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Drivers of Real Exchange Rate in the Small Open Island of Mauritius

Ashok Babubudjnauth

Abstract- **This paper investigates the factors of real exchange rate (RER) in Mauritius by implementing a dynamic regression approach on quarterly data from 1999:Q1 to 2016: Q4. Productivity differential, interest rate differential, openness, gross domestic fixed capital formation and share price index are the main triggers of RER in the long-run. In the short-run, productivity differential and interest rate differential drive real exchange rate. Thus, RER will converge to its long-run equilibrium level if these factors are allowed to adjust freely.**

I. Introduction

The real exchange rate is a key financial variable that measures the relative competitiveness of the traded sector of a country. Specifically, equilibrium real exchange rate (ERER) is the ratio of prices of tradable goods to prices of non-tradable goods that is compatible with the simultaneous attainment of internal[1] and external[2] equilibriums (Edwards, 1988). There is a general consensus that the prices of tradable goods are determined in the world markets and therefore are given whereas the prices of non-tradable goods are flexible as they are determined in the domestic economy. Thus, any shock to the prices of non-tradable goods leads to misalignment of real exchange rate (RER) from its long-run level and adversely affect competitiveness and economic growth (Kumar, 2010).

The pioneering theory of the exchange rate behavior is the doctrine of purchasing power parity (PPP). It posits that if the price level in domestic country rises relative to its foreign counterpart, the home currency will depreciates in nominal terms, leaving the real exchange rate constant. But, in practice, the equilibrium real exchange rate (ERER) is rather a path of RER equilibrium values (Edwards, 1988) that influences international trade, foreign direct investment (FDI) and capital flows (Villavicencio and Bara, 2008). Fluctuations in real exchange rate are also held responsible for poor growth rate, high current account deficit and financial crisis (Carrera and Restout, 2008).

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The objective of this paper is to investigate the determinants of real exchange rate in a small open island economy. In the exchange rate literature, there are only a few studies that attempt to explain the RER behavior in Small Island Developing States (SIDS) as compared to the huge number of studies carried out in developed countries. One of the most important characteristics of SIDS is their dependence on international trade. The high degree of dependency on imports and exports of SIDS validates the importance of exchange rate in these economies. Based on its remarkable performance in the African continent and its openness, Mauritius represents a good case study to examine the determinants of real exchange rate in SIDS. Undoubtedly, this study will add to the literature on factors determining equilibrium exchange rate by taking into account elements of dynamism and endogeneity in the modeling of RER which has been largely ignored in the exchange rate literature.

The remaining of this chapter is structured as follows. The determinants of real exchange rate and past empirical studies are discussed in section 2 followed by exchange rate regimes in Mauritius in section 3. Sections 4 deals with empirical analysis and finally section 5 concludes and provide some recommendations.

II. The Main Drivers of Real Exchange Rate: Theoretical Underpinnings

Unfortunately, the economic theory does not provide a comprehensive and conclusive view of the determinants of real exchange rate. Reasonably, different studies choose different fundamental factors as potential explanatory variables to explain real exchange rate movements. In this section, the factors that are believed to drive the bilateral real exchange rate between Mauritian rupee (MUR) and US dollar (USD) are highlighted.

a) Productivity differential

The Balassa (1964) and Samuelson (1964) hypothesis suggests that productivity improvement in rapidly growing economies concentrating primarily in the tradable sector causes an appreciation of RER through the increase of income and price of non-tradable goods (Chowdhury, 1999). Technological advancement generally increases the efficiency and productivity of tradable sector. Thus, when productivity goes up, wages

[1] Internal equilibrium means that the non-tradable goods market is in equilibrium in the current period and expected to be cleared in the future periods.

[2] External equilibrium means that the present and future current account balances are consistent with long-run capital flows

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reflecting the marginal productivity of labor also moves up. Since wages are equal across industries, workers in the non-trade sector also benefit from an equal proportional rise in their wages, although productivity gain remains low. The wage increase in traded commodities sector is matched by productivity gain and hence their prices do not rise whereas in the non-traded goods sector, hike in wage rates exceed productivity gain which exert an upward pressure in the prices of non-tradable goods. Consequently, the real exchange rate strengthens.

b) Interest rates

The flexible price monetary approach predicts a positive relationship between interest rate differential and exchange rate and considers a change in nominal interest rate as reflecting a change in the expected inflation. Contrarily, the sticky-price and portfolio balance approaches suggest a negative association between interest differential and nominal exchange rate. In portfolio balance models, which are based on the premise that the financial assets are not perfect substitutes, higher domestic interest rate generates more profit from an investment in domestic asset (Bouraoui and Phisuthtiwatcharavong, 2015). Foreign investors attracted by higher domestic returns invest more in the domestic assets. Thus, more foreign capital flows into the domestic economy and these capital inflows boost up the demand of local currency. In the absence of the central Bank intervention in the foreign exchange market this excess demand for domestic currency leads to an appreciation of the domestic currency.

Interest rate can also affect exchange rate indirectly through its effect on productivity differential. An increase in the interest rate reduces consumptions relative to the future as it boosts up incentive to save. Similarly, investment in physical assets is reduced as returns from bonds are higher (Aguiar and Gopinath, 2007). The induced impacts of consumption and investments lead to a fall in productivity differential. An inverse relationship between higher interest rate and lower productivity differential was reported by Monacelli et al. (2018) in emerging market economies.

c) Openness

The recognition that the tariffs level and the ERER are related in the long-run stimulates many countries to undertake reforms to liberalize trade among them. The trade liberalization reforms, among others, have dealt with the impact of long-term tariff reductions on the real exchange rate. The traditionally accepted view is based on a partial equilibrium interpretation of the elasticities approach which suggests that a lower tariff will reduce the domestic price of imports and consequently will increase its demand. This will generate a current account deficit which, in turn, will require depreciation in the RER to restore external balance, assuming that the Marshall- Lerner condition holds[3].

