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The Determinants of the Real Exchange Rate: the Case of New Zealand

1. Introduction

One of the topics in international finance which draws attention is the determination of real exchange rates. Real exchanges rate has been one of the most debated topics both in theory and practice since it plays a significant role in the economies. It plays a major role for international trade and tourism (Katircioglu, 2010; Katircioglu, 2009). The importance of real exchange rates especially in developing countries has been examined by many economists such as Edwards (1989), Elbadawi (1989), Kiguel (1992), Kıpıcı and Kesriyeli (1997), Ellis (2001), Chinn (2006) and Catão (2007). The existing empirical literature generally studies both developed and developing countries. It has been shown that best performers are those countries that can align an appropriate real exchange rate sufficiently close to the equilibrium real exchange rate (E*RER*) (Williamson, 1985; Harberger, 1986; Razin and Collins, 1997; and Richaud *et al.*, 2000). Some economists mention that many cases of the economic failures, particularly in developing countries have been the result of inappropriate exchange rate policies. For example, the January 1994 devaluation of the CFA Francs in West and Central Africa, the Mexican currency crisis at the end of 1994, the Asian crisis in mid-1997, and the Brazilian devaluation in January 1999 are reminders of the macroeconomic disruptions that can be caused by the *RER* misalignment. Therefore, the issue of how to choose a proper value of the nominal exchange rate has remained a key concern in developing countries.

The purpose of the present study is to estimate the determinants of the real exchange rate and the role of these determinants in the New Zealand economy. After a number

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of years of strong growth, the economy experienced a recession in early 2008. This study will also identify the effects of this recession on *RER* and its determinants. Furthermore, comparisons between different exchange rate regimes in the history of New Zealand will be also made in the present study.

The paper theoretically follows the framework introduced by Edwards (1989) and Domac and Shabsigh (1999). Edwards' model (1989) is an inter-temporal general equilibrium model of a small open economy where both tradable and non-tradable can be exchanged. The core of Edwards' experimental investigation is to verify the equilibrium real exchange rate by disentangling basic changes in the level of the real rate from momentary influences brought on by shifts in nominal exchange rate as well as fiscal and monetary policy. The estimation of the model will be done by using Microfit 4.0 (Pesaran and Pesaran, 1997) on quarterly data mainly collected from International Monetary *FUND* (IMF, 2011) and World Bank (WB, 2011), covering the period of first quarter of 1974 to third quarter of 2009.

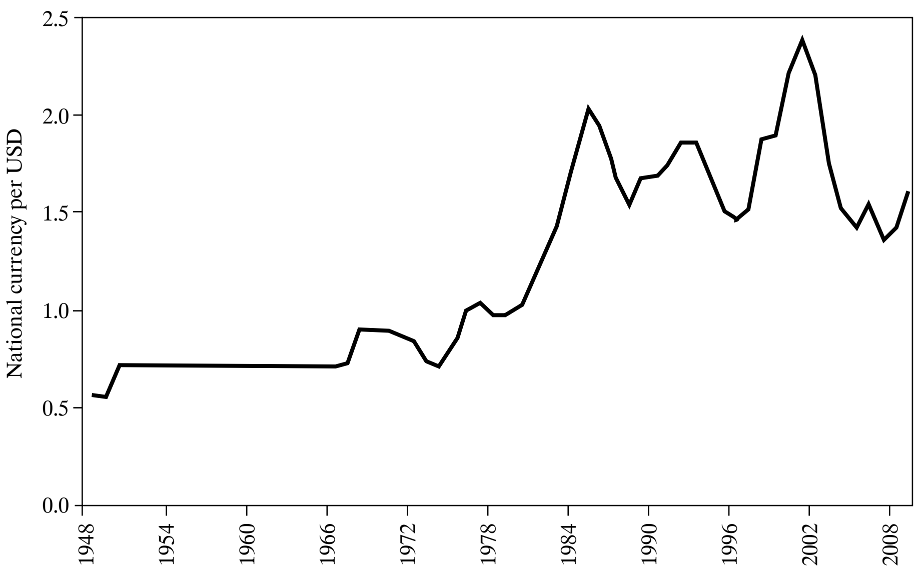
According to „Reserve Bank Bulletin" (1985), in July 1973, New Zealand exchange rate regime shifted to a system whereby the value of the NZ$ was fixed against a basket of currencies. In 1979, after a series of discrete devaluations, the 'crawling peg' approach was implemented for the exchange rate system. But this approach ended in 1982 since it led to a depreciation of NZ$ against the basket of currencies; the Reserve Bank reverted to fixing the exchange rate with occasional discrete adjustment. Finally, in order to facilitate structural adjustment in the economy in response to changing external circumstances, the New Zealand dollar was floated in 1985.

Figure 1 displays the evolution of the nominal exchange rate of the New Zealand currency against United State dollar between 1948 and 2009.

Figure 2 shows the evolution of the real exchange rate during the study period.

Figure 1

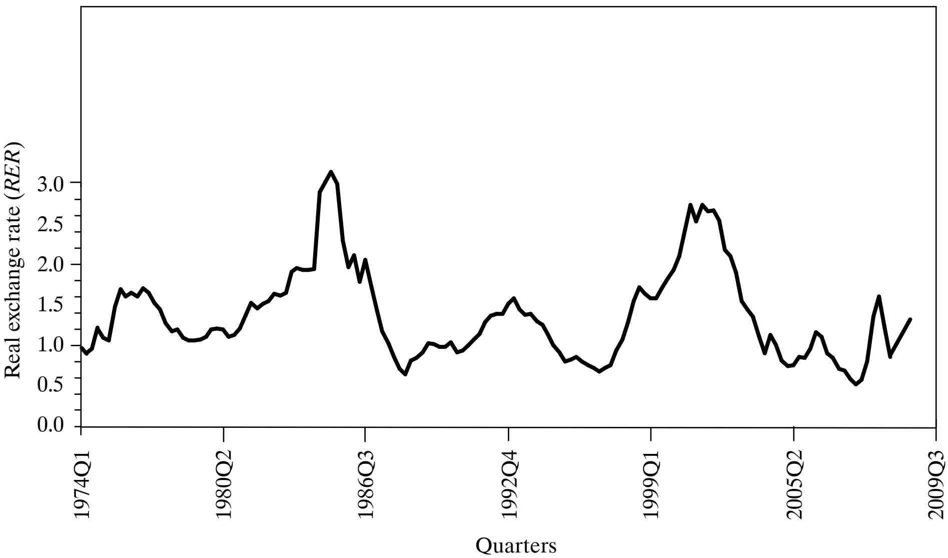
Market Exchange Rate of the NZ Currency against USD, 1948–2009



Source: IFS (2011).

