Neutral Rate of Interest: The Case of the Dominican Republic

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Abstract

The aim of this paper is to estimate the neutral rate of interest for the Dominican Republic. The methods used are reduced-form, interest rate parity, and marginal product of capital. Empirical evidence provides evidence in favor of the interest rate parity hypothesis as a useful tool for estimating the neutral rate of interest. The results suggest that nominal and real neutral rates of interest have fallen following the 2008 financial crisis. The reduced-form model and interest rate parity methods tell us that the average nominal neutral rate of interest of the post-financial crisis period stands at between 5.5% and 6.2%. These same methods yield values between 1.0% and 1.4% for the real neutral rate of interest. The marginal product of capital method estimates a real neutral rate of interest of 3.6%.
Keywords: neutral rate of interest, monetary policy and cointegration.

1. INTRODUCTION

The tool most commonly used by central banks for implementing monetary policy is the short-term interest rate. The foregoing is a consequence of the adoption of the inflation target scheme. The use of interest rates as a policy instrument makes the study of natural or neutral rate of interest levels relevant. In this regard, the central bank of the Dominican Republic has implemented the inflation target scheme since 2012. The adoption of this scheme, together with falling interest rates and the problem of zero interest rates in developed economies, have generated additional interest in understanding natural rates of interest.

Sustainable growth in an economy is achieved when efficient economic policies are formulated. Among these policies, monetary policy is responsible for maintaining price stability and consequently ensuring a reasonably foreseeable future that facilitates investor and consumer decisions. The effective formulation of monetary policy requires understanding of the economy's neutral rate of interest.

The neutral rate of interest is the interest rate level that would exist in a scenario with no inflationary pressures. This definition of neutral rate of interest was provided by the Swedish economist Knut Wicksell in the 19th Century. In keeping with this definition, it can be said that the natural rate of interest level is the one under which prices remain stable. It must therefore be the interest rate level the central bank wants to achieve.

The contributions of modern authors reveal that the neutral rate of interest is the one that allows the observed product to converge with potential (Bomfim, 2001). In Keynesian models, the neutral rate of interest is defined as the rate that would exist in equilibrium with no nominal rigidities (Gali, 2002). In the new Keynesian economy the neutral rate of interest is the steady-state or long-term rate.

In this context, the aim of this research paper is to obtain a solid estimate of the neutral rate of interest for the Dominican Republic. To achieve this, three estimation methodologies are used: the reduced-form method, the interest rate parity method and the marginal product of capital method. The project covers the period 1996-2017 with quarterly data.

The reduced-form model consists of estimating a regression by minimum least squares where the interest rate is a function of the external interest rate and potential growth. In this method neutral rate of interest estimates correspond to the value derived from regression. Therefore, the expected value of deviations between market and neutral rates of interest is equal to zero. Neutral rate of interest estimates using the interest rate parity method are obtained with the previous estimation of a Vector Error Correction (VEC) model. This model incorporates two co-integrated vectors that show the long-term relationship between the exchange rate and internal and external prices, and domestic and external interest rates. Lastly, the marginal product of capital method is obtained by estimating a production function using Vector Error Correction (VEC).

This document is structured as follows: Section 2 sets out the empirical strategy and Section 3 contains estimation results, followed by conclusions in Section 4.

2. EMPIRICAL STRATEGY

2.1 Reduced-form model

According to Mendes (2014) the reduced-form model opens up the possibility of global and national factors influencing neutral rates of interest. The basic elements of this approach are:

i) Balance of payments identity

1
$$S_t - I_t = N\chi_t + r_t^{world} NFA_t$$

ii) The accumulation equation

2
$$NFA_t = \left(1 + r_t^{world}\right) NFA_{t-1} + N\chi_t$$

iii) A linear approximation to the interest rate parity condition:

3
$$r_t = r_t^{world} + E_t \Delta q_{t+1} + \left(\phi_0 - \phi_1 nfa_t\right)$$

Where S_t is national savings, I_t is investment, $N\chi$ net exports, r_t^{world} international interest rate, NFA_t is the net position of external assets, r_t domestic interest rates, and q_t the real exchange rate. In addition, it is assumed that in the long term the savings rate $\left(\frac{S_t}{y_t}\right)$ and the investment/output ratio $\left(\frac{I_t}{y_t}\right)$ are given by linear functions:

4
$$s_t = \alpha_0 + \alpha_1 r_t$$
$$i_t = \beta_0 + \beta_1 r_t + \beta_2 g_t$$

Where g_t is potential growth.

