Investigating Monetary Policy Spillovers from the United States of America to Jamaica

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Abstract

This paper investigates the evidence of monetary policy spillovers from the United States of America (USA) to financial conditions and monetary policy decisions in Jamaica. It utilizes the method developed by Lombardi and Zhu (2014) to derive shadow policy interest rates for Jamaica as well as the shadow policy rate for the USA derived by Wu and Xia (2016), then employs a standard structural vector auto regressive (SVAR) model to identify the monetary policy shocks. Utilizing shadow policy rates is key to identifying the true monetary policy stance in both countries given their extensive use of unconventional monetary policy tools following the 2008 global financial crisis (GFC), albeit for different reasons. The results suggest that there are direct monetary policy spillovers from the USA to Jamaica. However, the largest spillover was indirectly through the response of the monetary authority in Jamaica to the US policy's impact on relative prices.

Keywords: monetary policy, international spillovers, Taylor rule
JEL classification: E52, E58, F33

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1. INTRODUCTION

Since the 2008 global financial crisis (GFC), most advanced economies, and in particular the USA, have been faced with a challenging monetary policy environment to stimulate output growth in the face of a global recession. In that regard, having initially reduced their policy interest rates close to their zero lower bound (ZLB), many have had to resort to unconventional monetary policy (UMP) tools, which primarily included large scale financial asset purchasing programs, usually referred to as quantitative easing (QE) programs. This new monetary policy environment has stimulated much research into the impact of these UMPs by advanced economies on monetary policy decisions in emerging market economies, typically referred to as spillovers.

Most of the studies on the effects of monetary policy actions in advanced economies since the 2008 GFC on other advanced as well as developing countries have found evidence of spillovers, primarily through changes in bond yields and asset prices resulting in changes in capital flows. However, there has been very little evidence of the impact from changes in the actual policy rate of the advanced economy. These findings were not surprising given that interest rates in advanced economies were approximately zero and not changing, which therefore meant they had very little informational content. However, this empirical challenge was addressed by Lombardi and Zhu (2014) as well as Wu and Xia (2016) who created shadow policy rates for the USA which were not bounded below by zero and incorporated the impact of these UMPs on the central bank's balance sheet, as well as changes in maturity structures of key assets into a single, easy-to-understand indicator.

During this period of generally loose monetary policy by central banks in advanced economies, some developing countries like Jamaica were faced with the difficult and sometimes conflicting objectives of building their international reserve positions while stimulating domestic output growth. Specifically, following the 2008 GFC Jamaica faced a major balance of payments challenge and implemented a stand-by arrangement (SBA) supported economic structural reform program primarily aimed at improving the country fiscal sustainability while reducing systemic financial sector risk. This program was discontinued in 2011 but was followed by an Extended Fund Facility (EFF) supported economic program in February 2014 also aimed at improving fiscal sustainability and improving price and

non-price competitiveness while boosting growth and employment. Over the life of these programs the monetary authority in Jamaica, the Bank of Jamaica (BOJ), was challenged with meeting its inflation objectives and monetary targets while creating an environment supportive of the growth required to allow the country to emerge from a prolonged and severe recession and to become placed on a sustained higher growth path.[1] In order to meet these sometimes conflicting objectives, the BOJ employed numerous UMPs, including the issuing of US dollar denominated certificates of deposit (CD) to build international reserves without having to significantly increase interest rates on domestic currency denominated securities.

The monetary policy environment in Jamaica, therefore, was being significantly influenced by domestic factors following the financial crisis, which may have been exacerbated by policy initiatives in the advanced economies. Therefore, the purpose of this study is to ascertain to what extent international monetary policy spillovers have affected the policy decisions at the BOJ historically by properly measuring the monetary policy stance in both countries during the post-crisis period.

The rest of the paper is organized as follows: Section 2 examines the literature on international spillovers and monetary policy transmission in Jamaica; Section 3 gives a brief description of the data utilized; Section 4 explains the models and methodology; and Section 5 the results and conclusions.

2. LITERATURE REVIEW

Although the literature on monetary policy spillovers has grown significantly since 2008, the idea is not new. Aizenman, Chinn, and Ito (2015) opine that in the mid-1990s, when advanced economies significantly increased their policy rates after an extended period of negative real rates, there was a significant impact on emerging Latin American and East Asian economies. The authors note that the difference in the impact was primarily a function of the exchange

[1] The BOJ operates a monetary policy regime referred to by Stone (2003) as *inflation targeting lite*. In this operational structure, the monetary authority, though without a formal mandate, announces an inflation forecast for the year and then utilizes monetary policy to achieve that target.

rate regime. That hypothesis is consistent with the Mundell (1963) hypothesis of a monetary trilemma where the policy trade-offs involve monetary autonomy, exchange rate stability and financial openness. The authors find that the exchange rate regime and financial openness have a direct influence on the magnitude of the spillovers.

Many of the papers on spillovers since 2008 use proxies for monetary policy stance, which include event studies on announcement dates to measure the impact on financial conditions and monetary policy responses in emerging market economies. These studies typically follow the works of Gürkaynak, Sack, and Swanson (2005), and Gürkaynak, Sack, and Swanson (2007), using event analysis to measure the impact of monetary policy. Studies of this nature include the works of Wright (2011), Hausman and Wongswan (2011) and Bowman, Londono, and Sapriza (2014), which examine the impact of policy changes pre-UMP in the USA. Other authors examine the UMP period looking at changes in actual US asset prices and their impact on policy spillovers. These include works by De Pooter et al. (2014), Moore, Nam, and Tepper (2013), and Ahmed and Zlate (2013).

Whilst previous authors have used indicators and proxies of monetary policy, another group of researchers developed shadow prices of the actual policy rate of the US economy to provide a metric that is robust to and easily identifiable with the history of monetary policy actions in the selected developed countries. These works include those of Kim and Singleton (2012), Bauer and Rudebusch (2013), and Wu and Xia (2016) which exploited the information content in various interest rate term structures to derive the shadow policy rate. These works are complemented by Lombardi and Zhu (2014) who utilized a large dataset where changes in the Federal Reserve balance sheet as well as selected interest rate are used to capture the implied impact of the UMPs in the US policy rate. By using this approach, the authors' results allow for the continued utilization of the policy rate as the measure of the monetary policy stance in the USA. Although these papers were not utilized to measure monetary policy spillovers, their ability to capture UMPs lends itself well to the body of research. In addition, given the limited interest rate data available in small developing states like Jamaica, the work of Lombardi and Zhu (2014) lends itself well to application with other available information.