Figure 2

The evolution of the real exchange rate against USD



Source: IFS (2011).

Table 1 illustrates the economic variables used in our study to explain changes in the real exchange rate observed in the period between 1974 and 2009, covered by this study. Sudden changes in these variables can be explained by policy changes and other events such as liberating the imports regulation after changing of exchange rate regime in 1985, financial crisis in 1997, 1998 and also 2008.

Table 1

Economic variables used in the study (selected data)*

Year	*RER*	*TOT*	*OPEN*	*CI*	*RP*	*GCON*	*GNER*	*DC*
1974Q3	1.499	0.555	0.421	–0.104	0.975	0.144	0.015	0.803
1979Q3	1.580	0.908	0.426	–0.007	0.894	0.168	0.029	1.040
1984Q3	2.502	0.744	0.546	–0.092	0.852	0.161	0.413	1.051
1989Q3	1.529	0.862	0.410	–0.024	0.983	0.185	0.034	3.178
1994Q3	1.591	0.907	0.469	0.001	0.993	0.176	–0.058	3.505
1999Q3	1.886	0.843	0.475	–0.055	1.039	0.177	0.060	4.359
2004Q3	1.527	0.769	0.435	–0.079	1.012	0.176	–0.059	4.679
2009Q3	1.449	0.857	0.408	–0.055	0.961	0.204	–0.177	6.109

Note: These ratios extracted from International Financial Statistics (IFS). Description of variables is given in Table 2.

Source: IMF (2011).

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2. Theoretical modeling

Edwards' model (1989) is an inter-temporal general equilibrium model for a small open economy where both tradable and non-tradable goods can be exchanged. The base of this experimental study is to verify the equilibrium real exchange rate by disentangling basic changes in the level of the real rate from temporary influences brought on by nominal exchange rate movements and by fiscal and monetary policy. From the theoretical model, two equations are derived; the first one shows the *FUND*amental factors affecting the real exchange rate while the second equation illustrates the dynamics of the real exchange rate.

The structural equation for the equilibrium real exchange rate is:

$$\log (RER_t^*) = \beta_0 + \beta i \log (FUND_{it}) + u_t, \tag{1}$$

where RER_t^* is the equilibrium real exchange rate, and $FUND_{it}$ is the vector of fundamental variables.

Edwards' model also assumes that in the short-run the real exchange rate changes towards the equilibrium rate at a speed given by the parameter θ. The equation describing these dynamics is given by:

$$\begin{aligned}\log (\Delta RER_t) = \theta[\log (RER_t^*) - \log (RER_{t-1})] - \lambda[Z_t - Z_t^*] + \\ + \Phi [\log (E_t) - \log (E_{t-1})],\end{aligned} \tag{2}$$

where RER_t is the real exchange rate, Z_t is a vector measuring fiscal and monetary policy, Z_t^* is a vector of policy measures consistent with the equilibrium rate, λ is the speed of adjustment to the policy gap $(Z_t - Z^*_t)$, E_t is the nominal exchange rate, and Φ is the speed of adjustment to depreciations.

The real exchange rate level adjusts between today and tomorrow in the path of the equilibrium rate with some resistance showed by the adjustment speed θ, which is the time needed for relative prices in the economy to adjust, where changes in both policy variables and nominal rate can disturb this adjustment in either direction. This equation declares that *RER* has a mean decline property in long run where the mean is equilibrium rate.

By substituting these two equations, a new equation can be derived for the real exchange rate:

$$\begin{aligned}\log (RER_t) = \gamma_0 + \gamma i \log (FUND_{it}) + \\ + (1 - \theta) \log (RER_{t-1}) - \lambda (Z_t - Z_t^*)_t + \Phi NDEP_t + \upsilon_t,\end{aligned} \tag{3}$$

where γ_i is a combination of the respective βi and θ, and $\Phi NDEP_t$ is the nominal depreciation.

This equation can be estimated empirically. In order to perform this estimation, the *FUND*amental variables affecting the equilibrium real exchange rate need to be identified.

Edwards' model was applied by many economists, including Domac and Shabsigh (1999) who present a formal econometric model of *RER* determination as below:

$$\begin{aligned}RER_{it} = \alpha_0 + \alpha_1 TOT_t + \alpha_2 CLOSE_t + \alpha_3 CAPFY_t + \\ + \alpha_4 EXCR_t + \alpha_5 NDEV_t + \alpha_6 t + \varepsilon_t,\end{aligned} \tag{4}$$

where *RER* is the actual real exchange rate, as measured above, *TOT* is the terms of trade measured as the ratio of the index of dollar value of export prices to the index of dollar values of import prices, *CLOSE*, defined as $[Y/(X + M)]$, is the ratio of GDP over the sum of imports (M) and exports (X), *CAPFY* is the capital inflow measured as the difference between net change in reserves and trade balance scaled by GDP, *EXCR* is the excess domestic credit, measured as the difference between growth in domestic credit and real GDP growth, *NDEV* is the growth in the official nominal exchange rate, t is time index, and ε is the error term.

3. The model, data and methodology

This study modified the framework developed by Edwards (1989) and Domac and Shabsigh (1999) by omitting term (t) and also by adjusting some independent variables to inspect the relationship between real exchange rate and its determinants for the economy of New Zealand as follows:

$$RER = c_0 + c_1 TOT + c_2 OPEN + c_3 CI + c_4 RP + c_5 GCON + \\ + c_6 GNER + c_7 DC + \varepsilon_t, \quad (5)$$

where *RER* is real exchange rate, *TOT* is terms of trade, *OPEN* is openness of the economy, *CI* is capital inflow, *RP* is relative productivity, *GCON* is the share of government consumption in the GDP, *GNER* is the growth in nominal exchange rate, *DC* is domestic credit ratio, ε_t is serially uncorrelated random disturbance term and c_0, c_1, c_2, c_3, ..., c_7 are estimated parameters for each explanatory variable respectively.

