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-RESEARCH ARTICLE-

EFFECT OF EXCHANGE RATE MOVEMENTS ON THE PERFORMANCE OF INVESTMENT PORTFOLIOS IN SOUTH AFRICA

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─Abstract ─

International diversification of investment portfolios creates substantial financial gains for investors exploiting investment opportunities in foreign economies. However, investors have to consider foreign exchange rate risk before deciding to invest in international markets. This paper examines the effect of exchange rate movements on investment portfolios with the aim of determining whether exchange rate risk can be mitigated through international diversification. An autoregressive distributed lag model (ARDL) is used to analyse the long-run and short-run relationships between the foreign exchange rate and the performance of 24 South African investment portfolios. The sample period includes 161 monthly observations from March 2006 to October 2019. The results show a long-run relationship between investment portfolios and the South African foreign exchange rate. In the short-run, returns of domestically diversified investment portfolios increase in response to an appreciation in the foreign exchange rate; while international investment portfolios tend to decrease in response to an appreciation in the exchange rate. Furthermore, domestically diversified investment portfolios are mostly influenced by instantaneous changes in the foreign exchange rate, whereas internationally diversified investment portfolios

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are influenced by current and previous values of the foreign exchange rate. This study concluded that exchange rate risk can be mitigated through international diversification. Consequently, policymakers should strive to promote the stability of the foreign exchange rate. Portfolio managers can also diversify the short-run exchange exposure by holding a combination of domestically and internationally diversified portfolios.

JEL Classification: F31, G11

Key Words: Exchange Rate, Investment Portfolio, International Diversification, ARDL, South Africa,

1. INTRODUCTION

The rise in globalisation gives rise to the importance of exchange rates. In the modern global economy, which is characterised by interdependence and international trade, exchange rates are fundamentally important to almost every business, regardless whether it trades in more than one country or not. Megginson, Smart and Graham (2010) mention that companies that do not necessarily operate in more than one country are still indirectly impacted by exchange rates. This can occur either when a company depends on inputs that must be imported or when the company competes with imports in the domestic market. This spill-over effect can substantially impact domestic companies and investors, especially under the free-floating exchange rate regime employed in South Africa.

South Africa adopted the free-floating exchange rate regime in 1995 (National Treasury, 2009). Since the adoption of this exchange rate regime, exchange rate movements became much more prevalent (Muzindutsi, 2011). The fluctuations of the South African rand (ZAR) were explicitly pronounced between 2009 and 2013 when the South African rand/United States dollar (ZAR/USD) exchange rate fluctuated by close to 61 percent between R6.60 per dollar and R10.60 per dollar. Another volatile period arose between the fourth quarter of 2015 and the first quarter of 2016. In this short period, the same exchange rate moved between R13.10 (October 2015) and R16.85 (January 2016) (Moneyweb, 2020). In spite of the volatile exchange rate of South Africa, investors have not become reluctant to exploit the potential benefits created by international diversification within the South African financial market. Planting (2019) argued that there is an increase in financial flows out of South Africa by South Africans by looking at portfolio flows into foreign currency denominated portfolios. There has also been an increase in acquisition of foreign capital, specifically in Europe by South African investors according to Mallinson (2019). This poses the question whether South

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African investment portfolios can diversify the risk associated with this volatility of the South African currency. Additionally, it is not clear whether domestic-based or internationally diversified investment portfolios respond the same way to exchange rate movements. Thus, this study aims to examine how the exchange rate affects both domestic-based and internationally diversified investment portfolios in South Africa.

The following section reviews literature pertaining to the diversification of investment portfolios with the aim of reducing exchange rate risk. Next, the methodology that was followed is outlined which is followed by the results and findings of the study. Lastly, the study concludes and policy recommendations are made.

2. LITERATURE

The concept of portfolio diversification exists primarily due to the pioneering work of Harry Markowitz in 1952 that spearheaded the modern portfolio theory (MPT) which emphasised the importance of diversification through the construction of an efficient portfolio (Mangram, 2013). This study adopts the MPT in context of geographical diversification, or international diversification, in particular. International diversification largely involves buying assets in markets outside the domestic economy. The first pioneering research surrounding international diversification was presented by Grubel (1968). Grubel (1968) built on the MPT of Markowitz and expanded the theory into global markets. Grubel (1968) mainly argued that international diversification is a source of an entirely different world of welfare gain. However, many years later, this does not seem to be entirely true, mainly due to the highly integrated global economy of today. This notion is supported by Abid, Leung, Mroua and Wong (2014), who state that although the global economy is becoming increasingly integrated, investors still prefer to keep the majority of their investments denominated in domestic assets. The reason for this home-bias illustrated by investors remains a subject of controversy because substantial financial gains can be obtained through international diversification. French and Poterbra (1991) state that numerous benefits have been identified for diversifying a portfolio internationally; but most investors prefer to keep the majority of their wealth in the domestic market and the main reason behind this home-bias remains investor choices rather than institutional constraints. This is supported by Eun, Lai, De Roon and Zhang (2010) who argue that the potential returns from international diversification have become somewhat diminished due to the high correlation among stock markets around the world. If this notion holds true in practice, investors will be more