To the best of this author's knowledge the only study of monetary policy spillovers from the USA to Jamaica was conducted indirectly

in Murray (2009). It found a weak direct impact of changes in the policy rate in the USA on the policy rate in Jamaica. The main channel of the spillovers was the impact of changes in the policy rate on US inflation and the impact of the changes in US inflation on the Jamaica dollar to US dollar exchange rate. This change then resulted in a domestic monetary policy response. Indeed, many of the studies on the monetary policy transmission mechanism in Jamaica, such as Allen and Robinson (2004), have found strong evidence of an exchange rate channel that has led to a monetary policy reaction function that is heavily weighted toward exchange rate changes. It should be noted that the study by Murray (2009) was conducted on data up to 2005 and therefore would not have captured the post 2008 financial crisis response.

3. UNCONVENTIONAL MONETARY POLICY

3.1 Unconventional Monetary Policy in the USA

In October 2008, the Federal Funds Rate (FFR) fell below 1%, effectively reaching its ZLB as the Federal Reserve tried to counter the recessionary impact of the 2008 GFC and stimulate the US economy. By November, the Federal Reserve began the first round of liquidity injection through the unconventional means of large scale direct purchase of Treasury notes and mortgage-backed securities. This phase of the program, referred to as QE1, led to the stock of these securities on its balance sheet increasing from between 700 billion USD and 800 billion USD in 2008 to approximately 1.75 trillion USD of bank debt, mortgage-backed securities, and Treasury notes by March 2009.

The second round of this program, QE2, was announced in November 2010, when the Fed targeted the purchase of an additional 600 billion USD of Treasury securities by the end of the second quarter of 2011. This was followed by QE3 in September 2012 which targeted a 40 billion USD per month open-ended bond purchasing program of agency mortgage-backed securities. This target was increased to 85 billion USD per month in December 2012. Additionally, the Federal Open Market Committee (FOMC) announced that it would likely maintain the FFR near zero at least through 2015.

By 2013 the US economy had begun to record strong economic growth with low inflation and on June 19, 2013, the Fed Chairman announced a *tapering* of some aspects of the program should the positive developments continue. Specifically, bond purchases would be reduced to 65 billion USD from 85 billion USD per month. This tapering actually began in February 2014, before ending completely on October 29, 2014. At the end of the program the Fed accumulated approximately 4.5 trillion USD in these assets, an increase of nearly 600 percent.

3.2 Unconventional Monetary Policy in Jamaica

Jamaica's financial market was significantly affected by the 2008 GFC, resulting in a sharp reduction in foreign currency flows and a spike in the pace of depreciation of the domestic currency against its main trading counterparts. In addition, during the March 2009 quarter there were significant maturities of government debt, which exacerbated the domestic financial challenges. In response the monetary authority in Jamaica initially implemented swift and aggressive conventional monetary policy actions which included sharp increases in interest rates as well as raising the cash reserve requirements for both foreign and domestic deposits.

In order to weather the post-GFC the Government of Jamaica (GOJ) signed two International Monetary Fund (IMF) supported economic reform programs: the first a 27-month Stand-by Arrangement approved in February 2010 and the second a four-year Extended Fund Facility (EFF) agreement approved in May 2013.[2] Both programs were aimed at improving the country's growth prospects whilst reducing its vulnerability to external shocks. In that regard, the reforms included two debt restructuring exercises of the country's public debt, with the first launched in January 2010 and the second in February 2013.[3] Both exercises resulted in a significant change in the maturity

[2] See <https://www.imf.org/external/np/sec/pr/2010/pr1024.htm> and <https://www.imf.org/external/np/sec/pr/2013/pr13150.htm>.

[3] The Jamaica debt exchange (JDX) launched in January 2010 and the national debt exchange (NDX) implemented in February 2013 represented 700 billion Jamaican dollars –JMD– (65% of GDP) and 860 billion JMD (64% of GDP), respectively, of the full amount of the marketable debt of the Goverment of Jamaica.

profile of a major portion of the debt obligations and hence the available liquidity of the financial sector.

In the context of the resulting global and domestic economic environment coupled with the challenges of meeting the targets under both economic programs, the BOJ implemented a number of UMPs. These policies can be broadly grouped into three main categories: foreign currency market operations, open market operations and other operations.

3.2.1 Foreign Currency Market Operations

Jamaica operates a floating exchange rate regime in which it intervenes occasionally to reduce unusually large changes in the value of the domestic currency relative to the US dollar. These episodes to buy or sell foreign currency are required primarily due to the size and openness of the market. In addition, given the level of development, the market is susceptible to substantial changes in value due to the actions of a few large players. In that regard the BOJ operates a surrender arrangement in which authorized dealers are required to *surrender* or sell a proportion of their foreign currency market purchases at the weighted average purchase rate of all banks for the previous day.[4] However, following the 2008 GFC there was increased volatility in the market for foreign currencies, which was attributed to the effect of the *lumpy* demand episodes of a few large public sector entities. In order to reduce this impact on the market, on February 03 the Bank implemented an additional surrender requirement, the public sector entities (PSE) foreign exchange facility, which consolidated the foreign exchange demand of these entities and coordinated foreign currency payments to minimize volatility in the market.

3.2.2 Open Market Operations

Given the need to build foreign currency reserves without adversely impacting domestic credit expansion prospects under the IMF EFF-supported economic program, the BOJ introduced foreign currency denominated certificates of deposit in November 2013. This approach was due to the provisions outlined in the IMF's Balance of Payments Manual that foreign currency liabilities with more than

[4] The foreign currency surrender requirement has been in effect since September 1990., see <http://www.boj.org.jm/pdf/foreign_exchange.pdf>.

one year to maturity would not be included in the calculation of the net international reserves (NIR).

Following the introduction of these instruments and in light of the generally tight liquidity environment that existed since the implementation of the debt exchanges, the BOJ provided liquidity support to the market at a six-month tenor for institutions that purchase the BOJ US dollar-denominated CDs for tenors in excess of two years. This lending tenor, which was the longest allowable under the Bank of Jamaica Act, allowed deposit-taking institutions that were holding strong foreign currency positions to access longer term liquidity without having to liquidate their hedges in an uncertain economic environment with bouts of sharp depreciation of the domestic currency.

3.2.3 Other Operations

During the December 2009 quarter the Bank also extended credit to the Government to assist in closing its financing gap in a context of reduced investor appetite for GOJ debt. The demand for GOJ instruments waned as a result of heightened uncertainty in the domestic market surrounding the terms and timing of the IMF agreement and associated Government debt management initiatives. This support to the GOJ included temporary advances of 5.1 billion JMD in November and the purchase of securities totalling 18 billion JMD on December 15. The Government repaid 2.5 billion JMD of the advance in December and the remaining 2.6 billion JMD was converted to GOJ securities. The Bank's secondary market sales of its holdings of GOJ securities reabsorbed 14.8 billion JMD from the financial market during the June 2010 quarter.

