Working Paper

Evaluating the Transmission Mechanism of Monetary Policy in Jamaica: A Factor-Augmented Vector Autoregressive (FAVAR) Approach with Time Varying Coefficients

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Abstract

Monetary policy in Jamaica has been conducted on the premise that the maximum effect of a policy action on inflation occurs two to three quarters after the adjustment and that the dominant channel in the mechanism is the exchange rate. This paper extends the work of Allen and Robinson (2004) by utilizing a factor augmented time varying vector autoregression (TV-FAVAR) to assess the impact of monetary policy shocks on macroeconomic variables in Jamaica. Common factors are extracted from an expanded data set of 65 quarterly Jamaican macroeconomic indicators spanning 1998Q1 - 2015Q4. These indicators include data on economic activity, inflation, money & credit, nominal Treasury bill rates and equity prices which are typically assessed by the Central Bank when determining monetary policy actions. Impulse response analysis is undertaken for innovations in two periods: 2001 Q1 and 2012 Q1. The first period was characterized by *'high'*/double-digit policy rates while the second represents the beginning of consistent *'low'*/single digit policy rates. The results suggest that the transmission of policy rate adjustments to inflation has evolved over the time period. In particular, the adjustment to the policy rate has the largest impact on inflation five to eight quarters ahead, towards the end of the time period. In addition we found that the impact of a policy adjustment on the exchange rate is larger and longer lasting than in the early 2000's.

Keywords: Monetary Transmission Mechanism, price puzzle, Time Varying FAVAR
JEL Classifications: E32, E52, E58, C11

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1. Introduction

Monetary policy in Jamaica has been conducted with the understanding that policy action has a maximum impact on inflation two to three quarters after the change in the interest rate and that the dominant channel is the exchange rate channel. This is based on the results of a series of research conducted in the early 2000s.[1] Subsequent to this body of research that has guided monetary policy, the advent of the global financial crisis, debt restructuring and the implementation of an economic transformation programme which involves sharp fiscal consolidation, major tax and business reforms, have and are inducing changes in the structure of the economy. Lower and less volatile inflation and interest rates are some signs of this structural change. While it is still early days in the transformation process, given the importance of a clear understanding of the monetary transmission to monetary policy, this paper examines whether there has been any substantial change in the transmission mechanism in light of the major economic developments since 2010.

We account for the evolution of the economy and consequently changes in the monetary transmission mechanism by estimating a vector autoregressive model (VAR) with time varying parameters. Traditionally, there are two main approaches to modeling changes in the transmission mechanism – estimating the models over subsamples (Clarida et al (2000)) or modelling the change in the coefficients in the VAR using structural breaks or a Markov switching regime (Stock and Watson (1996), Sims and Zha (2006)). The main problem with these approaches is that they assume abrupt changes in the economy. However, it is more likely that changes in the transmission mechanism take place more gradually. Consequently, time-varying VARs (TV-VAR), in which the coefficient change follows a random walk, have been increasingly used in studying changes in transmission mechanisms (Primiceri (2005), Canova et al (2007), Baumeister and Benati (2010), Bianchi et Al (2009), Mumtaz and Sunder-Plassmann (2010)).

A major issue in the use of VARs in analyzing the impact of policy is the ability to accurately identify monetary policy innovations given the use of a small number of variables. This arises as in order to ensure sufficient degrees of freedom, VARs are constrained to using a small number of variables. Bernanke, Boivin and Eliasz (2005), argued that low-dimensional VARs, which typically use less than eight variables, are ‘unlikely to span the information sets used by actual

[1] See Bank of Jamaica Quarterly Monetary Policy Report-March 2009 for a summary of research on the monetary transmission mechanism in Jamaica.

central banks.' Omitting critical variables may result in biased estimates and incorrect identification of structural innovations (Bernanke et al (2005)) and Stock and Watson (2005)). In this regard the resulting impulse response functions may display responses which are incongruous with economic theory. A classic example of this in the literature is the 'price puzzle' where some models suggest that inflation increases over the long term in response to monetary tightening. In addition, and even more concerning, is the fact that a researcher is limited to observing the impact of monetary policy shocks on a restricted subset of macroeconomic indicators. Korobolis (2009), Moussa (2010) and Mumtaz (2010), among others, extended the standard TV-VAR models to include factor analysis. The resulting TV-FAVAR model offers a solution to the dimensionality issue while allowing for time variation in both the coefficients and covariance matrix.

Similar to Korobolis (2009) this paper extends the work of Allen and Robinson (2004) by assessing the impact of monetary policy shocks on macroeconomic variables in Jamaica using TV-FAVAR model. This model includes a large data set of variables typically monitored by the Central Bank. In this regard common factors are extracted from 65 quarterly Jamaican macroeconomic indicators spanning 1998Q1 - 2015Q4 using principal component analysis. These indicators include data on economic activity, inflation, money, credit and equity prices which are assessed by the Central Bank when determining monetary policy actions.