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reluctant to invest internationally as international shocks tend to have a holistic impact on all investments, regardless whether denominated in foreign or domestic markets. Eun et al. (2010) therefore propose a new approach to international investing by foreign or domestic shocks in similar fashion in order to enhance portfolio efficiency.

Although the research suggests that international diversification seems to have lost its value in recent times due to the highly integrated global economy, some research suggests that international diversification can still be beneficial. Li, Sarkar and Wang (2003) argue that investors can still benefit from international diversification when they are prohibited from short selling in emerging markets. Additionally, the increased market integration has encouraged internationalisation of investment activities such as cross-listing of firms that has led to increase of foreign financial flows to emerging markets such as South Africa (Muguto, Rupande & Muzindutsi, 2019). This opening of financial markets globally still exposes international investors to foreign exchange rate risk that have to be considered in making foreign investment.

Due to the higher integration of the world, few studies (Caporale, Ali & Spagnolo, 2015; Abid et al., 2014; Ziobrowski & Ziobrowski, 1995) have placed emphasis on portfolio diversification in order to reduce risks. However, studies focussing on diversification of portfolios in order to reduce foreign exchange rate risk produced mixed findings with some (Caporale et al., 2015; Ziobrowski & Ziobrowski, 1995) concluding that exchange rate risk can be diversified; while others (Eun & Resnick, 1988) finding that exchange rate risk is not fully-diversifiable. Caporale et al. (2015) focussed on equity and bond flows specifically and used a vector autoregressive GARCH-BEKK-in-mean model to determine that due to risks, investors show a degree of home bias as they aim to reduce exchange rate risk in selected first world countries. Ziobrowski and Ziobrowski (1995) used a set of efficient frontier models to determine that international diversification of investment portfolios in the United States could reduce risk in general but gives rise to exchange rate risk in particular, implying that exchange rate risk can either be increased or decreased, and hence mitigated, through international diversification. Eun and Resnick (1988) developed an ex ante international portfolio selection strategy and found that due to the high correlation among exchange rates, exchange rate risk is largely undiversifiable. In the South African context, the link between the exchange rate stock and bond markets has been analysed but there seems to be a lack of research on the effect of exchange rate movements on investment portfolios. Hence, this warrants further investigation on

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the effect of the foreign exchange on both domestic-based, and internationally diversified investment portfolios in South Africa.

3. METHODOLOGY

3.1. Data and variables description

This study adopted a quantitative approach with time series data of 161 of monthly observations from March 2006 to October 2019. Data was obtained from Iress (2020) and the South African Reserve Bank (SARB, 2020) and the sample period was selected based on the availability of data on investment portfolios. In total, 24 South African equity investment portfolios consisting of 12 investment portfolios that are domestically diversified, and 12 investment portfolios that are predominantly internationally diversified, were analysed. The portfolio must also invest at least 80 percent in equities to be classified as an equity portfolio. According to the Association for Savings and Investment South Africa (ASISA, 2018), in order to be classified as domestically diversified, a portfolio must invest at least 60 percent in the South African investment market. Investment portfolios that are classified by ASISA (2018) as internationally diversified must invest at least 80 percent of their assets outside South Africa. The net asset values (NAV) of each of the investment portfolios were used to calculate the returns of the investment portfolios. The returns were calculated as follows:

$$r_{it} = \frac{NAV\ price_{it} - NAV\ price_{it-1}}{NAV\ price_{it-1}} \quad (1)$$

Where: r_{it} is the monthly rate of return of portfolio *i* in period *t*, $NAV\ price_{it}$ is the NAV price of portfolio *i* in period *t*. The nominal effective exchange rate of South Africa (NEER), which is a weighted average of the relative price levels of a country with its main trade partners, was chosen to represent the exchange rate in this study.