More openness to international trade can step up productivity of a country through increased competition pressure, changes in market shares, increased access to technological improvements and spillover. Choudhri and Hakura (2000) showed that increased import competition in medium growth manufacturing sectors enhanced overall productivity growth. Alcala and Ciccone (2004) also found economically significant and statistically robust positive effect of openness on productivity.

d) Stock prices

Stock price and exchange rate is theoretically related through the portfolio balance model (Mariano et al. 2016). Surging stock prices lure foreign capital. On the other hand, plummeting stock prices tend to diminish corporate wealth which in turn reduces a nation's wealth. The drops in the wealth of households may cause a slowdown in the demand for money and a cut in the interest rate. A lower interest rate will brisk up capital outflows to another part of the world and thereby causing the domestic currency to lose value. According to this model, plunging stock prices drops the price of the local money in the exchange rate market.

Stock prices can also have indirect influences on the real exchange rate through their impacts on investment and productivity. The mechanism was explicitly explained by Tobin (1969). The effect of share prices on the cost of capital is given by Tobin Q coefficient, which is merely the ratio of the market value of current capital to the cost of replacement capital. Higher share prices imply high Tobin's Q, and thus investment becomes more natural as it requires lower share offering. As a result, firms invest in capital goods. Consequently, higher investment leads to higher productivity growth.

e) Share of investment

Theoretically, gross fixed capital formation affects productivity either through increasing the physical capital stock or through promoting the technology indirectly (Dritsakis et al. 2006). The effects of investment on real exchange rate depend on its composition in tradable and non- tradable goods. If the investment spending occurs in the tradable sector then the RER will depreciate (Edwards, 1989; Baffles et al. 1999). On the other hand, channeling investment into non-tradable sector will cause the RER to appreciate (Rao and Tolcha, 2016).

The factors of real exchange rate discussed in this section are incorporated in the exchange rate modelling below which explains the behaviour of MUR

[3] The absolute sum of long-term export and import elasticities is greater than one.

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against USD. These triggers are selected by taking into account the economic structure of the domestic economy and the smallness of the sample size used in this study.

f) Empirical evidences

In a pioneering study, Meese and Rogoff (1983) compared the traditional exchange rate models with a driftless random walk model. None of the economic fundamentals beat a naïve no-change prediction in the short-run. But, in the long-run, evidence of the association between fundamental values and exchange rate was found. This latter finding was further consolidated by Mark (1995) and Chin and Meese (1995).

In South Africa, Aron et al. (1998) found that RER was overvalued and suggested that devaluation could be an effective instrument to accelerate convergence towards the equilibrium real exchange rate. Chowdhury (1999) examined the determinants of the real exchange rate in Papua New Guinea from 1970 to 1994. The results showed that the terms of trade had a marginal effect on trade-weighted real exchange rate in the long-run. The government expenditure had the expected negative sign but was insignificant both in the short-run and long-run. The coefficient of the net long-term capital inflow was significantly negative as per expectation. The trade restriction appreciated the RER in the long-run. The macroeconomic policy significantly and positively influenced RER. Finally, the predicting power of the nominal exchange rate was as per theory.

Locally, Heerah-Pampusa and Huree-Gobin (2006) used the Capital Enhanced Equilibrium Exchange Rates (CHEER) approach to determine an equilibrium exchange rate for MUR, utilizing monthly data from July 1994 to June 2005. The study found that the US interest rate had a greater influence on the MUR/USD rate than the local interest rate. Imam and Minoiu (2008) estimated the equilibrium real exchange rate (ERER) using the single equation equilibrium exchange rate approach (FEER-SE), and the capital enhanced equilibrium exchange rate approach (CHEER) to assess the exchange rate misalignment in Mauritius over the period 1960- 2007. They applied the autoregressive distributed lag (ARDL) approach to time series data and identified a long-run co-integration relationship among the real effective exchange rate (REER), terms of trade, openness and government consumption. The reported results indicated that both openness and government consumption had a depreciating effect on REER while terms of trade had an appreciating impact on REER.

The single equation equilibrium exchange rate analysis revealed that the MUR was in line with its equilibrium value since 2003 which implied that the exchange rate policy in Mauritius was appropriate since 2003. They then applied vector autoregressive (VAR) approach to estimate a CHEER model, using monthly series of nominal exchange rate, the inflation differential, and the interest rate differential between July 1995 and December 2007. The findings affirmed that the MUR/USD spot rate was consistent with conditional equilibrium since July 1995.

Ranadive and Burange (2013) analyzed the determinants of the real exchange rate in India from 1993 Q1 to 2011 Q4. The result reported that productivity gain weakened the RER in the long- run. Increases in Government final consumption expenditure depreciated the RER. The effect of foreign institutional investment and openness on the RER was mixed. The short-run interest rate rightly strengthened the RER whereas the long-run impact was mixed. The Inflation differential had the correct negative sign and was significant at 5% level of significance. The terms of trade had the positive and significant effect on the RER. Finally, the net foreign assets appreciated the real exchange rate after one year.