Table 2 illustrates the description and the source of the data.

Table 2

Description and source of data

Variables	Definition	Raw data used*	Source
Real exchange rate (RER)	Nominal exchange rate multiplied by the proportion of consumer price index in the US to consumer price index in New Zealand		
Terms of trade (TOT)	Annual export price divided by annual import price	Exports (70) Imports (71)	IFS
Openness (OPEN)	The sum of annual import and export divided by GDP	GDP (99B) Exports (70) Imports (71)	IFS
Capital inflow (CI)	Subtraction of net change in annual reserves from trade balance scaled by GDP	1. Total Reserve minus Gold (11.D) 2. Trade Balance (78ACD)	IFS
Relative productivity (RP)	Consumer price index divided by wholesale price index	Consumer Price Index (64) Wholesale Price Index (63)	IFS
Government consumption (GCON)	Proportion of the government consumption to GDP	Gov. Consumption (91F) GDP (99B)	IFS

Table 2 – con.

Domestic credit ratio (DC)	The ratio of domestic credit to GDP	Domestic Credit (32) GDP (99B)	IFS
The growth in the official nominal exchange rate (GNER)	Comparison of the change of the official nominal exchange rate between the present and the previous year	Market Rate (RF)	IFS

Note: * Figure in parentheses in 'Raw data used' column indicates the data code used in IFS.

Source: IMF (2011).

Theoretically, the sign of coefficient of the *terms of trade (TOT)* is ambiguous: it can be negative or positive, depending on whether the substitution or income effect dominates. The impact of *TOT* argued by Edwards (1989) and Hinkle and Montiel (1999), where both agreed with the negative sign for the coefficient of terms of trade, was based on the assumption that the income effect dominates the substitution effect since improving *TOT* tends to decrease the equilibrium real exchange rate by increasing the trade balance and creating excess demand for non-tradable goods. Thus, the opposite is true when the substitution effect dominates the income effect.

The *openness of the economy* (*OPEN*) influences changes in the real exchange rate. An increase in openness is measured by the rise of the sum of import and export values compared to gross domestic product. According to Elbadawi (1994) increased openness resulted in equilibrium real exchange rate depreciation in every case. The higher degree of openness leads to higher demand for foreign currency and depreciates the real exchange. Therefore the expected sign of coefficient would be positive.

Edwards (1989) predicts the sign of coefficient for the *capital inflows (CI*) to be negative since the structure of capital inflows is a combination of foreign direct investment and capital inflows in stock market, an increase in capital inflows reduces the demand for foreign currency which decreases the real exchange rate.

Improvement of *relative productivity* (*RP*) can decrease the cost of production and according to Balassa-Samuelson effect it can result in an appreciation of real exchange rate. Thus, the negative coefficient sign is expected for relative productivity[1].

Several recent studies, including Frenkel and Razin (1996), investigated the relationship between *government consumption* (*GCON*) and real exchange rate. They all noted that the coefficient sign can be either positive or negative. It depends on whether the consumption is directed towards the tradable or non-tradable goods sector. If it is directed towards the non-tradable goods, a positive sign will appear and vice versa.

For *domestic credit* (*DC*) variable, greater amount of domestic credit increases the gross domestic product insufficiently which can cause inflation in the economy and therefore appreciation of the real exchange rate. The coefficient of this variable is expected to be negative.

Finally, the *growth of nominal exchange rate* (*GNER*) will depreciate the real exchange rate in any case. Thus, the positive sign of coefficient is expected.

[1] Faruqee (1995) and Kawai and Ohara (1997) use relative productivity variable as a productivity proxy which is based on relative price of traded to nontraded goods (i.e. consumer price index divided by wholesale price index).

Using quarterly data[2] for New Zealand over the period of 1974Q1–2009Q3, we investigate the determinants of the real exchange rate and the role of these *FUND*amental factors by employing appropriate estimation methods.

Multivariate co-integration techniques are applied to highlight both the long-run and the short-run influences of the determinants of real exchange rate in the model for which the steady-state is represented by the following regression equation:

$$LRER = c_0 + c_1 LTOT + c_2 LOPEN + c_3 LCI + c_4 LRP + \\ + c_5 LGCON + c_6 LGNER + c_7 LDC + \varepsilon_t, \quad (6)$$

where all the variables retain thier previous meaning (as in equation (5)), but they are taken as natural logarithms (L).

In the next step, we first examine the stationary properties[3] of our data using the augmented Dickey-Fuller (ADF)[4] and the multivariate augmented Dickey Fuller (MADF)[5] unit root tests proposed by Dickey and Fuller (1979; 1981) and Johansen and Juselius (1992) respectively.

On the basis of the results obtained from both the ADF and the MADF unit root tests, we test equation (6) by utilizing the Engle-Granger (1987) and the Johansen (1988) co-integration procedures in order to estimate a long-run relation among the variables. Co-integrating analysis by Engle-Granger (1987) method assumes only one co-integrating vector whereas the Johansen full information maximum likelihood (FIML) method provides (P – 1) co-integration vectors[6].

Having constructed our model(s) for the variables in hand, the long-run OLS estimates may still be biased if the explanatory variables are not weakly exogenous. This means that if the variables are not weakly exogenous, they cannot enter on the right side of the model as explanatory variables. In order to test for weak exogeneity[7], we use the Johansen procedure (1992).

In order to establish the short-run relations among the variables embodied within equation (6), we utilize an error correction mechanism (ECM) estimated by ordinary least square (OLS), and derive the ECM using the residuals from the estimated co-integrating regressions for equation (7)[8].

[2] We estimate the matrices of correlation coefficients of the relevant variables which are based on each model used in this paper (see next section for details).