The results indicate that the impact of changes in interest rates on inflation in Jamaica has evolved in the 'low'/single digit sub period relative to the 'high'/double digit interest rate period. In contrast to previous studies which suggested that monetary policy had the largest impact on inflation two to three quarters following the shock to interest rates the results suggest the largest impact on inflation occurs five to eight quarters following the shock. The impact of the interest rate adjustment on inflation, however, lasts for approximately five years in both of the periods of study. The results also indicate that the impact of an interest shock on the exchange rate is larger and longer lasting in the post 2010 period relative to the 'high'/double digit period. In addition the exchange consistently appreciates before returning to equilibrium in both periods. This is contrary to Allen and Robinson (2004), who found evidence of a tendency for the exchange rate to overshoot following an appreciation after the shock to monetary policy. With regard to economic activity, the impact of the policy shock on growth is larger in the 'high'/double digit sub period relative to the 'low'/single digit interest rate period.

The paper is organized as follows. Section 2 outlines the methodology used in the study. Section 3 provides a review of the estimation strategy. Section 4 describes the data and specification tests. Section 5 outlines the key empirical results for the Jamaican economy. Section 6 concludes with a discussion of the key policy lessons.

2. Methodology

2.1. Time Varying Factor Augmented VARs (TV-FAVAR)

The workhorse model for most assessments of the impact of monetary policy on the economy is the typical VAR of the following form

$$y_t = \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \varepsilon_t \quad (1)$$

$$\varepsilon_t \sim N(0, \Omega) \quad (2)$$

where $y_t' = [x_t', i_t]$, x_t is a $(n \times 1)$ vector of macroeconomic variables that feature in the Central Bank's information set and i_t is the policy interest rate. Due to dimensionality issues, however, the information set used in VARs are limited to the main macroeconomic indicators (GDP, inflation, monetary aggregates etc.). In addition, the assumption that the coefficients are stable over time overlooks the importance of business cycle dynamics and the evolution of monetary policy. The latter suggests the need for time varying coefficients while the former implies the need for a factor augmented VAR framework.

In this paper, we estimate a TV-FAVAR of the following form:

$$y_t = \lambda_{0t} + \lambda_{1t} y_{t-1} + \cdots + \lambda_{pt} y_{t-p} + \varepsilon_{it} \quad (3)$$

or

$$\hat{\Gamma}(L)\hat{y}_t = \widehat{\varepsilon_{it}}$$

where $y_t' = (f_t', \, i_t)$ such that the VAR (State) equation is:

$$\begin{pmatrix} f_t \\ i_t \end{pmatrix} = \widetilde{\emptyset_1} \begin{pmatrix} f_{t-1} \\ i_{t-1} \end{pmatrix} + \cdots + \widetilde{\emptyset_p} \begin{pmatrix} f_{t-p} \\ i_{t-p} \end{pmatrix} + \widetilde{\varepsilon_t^f} \quad (4)$$

$$\widetilde{\varepsilon_t^f} \sim N(0, H_t) \tag{5}$$

In this regard, y_t includes both unobserved factors, f_t, which is a (K × 1) vector of latent factors and an observable factor, the policy interest rate, i_t, which is a (M × 1) vector.

Given that equation 4 cannot be estimated directly, the paper uses a two-step procedure. First we estimate the factors using principal component analysis (PCA). The factor (Observation) equation, with drifting coefficients, is given as:

$$x_t = \gamma_t^f f_t + \gamma_t^i i_t + \mu_t \tag{6}$$

$$\mu_t \sim N(0, R_t) \tag{7}$$

where x_t is a (N × 1) vector of economic time series, γ_t^i and γ_t^f are (N × K) and(N × M) matrices of factor loadings, and μ_t is an (N × 1) vector of error terms. As noted by Bernanke (2005), N is assumed to be 'large', (i.e. N can be greater than the number of time periods and far exceeds the number of factors) such that it captures all the economic indicators used by the central bank when making policy decisions. It is important to note that PCA assumes that the error term, μ_t, is weakly correlated with mean zero. To identify the factors, the following restriction is applied:

$$\gamma_t^{f\prime} \gamma_t^i / N = I$$

To identify the structural model, we use a triangular reduction of the VAR (State) error covariance as suggested by Korobolis (2009) and Primiceri (2005) where:

$$A_t H_t A_t' = \Sigma_t \Sigma_t' \tag{8}$$

Or

$$H_t = A_t^{-1} \Sigma_t \Sigma_t' (A_t^{-1})' \tag{9}$$

To simplify the notation, assume $\Sigma_t \Sigma_t' = \Omega_t$. The time varying matrices $A_t$and Ω_t are defined as:

$$\Omega_t \equiv \begin{bmatrix} \Omega_{1,t} & 0 & \cdots & 0 \\ 0 & \Omega_{2,t} & \cdots & 0 \\ \vdots & \cdots & \ddots & \vdots \\ 0 & 0 & \cdots & \Omega_{K+1,t} \end{bmatrix} \tag{10}$$

$$\mathrm{A}_t \equiv \begin{vmatrix} 1 & 0 & \cdots & 0 \\ a_{21,t} & 1 & \ddots & 0 \\ \vdots & \ddots & \ddots & \vdots \\ a_{(k+1)t} & \cdots & a_{(k+1)k,t} & 1 \end{vmatrix} \tag{11}$$