The behavior of the Swiss franc was examined by Griffoli et al. (2014). The findings were as expected. Increases in the explanatory variables tended to make the RER stronger in the long- run. Moreover, except for the Balassa-Samuelson effect, all other variables were statistically significant. Bouraoui and Phisuthtiwatcharavong (2015), based on a multiple regression approach, showed that the terms of trade and international reserves had a statistically significant positive influence on the nominal exchange rate, THB/USD. On the other hand, the interest rates differential, manufacturing production index, monetary base and government debt did not display any significant relationship with the exchange rate in Thailand.

A case study examining the sources of the real exchange rate fluctuations in the Philippines was undertaken by Mariano et al. (2016) over the period 1973-2014. The variance decomposition analysis indicated that the gross domestic product was responsible for a higher proportions of the movement in the real exchange rate, it accounted for 29.22% of the variation in the real exchange rate followed by the volume of money flow which accounted for 22.98%. The net foreign assets, the import restrictions, the oil prices, and the budget deficit had each contributed 6.64%, 3.92%, 2.87%, and 2.11%, respectively to the movements of RER.

The researchers investigating the determinants of real exchange rate were not uniform in their choice of variables, methodologies and sample frequencies. These inconsistencies have contributed to some extent to the different prediction of these studies. As regards to Mauritius, in so far, only two studies have been conducted- Heerah-Pampusa and Huree-Gobin (2006) and Imam and Minoiu (2008). These two studies were restricted to use specific variables as determined by

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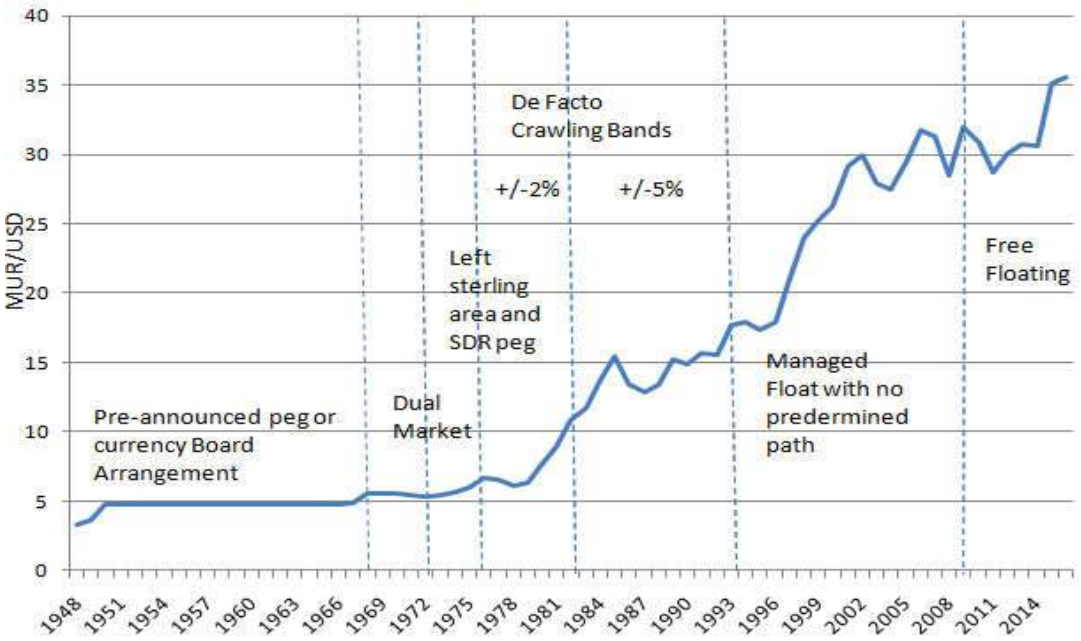
their respective models and thereby excluded significant determinants of MUR. The contribution of this study is therefore to extend the list of factors that may affect the MUR/USD by including more macroeconomic fundamentals. Moreover, the sample period is more recent and latest time series techniques are applied.

III. Exchange Rate Regimes in Mauritius

Initially, Mauritius, being a British colony, shifted between pound sterling and Indian rupee. MUR was first introduced in 1934 and linked to the pound sterling through a currency board until November 1967. Afterwards, it was directly pegged to the pound sterling. Mauritius left the sterling area in 1972 because pound sterling was weakening. An arrangement for a central exchange rate with special drawing rights (SDRs) was made and a parallel second exchange rate for capital transfers was adopted. In January 1976 the country officially fixed the MUR to the SDR within a 2% band. Officially, the rupee was devalued in 1979 and 1981 after a period of overvaluation. Figure 1 below shows exchange rate regimes shifts over the period 1948-2016. The diagram was initially used by Reinhard and Rogoff (2004) and is extended to 2016 in this study.



Source: Reinhard and Rogoff (2004) and Authors

Figure 1: Exchange rate regimes and the nominal exchange rate, 1948_2016

The MUR was officially de-linked from the SDR in mid-1982 and pegged to a trade-weighted basket of major trading partners' currencies, without disclosing the composition of the basket in virtue of an IMF program of liberalization. The exchange rate remained pegged de facto to the USD within a 5 percent band. Exchange rate for overseas travelling was controlled, and a multiple currency practice in the form of 15% tax on capital remittances was maintained up to the early 1990s.

Abolitions of exchange rate restrictions began in 1992 and by the mid-1994 all restrictions were removed. From 1994 to 2008, the country had a managed floating exchange regime. Acknowledging that the Central Bank of Mauritius did not intervene in the foreign exchange market between December 2008 and June 2009, the IMF re-classified the exchange rate to a free- floating exchange rate system in its 2009 Annual Report of Exchange Arrangements and Exchange Restrictions.

