Assessing the Usefulness of the Neutral Rate of Interest to Monetary Policy in Jamaica

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Abstract

Since the early 1990's, the transmission mechanism of monetary policy in Jamaica has been extensively researched. Most of this research focused on the speed and the effectiveness of the transmission. This paper extends the existing research by focusing on estimating and assessing the usefulness of the neutral rate of interest to the conduct of monetary policy. While the concept of the neutral rate is well-grounded in theory, as an unobservable variable, there are several proposed methods of estimation. In this paper, we estimate the neutral rate for Jamaica using four methods commonly found in the literature. Based on these methodologies, the real neutral rate is estimated to range between -2.6% to 2.6%, or 2.4% to 7.6% in nominal terms. This implies that the Bank of Jamaica's current monetary policy stance has been fairly accommodative given recent sub-optimal trends in inflation and growth.

Keywords: Monetary Transmission Mechanism, Neutral Interest Rate
JEL Classification: E52, E58, E43, C10.

1. INTRODUCTION

The Bank of Jamaica, the monetary authority in Jamaica, reduced its policy rate consistently between the latter half of 2009 and 2018. Importantly, real ex-ante short term interest rates in Jamaica became negative after December 2017. Notwithstanding this, the output gap for Jamaica remained negative over the period which contributed to inflation remaining below the Central Bank's inflation target. This implies that the stance of monetary policy may have been less accommodative than required to encourage a closure of the output gap and the achievement of the Bank's inflation target.

The monetary policy transmission mechanism in Jamaica has been extensively researched. Most of the research focused on the speed of the transmission (e.g. Allen and Robinson 2004, Robinson and Williams 2016) as well as its effectiveness (e.g. Dacass, McKenzie and Murray 2015). This paper adds to the literature by estimating the neutral interest rate, which represents a benchmark to assess the stance of monetary policy.

We estimate the neutral rate using four popular methods, namely, a reduced form ordinary least squares (OLS) regression, a time varying vector auto regression (TVP-VAR), an applied dynamic stochastic general equilibrium (DSGE) model and the Hodrick-Prescott (HP) filter. These estimates are presented to show the recent trends in – and the level of – the real interest rate gap for Jamaica. We also assess the statistical properties of the estimates using correlations of the estimated gaps with inflation and output and an assessment of their leading indicator properties.

Consistent with a priori expectations, Jamaica's neutral interest rate appears to be time varying and has declined, particularly over the last five years, due to structural changes in the economy. While there is a high degree of uncertainty with regard to the determination of the neutral rate, our findings further imply that the central bank's policy rate at the end of 2018 was accommodative. Based on these methodologies, the point estimate for the real neutral rate is estimated to range between -2.6% to 2.6%, or 2.4% to 7.6% in nominal terms as at September 2018. The estimate of the neutral rate derived from the TVP-VAR was found to display the best leading indicator properties with regard to inflation while the OLS was the least successful.

The remainder of the paper proceeds as follows. Section 2 outlines the main determinants of the neutral rate, particularly for small open economies. In section 3, we estimate the neutral rate for Jamaica using four methods commonly found in the literature. Section 4 provides an assessment of the statistical properties of the estimated real interest rate gaps (defined as the difference between the actual and neutral rate based on each methodology). Finally, Section 5 concludes.

2. DETERMINANTS OF THE NEUTRAL RATE

While there are many definitions of the neutral rate, this paper focuses on the definition made popular by Laubach and Williams (2003). The neutral rate is therefore the prevailing real interest rate at which the output gap is closed and inflation is stable. When market interest rates are consistent with their neutral level, then the economy is on a sustainable path, where the deviations away from this point of neutrality induces business cycles in an economy.[1]

The literature makes a distinction between a 'contemporaneous' and 'medium-to-long-run' neutral interest rate. The contemporaneous neutral rate is the rate of interest that ensures a zero output gap and stable prices in every period (Mendes (2014)). In this regard, the short-run or contemporaneous interest rate can be impacted by shocks as well as changes in potential output. It is usually estimated in 'real-time' using time series methodologies and therefore reflects the level of interest rate that is required based on current economic conditions. The long-run neutral rate, on the other hand, is consistent with output at its potential level after business cycle shocks have dissipated.

The long run neutral rate can evolve based on structural changes in the economy. Generally, a decline (increase) in the neutral rate is caused by an outward (inward) shift in the economy's savings supply curve or an inward (outward) shift in the demand for savings (April 2014 World Economic Outlook). Changes in monetary and fiscal policy as well as private and public saving preferences result in shifts in supply curve for savings. The latter includes changes in population growth and the age demographics of the population. As the population ages, the neutral rate has been found to decline. The demand curve for savings, on the other hand, shifts as a result of changes in expected investment profitability, productivity and the relative price of investment goods.

In small open economies, where capital can move freely across borders, domestic financing conditions are impacted not only by domestic savings but also the supply of net foreign savings through the balance of payments channel. Shifts in global savings and the resulting impact on the global neutral interest rate therefore impacts

[1] In addition, the neutral rate can be viewed as one of the guides for the path of monetary policy over the long term.

the domestic neutral rate. Importantly the domestic neutral rate may differ from the global neutral rate in the long run due to the level of the country's endogenous risk premium. If there is a trend increase in productivity growth for a country relative to its trading partners, the domestic neutral interest rate will rise as there will be a higher expected return on investments. Depending on foreign investors' risk appetite, the higher returns should: (1) incentivize capital inflows; (2) cause an appreciation of the exchange rate; (3) reduce the country's level of competitiveness; and (4) place downward pressure on investment returns (counteracting the upward pressure to the neutral rate). Therefore, the overall net impact on the neutral rate should be a smaller increase relative to a closed economy framework.