3.2. Model specification

In order to reach the objective of the study, an autoregressive distributed lag (ARDL) model by Pesaran, Shin and Smith (2001) was used to determine the long- and short-run relationships between the variables. The ARDL model has advantages of allowing for the simultaneous estimation of the short-run and long-run relationships among I(0), I(1) or a mixture of I(0) and I(1) series as long as none of the series is I(2). The estimated ARDL for this study is expressed as follows:

$$\Delta LF_t = \alpha_0 + \sum_{j=1}^{k} \beta_j \Delta LF_{t-j} + \sum_{j=0}^{k} \gamma_j \Delta LER_{t-j} + \varphi_1 LF_{t-1} + \varphi_2 LER_{t-1} + e_t \quad (2)$$

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Where: LF is the log of the return of portfolio, LER is the log of the exchange rate, β_j is the short-run dynamic of LF, γ_j is the short-run dynamic of LER, φ_i is the long-run relationship and e_t is the error term. This model is derived from a similar study done by Türsoy (2017) who analysed the relationship between stock prices and exchange rates in Turkey. In this study, for each investment portfolio, an ARDL model was estimated, meaning that 24 models were estimated. Each ARDL model employed in this study adopted different amounts of lags. The optimum number of lags were selected using the Akaike information criteria (AIC), the Schwartz information criteria (SIC), the Hannan-Quinn criteria (HQ), or the adjusted R-squared criteria (ARC). The following hypothesis was used to test for the long-run relationship, where the rejection of H_0 indicates that series is cointegrated, that would refer to the presence of a long-run relationship.

$H_0: \varphi_1 = \varphi_2 = 0 \qquad H_1: \varphi_1 \neq \varphi_2 \neq 0$

Where a long-run relationship was identified between the series, an error correction model (ECM) was derived from the ARDL model to determine the time it takes to return to equilibrium. The ECM, derived from equation 2, is expressed as follows:

$$\Delta LF_t = \alpha_0 + \sum_{j=1}^{k} \beta_j \Delta LF_t + \sum_{j=0}^{k} \gamma_j \Delta LER_{t-j} + \delta ECT_{t-1} + e_t \quad (3)$$

Where: δ is the coefficient of ECT and ECT is the error correction term. Before estimating the ARDL model, the unit root tests were conducted to check if none of the series is I(2). After the estimation, the necessary diagnostic tests such as normality, heteroscedasticity, stability and serial correlation were conducted to ensure that econometric assumptions are not violated.

In order to determine the causal relationship between the variables, the modified version of the Granger causality test proposed by Toda and Yamamoto (1995) was used. The Toda and Yamamoto (T-Y) Granger causality model was selected because it accounts for different order of integration.

4. RESULTS AND FINDINGS

4.1. Descriptive and correlation analyses

The values in Table 1 represents the descriptive statistics for the NEER, domestically diversified investment portfolios (D1 to D12) and internationally diversified investment portfolios (I1 to I12). The NEER moved between a maximum of 128.740 and a minimum of 51.590 with a standard deviation of 17.868. The average value of the NEER was 79.794. The average returns

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experienced by domestic portfolios is 0.693 percent compared to 0.877 percent experienced by international portfolios. The highest return reported during the sample period was 19.065 percent by portfolio I7 whereas the lowest return was -15.221 percent reported by domestic portfolio D9. The standard deviation figure signifies the volatile nature of equity portfolios as the average deviation from the mean for domestic portfolios is 3.779 percent compared to 4.421 percent for international portfolios. The normality test in the form of the Jarque-Bera test identifies a few instances where the data is not normally distributed. However, this would not create major problems due to the large sample size. Overall, the descriptive statistics shows the internationally diversified portfolios have earned higher return than the domestically diversified portfolios.

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Table 1: Descriptive statistics

	Mean	Median	Max.	Min.	Std. Dev	J.-Bera	Prob.
NEER	79.794	77.180	128.740	51.590	17.868	11.164	0.003
D1	0.933	1.424	7.782	-13.057	3.227	74.012	0.000
D2	0.678	1.113	8.635	-9.454	3.487	3.287	0.193
D3	0.792	0.836	10.273	-10.116	3.522	6.797	0.033
D4	0.797	0.965	10.041	-10.517	3.862	0.646	0.724
D5	0.527	0.586	9.430	-12.867	3.723	12.921	0.002
D6	0.649	1.047	9.971	-13.415	3.707	12.000	0.002
D7	0.822	0.789	18.990	-14.112	5.520	1.363	0.506
D8	0.843	1.313	10.905	-9.178	3.636	1.601	0.449
D9	0.508	0.476	10.765	-15.221	3.876	19.532	0.000
D10	0.633	1.066	8.456	-12.349	3.606	4.234	0.120
D11	0.569	0.907	9.611	-13.876	3.628	16.870	0.000
D12	0.567	0.786	8.674	-14.379	3.552	67.806	0.000
Avg.	**0.693**	**0.942**	**10.294**	**-12.378**	**3.779**	-	-
I1	0.806	0.611	14.250	-13.701	4.255	10.594	0.005
I2	1.140	0.906	18.535	-12.938	4.387	26.437	0.000
I3	1.044	1.118	15.680	-13.048	4.333	7.446	0.024
I4	0.965	1.083	17.190	-11.982	4.347	11.205	0.004
I5	0.870	0.725	12.804	-10.535	4.108	6.528	0.038
I6	1.107	1.147	15.533	-11.635	4.469	7.221	0.027
I7	0.706	0.693	19.065	-11.979	4.635	17.234	0.000
I8	0.988	0.963	15.382	-10.211	4.364	5.966	0.051
I9	0.858	1.011	13.990	-11.279	4.223	7.266	0.026
I10	0.615	0.579	10.972	-12.460	4.362	0.595	0.743
I11	0.575	0.880	13.917	-15.182	4.789	4.048	0.132
I12	0.847	0.808	14.664	-13.824	4.778	2.640	0.267
Avg.	**0.877**	**0.877**	**15.165**	**-12.398**	**4.421**	-	-