The standard practice is to assume that all time-varying parameters follow a random walk process with the innovation specification of Giordani and Kohn (2008). In this regard the error term of the random walk is defined as a combination of two normal components (see Korobolis 2009) such that:

$$\begin{aligned} \gamma_{i,t} &= \gamma_{i,t-1} + J_{i,t}^{\gamma}\eta_t^{\gamma} \\ r_{i,t} &= r_{i,t-1} + J_{i,t}^{r}\eta_t^{r} \\ \phi_{i,t} &= \phi_{i,t-1} + J_{i,t}^{\phi}\eta_t^{\phi} \\ a_{i,t} &= a_{i,t-1} + J_{i,t}^{a}\eta_t^{a} \\ ln\Omega_{i,t} &= ln\Omega_{i,t-1} + J_{i,t}^{\Omega}\eta_t^{\Omega} \end{aligned} \tag{12}$$

where $\eta_t^{\varrho} \sim N(0, Q_{\varrho})$ for $\varrho \in (\gamma, r, \phi, a, ln\,\Omega)$. These innovation vectors are assumed to be independent of each other and the error of the state and observation equation. Here, the estimation assumes stochastic volatility to account for the possibility that the variance of the shocks may not be constant. As such $J_{i,t}^{\varrho}$ are 0/1 dummy variables that represent structural breaks in the respective error term of each time varying parameter. It is assumed that there is an equal chance of the innovations remaining constant or displaying a break at any point in time. The paper adopts the similar assumptions for the variance of the covariance matrix as in Primiceri 2005 such that:

$$V = Var\begin{pmatrix} \eta_t^{r} \\ \eta_t^{\phi} \\ \eta_t^{a} \\ \eta_t^{\Omega} \end{pmatrix} = \begin{bmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix}$$

For purposes of identification, the interest rate is placed last in the TV-FAVAR model. Similar to Allen and Robinson 2004, changes in the policy rate are assumed to result in one-to-one changes in Treasury bill rates. In this regard, the 180-day Treasury bill rate is used as a proxy for the policy rate. Ordering the interest rate last in the TV-FAVAR is in keeping with the approach used by Bernanke et al (2005) who utilized a lower triangular exclusion restriction to identify monetary policy shocks. The exclusion restriction is based on three blocks of variables categorized as '*fast-moving'*, '*slow-moving'* and the interest rate. Fast moving variables (like financial variables) respond contemporaneously to interest rate shocks while slow moving variables (like aggregate demand measures) respond with a lag. We will discuss some of the key relationships using impulse response functions.

3. Estimation

The model outlined in equations (3) to (11) is estimated using the Bayesian methods proposed by Kim and Nelson (1999). The Gibbs sampler, which is recommended for highly dimensional parameter models, is used to approximate the posterior distribution. A description of the prior distributions is given in Appendix A.

A two-step approach is used. The factors are first estimated using principal components and then the estimated factors are used in equation (4). The number of factors that characterize the dataset are first determined. Following Bernanke et al (2005) and Stock and Watson (2005) we use three factors. We however test the sensitivity of our results to the number of factors. This factor augmented framework allows us to not only compute impulses responses of the fundamental factors but more importantly for all the variables included in the factors using the transformation

$$\hat{x}_t = \left[\gamma_t^f \; \gamma_t^i\right] \left(\hat{\Gamma}(L)\right)^{-1} \hat{\varepsilon}_t$$

Given initial estimates for the factors, the Gibbs algorithm can be summarized as follows:

1. Initialize the TV-FAVAR parameters $(\breve{\emptyset}_1)$ and the hyper parameters.
2. Simulate the TV-FAVAR coefficients $(\breve{\emptyset}_1)$ using the Carter and Kohn (1994) algorithm.

3. Draw the elements of Q_r using the inverse gamma distribution and the remaining Q_ϱ (i.e. the hyperparameters) using an inverse Wishart (IW) distribution.
4. Draw factor loadings (γ_t^f) and covariance matrix (R_t) given initialized factors.
5. Given all other parameters simulate factors as in Bernanke et al (2005).
6. Go back to step two