Laubach and Williams (2003) modelled the long–run neutral rate in a closed economy setting such that:

1 $$\bar{r}_t = cg_t + z_t$$

Where $\bar{r}_t$ is the time varying neutral rate, g_t is the growth rate of potential GDP in the domestic economy and z_t includes all other determinants of the neutral rate, such as private saving. Wynne and Zhang (2017) proposed an extension to this model to account for open economy determinants such that:

2 $$\bar{r}_t = cg_t + c^* g_t^* + z_t$$

Where g_t^* is the growth rate of potential GDP in the foreign country and z_t is extended to include variables that drive a wedge between the global and domestic neutral rate, such as the country's risk premium and the relevant risk free rate for the country's main trading partners.[2]

[2] Economies with high potential growth rates, due to strong productivity, tend to support expectations for higher future demand. This not only incentivizes firms to invest, but the prospect of future income growth reduces the incentive of households to save, together these factors tend to raise the neutral interest rate. As such, the prior sign on c is positive. Similarly, in an open economy because capital can move freely, global interest rates influence domestic interest rates so world productivity

There is a much uncertainty in the literature around the estimates for the neutral rate and most studies cite wide ranges for the neutral rate to capture this uncertainty. Among the recent literature on estimating the neutral rate in a small economy or emerging market context are Dacass (2011), Baksa *et al.* (2013), Kreptsev *et al.* (2016), and Grui *et al.* (2018). Dacass (2011) estimated the neutral rate for Jamaica using the methodology proposed by Laubach and Williams (2003). The author found that Jamaica's neutral rate had declined since the 1990's and that short term market interest rates were below the neutral rate between 2010 and 2011. Baksa *et al.* (2013), who estimated the neutral interest rate for Hungary, noted that the real uncovered interest parity condition as well as the Kalman filter could be considered as suitable techniques in cases where the neutral rate is viewed to be time varying. In particular, using the Kalman filter, the authors found that the real neutral rate for Hungary had declined to a range of 1.5% to 3.5% in 2012 from approximately 3.0% to 4.5% prior to 2003.

Kreptsev *et al.* (2016) developed a real business cycle general equilibrium model of the Russian economy to estimate both the contemporaneous (or short run) and long run neutral rate. Similar to Baksa *et al* (2013), the authors' indicated a high degree of uncertainty with regard to their estimates of the neutral rate. The contemporaneous neutral rate for Russia, based on semi structural methods, was estimated to range between -9.5% and 10.5% with a point estimate of 0.5%. For the long run equilibrium, the point estimates ranged between 1.0% and 3.0%. Grui *et al* (2018) estimated the neutral rate for Ukraine using an open economy forward-looking New-Keynesian Quarterly Projection Model. The authors found that there was a trend reduction in the neutral rate since 2015 due largely to a fall in the global neutral rate.[3]

growth will also impact the domestic neutral rate, hence the prior sign on c* is also positive.

[3] The smoothed estimates of the natural rate of interest in U.S. determined by the Laubach-Williams (2003) methodology was used as a proxy for the global neutral rate.

3. ESTIMATING THE NEUTRAL INTEREST RATE FOR JAMAICA

Given the absence of a consensus on the appropriate method of estimating the neutral rate and the sensitivity of estimates to model specification, we estimate the neutral rate using four methods, namely, a reduced form ordinary least squares (OLS) regression, a time varying vector auto regression (TVP-VAR), an applied dynamic stochastic general equilibrium (DSGE) model and the Hodrick-Prescott (HP) filter.

3.1 Reduced Form OLS

Following Mendes (2014), we employ a reduced form modeling approach that assumes that foreign and domestic factors impact the neutral rate for Jamaica. In a small open economy such as Jamaica, savings does not need to be equal to investments (from domestic sources), as the shortfall is financed by inflows of foreign capital. The domestic neutral rate may still differ from the global neutral rate, however, due to the risk premium.

The equation to be estimated is therefore derived from three conditions. These are:

a) The balance of payments identity:

3 $$S_t - I_t = NX_t + r_t^* NFA_t,$$

b) The NFA accumulation equation:

4 $$NFA_t = \left(1 + r_t^*\right) NFA_{t-1} + NX_t,$$

c) The linear approximation to the interest parity condition

5 $$r_t = r_t^* + E_t \Delta q_{t+1} + \left(\varphi_0 - \varphi_1 nfa_t\right),$$

Where; S is national savings, I is investments, NX is net exports, r is the domestic interest rate, r^* is the foreign interest rate, NFA is the net foreign asset position, q is the exchange rate, $nfa=NFA/Y$, which is the NFA to GDP ratio and $(\varphi_0 - \varphi_1 nfa_t)$ is the risk premium. In the long run, it is assumed that the processes driving the savings to GDP ratio and the investment to GDP ratio, denoted as $s = S / Y$ and $i = I / Y$ respectively, take the following form:

6
$$s = \alpha_s + \beta_{s,r} r$$

7
$$i = \alpha_i + \beta_{s,r} r + \beta_{i,g} g$$

Setting g as the growth rate of potential output.

To simplify, Mendes (2014) assumes that $\varphi_0 = 0$. Solving for the steady state of equations (3) to (5) and using the linear approximations for savings and investments from equation (6) and (7) yields the following reduced form equation:

8
$$r = \alpha + \beta_0 g + \beta_1 r^*$$

Two versions of equation (8) are estimated using OLS (See Table 1). The first equation models the ex-post 90-day real Treasury bill rate without dynamics (long run model), while the second includes short run dynamics. All interest rates were converted to real terms prior to estimation. Given the time varying nature of the neutral interest rate as well as the lower interest rate levels in Jamaica since the late 2000s, we use 74 observations (which equates to data spanning from March 2000 to September 2018). We also add dummy variables (0 for normal and 1 for crisis) to separate the effects of crisis or shock events. In this regard, dummies are included to capture the effect of a fiscal shock that impacted Jamaica in 2003, the pre and post global financial crisis (2007 and 2008) and the structural adjustment programme with the IMF. The economic reform programme is modelled by incorporating a shift and slope dummy. A shift dummy is used to capture the initial uncertainty that surrounded the beginning of the adjustment programme, particularly with regard to the sustainability of Jamaica's debt trajectory. The slope dummy, on the other hand, which is interacted with potential output, captures the successful implementation of the economic reform programme by the Jamaican authorities.