[3] Nelson and Plosser (1982) point out that the data generating process (DGP) for most macroeconomic time series data consist of a unit root, which is commonly accepted in the relevant literature. However, the counterpart of this assumption argues that non-linear or segmented trend stationary might be a better alternative for the traditional one (see Kwiatkowski *et al.*, 1992; Lau, Sin, 1997). In addition, Jones (1995) mentions that DGP with unit root is still a useful hypothesis in applied studies.

[4] The 'ADF' command in Microfit includes the intercept term in the ADF equation. Therefore the corresponding critical values should take the intercept term into account. In addition to this, we included trend in levels, but we excluded it in first difference (Pesaran, Pesaran, 1997).

[5] See Coe and Moghadam (1993) for more details about the application of MADF.

[6] P is the number of parameters used in a model (see Johansen (1988) for more details for this).

[7] In both the Johansen and the EHR procedures, models are considered closed-form where all variables depend on one another (i.e. all variables are considered as endogenous). However, some certain variables can be treated as weakly exogenous for the estimation of the long-run relationship.

[8] According to the information given in the theoretical part, we first construct a short-run ECM with one lag of each variable and eliminate those lags with insignificant parameter estimates. Then, we estimate restricted one to find out the most suitable model.

$$\Delta LRER_t = \alpha_0 + \alpha_1 u_{t-1} + \sum_{i=0}^{m} \alpha_i \Delta LTOT_{t-i} + \sum_{k=0}^{r} \alpha_k \Delta LOPEN_{t-k} +$$
$$+ \sum_{j=0}^{n} \alpha_j \Delta LCI_{t-j} + \sum_{i=0}^{m} \alpha_i \Delta LRP_{t-i} + \sum_{h=0}^{c} \alpha_h \Delta LGCN_{t-h} + \quad (7)$$
$$+ \sum_{d=0}^{p} \alpha_d \Delta LGNR_{t-d} + \sum_{c=0}^{t} \alpha_c \Delta LDC_{t-c} + \varepsilon_t,$$

where u_{t-1} is the lagged estimated residual from equation (7) and (Δ) denotes the first differences.

It is worthwhile noting that the estimated error correction terms (i.e. $u_t - {}_1$ and v_{t-1}) should be negative and statistically significant in the short-run equation (7) with respect to the granger representation theorem (GRT). Hence, negative and statistically significant error correction coefficients are a needed condition for the variables in question to be co-integrated.

Finally, having applied the final prediction error (FPE) criterion to determine the optimal lag length for the variables, we employ the Granger-Causality (G-C) testing procedure to see whether there is a pattern to causal relationships among the variables[9].

4. Empirical results

We firstly estimated correlation coefficient among variables as can be seen in Table A1[10]: It is expected to have low correlation among explanatory variables in order to avoid multicollinearity. The results estimated in Table 1 indicate that the correlation of these variables does not matter in terms of multicollinearity in the present study. The relationship between *RER* and *TOT* as well as *RER* and CI shows that there is lower correlation than expected.

Prior to modeling the relationships between the variables, the univariate time series properties are established. The results of the augmented Dickey-Fuller (ADF) and the multivariate augmented Dickey-Fuller (MADF) test indicate that the variables in question – *LRER*, *LTOT*, *LOPEN*, *LCI*, *LRP*, *LGCON*, *LGNER* and *LDC* – are all non-stationary in levels but stationary in first differences (see Table A2). In other words, the ADF and the MADF tests results for unit roots confirm that all variables are integrated of order one, I (1) in levels but integrated of order zero in first differences (i.e. stationary at first differences).

Before going a step further to analyze long-run relationship, we apply the Johansen procedure to test for 'weak exogeneity' of the explanatory variables. Table 4 shows that the hypothesis of weak exogeneity cannot be rejected at 5% level according to the test statistics of $x^2(k)$. It should be noted that the Johansen weak exogeneity test for the explanatory variables are implemented separately rather than investigated in a system based framework[11] (see Table A4).

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[9] It is noteworthy that we discuss the cost and benefits of all different methods why we use more than one for the same purpose.

[10] See Appendix.

[11] Boswijk and Franses (1992) investigate different techniques based on exogeneity assumption and they find that the Johansen procedure has higher power than the others used in the relevant literature which are based on single equation system.

The next step is to test for co-integration between the relevant variables which are all I(1). We employ a residual-based[12] cointegration technique to test the existence of a long-run relationship among the variables. A sufficient condition for joint co-integration among the variables in a long-run regression is that the error term should be stationary. The residual based ADF test statistics for the error term ensure that we must reject the null hypothesis of non-stationary (or no co-integration) at 5% significant level for the model used (equation 5). The estimation results from the co integration tests indicate that there is evidence of a long-run relationship between the real exchange rate (*RER*) and its determinants (the explanatory variables) (Table A5).

As far as equation (1) is concerned, we can conclude that the corresponding critical values as a whole show that the underlying model is correctly specified. This means that the coefficients estimated for this model are consistent with the prediction of the exchange rate model as presented in Table A6. Additionally, based on the diagnostic test results, results with equation (1) are robust.

Due to an insignificant constant coefficient, we dropped the constant term from the model and run another model. In other words, we need to observe whether there is any significant change In the variables when this parsimonious application is conducted. We saw that *RP* (relative productivity) and *GCON* (government consumption) became significant where the constant term was dropped from the model[13].

To confirm the uniqueness of the co-integrating vectors, we adopt the maximum likelihood (ML) test (Johansen, 1988; Johansen, Juselius, 1990)[14]. The VAR model is estimated with three lags which minimizes Schwarz Bayesian criterion (SBC), and is used with unrestricted intercepts and restricted trends.

Table A7 confirms the unique co-integration vector among the variables for both models 1 and 2. In this table, the maximum Eigen value statistics and trace statistics are conducted in finding number of co-integration vector.

Since the existence of joint co-integration among the variables in long-run regression is confirmed, the next step is to estimate the short-run dynamics through ECM[15].

With respect to the specification of the short-run dynamics, we prefer to follow an unrestricted ECM proposed by Banerjee *et al.* (1986) using the idea that we should start with a sufficiently large number of lags and progressively simplify it, as suggested by Hendry (see also Gilbert (1986) and Miller (1991)).