3.3 Justification for Shadow Interest Rates

While the justification for the use of the shadow interest rate for the US is obvious given the ZLB condition and implementation of relatively unpresented UMPs, the justification for its use for Jamaica is less clear. Jamaica's policy rate remained well above zero. However, in real terms, the policy rate had become negative and in nominal terms had reached the lowest level since the country started operating a floating exchange rate in 1991. The main rational for using a shadow interest rate was that the BOJ kept the policy rate unchanged from February 2013 until the end of the period reviewed in this

study. During that period the BOJ introduced a suite of UMPs, some of which had never been utilized in the country's history. This effectively resulted in changing money market conditions and a perceived breakdown in the relation of the policy rate with market rates. It is therefore anticipated that the estimated shadow policy rate will show that the perceived breakdown in the relation between market rates and the policy rate only reflects the reduced information content in the actual policy rate and not a breakdown in the transmission of monetary policy.

4. DATA

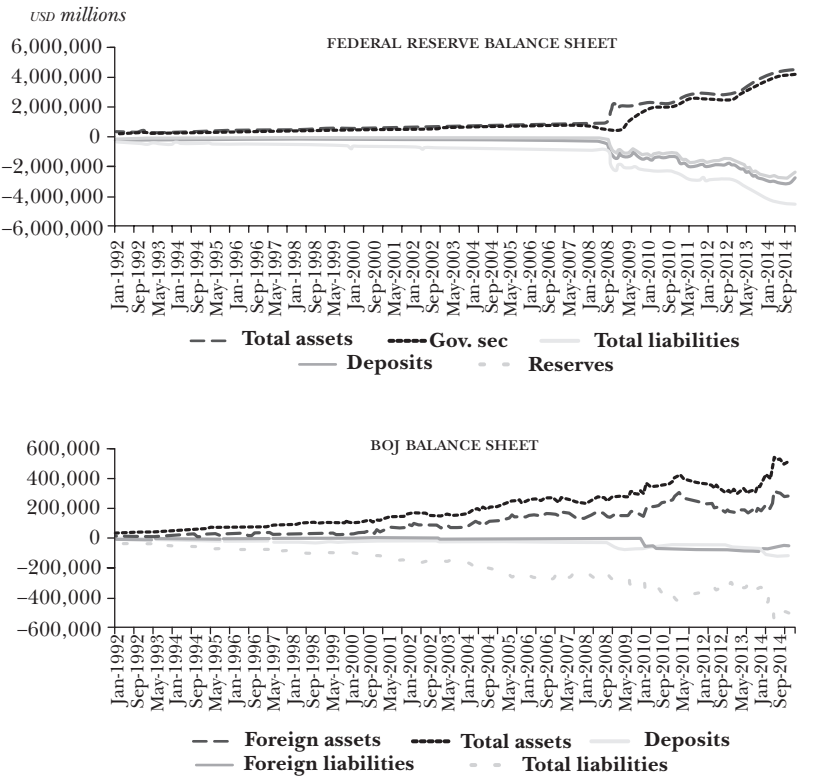
In order to measure the spillover of monetary policy, this study utilizes three sets of data, including real and monetary variables for both the USA and Jamaican economies. The Federal Reserve shadow interest rate used is from Wu and Xia (2016), available online at the Federal Reserve Bank of Atlanta's website.[5] Monthly as well as quarterly data for Jamaica is used to estimate the shadow policy rate for that country. This is then incorporated with monthly data from the USA in VAR models to measure the monetary policy spillovers of the policy action in the USA to the Jamaican economy.

The trends in the balance sheets of the Federal Reserve and the Bank of Jamaica suggest that, in general, both institutions followed a similar pattern of expansion in their balance sheets in the post-2008 GFC. For the USA there was a sharp expansion in the non-government securities assets of the balance sheet in 2009, before some normalization in the proportion of government securities to total securities occurred in 2010. There was also a reduction in the pace of expansion in the balance sheet in the second half of 2012 before the pace of expansion increased again in 2014. For Jamaica, the pace of expansion in 2009 was not as sharp as in the USA. There was also a contraction in the BOJ's balance sheet between March 2011 and November 2012. Within the liabilities there was a reversal in the pace of expansion between foreign liabilities and deposits. These changes in the respective balance sheets hint at the UMPs pursued in each country.

[5] See <https://www.frbatlanta.org/cqer/research/shadow_rate.aspx?panel=1>.

Figure 1

TREND IN FEDERAL RESERVE'S AND BANK OF JAMAICA'S BALANCE SHEETS



4.1 Monthly Data for the Jamaican Economy

The data for Jamaica was compiled to capture the similar information on monetary policy as estimated for the US economy in Lombardi and Zhu (2014). The variables are listed in Table 1 and span January 1992 to December 2014. It should be noted that the data on Jamaica is much more limited than the USA due to availability. In addition, Jamaica transitioned to a floating exchange rate in 1991 from fixed rates and auctioning regimes in prior periods and therefore limiting the data to post-1992 will allow for a purer examination of monetary policy spillovers in the domestic economy. In addition, utilizing a

single exchange rate regime data set will avoid issues of the trilemma as outlined in Aizenman, Chinn and Ito (2015).

It should be noted that a key difference between the balance sheets of the BOJ and those of the Federal Reserve is the inclusion of foreign assets and liabilities. This is important as Jamaica is a small country and the central bank holds a sizable amount of foreign assets. In addition, a key aspect of the UMPs employed by the BOJ was the issuance US dollar-denominated CD. These CDs were introduced in the context that the sixth edition of the International Monetary Fund's Balance of Payments Manual classifies foreign liabilities in excess of one year to maturity as part of the net international reserves. Therefore, the BOJ was able to build the net international reserves through these instruments by borrowing foreign currency directly from residents without having to raise domestic interest rates to induce holders to sell foreign currency for Jamaican currency.

Another important insight that should be derived from this approach is that a key component of the economic reform program was a major fiscal adjustment that would have resulted in a significant tightening of domestic currency liquidity despite little adjustment in the policy rate. Therefore, monetary policy could have been tighter than evident in the policy rate, but should be reflected in the monetary aggregates as well as the Treasury bill rates.

Table 1

MONTHLY DATA ON JAMAICA

Block I: Interest rates
- 30 day CD
- Rates on GOJ T-bills with maturities of one, three and six months

Block II: Monetary aggregates
- Monetary base or M0
- M1, M2 and M2F

Block III: BOJ balance sheet (assets)
- Total assets
- Net claims on the public sector

Block IV: BOJ balance sheet (liabilities)
- Currency in circulation
- Total liabilities
- Cash reserves

4.2 Other Data for the Jamaican and US Economies

In order to measure the spillovers from the USA to Jamaica, the study included monthly and quarterly macroeconomic variables for both countries. The data spanned January 1992 to December 2014. Monthly data on inflation, exchange rates, interest rate and the monetary base were utilized. In addition, quarterly real GDP for each country was included. The quarterly data was interpolated to a monthly frequency using a linear match to the last data point. All data, with the exception of the interest rates, were then logged and seasonally adjusted using the US Census Bureau X-13 seasonal adjustment tools. The full list of variables and descriptions utilized in the study are in Table 2 below.