IV. Econometric Model

The empirical model is based on Kildegaard (2006); Carrera and Restout (2008); Villaviacencio et al. (2008); Biekpe (2012); Rao et al. (2016) and has been modified by incorporating country specific variables. It is given as:

$$RER_t = \beta_0 + \beta_1 LOP_t + \beta_2 LPD_t + \beta_3 INTDIFF_t + \beta_4 LGDFCF_t + \beta_5 LSPI_t + \varepsilon_t \quad (1)$$

All the variables except interest rate differential are transformed in logs such that their coefficients represent elasticities. In expression (1) RER_t is the log of bilateral real exchange rate between MUR and USD. It is CPI-based *RER* and an increase in RER_t means a depreciation whereas a decrease implies an appreciation. LOP_t is the log of external openness. LPD_t denotes the log of productivity differential between Mauritius and US. The productivity differential is proxied by the ratio of domestic consumer price index to

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domestic manufacturing price index divided by the ratio of US consumer price index to US producer price index. $INTDIFF_t$ is the interest differential between Mauritius and US. The interest rate of Mauritius is the bank rate and of US it is the US Lombard rate. $LGDFCF_t$ is the log of share of investment and $LSPI_t$ is the log of share price index.

The parsimonious specification of equation (1) incorporates the structural determinants of RER as proposed in the theoretical literature. The export oriented and import dependent characteristics of the domestic economy justify the inclusion of openness as an explanatory variable. The spectacular economic performance and the scale of private as well as public investments registered in past recent years rationalize the presence of productivity differential and gross domestic fixed capital formation in the real exchange rate model. The Central Bank of Mauritius regularly smoothes the fluctuations of MUR/USD exchange rate by interest rate policy. Finally, more global financial integration is expected to influence the MUR/USD exchange through Mauritius stock exchange. These variables are largely used in the empirical literature (MacDonald and Clark (1997); Dufrenot and Egert (2005); Kildegaard (2006); Carrera and Restout (2008); Biekpe (2012); Ghalayin (2014); Rao and Tolcha (2016)). The table 1 below depicts the signs of the independent variables found by other researchers using these variables in their analysis.

Table 1: Independent variables and expected sign of their coefficients

Variable	Estimation	References	Source of data	Expected Results
Openness	$\frac{Exports + Imports}{GDP}$	Carrera and Restout (2008) -Depreciation Oriavwote and Oyovwi (2012) -Depreciation	Statistic Mauritius	Depreciation
Productivity Differential	$\left(\frac{MCPI}{MMPI}\right) \Big/ \left(\frac{UCPI}{UPPI}\right)$	Dufrenot and Egert (2005) -Appreciation Kildegaard(2006) -Appreciation	International Financial Statistic	Appreciation
Interest Rate Differential	$Mauritius\ Bank\ Rate - US\ Lambard\ Rate$	MacDonald and Clark (1997) -Appreciation Clostermann and Schatz (2000) -Depreciation Villavicencio et al. (2008) -Appreciation	US Federal Reserve Central Bank of Mauritius	Appreciation

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Gross Domestic Fixed Capital Formation	$\frac{Private\ Inv + Public\ Inv}{GDP}$	Korsu and Braima (2007) -Appreciation Rao and Tolcha (2016) -Appreciation	Statistic Mauritius	Depreciation/ Appreciation
Share Price Index	Share Price Index	Biekpe (2012) -Apppreciation Ghalayini (2014) -Appreciation	Central Bank of Mauritius	Depreciation/ Appreciation

Source: Author's Computation

In order to have a more dynamic interaction among dependent and independent variables in the empirical model, a vector autoregressive model (VAR) is employed. The VAR enables to identify, at least exactly, a system of simultaneous equations (Tarawalie et al. 2012). Moreover, a set of co-integrating equations within a VAR approach does not suffer from simultaneity bias even if the equations comprise a simultaneous equation model (Mukherjee at al. 2003). The empirical method used in this study follows Dufrenot and Egert, (2005), Kildegaard (2006) and Asmah (2013). The data was sourced from Statistics Mauritius, Central Bank of Mauritius, International Financial Statistic (IFS) and Federal Reserve of US.

a) Stationarity and Johansen co-integration tests

The Augmented Dickey-Fuller and the Phillip-Perron (PP) tests employed to carry out the stationarity tests indicate that the series are integrated of order one as shown in table 2 below.

Table 2: Unit root test results

Variable	Level		First Difference		Status	
	ADF	PP	ADF	PP	ADF	PP
Real Exchange Rate (RER)	-1.542668	-2.551847	-7.40679***	-7.408650***	I(1)	I(1)
Productivity Differential (LPD)	-2.423261	-2.544298	-8.7622***	-8.764480***	I(1)	I(1)
Interest Rate Differential (INTDIFF)	-2.544296	-1.303626	-7.60588***	-7.574690***	I(1)	I(1)
Openness (LOP)	-1.493418	-1.795352	-10.6563***	- 10.607560***	I(1)	I(1)
Domestic Fixed Capital Formation (LGDFCF)	-1.686345	-0.949834	-12.9765***	- 14.618020***	I(1)	I(1)
Share Price Index (LSPI)	-1.139654	-2.551847	-5.56669***	-4.498864***	I(1)	I(1)

*Notes: ***and ** indicate significant at 1% and 5% level of significant respectively.*
Source: Author's Computation

The Johansen co-integration test is carried out by including three lags[4] in the VAR model and assuming a linear deterministic trend with intercept but no trend in co-integration equation. Trace and Max-eigenvalue tests indicate one and two co-integrating vectors, respectively. Given the robustness of trace statistic over the Maximum eigenvalue test (Luintel and Khan, 1999), further investigations assume only one long-run relationship among the variables.