We therefore employ an ECM to test for short-run adjustment towards long-run equilibrium, and to explore the relationship between real exchange rate and its determinants (if any) for the model in the short-run. The results of the parsimonious dynamic model, using the error terms from OLS regressions, are given in Table A8.

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[12] Haug (1993) suggests that Engle-Granger's residual-based ADF test indicates the least size distortion among seven different residual-based co-integration tests based on Monte Carlo analysis.

[13] It is important to note that we include two kinds of dummy variables into the regression model to check whether the structural breaks exist or not. However we found that the t-values of both estimated dummies were insignificant, therefore, the output results with dummy variables is not displayed.

[14] It is worth emphasizing that the residual-based tests of a single co-integrating regression and system-based tests are grounded in different econometric methodologies. Charemza and Deadman (1997, p. 178) suggest that the Johansen method can be used for single equation modeling as a supplementary tool (or auxiliary tool). In this case, as pointed out by Charemza and Deadman, this could be regarded as a confirmation of the single equation method to which the Engle-Granger method is employed.

[15] Note that if two or more time series variables are co-integrated, then there exists an error-correction mechanism (ECM). Empirically, in small samples, statistically significant error-correction terms provide further evidence in favor of the presence of a 'genuine' long-run relationship.

The model presented in Table A8 shows that the error correction term's coefficient is negative and significant at the 1% level. The magnitude of the corresponding coefficients shows that 69% of the variation in the real exchange rate from its equilibrium level is corrected after each quarter. In other words, real exchange rate adjusts to its equilibrium level, reasonably at high level, and the error correction term gives further evidence that the variables in the equilibrium regression are co- integrated.

The ECM term for the model confirms the earlier findings that relative productivity (*RP*), growth rate of nominal exchange rate (*GNER*) and openness have a long-term effect as well as a short-term effect on *RER*. It is worth noting that the model estimated explains 49% of total variation of real exchange rate for the short-run period whilst the same model explains 51% of total variation of *RER* in the long-run period.

Finally, we apply two different techniques to see whether there is a causal relationship between the relevant variables that are found significant (i.e. *LRER-LOPEN*, *LRER--LGNER*, *LRER-LDC*, *LRER-LRP*). This refers to the earlier evidence of co-integration among the variables in a sense that if they are co-integrated, so causality should exist at least in one direction[16]. In brief, the results show that there exists an evidence of unidirectional causality from *LGNER*, *LOPEN* and *LDC* to *LRER* in the long-run. There is also unidirectional causality from *LGNER*, *LOPEN* and *LRP* to *LRER* in short-run period (see Table A9).

We also compared the results between fixed and floating exchange regimes separately in both the long-run and short-run periods, which are presented in Tables A10 and A11 respectively. Based on the co-integration regression equations, we can conclude that the corresponding critical values as a whole show that the underlying model is correctly specified. This means that the coefficients estimated for these models are consistent with the prediction of the exchange rate model which is presented in Tables A10 and A11. In addition, based on the diagnostic test results, estimations are robust. The long-run results displayed in Table A10 show that *RP*, *GNER*, *GCON* and *CI* are significant under the regime of fixed exchange rate whilst *GNER*, *OPEN* and *DC* are significant in floating exchange rate regime. The short-run results illustrated in Table A11 show that *GNER* and *OPEN* are significant under fixed regime whilst *RP* and *OPEN* are significant in floating exchange rate regime. This means that *OPEN* in the short-run and *GNER* in the long-run are the indicators which have an impact on real exchange rates in both regimes in the case of the New Zealand economy.

Table A12 confirms that there is a unique co-integration vector among the variables for both fixed and floating exchange regimes. This also indicates that there is no difference between the two regimes in terms of existence of a long-run relationship.

To summarize, comparison of these two different regimes (fixed and floating) indicates that there are more significant variables existing in fixed exchange rate regime therefore; policy makers have a much wider range of tools for decision making in case of real exchange rate.

5. Conclusion

The present study developed the framework introduced by Edwards (1989) and Domac and Shabsigh (1999) to investigate the determinants of the real exchange rates by using multivariate time series techniques. Quarterly data were used for the case of New Zealand

[16] In our application, we do not take into account the error correction term when we determine the direction of the causality. We just follow the standard causality test in a bivariate context.

over the period of 1974Q1–2009Q3. Given the small sample size, our results are indicative rather than definitive. Employing this quarterly data set, the series were found to be non-stationary at levels, but stationary at differences. Then, the models were found to be co-integrated because co-integration is essential for a valid test of the models in the long-run.

Furthermore, the Johansen method was employed to test for weak exogeneity. The results indicate that the explanatory variables used in the models are weakly exogenous. The next step was to confirm the uniqueness of the co-integration vector amongst the variables by conducting the Johansen and Juselius (1990) procedure. One co-integrating vector was found for both models in the fixed and floating regimes. For the short-run relation between the real exchange rate and its determinants, ECM was applied. This provides further evidence regarding both the static long-run and the dynamic short-run components of the *RER* model used in this study.

The results show that terms of trade, relative productivity, capital inflows and government consumption are insignificant whilst the domestic credit, the growth in the official nominal exchange rate and openness of the economy are significant determinantes of the real exchange rate in the long-run period. In the short-run period, relative productivity, the growth in the official nominal exchange rate and openness are the variables which have an impact on the real exchange rate in New Zealand. Openness of the economy and the growth rate of the nominal exchange rate are significant determinants of the real exchange rate in both fixed and floating exchange rate regimes of New Zealand.

6. Policy implications

Currency crises in Asian countries in 1997 and the global financial crisis of 2008 attracted a lot of attention to the changes in the real exchange rates and thier impact on the economies. Previous literature on real exchange rate determinants provides sufficient theoretical background for further studies in this area.

Based on the empirical evidence, there exists a relationship between real exchange rate and independent variables: openness of the economy, the growth of nominal exchange rate, relative productivity, government consumption, and domestic credits. The real exchange rate depreciates when the degree of openness and growth of the nominal exchange rate increases, while relative productivity, government consumption and domestic credit decreases. However, capital inflows and terms of trade are insignificant in explaining the movement in the equilibrium real exchange rate.