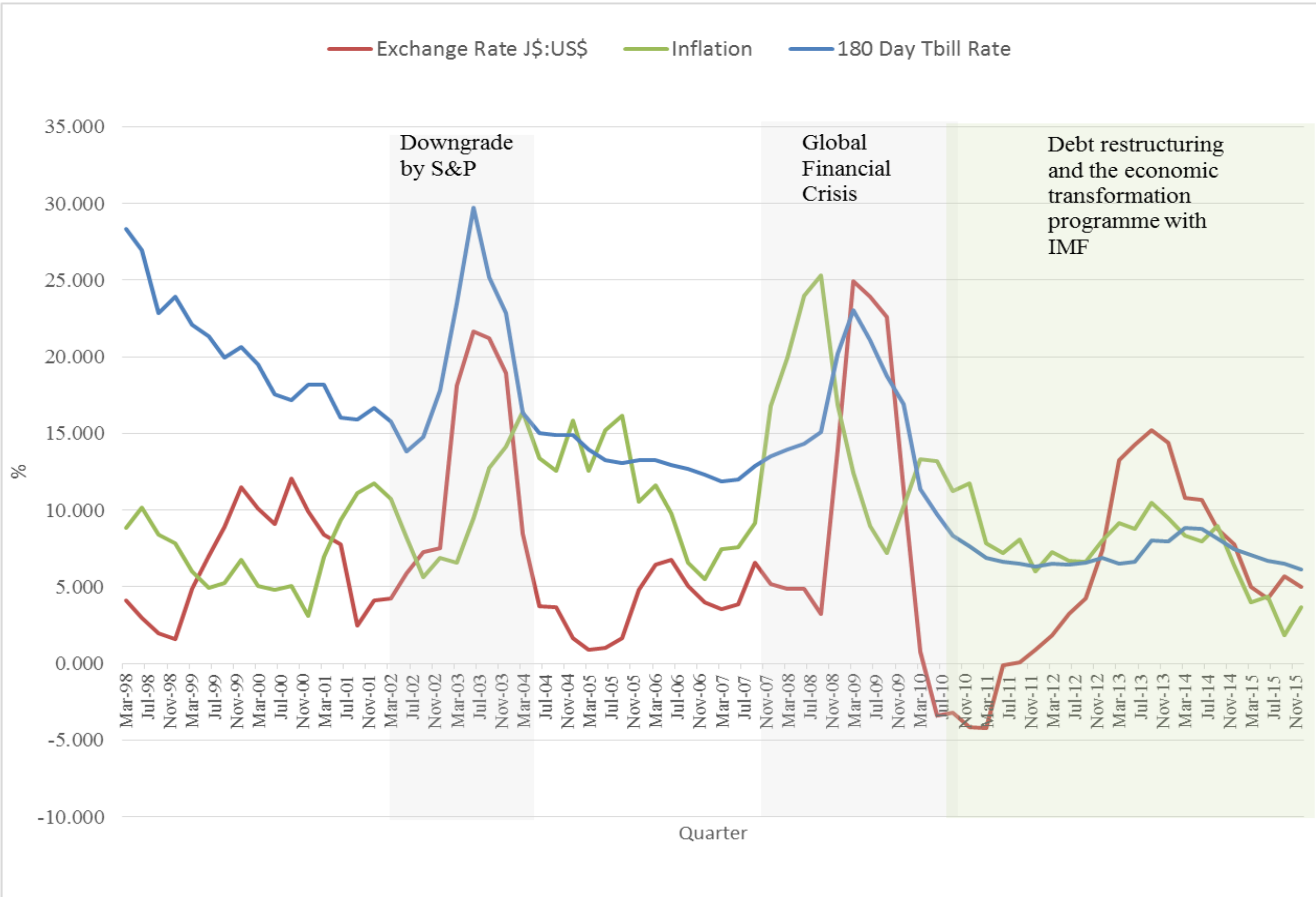
We use 20,000 Gibbs replications and discard the first 10,000 as burn-in to reduce the effect of initial conditions. Convergence is subsequently assessed by examining the recursive means of the retained draws. The recursive means of the retained draws are stationary which suggests that the Gibbs sampler has converged to the target distribution.

4. Data

The data set is comprised of 65 quarterly macroeconomic variables spanning the period 1998Q1 to 2015Q4 (see Appendix B). The data includes indicators of real domestic activity, consumer and producer prices, interest rates, the external sector, money and credit. These indicators reflect the direct inputs into the Central Bank's decision making process. All variables are transformed to be stationary and are standardized. The model results were not impacted by the inclusion of three or four factors. In this regard, given the benefits of parsimony, three factors were used to characterize the data set.

Figure 1 plots the trends in the three dependent variables, namely, the exchange rate, inflation and the interest rate. Prior to 2010, the 180-day Treasury bill rate averaged 17.7 per cent while depreciation and inflation averaged 8.1 per cent and 10.5 per cent respectively. This period was impacted by an unanticipated downgrade of Jamaica's sovereign debt from "stable" to "negative" in December 2002 due to weaker than programed fiscal performance. The exchange rate responded immediately to the fiscal shock, influencing higher inflation and interest rates. The second major shock in the pre-2010 period was the global financial crisis which occasioned significant volatility in the main macro variables. It is evident that both inflation and interest rates were less volatile subsequent to 2010. The 180-day Treasury bill rate decelerated to an average of 7.1 per cent while the exchange rate and inflation averaged 6.4 per cent and 7.1 per cent respectively. This structural change coincided with Jamaica's domestic debt restructuring and engagement of IMF supported economic reform programmes.[2]