Using the estimated parameters, we calculate the long run neutral rate based on assumptions for the historical growth rate in potential output in Jamaica (a proxy for the long run) and the long run foreign neutral rate. The historical growth rate in potential output for Jamaica was estimated to be 0.4%. This estimate was determined within a small scale macroeconomic model which was solved using the Kalman filter over the period March 1995 to September 2018. The estimate is marginally below the recent findings by Scarlett (2019) who used a production function approach to estimate potential output for Jamaica. Using this approach, the estimated growth rate in potential over a similar period was 0.7%. The long run foreign neutral rate, was assumed to be 0.75%. Based on these assumptions, both models imply a long run neutral rate of approximately 2.6%. Interestingly, the results imply that domestic factors (i.e., the growth rate of potential output) are more important than foreign factors in determining the neutral rate. In addition, if we switch on the IMF slope dummy (to capture the long run implications of Jamaica's economic reform programme) the long run neutral rate declines to -0.8%.

Figure 1 plots the contemporaneous as well as the long run neutral rate based on the model without short run dynamics. This methodology indicates that the neutral rate has been decreasing. Over the period January 2000 to December 2009 the neutral rate averaged 4.0% compared with an average of 0% over the period January 2010 to September 2018. The decline coincided with significant economic reforms following the engagement of the International Monetary Fund in February 2010. The economic reform programme, pursued by Jamaican authorities since 2010, focused on fiscal consolidation as well as refining the monetary policy framework. In this regard, the reduction in the neutral interest rate over the last decade possibly reflected an increase in private savings (outward shift in the supply of funds) driven by fiscal consolidation which influenced a reduction in public debt. This significant change in the fiscal stance has unmasked a very risk averse domestic financial sector which does

Table 1

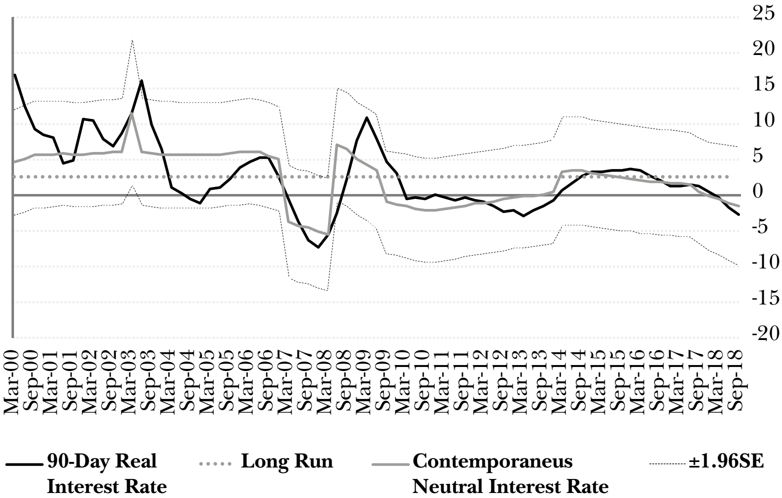
REGRESSION RESULTS (EQUATION 8)

	Dependent Variable *90-day T-bill rate (r)*	*Dependent Variable* *90-day T-Bill rate (r)*
	(1)	*(2)*
Potential growth rate (g)	5.358***	1.199***
	(0.701)	(0.400)
US LIBOR (r*)	0.404	0.315**
	(0.287)	(0.138)
90-Day T-bill(−1) (r −1)		1.038***
		(0.109)
90-Day T-bill(−2) (r −2)		-0.329***
		(0.100)
2007 Pre Fin Crisis Dummy	−8.332***	−3.028***
	(1.705)	(0.888)
Global Fin Crisis Dummy	4.078**	1.410*
	(1.673)	(0.824)
2003 Fiscal Shock Dummy	5.463	3.716**
	(3.786)	(1.662)
IMF Dummy*(g)	−8.057***	−2.187**
	(1.633)	(0.756)
IMF Dummy	4.094***	1.571
	(1.475)	(0.669)
R^2	0.480	0.904

Notes: (***), (**), and (*) denotes statistical significance at the 1.0, 5.0, and 10.0% level, respectively.

Figure 1

INTEREST RATE AND INFLATION



not accommodate compensation increases in private, albeit more risky, demand for savings.

A drawback of the reduced form OLS approach is the high degree of uncertainty in the estimation as displayed by the width of the 95% confidence intervals. In addition, as stated by Mendes (2014), the coefficients are highly sensitive to the sample period used. This method is therefore not appropriate to determine the forecast for the neutral rate. However, it identified a reduction in the neutral rate following the 2008 financial crises and signalled that the Central Bank's monetary policy stance has been fairly accommodative since early 2018.

3.2 Time Varying Parameter VAR

Given that the neutral rate is time varying and susceptible to demographic and structural changes in the economy, we estimate a time varying parameter VAR (TVP-VAR). Unlike Markov switching models or threshold VARs, TVP-VARs do not assume discrete changes between states. In particular, TVP-VARs are well suited for cases where a priori information suggests that there is non-linear behaviour in the data (Lubik and Matthes (2015)). This flexible framework avoids the restrictions imposed in structural models and allows for variation in model parameters (i.e., lag coefficients and the variances of the economic shocks) smoothly over time. However, the main drawback of this model, is that it is computationally demanding. The posterior simulation algorithm requires thousands of draws to ensure proper convergence.