Note: Values represented above are raw, untransformed values for easy of interpretation. Log values were used for the models.

Table 2 represents the correlational results. A positive relationship exists between the domestic portfolios. The degree of correlation varies between 0.932 and 0.415. Domestic portfolio D7 has the weakest average correlation (0.518) compared with the rest of the domestic portfolios. The international portfolios are all positively correlated with each other. The degree of correlation varies between 0.963 and 0.686. International portfolio I9 showed the strongest average correlation (0.922) with all the other international portfolios. The correlation between the portfolios (international and domestic) and the NEER are all very low. Only two instances

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are found, where a negative correlational relationship exists. The highest degree of correlation with the NEER is with domestic portfolio D6. On average, the degree of correlation between the NEER and the domestic portfolios is 0.098 as compared to 0.021 with the international portfolios.

Table 2: Correlation between portfolios and the real effective exchange rate

DF	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	L_I	
D1	**1.00**	*0.86*	*0.85*	*0.82*	*0.88*	*0.89*	*0.91*	*0.86*	*0.90*	*0.69*	*0.84*	*0.81*	0.01	***I1***
D2	0.79	**1.00**	*0.86*	*0.80*	*0.86*	*0.86*	*0.90*	*0.86*	*0.87*	*0.76*	*0.83*	*0.83*	0.01	***I2***
D3	0.80	0.90	**1.00**	*0.89*	*0.90*	*0.90*	*0.90*	*0.92*	*0.92*	*0.82*	*0.83*	*0.85*	0.01	***I3***
D4	0.80	0.89	0.89	**1.00**	*0.83*	*0.90*	*0.89*	*0.90*	*0.90*	*0.77*	*0.81*	*0.83*	0.04	***I4***
D5	0.77	0.91	0.88	0.89	**1.00**	*0.89*	*0.89*	*0.89*	*0.92*	*0.74*	*0.84*	*0.82*	0.04	***I5***
D6	0.82	0.89	0.84	0.88	0.89	**1.00**	*0.95*	*0.95*	*0.95*	*0.80*	*0.88*	*0.89*	0.01	***I6***
D7	0.42	0.54	0.57	0.58	0.49	0.51	**1.00**	*0.93*	*0.95*	*0.83*	*0.91*	*0.90*	0.03	***I7***
D8	0.73	0.86	0.85	0.93	0.86	0.84	0.65	**1.00**	*0.96*	*0.82*	*0.87*	*0.90*	-0.01	***I8***
D9	0.80	0.86	0.81	0.90	0.89	0.90	0.46	0.84	**1.00**	*0.82*	*0.88*	*0.90*	0.01	***I9***
D10	0.78	0.91	0.87	0.90	0.93	0.90	0.45	0.85	0.88	**1.00**	*0.80*	*0.80*	0.01	***I10***
D11	0.77	0.92	0.85	0.85	0.88	0.90	0.51	0.83	0.84	0.88	**1.00**	*0.95*	0.04	***I11***
D12	0.73	0.85	0.81	0.81	0.80	0.82	0.54	0.78	0.83	0.81	0.76	**1.00**	0.05	***I12***
L_D	0.11	0.14	0.10	0.10	0.11	0.16	-0.06	0.09	0.11	0.12	0.12	0.08	**1.00**	
	I1	***I2***	***I3***	***I4***	***I5***	***I6***	***I7***	***I8***	***I9***	***I10***	***I11***	***I12***		**IF**

Note: L_D and L_I show the correlation between LNEER and domestic portfolios and international portfolios respectively.