Figure 1: Trends in the Exchange Rate, Inflation and Interest Rate

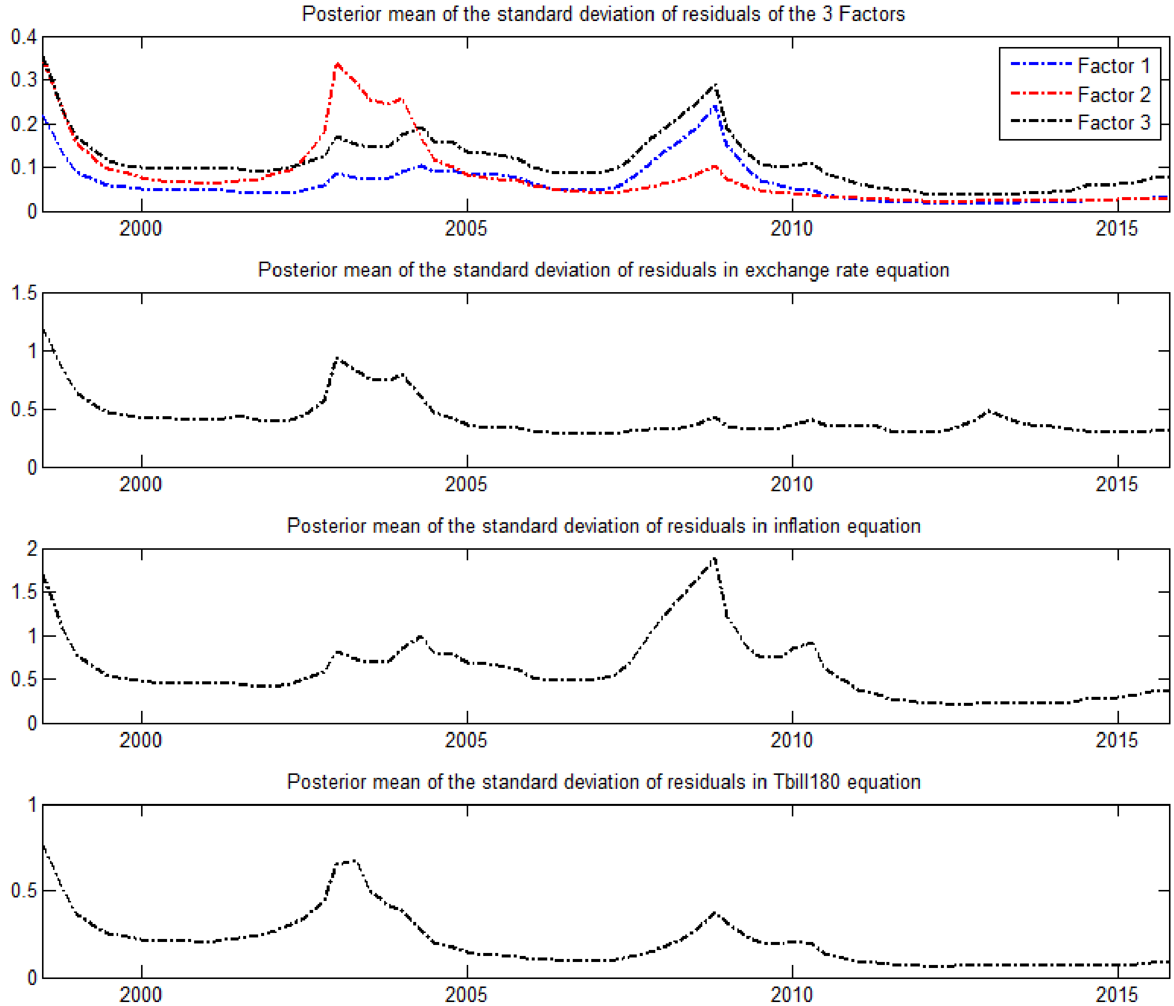


5. Empirical Results

The evolution of Jamaica's monetary policy can be assessed using the time-varying standard deviations of the residuals of the three factors, the exchange rate, inflation and interest rate equation. Figure 2 shows that there is time variation in the error in all equations, particularly in the first two years of the sample, which could reflect the impact of the financial crises of the mid 1990s and its resolution. In addition, the variation of the errors increases between 2007 and 2010, which may reflect the impact of the global financial crises and the engagement of an IMF programme.

[2] These were the Standby Agreement in 2010 and Extended Fund Facility in 2014.

