	7.26%	101.70%	31.46%	53.43%
Mar-17	12.95	(0.02)	0.79%	7.23%	102.30%	8.13%	87.09%
Apr-17	13.44	0.04	0.90%	7.41%	102.40%	29.66%	56.11%
May-17	13.27	(0.01)	0.91%	7.43%	102.70%	8.55%	86.74%
Jun-17	12.90	(0.03)	1.04%	7.34%	102.90%	9.07%	86.03%
Jul-17	13.12	0.02	1.15%	7.32%	103.20%	-6.90%	118.26%
Aug-17	13.25	0.01	1.16%	7.17%	103.30%	29.94%	56.45%
Sep-17	13.14	(0.01)	1.15%	7.10%	103.80%	52.95%	33.25%
Oct-17	13.68	0.04	1.15%	7.26%	104.10%	-6.32%	117.87%
Nov-17	14.11	0.03	1.16%	7.45%	104.20%	0.24%	103.70%
Dec-17	13.13	(0.07)	1.30%	7.53%	104.70%	-5.88%	117.48%
Jan-18	12.21	(0.08)	1.41%	7.32%	105.00%	54.48%	32.71%
Feb-18	11.83	(0.03)	1.42%	7.12%	105.80%	45.35%	41.59%
Mar-18	11.84	0.00	1.51%	7.06%	106.20%	22.61%	68.17%
Apr-18	12.08	0.02	1.69%	6.98%	107.00%	39.75%	48.12%
May-18	12.52	0.04	1.70%	7.01%	107.20%	41.59%	46.34%
Jun-18	13.27	0.06	1.82%	7.04%	107.60%	15.94%	79.06%
Jul-18	13.40	0.01	1.91%	7.07%	108.50%	0.67%	107.10%
Aug-18	14.06	0.05	1.91%	7.12%	108.40%	5.56%	97.43%
Sep-18	14.76	0.05	1.95%	7.14%	108.90%	11.62%	87.15%
Oct-18	14.53	(0.02)	2.19%	7.20%	109.40%	17.67%	77.96%
Nov-18	14.12	(0.03)	2.20%	7.32%	109.60%	-33.49%	215.16%
Dec-18	14.28	0.01	2.27%	7.50%	109.40%	-31.94%	207.67%
Jan-19	13.87	(0.03)	2.40%	7.51%	109.20%	19.07%	75.70%
Feb-19	13.78	(0.01)	2.40%	7.25%	110.10%	42.27%	47.68%
Mar-19	14.38	0.04	2.41%	7.04%	111.00%	56.41%	34.90%
Apr-19	14.15	(0.02)	2.42%	7.11%	111.70%	52.95%	38.41%
May-19	14.40	0.02	2.39%	7.17%	112.00%	21.29%	74.79%
Jun-19	14.58	0.01	2.38%	7.11%	112.40%	1.99%	108.25%
Jul-19	14.06	(0.04)	2.40%	7.03%	112.80%	16.71%	82.33%
Aug-19	15.15	0.07	2.13%	6.99%	113.10%	-0.51%	114.19%
Sep-19	14.87	(0.02)	2.04%	6.85%	113.40%	7.83%	97.90%
Oct-19	14.89	0.00	1.83%	6.81%	113.40%	22.86%	73.69%
Nov-19	14.81	(0.01)	1.55%	7.00%	113.50%	-5.36%	125.60%
Dec-19	14.41	(0.03)	1.55%	7.13%	113.80%	-9.10%	135.20%

Table A1.1.2 ADF & PP Test

Null Hypothesis: EXCDIF has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic-based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.882004	0.0000
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	
	10% level	-2.588902	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EXCDIF)

Method: Least Squares

Date: 03/10/21 Time: 13:14

Sample (adjusted): 2014M02 2019M12

Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCDIF(-1)	-0.819006	0.119007	-6.882004	0.0000
C	0.002731	0.003860	0.707305	0.4818

R-squared	0.407023	Mean dependent var	-0.000672
Adjusted R-squared	0.398429	S.D. dependent var	0.041594
S.E. of regression	0.032261	Akaike info criterion	-4.002146
Sum squared resid	0.071814	Schwarz criterion	-3.938409
Log likelihood	144.0762	Hannan-Quinn criterion	-3.976800
F-statistic	47.36198	Durbin-Watson stat	1.971010
Prob(F-statistic)	0.000000		

Null Hypothesis: EXCDIF has a unit root

Exogenous: Constant

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.887944	0.0000
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	

	10% level	-2.588902

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.001011
HAC corrected variance (Bartlett kernel)	0.001020

Phillips-Perron Test Equation
Dependent Variable: D(EXCDIF)
Method: Least Squares
Date: 03/10/21 Time: 13:15
Sample (adjusted): 2014M02 2019M12
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCDIF(-1)	-0.819006	0.119007	-6.882004	0.0000
C	0.002731	0.003860	0.707305	0.4818

R-squared	0.407023	Mean dependent var	-0.000672
Adjusted R-squared	0.398429	S.D. dependent var	0.041594
S.E. of regression	0.032261	Akaike info criterion	-4.002146
Sum squared resid	0.071814	Schwarz criterion	-3.938409
Log likelihood	144.0762	Hannan-Quinn criter.	-3.976800
F-statistic	47.36198	Durbin-Watson stat	1.971010
Prob(F-statistic)	0.000000		