To determine the neutral rate for the U.S., Lubik and Matthes (2015) estimated a three (3) variable TVP-VAR using real GDP growth (τ_t), inflation (π_t) and the real interest rate (r_t). We estimate a similar TVP-VAR with forgetting factors as proposed by Koop and Korobilis (2012). The model is estimated using quarterly data for the real interest rate, real GDP growth and inflation for Jamaica over the period March 2000 to September 2018.

The state space representation of the model is:

9
$$Y_t = \theta_t X_t + \varepsilon_t$$

10
$$\theta_t = \theta_{t-1} + \mu_t$$

Where, ε_t is i.i.d. $N(0, V_t)$ and μ_t is i.i.d. $N(0, Q_t)$. ε_t and μ_t are independent of each other for all s and t.

Additionally:

11
$$X_t = I * (Y_{t-1}, \ldots, Y_{t-p})$$

12
$$V_t = \varepsilon_{t-1}\varepsilon'_{t-1}$$

13 $$Q_t = \left(1 - \frac{1}{\lambda}\right) S_{t-1|t-1}$$

Where Y_t is a vector of variables: $\{r_t, \tau_t, \pi_t\}, \lambda$ is the forgetting factor, which implies that observations j periods in the past have a weight of λ^j in the filtered estimate of θ_t. The constant coefficient case can be estimated by setting $\lambda = 1$, while $\lambda = 0.99$ implies that observations five years ago receive approximately 80% as much weight as last period's observations (See Koop and Korobilis (2012) for discussion of forgetting factor approach). We set $\lambda = 0.99$.

With regard to the priors, we assume that θ_0 follows the typical Minnesota prior. All our data has been transformed to ensure stationarity, hence we set the prior mean to be $E(\theta_0) = 0$. Assuming a diagonal Minnesota prior covariance matrix, then $Var(\theta_0) = \eta$ and η_i denotes the elements along the diagonal such that:

14 $$\eta_i \begin{cases} \gamma / t^2 & \text{for coefficients on lag } t, \text{ for } t = 1, \ldots, p \\ \alpha & \text{for constants} \end{cases}$$

With regard to the hyperparameters, we set $\alpha = 10^2$, which is uninformative. For γ, which controls the degree of shrinkage in the VAR coefficients, we test the model's sensitivity to alternative specifications. In this regard, we impose:

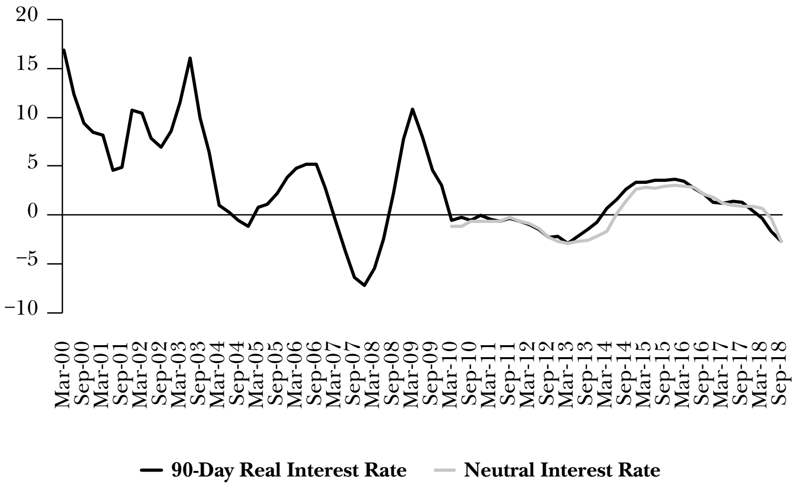
15 $$\gamma = [e-10,\ e-5,\ 0.001,\ 0.005,\ 0.01,\ 0.05,\ 0.01]$$

The neutral rate for Jamaica is determined using the conditional forecast generated by the TVP-VAR for the observed real rate. The forecast horizon is set at two years ahead and it is computed for each data point since 2010. This differs from Lubik and Matthes (2015) who proposed a conditional forecast 5-years ahead. That period was chosen to reflect the typical length of the U.S. business cycle. According to Murray (2007), Jamaica's business cycle typically ranges between two to four years.

Figure 2 plots the neutral rate, based on the two year ahead conditional forecast of the real interest rate from March 2010, and the actual real rate. Consistent with expectations, this methodology implies that the neutral rate has declined from 3.0% in December 2015

Figure 2

TWO YEAR AHEAD CONDITIONAL FORECAST OF THE REAL INTEREST RATE



to -2.6% in September 2018. The results also suggest that interest rates exceeded their neutral or equilibrium level between 2013 and early 2016. During this period, Jamaica's output gap was largely negative while inflation decelerated sharply from approximately 6.0% in January 2013 to below 3.0% by end 2016. Given the weakness in Jamaica's monetary transmission mechanism, this finding may suggest that more monetary accommodation was required to spur growth and to achieve the central bank's inflation target of 5.0%.

Similar to the results of the reduced form OLS, this methodology also identified an easing of the Central Bank's monetary policy stance starting in early 2018. The main shortcoming of this methodology, however, is that it does not include global determinants of the neutral rate given the lack of a risk premium and global neutral rate in the model. The results may therefore be interpreted as a signal of the floor for real rates given the absence of this wedge.