Table 2

SVAR VARIABLE LIST AND DESCRIPTIONS

Variable	*Symbol*	*Description*
US variables		
US GDP	y^*	Real GDP of the US
US policy rate	r^*	Estimated shadow policy rate of the US, the FFR
US inflation	p^*	Annual change in the consumer price index (CPI) of the US
Domestic variables		
Real GDP	y	Real GDP of Jamaica
Inflation	p	Annual change in the consumer price index of Jamaica
Depreciation	s	Annual change in the weighted average selling rate of the JMD per USD.[1]
Policy interest rate	r	Estimated shadow policy rate of the BOJ, the 30-day CD (BOJ30D)
Monetary base	mb	The monetary base stock in Jamaica

[1]Therefore, an increase in s implies a depreciation in the Jamaican dollar.

5. MODELS AND METHODOLOGIES

5.1 Dynamic Factor Models with Missing Variables

The shadow policy rates for Jamaica were estimated using the process outlined in Lombardi and Zhu (2014). This process was chosen for Jamaica instead of the method utilized by Wu and Xia (2016) for the USA as Jamaica does not have a rich enough set of instruments to derive the shadow price from these yields. An attempt was made to derive the shadow price for both economies using the method utilized by Lombardi and Zhu (2014). However, given some challenges in completing the dataset for the USA it was decided to utilize the Wu and Xia (2016) dataset as the resulting shadow policy rates are quite similar in magnitude and direction.

Estimating the shadow price for Jamaica using the method outlined in Lombardi and Zhu (2014) first employs the estimation of dynamic factor models (DFMs) with missing data for both countries using the dataset given in Table 1. DFMs, which date back to the work of Geweke (1977) have been widely utilized in macroeconomics as they allow for the reduction in the dimensionality of large data sets by extracting a small number of common, latent or unobserved components out of the information in the dataset. These common components are chosen to maximize the proportion of variability in the data they explain.

In order to estimate the DFM, let $\{X_t,\ t = 1,...,T\}$ be a stationary N-dimensional multiple time series with T observations. These observations are determined by a set of unobserved factors F_t such that:

$$X_t = \Lambda F_t + e_t, \tag{1}$$

where F_t is an $r \times 1$ vector of factors, Λ is an $N \times r$ matrix of the factor loadings and e_t the residuals assumed to be i. i. d. and Gaussian. It is assumed that the unobserved factors, F_t, follow a vector autoregressive (VAR) process of order p, given by:

$$F_t = \sum_{i=1}^{p} A_i F_{t-i} + u_t, \tag{2}$$

where A_i are the coefficient matrices for the p lags of the factors and u_t is the residuals which are also assumed to be i. i. d. and Gaussian. Equations 1 and 2 can be estimated as a state-space using the Kalman

filter as outlined in Engel and Watson (1981). The system is estimated using the expectation maximization (EM) algorithm which was first proposed by Dempster, Laird and Rubin (1977) and Watson and Engel (1983) for estimating unobserved variables models. This algorithm works by iteratively replacing unobserved variables with their expected values based on the specified law of motion in equation 2 conditioned on the observed series and then maximizing the likelihood conditional of these expected values.

The algorithm was extended by Banbura and Modungo (2014) to not only estimate the unobserved factor loadings, but also to estimate missing data from the observed series X_t, even for cases where the missing data has an arbitrary pattern. This is achieved by writing the likelihood as if the dataset were complete, then using the estimated factor loading to *fill in* the missing data. This process is then iterated and the authors prove that under a regularity condition the EM algorithm converges to a local maximum of the likelihood. This method was then exploited in Lombardi and Zhu (2014) where the factor loadings were determined by the monetary aggregates, balance sheet and interest rate data, and the US interest rate was treated as missing when they seemed to reach their ZLB. These include the federal funds rate and Treasury bill rates which have been approximately zero since 2008. In addition, the dataset included a number of missing data points, particularly interest rates in periods when no issues occurred.

A similar process was applied to the Jamaican data. However, although interest rates in Jamaica did not reach their actual ZLB, BOJ's policy rate reached historic lows and movements in the policy rate may have had less information content than in prior periods. In that regard, similar to the US policy rate, interest rates in those periods were treated as missing.

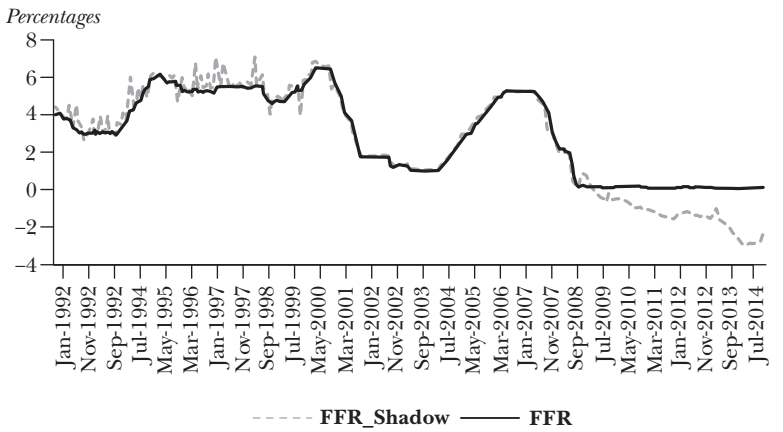
To satisfy the estimation criteria that the observed series be stationary, data in blocks II, III and IV were expressed in 12-month changes. Using 12-month changes also reduced the pattern of seasonality that may have been evident in the series. In order to capture the full impact of the UMPs in Jamaica, the policy rate was treated as missing data over the period February 2012 to December 2014.

5.1.1 Shadow Policy Rate for the USA

The shadow policy rate from Wu and Xia (2016), is plotted against the actual rate in Figure 1. This shadow policy rate suggests a significant easing of the Federal Reserve policy rate since 2009 where the rate has been generally negative. However, the pace of easing has been gradually reduced since December 2013, consistent with the tapering in the QE programs.