Null Hypothesis: CPIDIFSAUS has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic-based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.230413	0.0000
Test critical values:	1% level	-3.527045	
	5% level	-2.903566	
	10% level	-2.589227	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(CPIDIFSAUS)
Method: Least Squares
Date: 03/10/21 Time: 13:16
Sample (adjusted): 2014M03 2019M12
Included observations: 70 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPIDIFSAUS(-1)	-0.540864	0.103407	-5.230413	0.0000
D(CPIDIFSAUS(-1))	0.331498	0.114848	2.886406	0.0052
C	0.498928	0.109112	4.572631	0.0000

R-squared	0.292769	Mean dependent var	0.014201
Adjusted R-squared	0.271657	S.D. dependent var	0.561971
S.E. of regression	0.479603	Akaike info criterion	1.410196
Sum squared resid	15.41129	Schwarz criterion	1.506560
Log likelihood	-46.35687	Hannan-Quinn criter.	1.448473
F-statistic	13.86780	Durbin-Watson stat	1.965795
Prob(F-statistic)	0.000009		

Null Hypothesis: CPIDIFSAUS has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.715564	0.0058
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	
	10% level	-2.588902	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.244788
HAC corrected variance (Bartlett kernel)	0.156811

Phillips-Perron Test Equation
Dependent Variable: D(CPIDIFSAUS)
Method: Least Squares
Date: 03/10/21 Time: 13:16
Sample (adjusted): 2014M02 2019M12
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPIDIFSAUS(-1)	-0.402892	0.096276	-4.184774	0.0001
C	0.375249	0.104854	3.578765	0.0006

R-squared	0.202426	Mean dependent var	0.014125
Adjusted R-squared	0.190867	S.D. dependent var	0.557943
S.E. of regression	0.501880	Akaike info criterion	1.486853
Sum squared resid	17.37997	Schwarz criterion	1.550591
Log likelihood	-50.78329	Hannan-Quinn criter.	1.512200
F-statistic	17.51234	Durbin-Watson stat	1.606245
Prob(F-statistic)	0.000083		

Table A1.1.3 Johansen Cointegration Test

Date: 03/10/21 Time: 13:17
Sample (adjusted): 2014M04 2019M12
Included observations: 69 after adjustments
Trend assumption: Linear deterministic trend
Series: CPIDIFSAUS EXCDIF
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.287590	37.56926	15.49471	0.0000
At most 1 *	0.185663	14.17127	3.841466	0.0002

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesised No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.287590	23.39798	14.26460	0.0014
At most 1 *	0.185663	14.17127	3.841466	0.0002

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalised by b'*S11*b=I):

CPIDIFSAUS	EXCDIF
-1.819898	38.38612
1.250994	32.50265

Unrestricted Adjustment Coefficients (alpha):

D(CPIDIFSAUS)	0.234206	-0.129516
D(EXCDIF)	-0.010728	-0.012912

1 Cointegrating Equation(s): Log likelihood 88.99325

Normalised cointegrating coefficients (standard error in parentheses)

CPIDIFSAUS	EXCDIF
1.000000	-21.09246
	(5.28770)

Adjustment coefficients (standard error in parentheses)

D(CPIDIFSAUS)	-0.426231
	(0.10906)
D(EXCDIF)	0.019524
	(0.00789)

Appendix 2.1: One-page bio of the researcher including declaration of interest in the research and funders, if any

Ricardo de Beer is an accomplished development finance practitioner with over 15 years of experience in the development finance sector with a deep understanding of risk assessment, finance restructuring, cost of risk mitigation, debt portfolio management, business diagnostics, project management and post investment monitoring. Ricardo holds a Master's degree in Development Finance from Stellenbosch University (South Africa).

He is currently employed as the Business Analyst in the Investment Promotion and Investment Facilitation Unit at the East London Industrial Development Zone (ELIDZ). The ELIDZ mandate, among other things, is to attract Foreign Direct Investment (FDI) and Domestic Direct Investment (DDI) and create employment for the people of the Buffalo City Metropolitan Municipality region and the Eastern Cape Province at large.

Ricardo has a good sense of urban and rural economics, skilled in time and cost-saving due diligence as well as monitoring and evaluation techniques. Highly committed with strong entrepreneurial communication, interactive and facilitation skills.

Appendix 2.2: Ethic documentation

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee

2021/02/15

Ethics clearance number: **WWBS/BA1801533/929**

RE: Mr Ricardo De Beer

To whom it may concern

Mr Ricardo De Beer (1801533) is currently registered as a MBA (Research Article) student at the Wits Business School, University of the Witwatersrand, Johannesburg.

This letter is to confirm that, at the time of writing, Ricardo De Beer does not need ethical clearance for the study entitled:

International Fisher Effect and purchasing power parity: the case of the South African Rand and US Dollar

This decision has been reached based upon a description of the project supplied by Ricardo De Beer to the Wits Business School Ethics Committee, constituted as a subcommittee of the University Human Research Ethics Committee (Non-Medical), which has been evaluated by the subcommittee chair. This decision has then been ratified by the University Human Research Ethics Committee (Non-Medical).

If, however, Ricardo De Beer changes the methods of data collection and analysis for this project, this decision may no longer be valid. If such changes take place, this should be communicated to the Wits Business School Ethics Committee.

Please feel free to contact me or the supervisor should you require any further information.

Yours sincerely,

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Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

17/02/2021
Date