After solving the system of equations in steady state, the following reduced-form is obtained:

5
$$r_t = \varphi_0 + \varphi_1 g_t + \varphi_2 r_t^{world}$$

2.2 Interest rate parity method

Interest rate parity is a method used for inferring the neutral rate of interest through the long-term relationship between the domestic and external interest rates. In the case of the Dominican Republic, the neutral rate of interest is expected to be determined by the interest rate of the United States plus a measure of country risk.

In this regard, the best way to identify the long-term relationship between the domestic interest rate and the external interest rate is through the estimation of a model that determines long-term external relations of the Dominican economy. In economic literature, it is common to simultaneously estimate the long-term relation between the exchange rate and internal and external prices with the relation between domestic and external interest rates. Conventionally, estimates of these relationships are made using a VEC model with the following specification:

6
$$\Delta y_t = \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + \pi y_{t-1} + \theta x_t + \varepsilon_t$$

Where y_t is the endogenous variables vector; x_t, the centered dummies vector, and $\varepsilon_t \sim iid\ N(0, \sigma^2)$. Endogenous variables are: the logarithm of the bilateral nominal exchange rate between US$/RD$ e_t; the U.S consumer price index logarithm, p_t^*, , the 30-day passive interest rate r_t, and the interest rate on federal funds is r_t^*. It is expected that two cointegration vectors will be found where purchasing power parity and interest rate parity can be identified. With this second vector, the neutral rate of interest is estimated. Therefore, the matrix $\pi = \alpha\beta'$, under the hypotheses that $\beta' = \begin{pmatrix} 1 & -1 & 1 & 0 & 0 & \beta_{16} \\ 0 & 0 & 0 & 1 & -1 & \beta_{26} \end{pmatrix}$ allows us to obtain the neutral rate of interest as $r_t^n = r_t^* + \beta_{26}$.

2.3 Marginal product of capital methodology

The marginal product of capital method makes it possible to obtain a neutral real interest rate estimate based on the equilibrium conditions of a closed economy long term. In this context, the neutral rate is explained by the marginal product of capital, net of depreciation and adjusted for a risk premium associated with holding equity assets in relation to fixed income assets.

7
$$r_t^n = f'(k) - \phi = \alpha\left(\frac{Q}{k}\right) - \phi$$

According to the above equation, the neutral rate is equal to the marginal product of capital (PMK) minus the return from risk-free assets; in the case of the Dominican Republic, the interbank rate is used. The estimation of the neutral rate requires calculating equity participation in the product (α), the depreciation rate (δ) and the trajectory of the output-capital ratio (Q/K). The alpha parameter is estimated with a Cobb-Douglas production function using a Vector Error Correction model for the period 1970-2017.

3. ESTIMATION RESULTS

3.1 Reduced-form model

This chapter presents the results of model estimations. Here, domestic interest is a function of the external interest rate and potential growth.[1] The estimation of neutral rates of interest is the component explained by the model. Equation 8 contains the parameters (t student statistics in brackets) for the period 1996-2017. Data are given quarterly:

8
$$r_t^n = \underset{(2.45)}{0.84} r_t^* + \underset{(6.67)}{0.78} g_t + \underset{(3.79)}{0.03}$$

$$R^2 = 0.64$$

This model does not pass the autocorrelation (LM), heteroscedasticity (White) and normality (Jarque-Bera) tests, which implies

[1] The potential growth corresponds to the HP filter.

that the estimates are not efficient. However, this does not prevent the model from producing consistent estimates. Loss of efficiency forces us to use Newey-West errors to make statistical inferences. It should be noted that all coefficients have the theoretically expected signs and are significant at 5%.

The Dominican Republic's interest rate is strongly influenced by external interest rates. For every percentage point increase in the U.S interest rate, the domestic interest rate goes up 0.84 percentage points. Like the external interest rate, the potential growth rate has a less than proportional impact on the domestic interest rate. A 100 basis points increase in growth generates a 78 basis points increase in the domestic interest rate.

Consistent parameter estimates make it possible to obtain a consistent approximation of the natural rate of interest. During the period under review, market and neutral rates of interest fell, as can be seen in Figures 1 and 2. In both rates, the drop was identifiably accentuated by the international financial crisis of 2008.