Comparison of two different exchange rate regimes (fixed and floating) indicates that there are more significant variables affecting the real exchange rate in the fixed exchange rate regime therefore the government could have a much wider range of tools for decision making regarding the real exchange rate.

Some further lessons can be deducted from this study. First, due to the influences of macroeconomic policies, increasing government consumption causes the real exchange rate appreciation; this means that public consumption is mainly directed towards the tradable goods sector. Secondly, the degree of openness influences changes in the real exchange rate; so increasing openness of the economy results in a depreciation of the real exchange rate. In order to control current account balance[17] and the balance of payments, government could apply various economic measures, including fiscal and monetary policy, but the attempts at

[17] One of the basic aims of countries is to arrive at a zero balance in their balance of payment (BOP). Current account as one of the most liquid and important parts of BOP, plays an important role in this issue.

reducing the import volume through limitations, tariffs and quotas are against the policies of World Trade Organization (WTO) and IMF. Third, reducing the cost of production and more productive activities in the tradable sector cause real exchange rates to fall; therefore, government may consider more investment in the industrial sector to raise the country's productivity. Additionally, government should develop a policy concerning capital inflows as well as domestic credits to increase the proportion of foreign direct investment. Finally, increase in domestic credit or money supply leads to more spending on both non-tradable and tradable goods. With the price of tradable goods being exogenous to the system, the price of non-tradable goods is driven up which discourages the production of non-tradable and causes a movement of factors of production to the tradable sector; as a result, real exchange rates will fall down.

Based on the findings of the study, the New Zealand's government could consider following issues for policymaking as regards real exchange rate. First, there are more significant variables to be controlled in the fixed exchange rate regime; therefore, a much wider range of tools is available for policymaking. Second, in the long-run openness, growth of nominal exchange rate, relative productivity, government consumption and domestic credits play an important role in keeping the real exchange rate on an appropriate level while for the short-run, only openness, growth of nominal exchange rate and relative productivity are key determinants. Third, the most significant variable in the short-run is relative productivity, while in the long-run openness explains the greatest component of the variation in the real exchange rates.

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Appendix

Table A1

Correlation matrix of variables

	LRER	*LTOT*	*LOPEN*	*LCI*	*LRP*	*LGCON*	*LGNER*	*LDC*
LRER	1.00							
LTOT	–0.004	1.00						
LOPEN	0.58	–0.05	1.00					
LCI	0.03	–0.37	0.04	1.00				
LRP	–0.37	–0.001	–0.34	0.02	1.00			
LGCON	–0.24	0.34	0.03	–0.14	0.23	1.00		
LGNER	0.35	–0.09	0.24	0.10	–0.06	0.15	1.00	
LDC	–0.22	–0.03	0.19	–0.02	0.58	0.57	0.21	1.00

Note: Correlation matrix prepared in order to investigate the relationship between the relevant variables as well as to check whether the multicollinearity problem exists or not. Multicollinearity is the existence of a strong relation among some or all explanatory variables of a regression.

Table A2

The ADF (augmented Dickey-Fuller) test for unit roots

Variables	Test statistics & critical values				Integration levels
	levels		1st differences		
	ADF	C.V. (5%)	ADF	C.V. (5%)	
RER	–2.72(1)	–2.88	–8.00(0)	–2.88	I(1)
TOT	–2.83(8)	–2.88	–5.83(5)	–2.88	I(1)
OPEN	–2.85(8)	–2.88	–6.12(5)	–2.88	I(1)
CI	–3.40(7)	–3.44	–8.22(5)	–2.88	I(1)
RP	–2.46(2)	–3.44	–7.51(0)	–2.88	I(1)
GCON	–2.53(1)	–3.44	–14.90(0)	–2.88	I(1)
GNER	–2.83(3)	–2.88	–7.69(5)	–2.88	I(1)
DC	–2.43 (3)	–3.44	–6.03(3)	–2.88	I(1)

Note: The corresponding critical values for 143 numbers of observations at the 5% significance levels are obtained from Mackinnon (1991) and reported by MFIT 4.0. It is worth noting that the intercept and trend terms are in the ADF equations. The numbers in the parenthesis indicate the number of augmentations which are necessary to be sufficient to secure lack of auto-correlation of the error terms with regard to the variables. We chose the Akaike information criterion to determine ADF values.

Table A3

The Johansen maximum likelihood tests for the order of integration MADF (multivariate form of augmented Dickey-Fuller)

Variables	Test statistics & critical values				Integration levels
	levels		1st differences		
	MADF	C.V. (5%)	MADF	C.V. (5%)	
RER	0.28	4.16	29.00	4.16	I(1)
TOT	0.12	4.16	119.75	4.16	I(1)
OPEN	0.14	4.16	68.84	4.16	I(1)
CI	3.35	4.16	98.29	4.16	I(1)
RP	0.22	4.16	23.27	4.16	I(1)
GCON	1.09	4.16	33.97	4.16	I(1)
GNER	1.29	4.16	68.39	4.16	I(1)
DC	3.99	4.16	55.85	4.16	I(1)

Note: The corresponding critical values at the 5% significance levels are obtained from Osterwald-Lenum (1992). It is worth noting that unrestricted intercept and unrestricted trend are included for the variables in levels and in differences respectively. VAR 3 based on AIC is used in the Johansen procedure. The MADF stands for the multivariate form of the augmented Dickey-Fuller unit root test.

Table A4

Testing for weak exogeneity using the Johansen approach

Variable	Test for weak exogeneity (Johansen approach)	
	test statistics	conclusion
LTOT	$\chi^2(1) = 1.78(.182)$	accept
LOPEN	$\chi^2(1) = 2.25(.133)$	accept
LCI	$\chi^2(1) = 2.33(.126)$	accept
LRP	$\chi^2(1) = 3.04(.081)$	accept
LGCON	$\chi^2(1) = 1.10(.294)$	accept
LGNER	$\chi^2(1) = 2.98(.084)$	accept
LDC	$\chi^2(1) = 3.76\ (.052)$	accept

Note: This table shows the results that the hypothesis of weak exogeneity cannot be rejected at the conventional level for all explanatory variables under the study. The results in the table also indicate that the hypothesis of weak exogeneity cannot be rejected at the 5% or 10% level for the explanatory variables. The tabulated test statistics of $\chi^2(1)$ is 3.84 for the Johansen approach.