3.3 Applied DSGE – Quarterly Projection Model

An estimate of the neutral rate is determined using an applied DSGE model - the Bank of Jamaica 'Quarterly Projection Model – QPM.' This is a semi-structural, small-scale, forward-looking, open economy gap model with rational expectations. The output gap is dependent on real monetary conditions (a weighted average of the real interest rate gap and the real exchange rate gap) and the inflation rate is dependent on the output gap (the traditional Philips curve). In addition, monetary policy is endogenously determined. Whilst the QPM is still in its development stages, it is calibrated to reflect the main stylised facts of the Jamaican economy and used to explain the core macroeconomic dynamics in Jamaica. Underlying the main theoretical principles are five (5) transitional behavioural equations:

Investment/Saving (IS) Curve

The output gap $(\hat{y})$ is defined as a deviation of the log of real output from its potential level and modelled as:

16 $$\hat{y} = a_1 \hat{y}_{t-1} + a_2 E_t \hat{y}_{t+1} - a_3 * \left(rmci_{t-1} \right) + a_4 \hat{y}_t^* + a_5 fiscimp_t + \varepsilon_t^{\hat{y}}$$

17 $$rmci_t = aa_1 \hat{r}_t + \left(1 - aa_1\right)\left(-\hat{z}_t\right)$$

On a quarterly basis, the current output gap depends on its lagged estimates and model consistent expected values $\left(\hat{y}_{t-1} \text{ and } E_t \hat{y}_{t+1}\right)$. Furthermore, it captures aggregate demand dynamics between real monetary conditions ($rmci_t$). This is a weighted sum of the real interest rate deviation ($\hat{r}_t$) from its neutral (noninflationary) equilibrium level and the deviation of the real effective exchange rate ($\hat{z}_t$) from its equilibrium level. In this regard, tight monetary policy reduces the output gap either through higher real interest rate or stronger real exchange rate. Loose monetary policy has the opposite effects. External demand dynamics are accounted for in terms of the U.S. output gap ($\hat{y}_t^*$), since the United States is Jamaica's major trading partner. And finally, the IS curve includes the impact of the fiscal impulse ($fiscimp_t$) and an aggregate demand shock ($\varepsilon_t^{\hat{y}}$).

Aggregate Supply Curve

Inflation dynamics are modelled through the standard open economy forward-looking Phillips curve:

18
$$\pi_t = b_1 E_t \pi_{t+1} + \left(1 - b_1 - b_2 - b_3\right)\pi_{t-1} + b_2\left(\Delta s_t + \pi_t^* - \Delta\overline{z}\right) + b_3\left(\Delta oil_{t-1} + \Delta s_t - \Delta\overline{oil_{t-1}} - \Delta\overline{z}\right) + b_4 * \left(rmc_{t-1}\right) + \varepsilon_t^{\pi}$$

19
$$rmc_t = \left(bb_1 + bb_2\right)\hat{z}_t + bb_2 \widehat{rp}_t^{oil} + \left(1 - bb_1 + bb_2\right)\hat{y}_t$$

Current headline inflation (QoQ, at an annualized rate) depends mostly on the projected future and past levels for inflation. It also includes imported inflation, which consists of changes in the nominal exchange rate (Δs_t), U.S. inflation (π_t^*), and changes to the real exchange rate trend ($\Delta\overline{z}$). Because Jamaica is largely dependent on fuel imports, the PC relationship features an imported oil component $(\Delta oil_{t-1} + \Delta s_t - \Delta\overline{oil_{t-1}} - \Delta\overline{z})$. Furthermore, real marginal costs $\left(rmc_{t-1}\right)$, a reflection of demand pressures or the output gap, and the intensity of oil prices and real exchange rate on production, contributes to headline inflation.

Monetary Policy Rule

The short-term policy interest rate (i_t), is set according to a standard forward-looking monetary policy reaction function with an aim to stabilize inflation:

20
$$i_t = c_1 i_{t-1} + \left(1 - c_1\right)\left(i_t^n + c_2 \pi_{t+3}^{dev} + c_3 \hat{y}_t\right) + \varepsilon_t^i$$

The equation features a smoothing of the policy rate, to reflect the fact that in practice, the Bank of Jamaica does not typically change the policy rate in large increments. Furthermore, the policy rate reacts to the nominal equilibrium interest rate, which is a sum of the real neutral interest rate and the Bank's five percent inflation target. The policy rate also responds to inflation deviations from the target one year ahead, in addition to the output gap.

Uncovered Interest Rate Parity in Real Terms

The real neutral interest rate ($\overline{r}_t$) is determined as a function of the U.S. equilibrium real interest rate, Jamaica's sovereign risk premium, and expected changes in the real exchange rate.

21 $$\overline{r}_t = \overline{r}_t^* + \overline{prem}_t + \Delta\overline{z}_t$$

Where $\overline{r}_t^*$ is the US real interest rate trend, $\overline{prem}$ is Jamaica's country sovereign risk premium, $\Delta\overline{z}$ is the expected change in the real exchange rate (an increase is a depreciation).

In this regard, the domestic neutral real interest rate must cover yield expectations in the U.S. capital market. Therefore, the domestic rate must satisfy the arbitrage condition such that the differential between domestic and U.S. interest rates must equate to Jamaica's sovereign risk premium plus expected changes in the real exchange rate.

Results

Using the Kalman filter, we estimate the neutral real interest rate and its determinants, namely the real exchange rate trend and risk premium (Figure 3). The filtration approach implies that monetary policy was relatively tight in the periods 2000 to 2003 and in early 2009. This followed times of extreme inflationary pressures (the former being Jamaica's domestic market financial crisis FINSAC in the 1990's, and the latter being the shock from the Global Financial Crisis in 2008). Since 2016, monetary policy based on this estimate, has been fairly accommodative. Therefore, the Kalman filter does relatively well in capturing these pivotal shifts and ultimately helps to identify changes in the policy stance. Given the assumption of a U.S. neutral rate of 0.75%, zero change in the equilibrium exchange rate and premium of -0.75%, the long run neutral rate using this methodology is estimated at 0%.