[4] The information criteria approach was used to select the lag order of the VAR

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b) Long-run real exchange model

The long-run equilibrium real exchange rate is simply the co-integration vector. The long-run coefficients are depicted in table 3 below.

Table 3: Estimates of long-run coefficients of the variables

Productivity Differential (LPD)	Interest Rate Differential (INTDIFF)	Openness (LOP)	Domestic Fixed Capital Formation (LGDFCF)	Share Price Index (LSPI)	Intercept
-2.114232***	−0. 006964***	0. 479462***	−0. 151053**	−0. 137015***	1. 781789

*Notes: ***and ** indicate significant at 1% and 5% level of significant respectively.*
Source: Author's Computation

The signs of the long-run coefficients are statistically significant and consistent with theoretical predictions. The openness of Mauritian economy to international trade is statistically significant in explaining the depreciation of real exchange rate, with 0.48% depreciation in response to a one percent rise in trade openness. This result is in line with the findings of Imam and Minoiu (2011) and Carrera and Restout (2008). Jongwanich (2009) and Ranadive and Burange, (2013), on the other hand, reported mixed results in eight Asian developing economies and India, respectively.

Productivity differential plays a crucial role in determining long-run real exchange rate in Mauritius. The real exchange rate appreciates by 2.11% in response to a productivity improvement of 1%. This proves that in the long-run the Samuelson-Balassa effect hold in Mauritius and productivity growth primarily takes place in the trade sector. Among the structural variables, the model indicates that the largest estimated coefficient is for productivity differential. The finding is in line with Kumar (2010). Conversely, Griffoli at al. (2014) found all variables except the Balassa-Samuelson measure highly significant.

The semi-elasticity of interest rate differential is negative and significant. In the long-run, an increase by 1 percentage point in the interest rate appreciates the real exchange rate by 0.007%. The finding supports the results of Villavicencio et al. (2008) in Mexico and MacDonald and Clark (1997) between mark and dollar while it is in sharp contrast with the latter's result in Japan.

The coefficient of share of investment is negative and statistically significant. One percent increase in share of investment appreciates the real exchange rate by 0.15 percent. The negative and significant coefficient of share of investment suggests that the gross domestic fixed capital has more influence on the relative price of non-tradable sector than the tradable sector. This implies that the demand side effect of investment outweigh its supply side effect. The result concurs with the findings of Rao and Tolcha (2016); Carrera and Rostout (2008) and Koru and Braima (2007), each showed that high domestic investments appreciated real home currency.

The parameter of share price index is negative and highly significant. In the long-run, 1% increases in share price index causes the real exchange rate to appreciate by 0.14%. The data generating process in Mauritius seems to suit the portfolio balance approach quite well. An increase in stock prices results in an increase in cooperate wealth which ultimately raises the wealth in the economy. The demand for money surges and the monetary authorities increase the interest rate to avoid inflation in the country. Higher interest rate attracts inflows of capital which eventually appreciate the home currency. This result is in accord with the findings of Biekpe (2012) and Ghalayini (2014) in South Africa and European Union, respectively.

c) Short run dynamics of the real exchange rate

In addition to the long-run effects, temporary changes in the fundamentals have also been estimated by a Vector Error Correction Model (VECM) and the estimated short-run coefficients are depicted in table 4.

In the short-run, lag values of the real exchange rate do not appear to have any impact on the actual real exchange rate. These findings can be interpreted as an indication that in Mauritius real exchange rate is driven solely by fundamental factors, and it is not affected by the market behavior of chartist. The coefficients of the short-run productivity differential at lags one and two are positive and significant. These results agree with the prediction of Mundel-Fleming model. Second lag value of interest rate and real exchange rate move together in the short-run. This prediction concurs with the forecast of the flexible price monetary model. The impact of openness on RER is negative at the first lag whereas it is positive at the third lag. These findings indicates that tariff cut and other trade liberalization measures have their expected effects only in the long-run as evidenced by statistically significance and a positive parameter of the third lag of openness variable.

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Table 4: Vector error correction model

Lag	Real Exchange Rate RER	Productivity Differential (LPD)	Interest Rate Differential (INTDIFF)	Openness (LOP)	Domestic Fixed Capital Formation (LGDFCF)	Share Price Index (LSPI)
1	0.338435	0.994230***	0.004124	-0.154267	-0.010253	-0.010055
2	0.282600	0.685110**	0.007115**	0.150306	-0.068341	0.052092
3	0.227927	-0.060798	0.002304	0.216048*	-0.090669	0.087789
C	0.0000946 [0.03707]					
ECM(-1)	-0.509812** [-2.72858]					
R-squared	0.392423					
Adj R-squared	0.151923					

*Notes: ***and ** indicate significant at 1% and 5% level of significant respectively.*
Source: Author's Computation

The speed of adjustment term is negative and significant as expected. It indicates that about 51 percent of the adjustment towards long-run real exchange rate equilibrium takes place within three quarters.

The R-squared coefficient indicates that approximately 39 percent of the variation in the dependent variable is jointly explained by the explanatory variables in the model. The adjusted R-squared takes into account the degree of freedom and shows that only up to 15 percent of the changes in the real exchange rate are being accounted by its fundamental values in the short-run.

d) Diagnostic tests of the VECM model of the real exchange rate

A battery of diagnostic tests has been conducted to check the robustness of the VECM model of the real exchange rate. The error terms of the VECM model are tested for serial correlation, heteroscedasticity and for normality assumption.