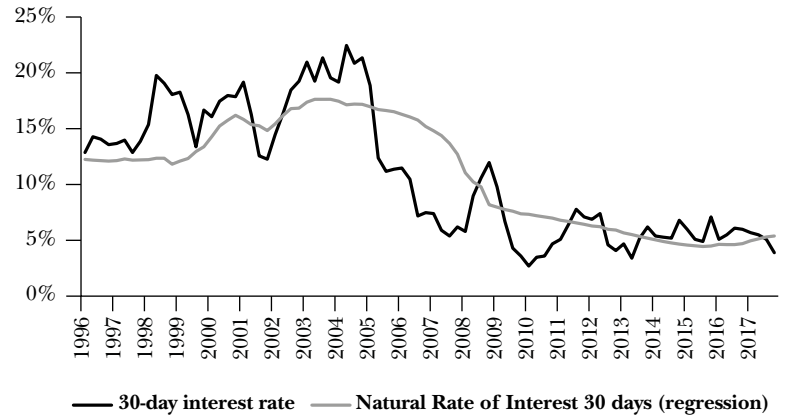
During the period prior to the local financial crisis of 2003, 1996Q1-2002Q4, the market interest rate remained above neutral rates of interest. In other words, during most of this period the interest rate gap was positive, implying that monetary policy was restrictive. On average, the market rate was 15.9% and the neutral rate 13.5%. During the financial crisis the average market rate reached 20.7% and the neutral rate of interest 17.4%.

In the years between the crises, market and neutral rates of interest dropped. However, the fall in market rates changed the sign of the gap from positive to negative. This means that monetary policy became expansive. The market and neutral rates of interest average 9.6% and 15.5%, respectively. In the period following the international financial crisis, a negative interest rate gap remained, suggesting an expansive monetary policy. In this period, market and neutral rates of interest were unusually low. The market and neutral rates of interest averaged 5.8% and 6.2%, respectively.

If we carry out the analysis presented above, with the real interest rate, we arrive at the same conclusions regarding the monetary policy position. Other findings of note include interest rate levels lower than the ones observed in previous studies. Specifically, values of 1.3% and 1.4% are observed for the market and neutral rate of interest, respectively. In previous projects the values are close to 4%.

Figure 1

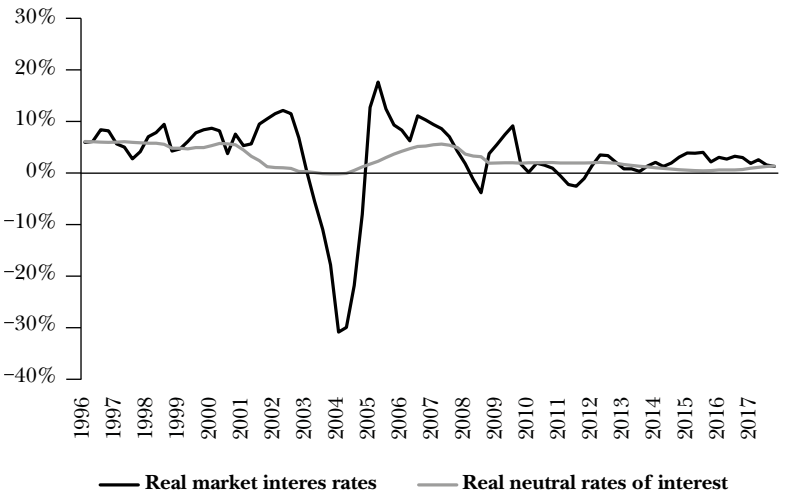
NOMINAL INTEREST RATE REGRESSION METHOD



Source: Central Bank of the Dominican Republic and the FED.

Figure 2

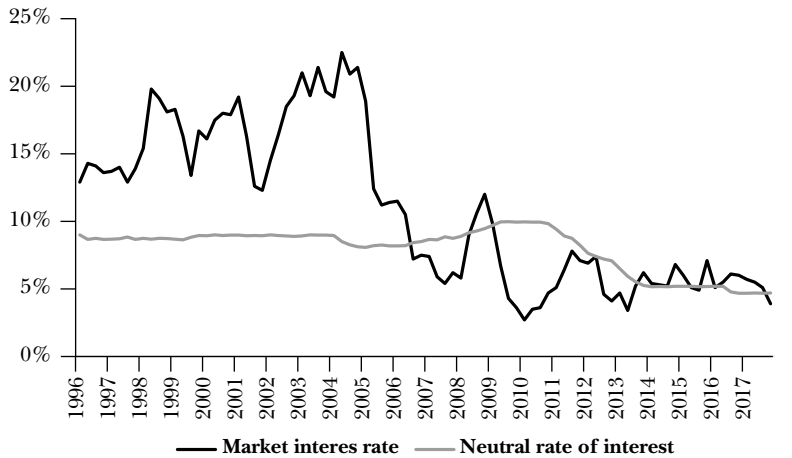
REAL INTEREST RATE, PARITY METHOD



Sources: Central Bank of the Dominican Republic and the FED.