Table A5

The residual-based ADF test for cointegration

Cointegration regression	R^2	R^2	CRDW	Calculated ADF residuals	Critical value
					Mackinnon (5%)
Model 1	0.51	0.49	1.67	–3.61(0)	–3.58
Model 2	0.55	0.53	1.74	–3.63(0)	–3.58

Note: This residual-based co-integration technique employed in order to test for co-integration (long-run relationship) among the relevant variables. The reported critical value is obtained from Mackinnon (1991) and reported by MFIT 4.0. The numbers in parentheses indicate number of lags, which are chosen by the Schwarz Bayesian criterion (SBC). This means that zero augmentation is necessary to be sufficient to secure lack of autocorrelation of the error terms for the relevant cointegration regressions.

Table A6

Engle granger static long-run regressions

Explanatory variables	Dependent variable: *LRER*	Dependent variable: *LRER*
	Model 1	Model 2
C	–0.77 (–0.28)	–
LTOT	–0.09 (–1.45)	–0.16 (–1.26)
LRP	–0.38 (–1.43)	–0.47 (–2.33)
LCI	–0.02 (–1.15)	–0.30 (–0.51)
LGCON	–0.16 (–0.93)	–0.22 (–2.39)
LGNER	0.05 (5.15)	0.50 (5.30)
LDC	–0.11 (–3.69)	–0.06 (–5.46)
LOPENNESS	0.99 (7.99)	0.90 (12.55)
R^2	0.51	0.55
R^2	0.49	0.53
CRDW	1.67	1.74
ADF*	–3.61	–3.63
CV	–3.58	–3.58
SER	0.011	0.099
χ^2_{SC} (4)	9.45 (prob = 0.048)	9.47 (prob = 0.049)
χ^2_{FF} (1)	0.11 (prob = 0.740)	0.21 (prob = 0.648)
χ^2_{NORM} (2)	3.31 (prob = 0.190)	3.41 (prob = 0.181)
χ^2_{HET} (1)	3.78 (prob = 0.046)	3.68 (prob = 0.045)

Note: *t*-statistics are in parentheses and all diagnostic pass at 5% level of significance for models 1 and 2. It is worth emphasising that the star (*) indicates no augmentation is necessary to remove autocorrelation from the error terms.

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Table A7

The Johansen maximum likelihood (ML) procedure

Cointegration Regression	H0	H1	λmax	C.V. at 5%	λTrace	C.V. at 5%
Model 1*	$r = 0$	$r = 1$	74.56	47.94	201.28	141.24
	$r <= 1$	$r = 2$	39.06	42.30	110.10	126.72
	$r <= 2$	$r = 3$	33.74	36.27	83.18	87.65
	$r <= 3$	$r = 4$	25.82	29.95	53.92	59.33
Model 2	$r = 0$	$r = 1$	76.60	47.94	211.28	141.24
	$r <= 1$	$r = 2$	38.36	42.30	113.10	126.72
	$r <= 2$	$r = 3$	34.65	36.27	84.17	87.65
	$r <= 3$	v = 4	25.94	29.95	54.81	59.33

Note: Cointegration likelihood ratio (LR) test to determine the number of cointegration vectors (r) based on maximal eigen value of stochastic matrix and trace of the stochastic matrix. r indicates the number of co integrating relationships, λ_{max} is the maximum Eigen value statistics and λ_{trace} is the trace statistics. Var3, based on SBC is used in the Johansen procedure and unrestricted intercepts and restricted trends in the VAR model are not rejected in all cases. The critical values are obtained from Osterwald-Lenum (1992).

* Unrestricted intercepts and restricted trends applied in model (1), while restricted intercepts and restricted trends used in model (2).

Table A8

Error correction modeling (short-run dynamics)

Explanatory variables	Dependent variable: *DLRER*
	Model
C	–0.001 (–0.33)
ER (–1)	–0.69 (–3.22)
DLTOT	–0.005 (–0.21)
DLRP	–0.93 (–2.57)
DLCI	–0.95 (–0.35)
DLGCON	–0.19 (–1.54)
DLGNER	0.006 (2.10)
DLDC (–3)	0.06 (1.44)
DOPENNESS	0.24 (3.93)
R^2	0.49
$\bar{R}^2$	0.45
DW	1.61

SER	0.044
χ^2_{SC} (4)	9.47 (prob = 0.492)
χ^2_{FF} (1)	0.02 (prob = 0.962)
χ^2_{NORM} (2)	2.95 (prob = 0.37)
χ^2_{HET} (1)	3.45 (prob = 0.063)

Note: *t*-statistics are in parentheses and all diagnostic pass at the 5% or 1% level of significance for the model.

Table A9

Summary of granger causality results (the wald and fpe tests)