4.2. Long-run analysis

Before estimating the ARDL models, the Augmented Dickey-Fuller (ADF) unit root test was used to confirm that none of the variables is I(2). The unit root test results indicate that the NEER became stationary at the first difference, I(1) whereas all the portfolios are stationary at level, I(0). The results indicated that there is a mixture of I(0) and I(1) series confirming that the ARDL model is a suitable model to test for the long-run relationship between the variables. Cointegration results with the best model selected for each portfolio are summarised in Table 3. In all of the cases, the F-statistic is higher than the upper bound I(1) indicating the presence of a cointegration or a long-run relationship between the portfolios and the NEER. The table further shows the NEER long-run coefficients for each portfolio. In the case of the domestically diversified investment portfolios, the portfolio returns tend to increase by 4.389 percent in response to an appreciation of the NEER in the long-run. Only one case, D7, is identified to decrease by 3.634 percent in response to an appreciation of the NEER in the long-run. The returns of the internationally diversified investment portfolios tend to increase by 0.890 percent in response to an appreciation of the

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NEER in the long-run. Based on the long-run coefficients, the impact of exchange rate movements on returns of investment portfolios (domestic and international) is minute. This can be due to the fact that the investment portfolio returns, especially in the long-run, should largely be determined by the underlying assets rather than by exchange rate movements. Another explanation for the small effect in the long-run is that in the long-run, as equity (assets) is bought and sold regularly at different currency prices, a form of rand cost averaging occurs that in essence, could mitigate the effect of exchange rate movements on portfolio returns.

Table 3: Model selection and bounds test

Portfolio	Model	F-stat.	I(0) Bound	I(1) Bound	Long-run equation
D1	ARDL (2,0)	27.054	4.940	5.730	D_1= -7.024 + 4.228(NEER)
D2	ARDL (1,1)	92.453	4.940	5.730	D_2= -8.661 + 4.994(NEER)
D3	ARDL (1,0)	90.896	4.940	5.730	D_3= -6.468 + 3.842(NEER)
D4	ARDL (1,1)	95.622	3.150	4.110	D_4= 0.000 + 0.499(NEER)
D5	ARDL (1,1)	85.674	4.940	5.730	D_5= -7.845 + 4.500(NEER)
D6	ARDL (1,3)	86.014	4940	5.730	D_6= -12.322 + 6.888(NEER)
D7	ARDL (2,6)	25.349	4.940	5.730	D_7= 7.561 – 3.634(NEER)
D8	ARDL (2,5)	29.065	4.940	5.730	D_8= -5.393 + 3.390(NEER)
D9	ARDL (1,3)	86.002	4.940	5.730	D_9= -10.169 + 5.708(NEER)
D10	ARDL (1,1)	94.722	4.940	5.730	D_{10}= -7.506 + 4.347(NEER)
D11	ARDL (1,4)	81.488	4.940	5.730	D_{11}= -9.585 + 5.437(NEER)
D12	ARDL (2,5)	23.719	3.150	4.110	D_{12}= 0.000 + 0.312(NEER)
I1	ARDL (3,2)	16.923	4.940	5.730	I_1= 2.381 – 0.889(NEER)
I2	ARDL (2,5)	30.007	4.940	5.730	I_2= 2.208 – 0.597(NEER)
I3	ARDL (1,1)	129.814	4.940	5.730	I_3= 0.987 – 0.058(NEER)
I4	ARDL (2,6)	28.268	4.940	5.730	I_4= 1.661 – 0.339(NEER)
I5	ARDL (1,5)	96.003	6.560	7.300	I_5= -21.273 + 10.559(NEER)
I6	ARDL (2,5)	24.969	4.940	5.730	I_6= 1.843 – 0.413(NEER)
I7	ARDL (1,0)	91.189	4.940	5.730	I_7= -1.422 + 1.120(NEER)
I8	ARDL (2,5)	30.365	3.150	4.110	I_8= 0.000 + 0.514(NEER)
I9	ARDL (1,0)	88.373	4.940	5.730	I_9= 0.639 + 0.119(NEER)
I10	ARDL (1,2)	97.154	4.940	5.730	I_{10}= 1.309 – 0.340(NEER)
I11	ARDL (1,5)	71.796	4.940	5.730	I_{11}= 0.490 – 0.006(NEER)
I12	ARDL (1,5)	65.434	4.940	5.730	I_{12}= -1.092 + 1.008(NEER)

Note: Models were estimated with a constant with the use of *AIC or SIC to select the best model.*

4.3. Short-run analysis

In order to establish the rate at which the models return to equilibrium, the error correction model was used. Table 4 shows the error correction terms for all the cases that exhibit the speed of adjustment to the long-run equilibrium. The results