Figure 2: Posterior mean of the standard deviation of the equation residuals



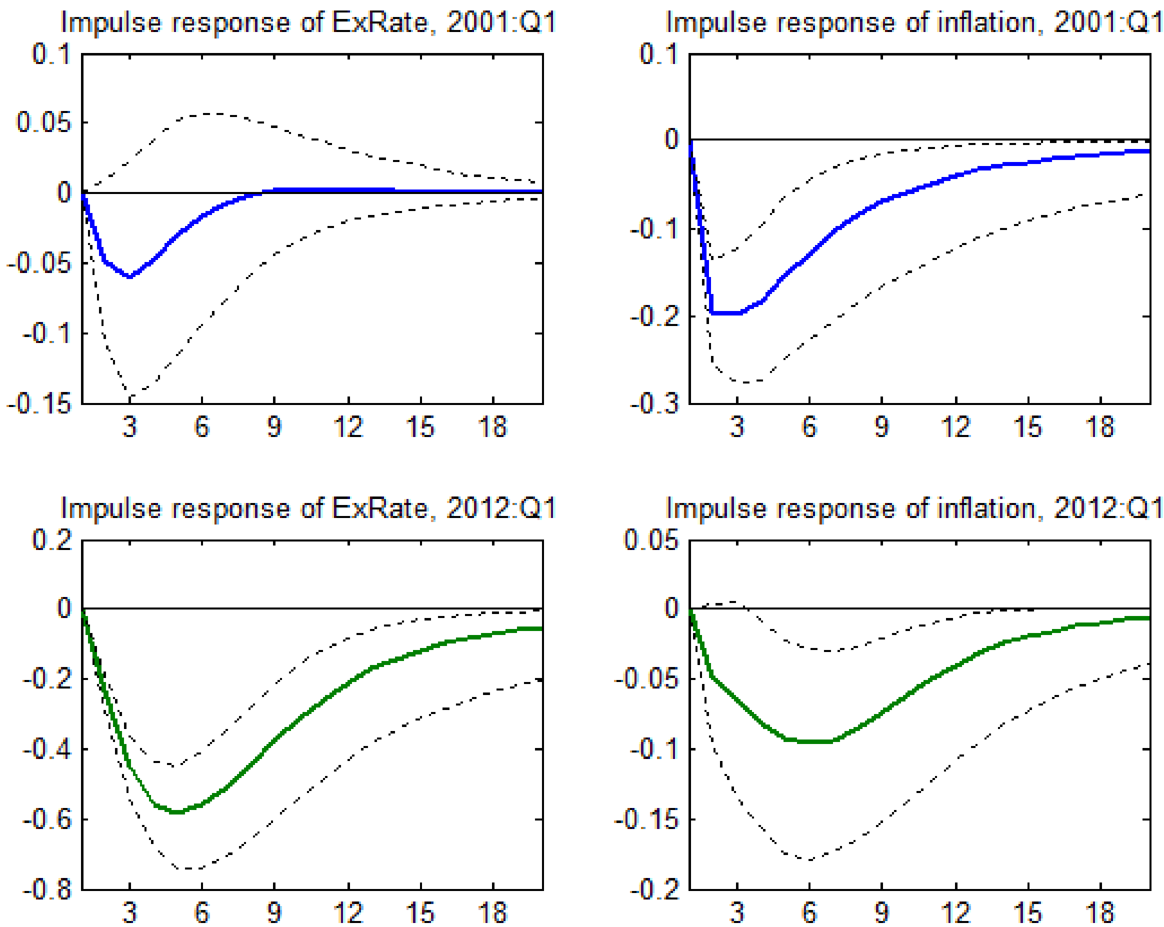
With regard to the interest rate equation, a high variance of shocks may imply that policy has been largely non-systematic. Monetary policy is deemed non-systematic when there are policy errors and/or policy responds to variables that are exogenous to the data set. As shown in figure 1, with the exception of the 1990's, 2003-2004 and the 2008 great recession, the volatility of shocks in the interest rate equation has been quite low. In this regard, the Bank's monetary policy reaction function has largely been conditioned on changes in the domestic economy. Note also that the volatility of inflation has been noticeably lower since 2010, which coincides with the implementation of the IMF programme. The standard deviation of the factors reveals more volatility particularly for the two years following the 2008 recession. The volatility of the errors declined noticeably in the post 2010 period. This moderation in volatility is consistent among all equations, with the exception of the exchange rate equation which shows an uptick in volatility towards the end of the sample period. The trend in volatility post 2010 underscores the structural adjustment that has been pursued during that time.

5.1 Impulse Response Functions for Selected Economic Indicators

Impulse response analysis is undertaken for innovations in two periods: 2001 Q1 and 2012 Q1. The first period was characterized by 'high'/double-digit interest rates while the second represents the beginning of consistent 'low'/single digit interest rates. The dates of the innovations were also chosen to coincide with periods of low volatility. In particular 2012Q1 was chosen to ensure sufficient time following the observed structural change in 2010. The response of inflation and the exchange rate to a 100 basis point shock to the interest rate for the two periods is shown in Figure 4. The solid lines give the posterior median response and the dotted line the 40^{th} and 60^{th} percentiles.