Figure 2

UNITED STATES: SHADOW POLICY RATE FROM WU AND XIA (2016) AND ACTUAL RATE



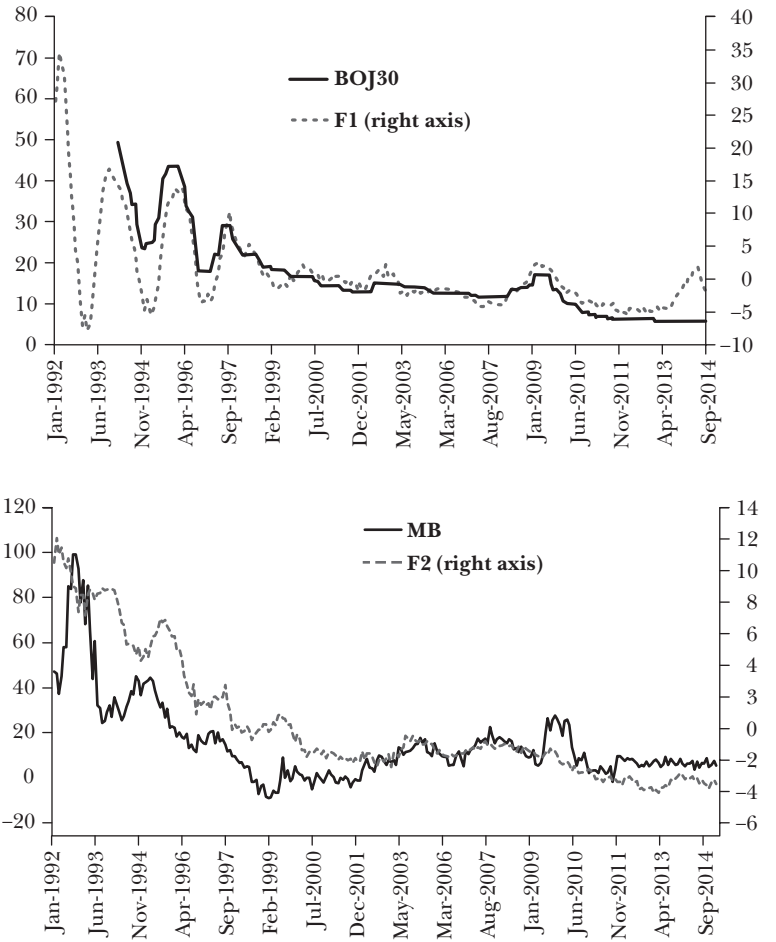
5.1.2 Shadow Policy Rate for Jamaica

For the estimation for Jamaica, the selected specification was three factors *(r = 3)* and three lags *(p = 3)*. As was done in the case for the USA in Lombardi and Zhu (2014), two of the estimated factors are plotted against policy rate and the monetary base to illustrate the comovement between the observed data and the estimated factors. The results, shown in Figure 3, show a strong comovement, with the three factors accounting for approximately 90% of the variation in the data.

Figure 3

JAMAICA: SHADOW POLICY RATE, POLICY RATE AND MONETARY BASE

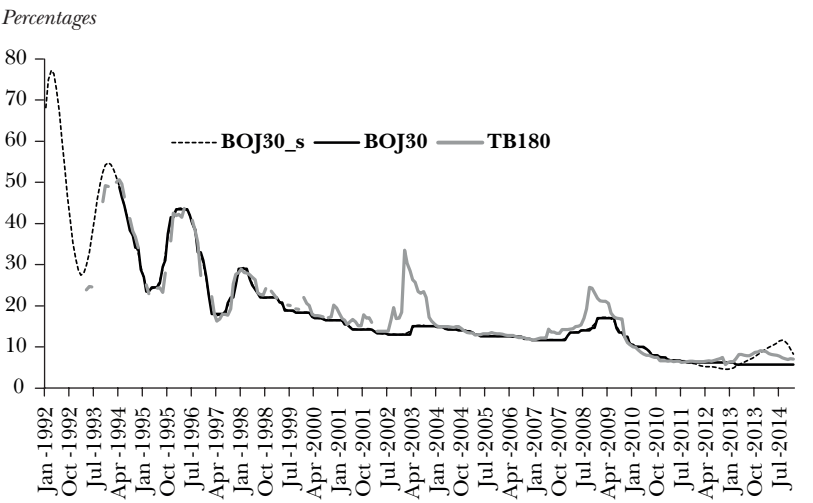
Percentages



The shadow policy rate is then plotted against the actual rate in Figure 4. The results indicate that though policy eased greater than suggested by the policy rate in 2012, there was a sharp tightening in monetary policy in 2013, which continued into the latter half of 2014 when there was a sharp easing in policy by the end of the year.

Figure 4

JAMAICA: SHADOW POLICY RATE AND ACTUAL RATE



5.2 Structural Vector Autoregressive Model

The model estimated consisted of eight variables outlined in Table 3 to capture the monetary policy transmission from the USA into the Jamaican economy. Each variable was analysed in changes to ensure stationarity of the system. All variables except the interest rates were expressed as logged differences while interest rates are expressed as differences.

The model takes the form of a standard structural VAR specified as outlined in Amisano and Giannini (1997) and Hamilton (1994) expressed as:

3 $$y_t = \sum_{i=1}^{p} A_i y_{t-i} + \upsilon_t,$$

where A_i are $k \times k$ matrices, the variables y_{t-i} and ε_t are $k \times 1$ vectors for $i = 0, 1, 2, \ldots p$ and $\upsilon_t \sim N(0, \Sigma_\upsilon)$. This is the reduced form of the specification and can therefore be estimated by ordinary least squares for the appropriate lag length. In order to obtain the structural innovations, the model can be transformed by pre-multiplying

the system with the matrix of contemporaneous relations between the variables A_0 to transform the VAR model in equation 3 into the structural vector autoregressive (SVAR) model:

4 $$A_0 y_t = \sum_{i=1}^{p} A_i^* y_{t-i} + A_0 \upsilon_t ,$$

where $A_i^* = A_0 A_i$, for $i = 1, 2, ..., p$. The notation of the model can be further simplified, assuming $A = A_0$ such that equation 4 can be re-written as

4' $$AA(L)\, y_t = A\upsilon_t ,$$

and $A\upsilon_t = B\epsilon_t$ with $\epsilon_t \sim N(0, I_k)$. The reduced form or observed residuals are given by ϵ_t, while υ_t is the unobserved structural innovations which are assumed to be orthonormal. Therefore,

5 $$E\left[\upsilon_t \upsilon_t'\right] = I_k , \text{ and}$$

6 $$A\Sigma_\upsilon A' = BB' .$$

This structure, called the AB-model by Amisano and Giannini (1997) can then be estimated by maximum likelihood by imposing the appropriate restrictions on *A* and *B*. Given both sides of equation 6 are symmetric, there are $k(k+1)/2$ restrictions on the $2k^2$ elements of *A* and *B*. Therefore, the system can be estimated by imposing at least $2k^2 - k(k+1)/2 = k(3k-1)/2$ restrictions.

This paper uses the identification approach for modelling the interactions between a relatively large and small economy by applying block exogeneity restrictions as introduced by Cushman and Zha (1997) and Dungey and Pagan (2000) on *A*. There are essentially two blocks of data for the foreign and domestic economies. The identifying restrictions are essentially two sets of ordering restrictions based on Cholesky ordering. However, the domestic block is connected to the foreign block using theories such as uncovered interest and purchasing power parity conditions for the exchange rate. In

Table 3

Dependent	*Explanatory*							
	y^*	r^*	p^*	y	p	r	s	mb
y^*								
r^*								
p^*								
y								
p								
r								
s								
mb								

addition, other variables such as foreign output, y_t^*, are assumed to have a direct impact on their domestic counterparts. The resulting identifying matrix *A* is given in Table 3.[6]

This model is essentially a smaller scale version of the model estimated in Murray (2009) and therefore provides some insight as to whether there has been a change in the spillovers before and after the GFC. Also, in order to establish the efficacy of the shadow policy rate, the model was estimated using both the shadow policy rate and the actual policy rates, and the results were compared.