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indicate that the error correction term in all the cases are negative and the coefficient is significant, further supporting the long-run relationship amongst the variables. Although some of the coefficients are lower than -1, these values still exhibit stability based on the statement by Loayza and Ranciere (2005) that the error correction term must fall between 0 and -2. In the cases where the error correction term is lower than -1 (absolute value of greater 1), the models return to equilibrium within a timeframe that is less than a month. On average, 98.500 percent of the error is corrected each month in the case of domestically diversified investment portfolios as opposed to 101.058 percent that is corrected each month on average in the case of internationally diversified investment portfolios. This implies that it takes domestically diversified investment portfolios 1.015 (1/0.985) months to return to equilibrium while internationally diversified investment portfolios take approximately 0.989 (1/1.011) months to return to equilibrium. The quicker adjustment to equilibrium in the case of the internationally diversified portfolios can be explained by the T-Y Granger causality results shown in Table 6. In the case of the internationally diversified investment portfolios, changes in the portfolio return occur before changes in the NEER occur. This indicates that the returns of the internationally diversified investment portfolios absorb some of the impact of the changes in the NEER before the change materialises and hence, once the change occurs, smaller adjustments are required to return to equilibrium.

Table 4: Error correction terms

	D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**
CointEq (-1)	-0.789	-1.088	-1.081	-1.080	-1.051	-1.048	-0.815	-0.895	-1.046	-1.099	-1.040	-0.788
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**	**I8**	**I9**	**I10**	**I11**	**I12**
CointEq (-1)	-0.857	-0.932	-1.304	-0.915	-1.176	-0.826	-1.067	-0.956	-1.053	-1.106	-0.978	-0.957
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Table 5: ECM short-run coefficients

Portfolio	C	$Fund_{t-1}$	$Fund_{t-2}$	$LNEER_t$	$LNEER_{t-1}$	$LNEER_{t-2}$	$LNEER_{t-3}$	$LNEER_{t-4}$
D1	-5.545	0.068	0.143	3.338	0.000	0.000	0.000	0.000
D2	-9.423	-0.088	0.000	59.540*	-54.107*	0.000	0.000	0.000
D3	-6.991	-0.081	0.000	4.152	0.000	0.000	0.000	0.000
D4	0.000	-0.080	0.000	62.632*	-62.093*	0.000	0.000	0.000
D5	-8.247	-0.051	0.000	70.899*	-66.168*	0.000	0.000	0.000
D6	-12.913*	-0.048	0.000	50.959*	-29.457	-62.524	48.240*	0.000
D7	6.158	0.034	0.152	31.154	-64.746	-17.286	68.780	25.694
D8	-4.825	-0.022	0.127	46.889*	-16.199	-78.840*	58.263	31.321
D9	-10.635	-0.046	0.000	57.780*	-25.732	-72.289*	46.211*	0.000
D10	-8.253	-0.099	0.000	50.209*	-45.430*	0.000	0.000	0.000
D11	-9.972	-0.040	0.000	56.477*	-43.981	-62.580	99.392*	-43.651*
D12	0.000	-0.001	0.213*	34.525	-40.752	-58.751	68.223*	35.476
I1	2.041	-0.163*	0.151	-82.791*	147.233*	-65.205*	0.000	0.000
I2	2.058	-0.053	0.121	-84.401*	157.060*	-110.295*	44.371	31.677
I3	1.288	-0.304*	0.000	-96.446*	96.370*	0.000	0.000	0.000
I4	1.520	-0.111	0.196*	-56.092*	129.106*	-88.873*	-10.145	74.099
I5	-25.017	-0.176*	0.000	-95.877*	149.413*	-93.364*	58.602	35.168
I6	1.522	-0.007	0.182*	-81.837*	170.039*	-134.741*	46.585	38.449
I7	-1.517	-0.067	0.000	1.194	0.000	0.000	0.000	0.000
I8	0.000	-0.079	0.123	-70.872*	154.203*	-122.318*	43.295	32.679
I9	0.673	-0.053	0.000	0.125	0.000	0.000	0.000	0.000
I10	1.449	-0.106	0.000	-35.715	100.079*	-64.740*	0.000	0.000
I11	0.479	0.0219	0.000	-76.916*	156.711*	-149.700*	98.759*	14.050
I12	-1.045	0.043	0.000	-54.481	143.168*	-164.213*	100.792*	13.186