Table 5: Diagnostic tests results

Test	Null Hypothesis	Statistics	Probability
Serial Correlation LM test	No serial correlation in residuals	1.362272	0.7144
Heteroskedasticity test	No heteroscedasticity in residuals	32.25976	0.1207
Jarque-Bera (JB) test	Residuals are normally distributed	1.325476	0.515438

Source: Author's Computations

The results of the tests in table 5 depict that the null hypothesis of no serial correlation in residuals, no heteroscedasticity in residuals and that the residuals are normally distributed cannot be rejected at 5% significance level.

e) Variance decomposition analysis

Variance decomposition gauges the proportion of variation in the independent variables brought about by its innovations and shocks emanating from any other variables in the model. More specifically, variance decomposition of the VECM provides "information on the relative importance of shocks to the determinants of the real exchange rate in explaining variations in the real exchange rate" (Rao and Tolcha, 2016). The methodology adopted in this analysis is Choleski decomposition with the following ordering: LRER, LPD, INTDIFF, LOP, LGDFCF, and LSPI.

Table 6: Variance decomposition of the real exchange rate

Period	S.E.	LRER	LPD	INTDIFF	LOP	LGDFCF	LSPI
1	0.016789	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.022372	96.66665	0.030068	0.000455	0.099417	2.722908	0.480501
3	0.027320	83.41411	0.120092	1.852994	3.283607	10.44081	0.888385

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4	0.032851	68.67562	0.112175	2.705742	8.023450	19.76837	0.714636
5	0.036122	61.69320	0.717602	2.356963	10.03142	24.49092	0.709898
6	0.039499	54.24223	3.076491	2.009041	10.97458	28.97115	0.726508
7	0.042750	48.59998	6.002033	1.821295	10.87298	32.00407	0.699648
8	0.045475	45.21774	9.093600	1.746301	10.30496	32.88529	0.752109
9	0.048515	42.37171	12.15577	1.572671	9.590511	33.47111	0.838228
10	0.051504	39.95459	14.42113	1.395416	8.938579	34.32739	0.962904
11	0.054325	37.95186	16.09551	1.276327	8.356266	35.17056	1.149474
12	0.057241	36.05073	17.46872	1.210247	7.824643	36.14807	1.297589
13	0.059984	34.36857	18.51712	1.187525	7.388948	37.12687	1.410969
14	0.062567	32.92635	19.42788	1.181021	7.023143	37.93838	1.503236
15	0.065074	31.69032	20.26127	1.170445	6.700782	38.61078	1.566409
16	0.067429	30.67354	20.97219	1.157265	6.419211	39.15580	1.621996
17	0.069689	29.83061	21.58816	1.146378	6.167047	39.59617	1.671638
18	0.071882	29.12309	22.10639	1.139708	5.945416	39.97346	1.711934
19	0.073988	28.52195	22.52577	1.138153	5.755454	40.30939	1.749287
20	0.076036	27.98995	22.88099	1.138869	5.590234	40.61774	1.782222
21	0.078029	27.50978	23.18698	1.139125	5.446275	40.90736	1.810476
22	0.079963	27.07552	23.45647	1.138205	5.319480	41.17464	1.835693
23	0.081849	26.68095	23.70472	1.135521	5.205600	41.41606	1.857152

Notes: S.E indicates standard error. Period refer to one quarter.
Source: Author's Computations

Table 6 reports only the variance decomposition in real exchange rate because the interest of this study is to track the movements of the real exchange rate emanating from its shocks and innovations from its sources.

In the first year, innovation in real exchange rate accounts for 69% of its forecast error variance, while the remaining 31% of its variance is explained by its determinants. Out of this 31%, the share of investment explains about 20% and openness about 8%. The rest of the variables contribute trivially to the variation in the real exchange rate.

The real exchange rate accounted for approximately 45% of its variation in the second year. 55% of the movements in the real exchange rate are caused by its fundamental variables. The contribution of the share of investment augments from 20% to 33%, that of productivity differential from 0.1 % to 9% and the importance of openness in explaining the variation in the real exchange rate increases by approximately 2%.

It can be observed from table 6 that as we move further in the future, the shock in real exchange rate becomes a less important source of its forecast variance error, while disturbances in its determinants become the most important sources of its forecast error variance. For instance, in year six share of investment is the highest contributor to the variations in the real exchange rate followed by its innovation and shock emanating from productivity differential. As we move further in the future, fundamental macroeconomic variables become the most critical drivers of the real exchange rate and thereby confirming the long-run co-integration results obtained in table 3 above.

f) Impulse response analysis

In addition to the variance decomposition, to have a precise idea of how the effect of a shock to each factor is transmitted to the real exchange rate, the impulse response analysis is performed in the VECM. It demonstrates the dynamic reactions of an endogenous variable following a one- standard deviation shock to its innovation and innovations of other factors in the VAR model. It indicates the direction to which the independent variable moves in response to shocks to the innovation of each dependent variable in the system for an extended future period. Figure 2 below shows the