Dependent variable	Independent Variable	Degrees of freedom[a]	Wald test	m^*	n^*	FPE (m^*)	FPE (m^*, n^*)	Causal inference
LRER	*LTOT*	2	4.24	2	2	2.71×10^{-3}	2.74×10^{-3}	NC
DLRER	*DLTOT*	1	0.51	3	1	1.08×10^{-2}	1.19×10^{-2}	NC
LRER	*LRP*	1	1.26	5	1	6.78×10^{-2}	7.15×10^{-2}	NC
DLRER	*DLRP*	3	12.7*	1	3	2.81×10^{-3}	2.24×10^{-3}	RP → *RER*
LRER	*LCI*	2	1.81	1	2	2.56×10^{-3}	2.94×10^{-3}	NC
DLRER	*DLCI*	1	2.46	1	1	2.03×10^{-1}	2.02×10^{-1}	NC
LRER	*LGCON*	1	0.19	1	1	2.34×10^{-3}	3.21×10^{-3}	NC
DLRER	*DLGCON*	1	2.85	1	1	2.8×10^{-1}	3.11×10^{-1}	NC
LRER	*LGNER*	1	4.48*	1	1	2.69×10^{-3}	2.53×10^{-3}	*GNER* → *RER*
DLRER	*DLGNER*	1	3.86*	1	1	2.03×10^{-1}	2.05×10^{-1}	*GNER* → *RER*
LRER	*LOPENNESS*	2	7.19*	2	2	2.94×10^{-3}	3.11×10^{-3}	*OPENNESS* → *RER*
DLRER	*DLOPENNESS*	2	15.6*	1	2	2.96×10^{-2}	2.01×10^{-2}	*OPENNESS* → *RER*
LRER	*LDC*	3	14.2*	1	3	2.91×10^{-3}	2.57×10^{-3}	*DC* → *RER*
DLRER	*DLDC*	2	2.83	2	2	8.72×10^{-1}	9.41×10^{-1}	NC

Note: If FPE (m^*, n^*) < FPE (m^*), *Y* Granger causes *X*.
m^* – denotes maximum lag on dependent variable; n^* – stands for minimum lag on independent variable; [a] – χ^2 degrees of freedom for the Wald test; [b] – degrees of freedom for FPE; NC – no causality, *L* and *D* – show long--run and short-run periods respectively.
Critical values for the Wald test: $\chi^2(1)$ =3.84, $\chi^2(2)$ = 5.99, and $\chi^2(3)$ = 7.81

Table A10

Engle Granger static long-run regressions

Explanatory variables	Dependent variable: *LRER* Fixed regime 1974Q1–1985Q1	Dependent variable: *LRER* Floating regime 1985Q2–2009Q3
	Model 1	Model 2
C	0.79 (4.88)	0.46 (0.59)
LTOT	–0.11 (–0.69)	–0.16 (–0.98)
LRP	–0.65 (–4.33)	–0.19 (–0.33)
LCI	–0.75 (–2.29)	–0.93 (–1.21)
LGCON	–0.67 (–4.80)	–0.48 (–1.35)
LGNER	0.38 (3.77)	0.58 (2.84)
LDC	–0.28 (–1.05)	–0.10 (–4.80)
LOPENNESS	0.16 (0.21)	0.70 (8.12)
R^2	0.76	0.58
$\bar{R}^2$	0.72	0.55
CRDW	1.75	1.70
ADF*	–3.65	–3.67
CV	–3.58	–3.58
SER	0.077	0.081
χ^2SC (4)	2.45 (prob = 0.148)	2.17 (prob = 0.178)
χ^2FF (1)	3.32 (prob = 0.082)	0.23 (prob = 0.525)
χ^2NORM (2)	2.35 (prob = 0.308)	0.07 (prob = 0.962)
χ^2HET (1)	2.85 (prob = 0.091)	3.59 (prob = 0.043)

Note: *t*-statistics are in parentheses and all diagnostic variables pass at 5% level of significance for models 1 and 2. It is worth emphasising that the star (*) indicates that no augmentation is necessary to remove autocorrelation from the error terms.

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Table A11

Error correction modeling (short-run dynamics)

Explanatory variables	Dependent variable: *DLRER* Fixed regime 1974Q1–1985Q1	Dependent variable: *DLRER* Floating regime 1985Q2–2009Q3
	Model 1	Model 2
C	–0.008 (–1.47)	–0.002 (–0.50)
ER (–1)	–0.82 (–3.34)	–0.79 (–3.25)
DLTOT	–0.061 (–1.64)	–0.031 (–0.99)
DLRP	–0.78 (–1.27)	–0.88 (–2.04)
DLCI	–0.32 (–0.82)	–0.17 (–0.49)
DLGCON	–0.34 (–1.36)	–0.11 (–0.78)
DLGNER	0.014 (3.38)	0.002 (0.61)
DLDC	–0.07 (–1.01)	–0.024 (–0.42)
DOPENNESS	0.17 (2.28)	0.27 (3.32)
R^2	0.45	0.39
$\bar{R}^2$	0.35	0.29
DW	1.65	1.71
SER	0.037	0.046
χ^2_{SC} (4)	5.11 (prob = 0.276)	7.58 (prob = 0.092)
χ^2_{FF} (1)	0.04 (prob = 0.963)	0.75 (prob = 0.386)
χ^2_{NORM} (2)	1.74 (prob = 0.417)	4.95 (prob = 0.084)
χ^2_{HET} (1)	3.48 (prob = 0.067)	1.30 (prob = 0.253)

Note: *t*-statistics are in parentheses and all diagnostic variables pass at the 5% or 1% level of significance for the model.

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Table A12

The Johansen maximum likelihood (ML) procedure

Cointegration regression	H0	H1	λmax	C.V. at 5%	λtrace	C.V. at 5%
Model 1 Fixed regime 1974Q1–1985Q1	$r = 0$	$r = 1$	83.28	47.94	229.28	141.24
	$r <= 1$	$r = 2$	41.06	42.30	115.15	126.72
	$r <= 2$	$r = 3$	35.74	36.27	86.87	87.65
	$r <= 3$	$r = 4$	22.82	29.95	58.52	59.33
Model 2 Floating regime 1985Q2–2009Q3	$r = 0$	$r = 1$	60.38	47.94	185.54	141.24
	$r <= 1$	$r = 2$	40.61	42.30	125.15	126.72
	$r <= 2$	$r = 3$	31.55	36.27	84.54	87.65
	$r <= 3$	$r = 4$	26.18	29.95	52.88	59.33

Note: Cointegration likelihood Ratio (LR) test to determine the number of cointegration vectors (r) based on maximal Eigen value of stochastic matrix and trace of the stochastic matrix.
r – indicates the number of co integrating relationships, λ_{max} is the maximum Eigen value statistics and λ_{trace} is the trace statistics. Var3, based on SBC, is used in the Johansen procedure, and unrestricted intercepts and restricted trends in the VAR model are not rejected in all cases. The critical values are obtained from Osterwald-Lenum (1992).