**Indicate significant at the 5 percent level of significance.*

The short-run equations shown in Table 5 indicates that the exchange rate does have an impact on the returns of the investment portfolios in the short-run. The current exchange rate influences the return of the domestic and international portfolios. On average, returns of domestic portfolios tends to increase by 44.046 percent in response to a one percent appreciation in the current NEER. Conversely, a one percent appreciation in the current NEER results in a 61.176 percent decrease in the returns of the international portfolios. In the majority of the domestic portfolio cases, the first lagged values of the NEER are not significant explanatory variables of the returns of the portfolios. However, in the case of the international portfolios, up to the third lagged value of the NEER remain significant in explaining the variation in the return of the portfolios in the majority of the cases. The fact that the NEER influences portfolios that are predominantly invested in the domestic market and the domestic currency;

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different to portfolios that are predominantly invested in foreign markets in foreign currencies; indicates that international diversification can be used to manage exchange rate risk. This finding is in accordance with Kabundi and Mwamba (2012) and Eun and Resnick (1988) that found that exchange rate risk plays an important role in the investment decision-making process, especially when it comes to international diversification. Mwamba and Djemo (2019) mention that investors need an effective exchange rate risk methodology due to the fact the exchange rates play a significant role in the determination of investment returns. Based on the findings of this study, the effectiveness of the exchange rate risk methodology is of utmost importance, especially when investing in foreign markets.

The last objective of this study is to determine the causal relationship between all the investment portfolios. The T-Y Granger-causality test results in Table 6 show that only two unidirectional significant Granger-causal relationships are identified between the NEER and the domestically diversified investment portfolios. However, bidirectional and unidirectional relationships, with the latter being more prominent, were identified in the case on the internationally diversified investment portfolios. In all of the unidirectional cases, the return of the internationally diversified investment portfolios Granger-causes the NEER. One bidirectional case is found where the returns of the internationally diversified investment portfolio Granger-causes the NEER and where the NEER Granger-causes the returns of the internationally diversified investment portfolio. In the case of the internationally diversified investment portfolios, during the investment process, foreign currency will have to be bought with the domestic currency. This regular exchange between currencies can be one of the causes for the Granger-causality relationships found amongst the international portfolios. In the case of the domestically diversified investment portfolios, equity can be bought with the domestic currency without any need to buy foreign currency. Hence, there is no regular exchange between currencies which could explain the absence of a Granger-causal relationship between the NEER and domestically diversified investment portfolios.

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Table 6: Granger-causality test

Domestic portfolios				International portfolios			
Null hypothesis	**F-stat.**	**Prob. F-stat**	**Relation**	**Null hypothesis**	**F-stat.**	**Prob. F-stat**	**Relation**
D1 ≠* NEER	0.204	0.816	None	I1 ≠* NEER	6.504	0.002	→
NEER ≠* D1	1.234	0.294		NEER ≠* I1	1.572	0.211	
D2 ≠* NEER	3.269	0.041	→	I2 ≠* NEER	5.378	0.006	→
NEER ≠* D2	1.237	0.293		NEER ≠* I2	1.983	0.141	
D3 ≠* NEER	1.051	0.352	None	I3 ≠* NEER	11.524	0.000	→
NEER ≠* D3	0.815	0.444		NEER ≠* I3	1.399	0.250	
D4 ≠* NEER	1.027	0.361	None	I4 ≠* NEER	7.680	0.001	→
NEER ≠* D4	1.307	0.274		NEER ≠* I4	3.149	0.046	←
D5 ≠* NEER	3.184	0.044	→	I5 ≠* NEER	13.915	0.000	→
NEER ≠* D5	0.985	0.376		NEER ≠* I5	1.259	0.287	
D6 ≠* NEER	1.454	0.237	None	I6 ≠* NEER	6.554	0.002	→
NEER ≠* D6	1.560	0.213		NEER ≠* I6	2.971	0.054	
D7 ≠* NEER	1.735	0.180	None	I7 ≠* NEER	4.442	0.013	→
NEER ≠* D7	0.728	0.485		NEER ≠* I7	2.919	0.057	
D8 ≠* NEER	1.630	0.199	None	I8 ≠* NEER	8.473	0.000	→
NEER ≠* D8	1.362	0.259		NEER ≠* I8	2.714	0.069	
D9 ≠* NEER	1.572	0.211	None	I9 ≠* NEER	6.740	0.002	→
NEER ≠* D9	1.473	0.233		NEER ≠* I9	2.434	0.091	
D10 ≠* NEER	2.716	0.069	None	I10 ≠* NEER	3.234	0.042	→
NEER ≠* D10	1.207	0.302		NEER ≠* I10	2.482	0.087	
D11 ≠* NEER	2.635	0.075	None	I11 ≠* NEER	3.090	0.048	→
NEER ≠* D11	1.054	0.351		NEER ≠* I11	1.817	0.166	
D12 ≠* NEER	1.941	0.147	None	I12 ≠* NEER	7.547	0.001	→
NEER ≠* D12	0.197	0.821		NEER ≠* I12	2.623	0.076	