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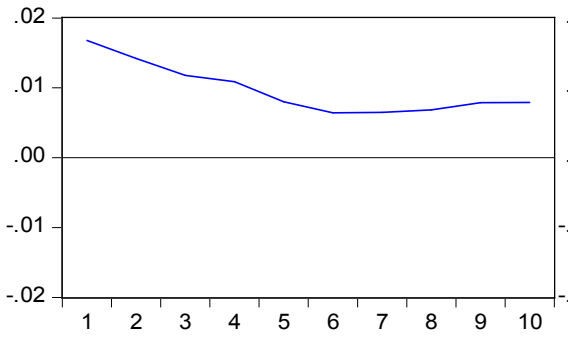
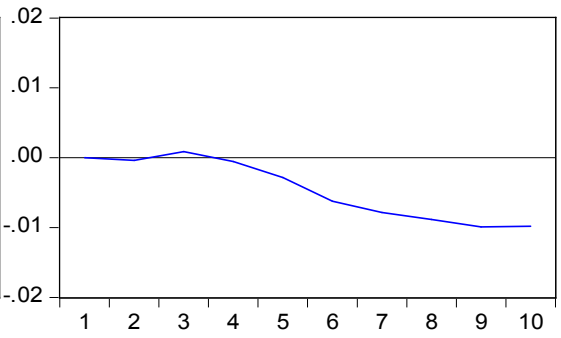
results from the impulse response analysis and the focus is only on the reactions of the real exchange rate from shocks arising from its innovation and innovations from other sources.

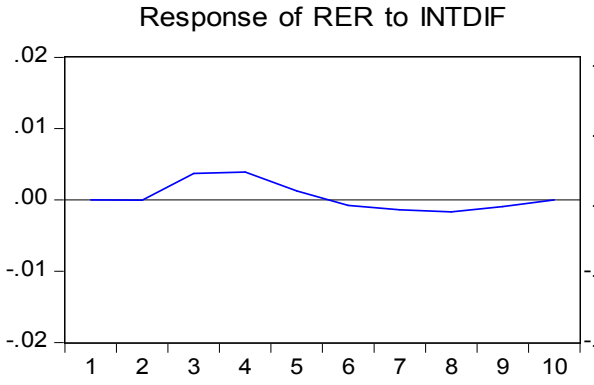
Graph 1



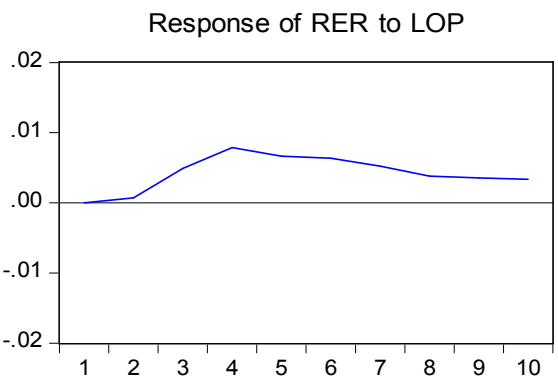
Graph 2



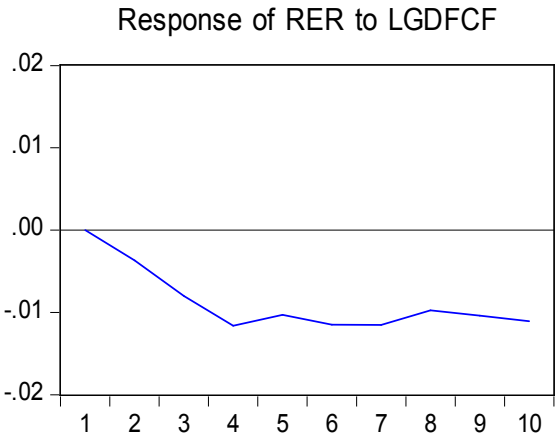
Graph 3



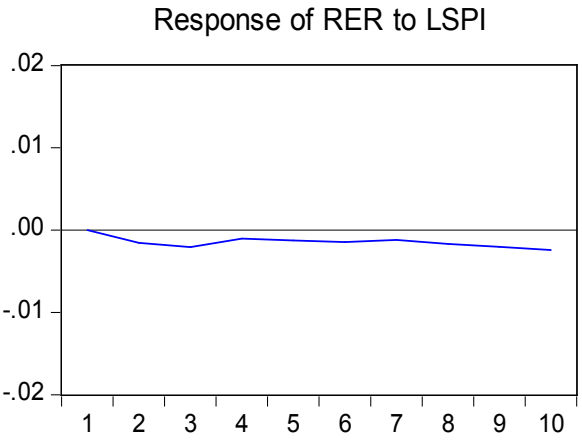
Graph 4



Graph 5



Graph 6



Source: Author's calculation

Figure 2: Impulse response of the real exchange rate

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In graph 2, a one standard deviation shock to productivity differential seems to have no effect on real exchange rate during the first two quarters after which it slightly depreciates the real exchange rate in quarter 3 and then it appreciates the real exchange rate starting from quarter 4. This result is compatible with the short-run and long-run behavior of the real exchange rate as indicated by the VECM and the long- run co-integration vector.

A shock to the innovation of interest differential initially increases the real exchange rate then appreciates it in the long-run before leveling off to zero after two years (see graph 3). The reaction of openness to the real exchange rate is zero during the first two quarters, and then it depreciates for the following two quarters before appreciating after the first year (see graph 4). The responses of real exchange rate to one standard deviation shocks to gross domestic fixed capital formation (graph 5) and share price index (graph 6) are negative over the entire period. In other words, positive shocks to gross domestic fixed capital formation and share price index cause an appreciation of the real domestic currency over time.

Generally, the impulse response functions reveal the expected patterns and confirm the short-run and long-run results obtained from the VECM and co-integration analysis.

g) Real exchange rate misalignment

In order to assess the misalignment of real exchange rate from its steady rate value, the long-run equilibrium real exchanges are calculated and compared to the actual real exchange rate. For this purpose, the fundamentals are first decomposed into their transitory and permanent components by using the Hodrik-Prescott method and then the latter are substituted into the long-run co- integration to obtain the equilibrium real exchange rates.