With regard to inflation, the response to the interest rate innovation is negative in both periods. In 2001, an adjustment to interest rates had the largest impact on inflation two to three quarters following the shock. This is similar to the findings of Allen and Robinson (2004) who used an aggregated small-scale macroeconomic model to study the monetary transmission mechanism in Jamaica. Subsequent to 2012, however, the greatest impact on inflation occurs five to eight quarters following the shock. This is comparable to Mitchell and Robinson (2007), who found using a non-linear VAR (LSTVAR) that the impact of monetary policy differs significantly depending on the state of the economy. In particular, the authors found that the response of inflation and growth to positive interest rate shock is lower in a low inflation environment. A key result of our analyses is that the monetary policy adjustment also has a smaller impact on inflation in the post 2010 period. In addition, the transmission of interest rate adjustments to inflation has a similar duration in the current 'low' interest rate relative to the 'high' interest rate environment. The impact of the interest rate adjustment on inflation lasts for approximately five years in both periods. Allen and Robinson (2004), however, found that the negative effect lasts for less than two years. In addition, the authors' results indicated a minor *'price puzzle'* after seven quarters as inflation transitioned to equilibrium. This '*price puzzle'* is eliminated in this analysis given the expanded data set used.

Figure 4: Impulse Responses to a 100 basis point shock to interest rates



With regard to the exchange rate, for both periods, the exchange rate appreciates in the second quarter following the increase in interest rates. In 2001, however, the impact of the interest rate shock on the exchange rate dissipates after nine quarters while the effect is larger and longer lasting in the post 2010 period. In addition, the maximum impact of the interest rate adjustment on the exchange rate occurs within two to three quarters in the 'high' interest rate environment compared to four to six quarters in the 'low' interest rate environment. This finding suggests that the exchange rate channel has strengthened in the post 2010 period.

One of the main benefits of using the TV-FAVAR methodology is that it allows for the isolation of impulse responses for a myriad of economic indicators. A selected group of impulse responses is presented in Figure 3 (in Appendix C). Most of the responses meet *a priori* expectations. Real investment declines; employment contracts; the external account improves and private sector credit falls.

Average Real Wages

With regard to average real wages, the impact of the interest rate shock is initially negative in both periods. For the 2001 shock, however, real wages increase following the second quarter after the shock. This result is largely consistent with the inflation dynamics implied by the 2001 shock to interest rates. For the 2012 shock, average real wages increase after the fourth quarter.

Private Sector Credit

The impact of the interest rate shock on private sector credit is immediate for both the 2001 and 2012 shock. The results suggest that the negative impact of an interest rate adjustment on private sector credit persists for approximately three years following the 2012 shock relative to ten quarters following the 2001 shock. The results also suggest that monetary policy innovations have a disparate impact on the various sectors that receive credit. The response of credit during the low/single digit interest rate period, for example, was largely driven by the impact of the shock on credit to the manufacturing sector. This sector proved to be more resilient to interest rate shocks, with credit contracting for approximately 2 years following the 2012 shock. Similarly credit to the agriculture sector, returned to equilibrium after approximately thirteen quarters in the post-2010 period.

Real GDP

The negative impact of the shock to interest rates on growth was larger in the ‘high’/double digit interest rate period relative to the post 2010 period. The relatively low response to the monetary policy shock during the ‘low’/single digit interest rate period is consistent with Serju (2003), who found that adjustments to the policy rate had a marginal impact on Jamaica’s overall GDP two to three quarters after the shock. Similarly our results show that growth is most significantly impacted by the shock to interest rates two to three quarters following the shock. In addition, growth returns to its long run trend three years after the 2012 shock relative to six quarters after the 2001 shock.

Current Account Deficit

The current account deficit (CAD) improves after the first quarter following the 2001 shock. The impact of the monetary policy innovation, however, leads to a deterioration in the current account deficit during the 'low'/single digit interest rate period. The results indicate that the worsening in the CAD in the post 2010 period emanates from an expansion in imports coupled with a decline in exports. This may reflect the impact of the interest rate adjustment on exchange rates. As noted earlier, the exchange rate appreciates following the upward adjustment in interest rates which may explain the higher imports in the post 2010 period. This does not occur in the pre-2010 period, given the larger impact of interest rates on domestic growth which should constrain demand for imports.

Equity Prices

The response of equity prices, proxied by the JSE index, is incongruous with a priori expectations. The results suggest that equity prices increase in 2012 following the upward adjustment to policy rates. The expected negative response, however, occurs after the 2001 shock to interest rates. For the 2001 shock, the response is consistently negative before dying out after three years. The response in 2012 may reflect the growing importance of financial sector stocks to the overall performance of the index. An increase in interest rates, may therefore portend well for the performance overall index.

6. Concluding Remarks

The paper utilizes a factor augmented time varying vector autoregression (TV-FAVAR) to assess the impact of monetary policy shocks on macroeconomic variables in Jamaica. We find that the transmission mechanism has evolved over the last two decades. In particular, the results suggest that volatility in inflation has declined since 2010 and that the horizon over which the Central Bank should respond to inflationary pressures has lengthened to five to eight quarters following the shock to interest rates. In this regard, the Bank could consider modifying its macro model and

Inflation Forecast and Policy Assessment System (IFPAS) to incorporate an inflation-forecast-based policy rule that responds to inflation pressures some five to eight quarters in the future instead of the two to three quarters that currently obtains. In addition, the results indicate that the impact of a monetary policy adjustment on the exchange rate is larger and longer-lasting in the current ‘low’/single digit interest rate environment. The impact on growth and credit is, however, smaller albeit longer lasting. This may imply that there is a need to strengthen the credit channel of monetary policy prior to the country’s transition to full-fledged inflation targeting.