* *"Does not Granger Cause" represented by symbol: ≠*

The literature pertaining to the effect of exchange rate volatility of investment portfolios suggests that exchange rates do influence investment portfolios. The studies of Horobet and Ilie (2010), Hau and Rey (2004) and Solnik (1995) suggests that exchange rate movements has an effect on investment portfolios. Gyntelberg, Loretan, Subhanij and Chan (2012) on the other hand identifies that investment portfolios could also influence the exchange rate. This indicates that a bidirectional relationship can exist between exchange rate volatility and investment portfolios. The findings of this study are consistent with previous findings and this further emphasises the role of exchange rate risk in the investment process.

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In order to test the reliability of the results a set of diagnostic tests were done for the 24 models. The results of the diagnostic tests are summarised in Table 7. The residuals were tested for serial correlation through the Breusch-Godfrey LM test, for heteroscedasticity through the Harvey test, for normality through the Jarque-Bera test and lastly for stability through the CUSUM control chart test. None of the models violated any of the diagnostic tests according to the results in Table 7. Although the normality test identifies a few instances where the data is not normally distributed, no major problems are created due to the large sample size.

Table 7: Diagnostic tests

	Normality test		**Serial correlation test**		**Heteroscedasticity**		**Stability test**
Portfolio	**t-statistic**	**Prob. T**	**F-statistic**	**Prob. F**	**F-statistic**	**Prob. F**	**CUSUM test***
D1	78.234	0.000	0.145	0.865	0.694	0.557	S
D2	4.041	0.133	0.013	0.987	1.596	0.193	S
D3	10.557	0.005	0.277	0.758	0.824	0.441	S
D4	0.326	0.850	1.361	0.259	2.061	0.108	S
D5	15.279	0.000	0.734	0.482	1.518	0.212	S
D6	15.292	0.000	0.793	0.454	1.743	0.128	S
D7	0.684	0.710	1.354	0.261	1.404	0.191	S
D8	1.842	0.398	0.057	0.945	0.734	0.662	S
D9	11.697	0.003	0.806	0.449	1.439	0.213	S
D10	4.904	0.861	0.736	0.481	1.277	0.284	S
D11	16.957	0.000	0.178	0.837	1.394	0.221	S
D12	26.163	0.000	0.138	0.871	1.149	0.334	S
I1	10.174	0.006	1.631	0.199	1.388	0.223	S
I2	21.176	0.000	1.287	0.279	1.110	0.360	S
I3	3.832	0.147	2.521	0.084	1.976	0.120	S
I4	4.205	0.122	0.317	0.729	1.096	0.370	S
I5	3.253	0.197	1.674	0.191	1.420	0.192	S
I6	0.568	0.753	1.583	0.209	1.263	0.267	S
I7	16.544	0.000	1.505	0.225	0.964	0.384	S
I8	2.626	0.269	1.953	0.146	1.634	0.120	S
I9	6.567	0.037	0.684	0.506	1.803	0.168	S
I10	0.907	0.636	0.803	0.450	1.805	0.131	S
I11	2.126	0.345	1.418	0.246	0.674	0.694	S
I12	0.763	0.683	1.807	0.168	0.553	0.793	S

**S indicates stability (remained within the 5% bound)*

5. CONCLUSION

Globalisation has resulted in a modern global economy where global markets tend to be decidedly integrated. This however, does not mean that investors should

refrain from exploring foreign markets in their investment endeavours as international diversification still proves beneficial, specifically in the wake of fluctuating exchange rates. The findings of this study support international diversification as a tool to mitigate exchange rate risk. The presence of the long-run relationship between the South Africa foreign exchange rate and investment portfolio returns shows that the exchange rate shocks have a lasting effect on investment portfolio returns. However, the difference in the speed of adjustment to equilibrium suggests that the internationally diversified portfolios react to exchange shocks faster than the domestically diversified portfolios. This was also confirmed by the absence of any significant causal relationship between the exchange rate and the domestically diversified investment portfolios. Additionally, the short-run reaction of portfolio returns is not standardized across the domestic or internationally diversified portfolios, implying that exchange rate risks can be diversified among these portfolios. Our findings show that foreign exchange rate fluctuations have an effect on international portfolio flows, implying that such fluctuations affect international investors' decisions. Consequently, policymakers should strive to promote the stability of the foreign exchange rate. The portfolio managers can also diversify the short-run exchange exposure by holding a combination of domestically and internationally diversified portfolios.

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