The trend in the U.S. neutral rate is estimated by a weighted equation that includes inertia and a steady state of 0.75%. Note that the prevailing low interest rate environment around the globe is captured in the foreign real interest rate equation post-2007 after the financial crisis, and has remained close to zero since 2017.[4] Simultaneously, while these external yields spilled over into Jamaica's domestic market, fiscal and debt

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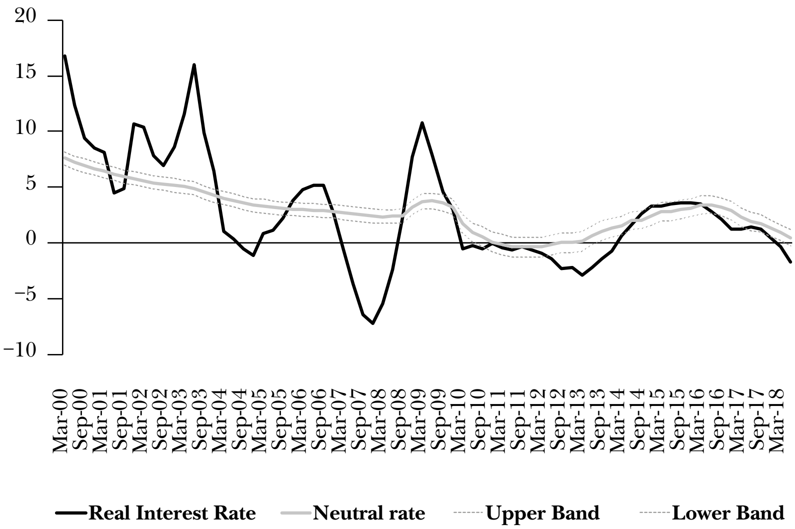
[4] Grui *et al.* (2018) and Holsten *et al.* (2017) characterize this as a reflection of the global savings glut, ageing population, and slowing potential growth.

Figure 3

REAL INTERES RATE



sustainability improved due to the economic reform program; hence the country's sovereign risk premium trended lower (See Figure 4). Faster domestic productivity growth also influenced an appreciation in the real exchange rate trend. There were some periods of major depreciations in mid-2018 that caused some trend reversal, but in recent times the trend has appeared relatively stable.

3.4 HP Filter

The HP filter was also used to estimate the neutral rate with quarterly data for the period March 1994 to September 2018 (See Figure 5). To avoid end of sample bias, forecasts of the real rate were included up to the March 2020 quarter.

The HP filter implies that the neutral rate declined to -0.6% in September 2018, which was above the estimated real rate. Consistent with the reduced form OLS and TVP-VAR, the filter identifies that interest rates have been below their neutral level since early 2018.