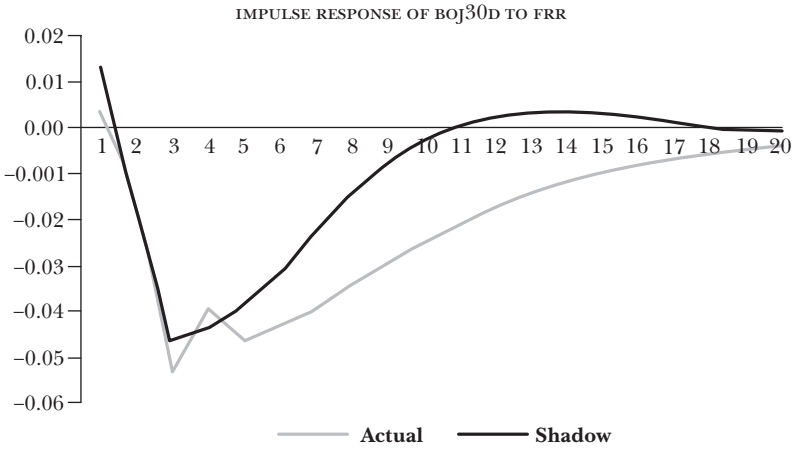
Two models were estimated, one using the shadow policy rates for each economy and the other with the actual rates. Both models were estimated with two lags based on the selection criteria (see Table A.1). The results of the estimation with the shadow rates as well as the actual policy rate are provided in the impulse responses below. They suggest, for the most part, that using the actual interest rates would have resulted in counter intuitive responses for many of the variables while the shadow policy rates provide responses that are more intuitive and in keeping with previous findings.

In Figure 5, the impulse responses show that a change in the FFR has a direct impact on the policy rate in Jamaica. However, following

[6] Alternative orderings of the domestic variables were examined. While they did result in some changes in the magnitudes of the impulses, there was no impact on the directions and timing of the impulses of the key variables of interest.

Figure 5

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO THE FFR



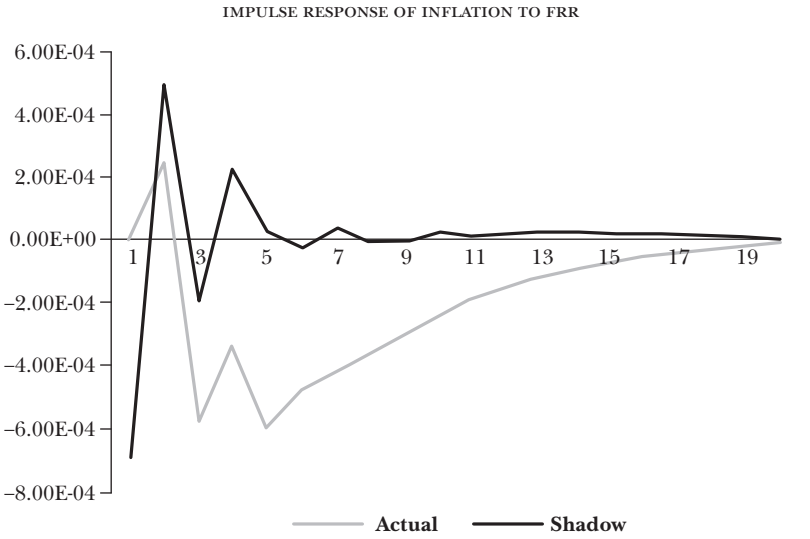
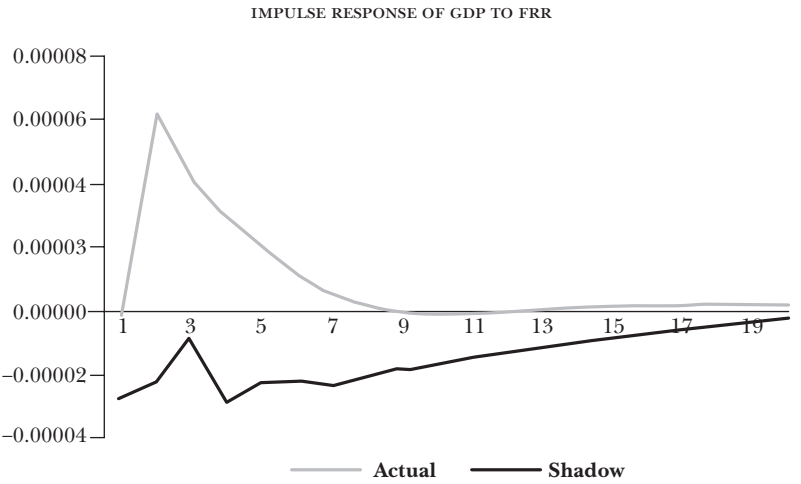


Figure 5

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO THE FFR



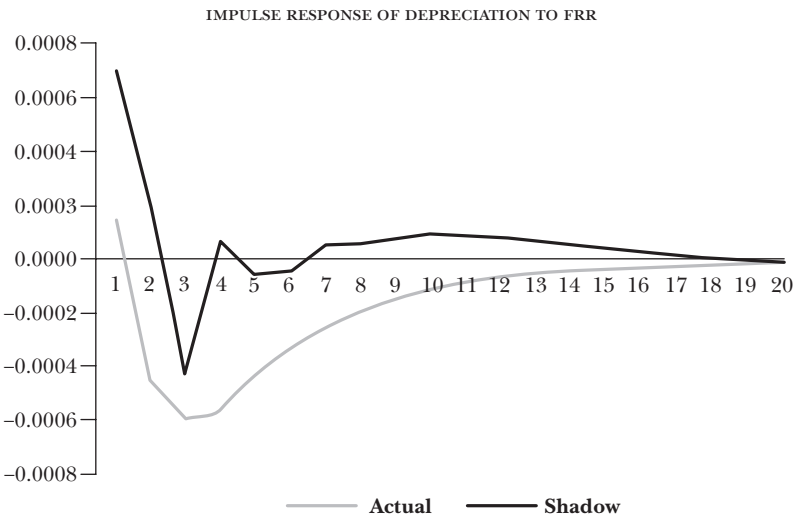
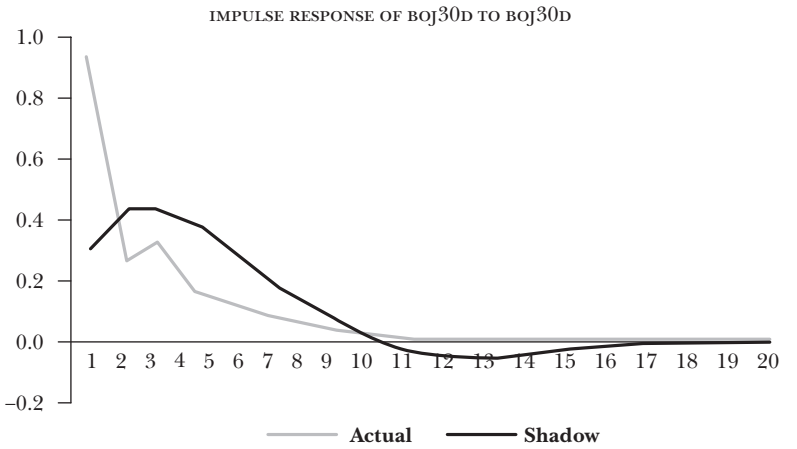