Figure 3

NOMINAL INTEREST RATE, PARITY METHOD



Note: The data is presented at an annual frequency.
Source: INEGI.

3.2 Interest rate parity method

This chapter presents the results of neutral rate of interest estimates using the rate parity method with a VEC model. The first step consists of selecting one of the four models proposed in the work of Johansen and Juselius (1990); in this document the model selected is the one with constant co-integration relations, where there are no trends, and the VAR neither has a trend nor is constant. The unrestricted model is then estimated and, once the hypotheses of normality, absence of autocorrelation and distributed identity of the residuals have been contrasted, the number of cointegration vectors is determined with the contrast of the trace.

Following previous research, such as the original studies by Johansen and Juselius, a VEC with two lags is estimated. The results of the specification tests are contained in Table 1. This table shows that there is evidence in favor of null hypotheses of normality, absence of autocorrelation and homoscedasticity of the residuals at 5%, given that probability exceeds the critical value of 0.05.

Once it has been confirmed that the classic assumptions are satisfied, the statistical inference is made about the range of the matrix π, which is equivalent to the number of cointegration vectors. These

Table 1

CLASSIC ASSUMPTIONS

Test	*Null hypothesis*	*Statistics*	*p-value*
Jarque-Bera	Joint normality	12.9	0.22
Breusch-Pagan-Godfrey	Homocedasticity	441.6	0.60
Breusch-Godfrey (four lags)	Absence of autocorrelation	AR(1)=42.7	0.14
		AR(2)=35.6	0.39
		AR(3)=42.0	0.16
		AR(4)=22.7	0.94

Sources: Central Bank of the Dominican Republic and the FED.

Table 2

CONTRAST OF COINTEGRATION, TRACE STATISTICS

Null Hypothesis cointegration vectors	*Alternative Hypothesis*	*Trace statistics*	*Critical value at 5%*	*p-value*
$r = 0$	$r > 0$	178.00	95.80	0.00
$r = 1$	$r > 1$	90.00	69.81	0.00
$r = 2$	$r > 2$	21.48	47.91	0.63

are determined using the trace test, the results of which are given in Table 2. This test consists of evaluating the null hypothesis that the range of the matrix π is equal to r against the alternative that the range is greater than r where $r = 0,1,\ldots, N$. The test ends when the null hypothesis is not rejected. As can be seen, the null hypothesis is not rejected when =2, indicating that there are two cointegration vectors.

Under the null hypothesis of two cointegration vectors, the hypotheses of interest rate parity and price parity can be contrasted. The purpose of testing these hypotheses is to determine whether the neutral rate of interest can be estimated using the interest rate parity method. The weak exogeneity of the external and domestic interest rates is tested together. The results, presented in Table 3, indicate

Table 3

CONTRAST OF THE UIP AND PPP HYPOTHESES

Statistic χ2	*p-value*
15.2	0.09

that the hypotheses of UIP, PPP and weak exogeneity of domestic and external interest rates at 5% significance are not rejected jointly.

Statistical evidence does not allow us to reject the UIP and PPP hypotheses, therefore we estimate a restricted VEC, following Johansen and Juselius (1990). The restrictions incorporated into the matrix π can be found in the Appendix. The first cointegration vector derived by this restricted estimate has the characteristics expected in a long-term exchange rate equation, while the second vector takes the form of a parity rates equation. Their results are contained in the expression:

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$$e_t = p_t - p_t^* + 4.64$$
$$r_t - r_t^* = 0.034$$

Where e_t is the exchange rate logarithm; p_t is the consumer price index logarithm; p_t^* the U.S price index; r_t 30-day passive interest rates, and r_t^* is the U.S interest rates.