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Appendix A – Prior Distributions & Sensitivity

Following Primiceri 2005, the priors take the following form:

$\emptyset_0 \sim N(\widehat{\emptyset}_{ols}, 4 * V(\widehat{\emptyset}_{ols}))$,

$A_0 \sim N(\hat{A}_{ols}, 4 * V(\hat{A}_{ols}))$,

$ln\Omega_0 \sim N(ln\,\widehat{\Omega}_{ols}, I_n)$,

$Q \sim IW(K_q^2 * \ 42 * V(\hat{B}_{ols}), 42)$ Where '42' is the size of the matrix Q,

$W \sim IW(K_w^2 * \ 4 * \ I_n, 4)$,

$S \sim IW(K_s^2 * \ 4 * \ I_n, 4)$,

The hyperparameters, K_q , K_w and K_s , are assumed to be distributed as inverse-Wishart(*IW)*, which is the typical choice for local scale models. The *IW* distribution is a conjugate prior for the covariance matrix of a multivariate normal distribution. Set in this way, the priors are uninformative and reflect a priori expectations regarding the degree of time variation.

We set $K_q = 0.01$, $K_w = 0.1$ and $K_s = 0.01$. The choice to set $K_q = 0.01$ primarily reflects the fact that the model misbehaves if a higher value is chosen. In addition, the literature supports using a low value for K_q since models that impose a high degree of time variation tend to perform poorly out of sample (See Stock and Watson 1996). With regard to K_w and K_s , the choice primarily reflects the values that best fit the model and are informed by Primiceri 2005.

Appendix B – Data Description

All data was sourced from the Bank of Jamaica database. The data span the period 1998Q1 to 2015Q4.

Real Sector

AvgNomWage	Average Nominal Wage
AvgRwage	Average Real Wage
RInv	Real Investment (Gross Fixed Capital Formation)
RPrivCons	Real Private Consumption
RPubCons	Real Public Consumption
RElectSales	Real Electricity Sales
Agrforfish	Agriculture Forestry & Fishing
MinQuar	Mining & Quarrying
Manuf	Manufacture
ElectWater	Electricity & Water
Construct	Construction
WholeR	Wholesale & Retail Trade
Hotels	Hotels and Restaurants
Trans	Transport , Storage & Communication
Fism	Financial Services Indirectly Measured
RealEstate	Real Estate
GovServ	Government Services
OtherServ	Other Services
RGDP	Real Gross Domestic Product
EmplLabour	Employed Labour Force

Money & Credit

BaseM	Base Money
M1	Narrow Money – Currency in circulation + demand deposits
M2	Broad Money – M1+Savings &Time deposits

M3	M2 + other deposits
M2_star	M2+ Foreign currency deposits
M3_star	M3 + Foreign currency deposits
Broadm_EIP	Broad Money
divisiam2j	Divisia Monetary Aggregate of M2[3]
divisiam2f	Divisia Monetary Aggregate of M2_star
divisiam3j	Divisia Monetary Aggregate of M3
divisiam3f	Divisia Monetary Aggregate of M3_star
Domdebt	Domestic Debt
Fordebt	Foreign Currency Debt
PrivCred	Private Sector Credit
credit_MAN	Credit to the Manufacturing Sector
credit_CONST	Credit to the Construction Sector
credit_Agri	Credit to the Agriculture, Forestry & Fishing Sector
credit_TRANS	Credit to the Transportation, Storage & Communication Sector
Credit_Mining	Credit to the Mining & Quarrying Sector
credit_TOUR	Credit to the Tourism Sector
credit_DISTR	Credit to the Distributive Trade Sector

External Sector

CAD	Current Account Deficit
Exp	Exports
Imp	Imports
cons_imp	Imports of Consumer Goods
raw_imp	Imports of Raw Material
cap_imp	Imports of Capital Goods
fuel_imp	Imports of Fuel
Ptrans	Private Transfers

[3] The divisia monetary index is a measure of money supply which weights the monetary components (e.g., currency, demand deposits, savings and time deposits) according to their usefulness in transactions (See Smith 2013).

TourArr	Tourism Arrivals
FDI	Foreign Direct Investment
NIR	Net International Reserves
TOT	Terms of Trade

Inflation

PPI_JA	Producer Price Index
CPIAF_JA	CPI excluding Agriculture & Fuel
CPIFF_JA	CPI excluding Food and Fuel

Interest Rates & Exchange Rate

DemandRate	Interest rate on Demand deposits
SavingsRate	Interest rate on Savings deposits
TimeRate	Interest rate on Time deposits
OtherRate	Interest rate on other deposits
Forintrate	Interest rate on foreign deposits
180Day	180 day Treasury bill rate
Usdjd	Exchange rate: J$ per US$

Stock Prices

JSE	Jamaica Stock Exchange Index

Appendix C

Figure 3: Selected Impulse Responses