Figure 6

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO THE BOJ30D RATE



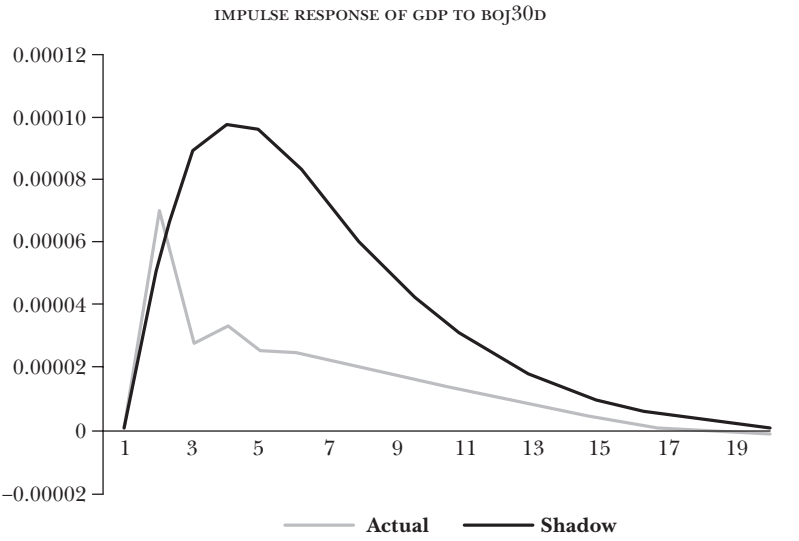
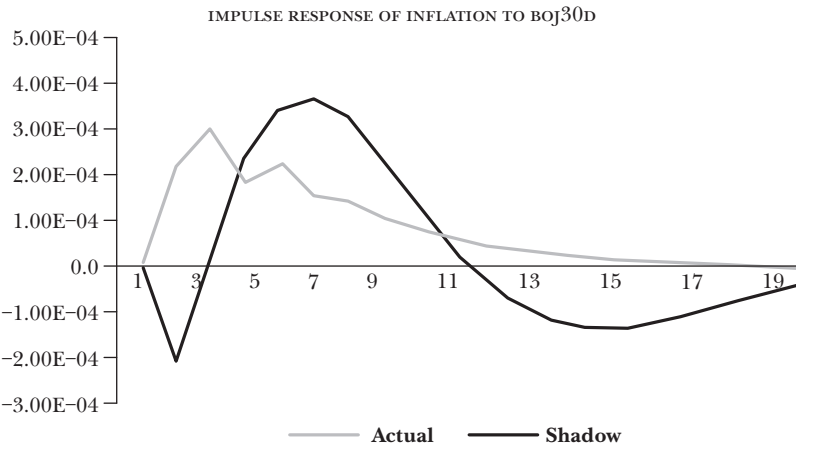
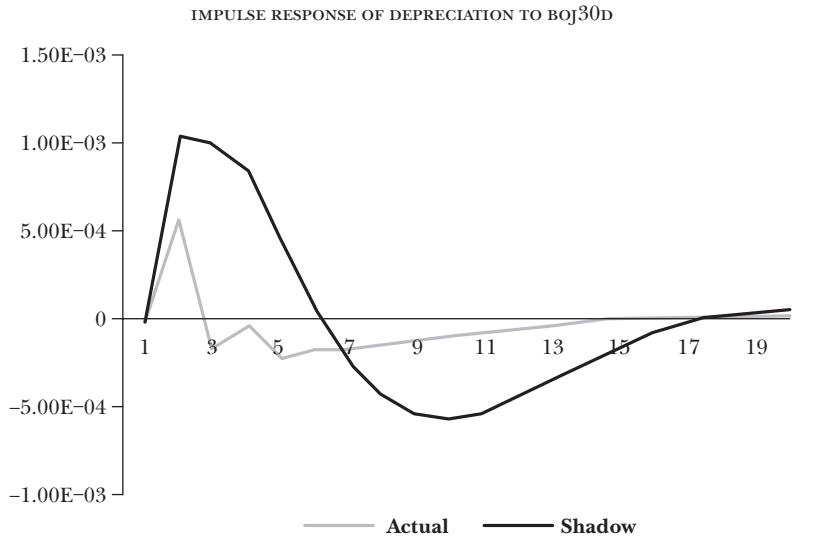


Figure 6

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO THE BOJ30D RATE





the initial positive response of the BOJ to this innovation, there is a reduction in the third month in response to a sharp appreciation of the Jamaican dollar, possibly due to a stronger than initially required policy response. The BOJ then responds to the appreciation by lowering the policy. This response is consistent with previous assessments of Jamaica, such as Allen and Robinson (2004) and Murray (2009), which show a strong response of the BOJ to the exchange rate changes. The impulse response of Jamaica's output to the shadow policy rate changes in the USA is also consistent with a priori expectations as well as the findings of Murray (2009). The policy action in the USA reduces that country's demand, which in turn reduces the output in Jamaica.

With regards to the domestic monetary policy transmission mechanism process, the shadow policy rates give more plausible responses than the actual policy rate based on the direction of the impulses. However, the results differ somewhat from previous studies. Changes in the shadow policy rate have the expected impact on domestic inflation, output and the exchange rate. However, the impulse response of output to the actual rate is counterintuitive. With the exception of output, the domestic variables response to the adjustments in the shadow policy rates have a similar direction; however, the magnitude of the initial response to the shadow policy innovation is much larger and in general dies out much faster.