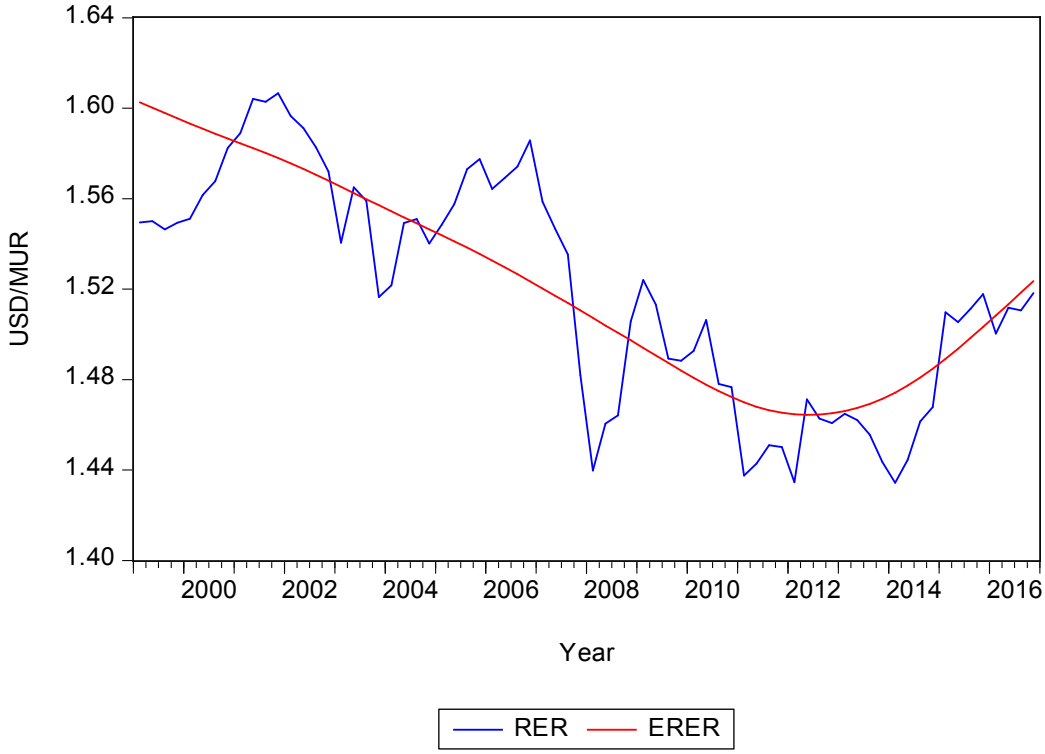

Figure 3: The equilibrium and actual real exchange rates

Figure 3 jointly shows the actual (RER) and long-run estimated equilibrium real exchange rate (ERER) estimated by VECM model. The Mauritian rupee has been overvalued over the periods 1999- mid 2001, 2003-2005, 2007-2008, 2011-2014 and in 2016. It has been undervalued over the periods mid 2001-2002, 2005-2007, 2009-2010 and in 2015. The trends of both actual and equilibrium real exchange rate are similar. This means that the estimated model fit the observations quite well; the explanatory variables are the main determinants of real exchange rate; and the chosen methodology is appropriate for the analysis.

V. Conclusions and Recommendations

This paper analyzes the relationship between the real exchange rate and its fundamental determinants by using quarterly data from 1999Q1 to 2016Q. An econometric model relating real exchange to its potentials determinants is specified. In the short-run, productivity differential and interest differential drive real exchange rate. In addition to productivity and interest differentials between Mauritius and US, openness, share of gross domestic fixed capital formation on GDP and share price index are the main long-run triggers of real

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exchange rate. However, in short-run the predictions of productivity and interest differentials on equilibrium real exchange rate are in sharp contrast with their long term counterparts.

In recent years, Mauritius has made a big stride in technological improvement, innovation, infrastructure development, addressing the skill mismatch through training, labor market efficiency and improving constitutional quality. Moreover, initiatives have been introduced to enhance the business climate, construct innovative capacity and establish robust investment ties with the continent of Africa through Africa Strategy. The government reaffirmed its ambitions to increase public investment expenditure notably on road construction, sea port, airport, utilities and sport complexes. According to the findings of this study, all these measures will strengthen the value of MUR through their effects on macroeconomic fundamentals. The authorities should allow the real exchange rate to adjust to its new higher equilibrium level to reflect the changes in its fundamentals values and refrain from intervening in the exchange market during the adjustment periods. Additionally, monetary and stock market policies should take into account the exchange rate as disturbances in these two markets can perpetually endanger real exchange rate stability. The strengthening of the equilibrium real domestic currency can be mitigated by opening the country to more international trade and integrating to the global economy. The government should continue to dismantle barriers of trade and should consolidate the global business, information and communications technology (ICT), and financial sectors to better integrate to the world economy. Furthermore, maintaining the real exchange rate to its long-run equilibrium value will spare the domestic economy from the undesirable consequences of overvaluation and undervaluation of real home currency.

However, the findings should be interpreted with some precautions as this empirical investigation is not free from weaknesses. VECM usually yields unbiased estimators in large samples and the sample period used in this study is relatively small. Moreover, VARs are very often claimed to be atheoretical and each variable is assumed to influence other variables in the system.

Finally, this study open venues for further research as this type of work can be replicated in other developing countries and SIDS. In addition, other sampling strategies and econometric modelling techniques can be deployed to examine the determinants of real exchange rate.

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