Figure 4

REAL UIP DECOMPOSITION

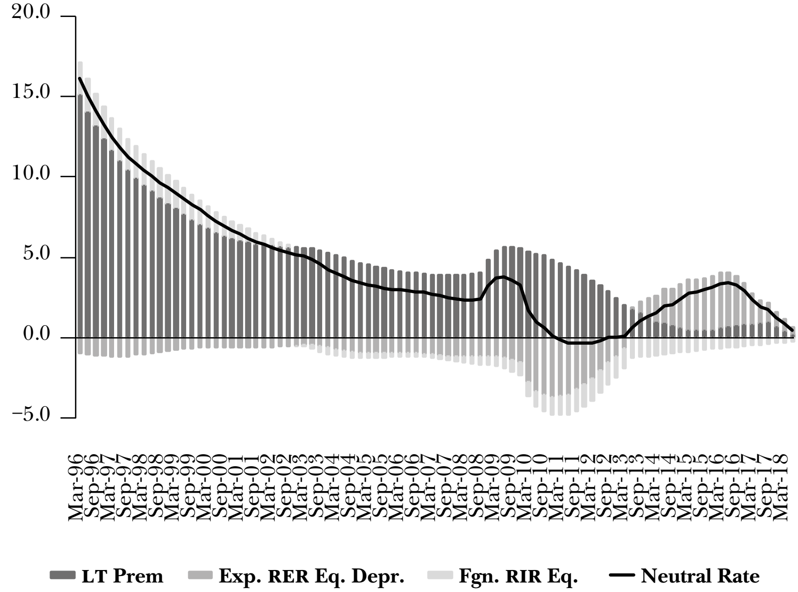


Figure 5

HP FILTER

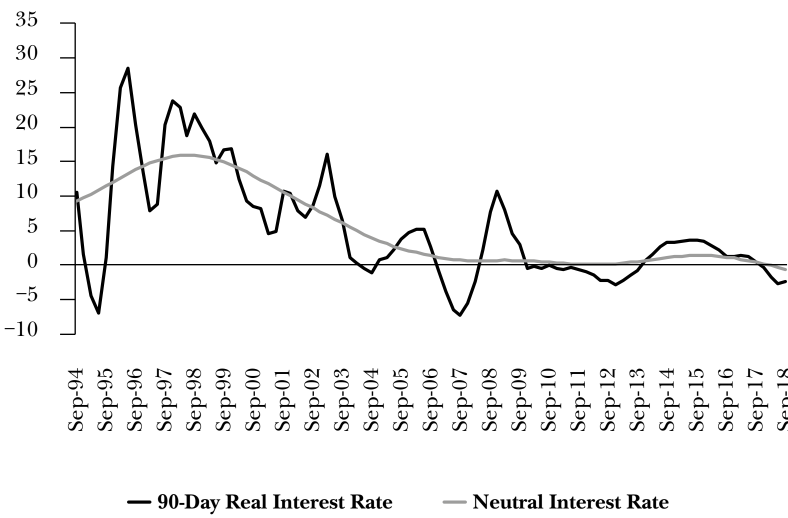
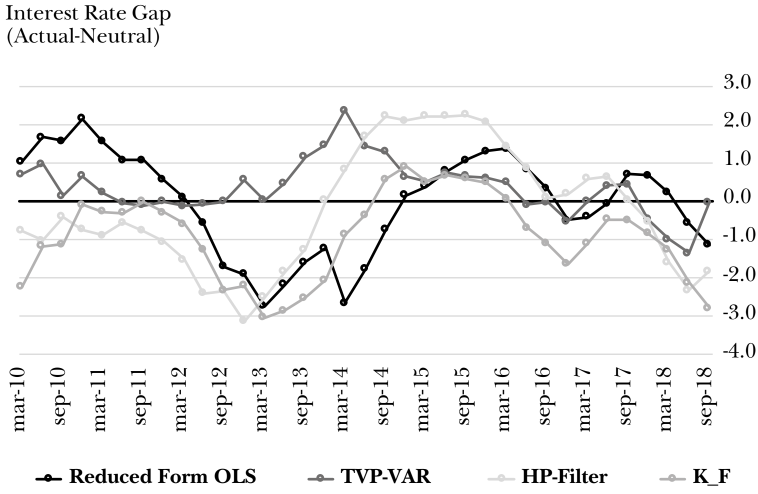


Figure 6

INTEREST RATE GAP



4. STATISTICAL PROPERTIES OF THE ESTIMATED REAL INTEREST RATE GAPS FOR JAMAICA

This section assesses the statistical properties of the estimated neutral rates from the four methodologies. We first evaluate the relative trends and relative levels of the various measures of the neutral rate before assessing their relative abilities to predict inflation. Figure 6 compares the real interest rate gaps computed by each methodology. The graph shows that, by all the measures, monetary policy became increasingly accommodative since late 2017 throughout most of 2018. At September 2018, the range of accommodation was between 0% and -2.4%.

The information content of each estimate of the real interest rate gap is first assessed based on their correlations with inflation (headline and core) and the output gap (see Table 2). All of the models indicated, appropriately, a moderate negative correlation of the real interest rate gap with the output gap over the first four quarters.

The reduced form OLS estimate displayed the strongest negative correlation with the output gap over four quarters. The neutral rate based on the HP filter was the least correlated with the output gap and underperformed relative to the TVP-VAR. With regard to headline inflation, the results were mixed. With the exception of the TVP-VAR, all measures were weakly negatively correlated with headline inflation up to four quarters.

All models performed better when assessed relative to core inflation. Over the first three lags the gaps based on the TVP-VAR estimate implied a positive relationship with core inflation which is contrary to a priori expectations. Interestingly, however, the TVP-VAR gaps displayed the strongest negative correlation with core inflation between six and eight lags. This is not surprising, given the conditional forecast framework used in the estimation. The gaps determined using the Kalman and HP filter displayed the strongest negative correlation with core inflation at two to four lags.

While the correlations imply that underlying inflation in Jamaica, since 2000, has been related to changes in the real interest rate gap, a more robust assessment is required to determine the usefulness of the gaps in predicting inflation. The leading indicator properties of the gaps for inflation may be investigated using the approach suggested by Garnier and Wilhelmsen (2008) and Neiss and Nelson (2003). These authors proposed a regression of inflation (π_t) on a constant, its lagged value (π_{t-1}) and lagged values of the real interest gap ($\widehat{r_{t-k}}$)such that:

22 $$\pi_t = a + b_1\pi_{t-1} + b_2\widehat{r_{t-k}} + \varepsilon_t$$

23 $$\widehat{r_{t-k}} = r_{t-k} - \overline{r_{t-k}}$$

Given Jamaica's susceptibility to supply shocks, we modify this approach by assessing the leading indicator properties using core inflation, which removes the impact of the volatile agriculture and energy components from headline inflation. Table 3 – 5 shows the results of the regression of core inflation on the estimate of the neutral rate determined using the TVP VAR, the Kalman Filter and the HP filter.