The neutral rate of interest can be defined as:

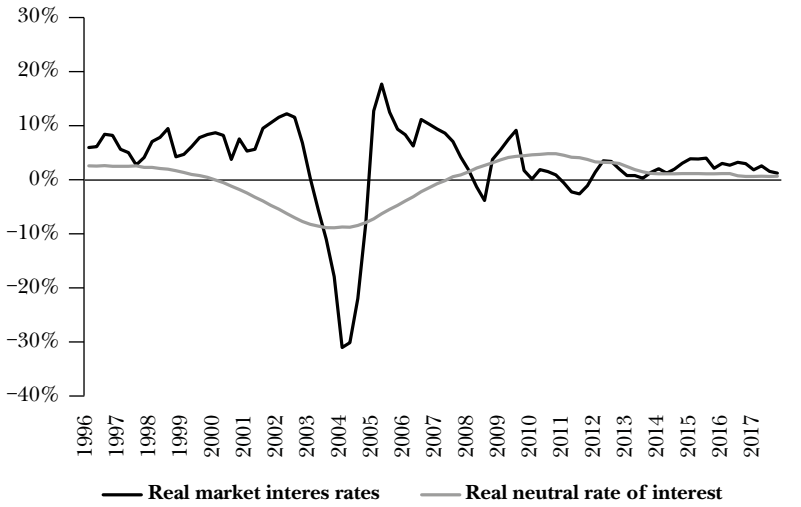
10

$$r_t^n = r_t^* + 0.034$$

During the 1996Q1-2011Q4 period, the average neutral rate of interest stood at 8.9%, as can be seen in Figures 3 and 4. In this period, neutral interest was lower than the market interest rate. The interest rate gap is therefore positive in this period, indicating that monetary policy was restrictive. During the implementation period for the inflation targeting scheme, the estimation for neutral rates of interest

Figure 4

REAL INTEREST RATES, PARITY METHOD



Sources: Central Bank of the Dominican Republic and the FED.

averages 5.5%. During this stage the gap between the neutral rate of interest and the market rate was narrowed.

3.3 Marginal product of capital method

Marginal product of capital is estimated using a Cobb-Douglas production function obtained from a VEC model.[2] The first cointegration vector has the characteristics of a production function:

11

$$y_t = 0.24l_t + 0.48k_t + 0.34h_t$$

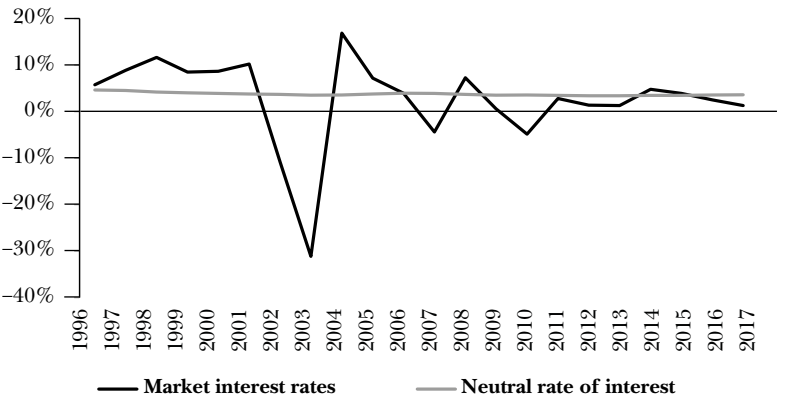
Where y_t is the output logarithm; l_t is the workforce; k_t the physical capital stock and h_t human capital. In the Cobb-Douglas functions, the marginal product of capital is equal to the multiplication of the capital-output elasticity (0.48) and the average productivity

[2] Details of the VEC model are provided in the Appendix.

of capital as shown in equation (7). Using this method we obtain an average real neutral rate of interest of 3.75%. As with the previous methods, a drop in the neutral rate of interest is observed. The evolution of the real neutral rates of interest is given in Figure 5.

Figure 5

REAL INTEREST RATES, MARGINAL PRODUCT



Sources: Central Bank of the Dominican Republic and the FED.

4. CONCLUSION

In this research paper, the reduced-form model, interest rate parity and marginal product of capital methods are used to estimate the neutral rate of interest for the Dominican Republic. Empirical evidence provides support in favor of the interest rate parity hypothesis as a useful tool for estimating the neutral rate of interest. The results suggest that nominal and real neutral rates of interest fell after the 2008 financial crisis. The reduced-form model and interest rate parity methods reveal that average nominal neutral rates of interest in the post-financial crisis period were between 5.5% and 6.2%. These same methods yield values between 1.0% and 1.4% for the real neutral rates of interest. The marginal product of capital method estimates a real neutral

rate of interest of 3.75%. For future research, it is recommendable to broaden the analysis to the countries of Central America and consider structural changes by estimating an MS-VEC.

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