Table 2

CORRELATION COEFFICIENTS

	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$	$k = 6$	$k = 7$	$k = 8$
Real Interest Rate Gap based on TVPVAR								
Corr $\left(\hat{r}_t, \widehat{r_{t-k}}\right)$	0.76	0.55	0.29	0.19	0.21	0.14	−0.02	−0.21
Corr $\left(\pi_t, \widehat{r_{t-k}}\right)$	0.53	0.41	0.24	0.08	−0.01	−0.18	−0.27	−0.43
Corr $\left(\text{Core } \pi_t, \widehat{r_{t-k}}\right)$	0.46	0.29	0.03	**−0.24**	**−0.37**	**−0.50**	**−0.52**	**−0.57**
Corr $\left(\hat{y}_t, \widehat{r_{t-k}}\right)$	−0.25	−0.23	−0.04	0.05	0.09	0.13	0.11	0.26
Real Interest Rate Gap based on Reduced Form OLS								
Corr $\left(\hat{r}_t, \widehat{r_{t-k}}\right)$	0.65	0.40	0.18	0.08	−0.06	0.01	0.01	−0.04
Corr $\left(\pi_t, \widehat{r_{t-k}}\right)$	**−0.23**	−0.20	−0.14	−0.08	−0.03	0.01	−0.01	−0.02
Corr $\left(\text{Core } \pi_t, \widehat{r_{t-k}}\right)$	**−0.36**	−0.27	−0.14	−0.01	0.10	0.12	0.08	0.08
Corr $\left(\hat{y}_t, \widehat{r_{t-k}}\right)$	−0.27	−0.19	−0.18	−0.22	−0.30	−0.28	−0.29	−0.31
Real Interest Rate Gap based on Kalman Filter								
Corr $\left(\hat{r}_t, \widehat{r_{t-k}}\right)$	0.84	0.50	0.12	−0.13	−0.27	−0.32	−0.27	−0.10
Corr $\left(\pi_t, \widehat{r_{t-k}}\right)$	−0.18	**−0.25**	**−0.27**	−0.21	−0.10	0.03	0.12	0.14
Corr $\left(\text{Core } \pi_t, \widehat{r_{t-k}}\right)$	−0.30	**−0.40**	**−0.39**	−0.25	−0.06	0.12	0.25	0.28
Corr $\left(\hat{y}_t, \widehat{r_{t-k}}\right)$	−0.25	−0.14	−0.05	−0.03	−0.03	0.01	0.06	0.09
Real Interest Rate Gap based on HP Filter								
Corr $\left(\hat{r}_t, \widehat{r_{t-k}}\right)$	0.81	0.44	0.06	−0.24	−0.44	−0.53	−0.51	−0.39
Corr $\left(\pi_t, \widehat{r_{t-k}}\right)$	−0.05	−0.18	−0.27	**−0.31**	**−0.28**	−0.21	−0.11	−0.06
Corr $\left(\text{Core } \pi_t, \widehat{r_{t-k}}\right)$	−0.11	−0.31	−0.42	**0.44**	**−0.32**	−0.17	−0.02	0.06
Corr $\left(\hat{y}_t, \widehat{r_{t-k}}\right)$	−0.12	−0.09	−0.03	0.00	−0.01	−0.05	−0.07	−0.07

Interestingly, the TVP VAR yielded the best results in terms of the sign and significance of the real interest rate gap in explaining underlying inflation. The results indicate that lags of the real interest gap up to the fifth quarter are statistically significant when included in a simple autoregression of core inflation. This is consistent with the view that inflation typically displays a delayed response to monetary policy actions. The Kalman filter estimate of the real interest rate gap yielded the appropriate sign and significance up to two quarters. This is faster than expected given the lags in the transmission mechanism. The HP filter implied that lags of the interest rate gap up to three quarters were statistically significant and appropriately signed.

The interest gaps deduced from the reduced form OLS model underperformed relative to the three other estimates (See Table 6).

Table 3

REGRESSION RESULTS-TVPVAR INTEREST RATE GAP (EQUATION 22)

	TVPVAR Regressions				
	k = 1	*k = 2*	*k = 3*	*k = 4*	*k = 5*
a	0.44	0.67	0.72	1.14	0.91
b_1	0.90	0.86	0.90	0.85	0.87
b_2	−0.19	−0.23	−0.78**	-0.98***	−0.62*
	(−0.59)	(−0.72)	(−2.52)	(−3.33)	(−1.97)
R^2	0.87	0.86	0.86	0.86	0.85

Table 4

REGRESSION RESULTS–KALMAN FILTER INTEREST RATE GAP (EQUATION 22)

	Kalman				
	k = 1	*k = 2*	*k = 3*	*k = 4*	*k = 5*
a	1.25	1.36	1.08	0.52	0.52
b_1	0.86	0.85	0.88	0.94	0.94
b_2	−0.23***	−0.18**	−0.03	0.19*	0.24*
	(−3.38)	(−2.34)	(−0.32)	(2.39)	(3.33)
R^2	0.82	0.81	0.79	0.80	0.82

Table 5

REGRESSION RESULTS – HP FILTER INTEREST RATE GAP (EQUATION 22)

	HP Filter				
	k = 1	*k = 2*	*k = 3*	*k = 4*	*k = 5*
a	0.53	1.04	1.28	1.14	0.58
b_1	0.92	0.87	0.85	0.87	0.93
b_2	−0.31***	−0.29***	−0.21***	−0.09	0.12
	(−4.68)	(−4.27)	(−2.86)	(−1.12)	(1.49)
R^2	0.84	0.83	0.81	0.79	0.80

Table 6

REGRESSION RESULTS – REDUCED FORM OLS INTEREST RATE GAP (EQUATION 22)

	Reduced Form OLS				
	k = 1	*k = 2*	*k = 3*	*k = 4*	*k = 5*
a	1.23	0.72	0.63	0.74	0.48
b_1	0.87	0.92	0.92	0.91	0.94
b_2	−0.09	0.08	0.15	0.19	−0.01
	(−1.13)	(0.94)	(1.94)	(2.60)	(−0.25)
R^2	0.79	0.79	0.80	0.80	0.88

5. CONCLUSION

This paper presents a comprehensive review of four methodologies typically used to estimate the neutral rate for a small open economy. We find that accounting for time variation improves the statistical properties of the estimated interest rate gaps. In this regard, three of the four methodologies (TVP-VAR, Kalman Filter and HP Filter) yielded promising results in terms of their ability to forecast inflation. All methodologies implied that Jamaica's neutral rate has declined over the last five years. This is consistent with improvements in the country's risk premium induced by extensive economic reform during that period. Further demographic and structural changes should continue to support a low interest environment over the long run.

Based on our estimates, monetary conditions in Jamaica have been fairly accommodative since late 2017, which should support the authorities' inflation and growth objectives. The point estimate for the long-run neutral rate is found to range between -2.6% to 2.6% or (2.4% to 7.6% in nominal terms). However, given that the neutral rate is unobservable, there is a high level of uncertainty with regard to its estimation. It is therefore important to support these estimates with robust discussions on the trends in the main macroeconomic variables as well as the effectiveness of the transmission mechanism of monetary policy.

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