With regards to the responses of domestic variables to shocks to changes in the domestic policy rate, again the impulse responses of the model with the shadow policy rate provide more intuitive results than the actual rate (see Figure 6). In particular, the impulse of inflation to an increase in the actual policy rate results in an increase in inflation. However, using the shadow policy rate results in an expected fall in inflation. Interestingly, the shadow policy rate models suggest a smaller policy response yields a larger than expected response of domestic variables to the innovation. Therefore, the actual policy rate would have underestimated the size of the required policy response. However, it should be noted that the size and duration of the impact of the shadow rates differs from previous studies like Allen and Robinson (2004) and Murray (2009) that suggest that the greatest impact of the policy innovation on inflation occurs six to eight quarters after the action. These results may be due to the use of a model in changes on monthly data with an interpolated measure of GDP. This approach would ignore the long-run impact of the policy changes on the variables.

Again, the impulse responses of the other domestic variables to innovations from inflation and depreciation are more plausible based on the shadow policy rate molds (see Figures A.1 and A.2 in the Annex). However, the domestic policy response to inflation suggests that the BOJ's initial response would be to reduce the policy rate. The response increased depreciation, however, is consistent with *a priori* expectations. The clear and strong response to depreciation is consistent with previous studies on Jamaica which suggests that historically there has been a stronger focus and policy response of the BOJ to depreciation than inflation given that depreciation has played a strong role as a nominal inflation anchor to the public.

6. CONCLUSION

The paper investigated the evidence of spillovers of monetary policy innovations in the USA to the Jamaican economy. Utilizing the approach by Lombardi and Zhu (2014) provided a useful measure of the true policy stance in Jamaica, allowing for a reasonable assessment of domestic policy changes to domestic as well as international factors. The results point to evidence of direct policy spillovers as the BOJ responds immediately and in the same direction as the Fed in order to maintain some interest rate parity. However, subsequent to this initial response, the largest domestic policy interest rate adjustment is to the impact of the Fed policy rate changes to relative prices in the two countries. In particular, the subsequent domestic interest rate response to exchange rate changes far outweighs the initial response to adjust to maintain parity between the foreign and domestic interest rate.

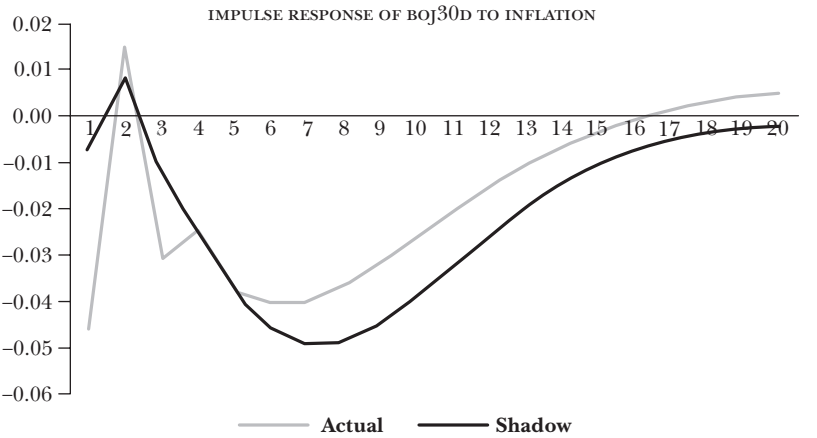
In addition to identifying the direct spillovers, the shadow policy rate approach also provided more intuitive responses than the actual policy rate model. Of note, using the actual policy rate model leads to an underestimation of the domestic monetary policy transmission mechanism and the measured impact on prices. There were, however, some counterintuitive impulse responses from the exercise which may be a result of the data frequency and the methodology. This would suggest a better measure of domestic and foreign output could be examined as well as a methodology to measure the long-run impact of the monetary policy innovations.

ANNEX

References

Figure A.1

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO INFLATION



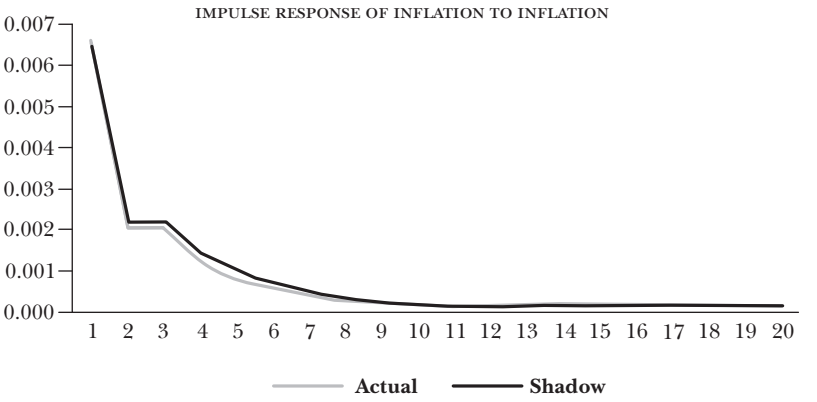
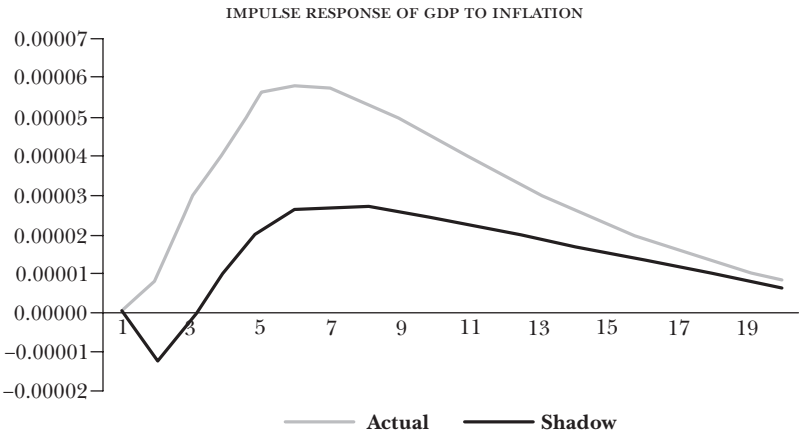


Figure A.1

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO INFLATION



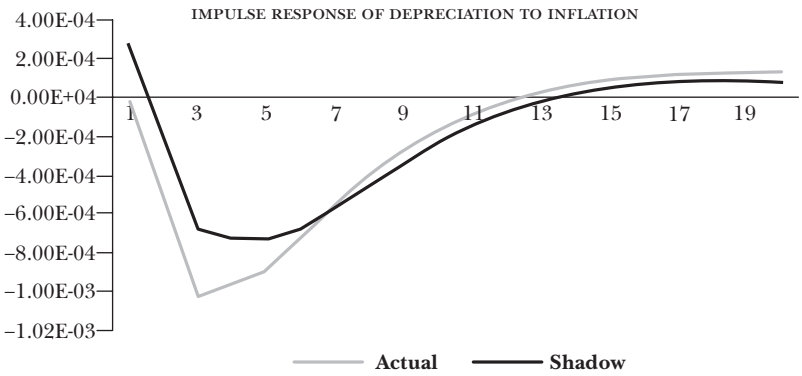
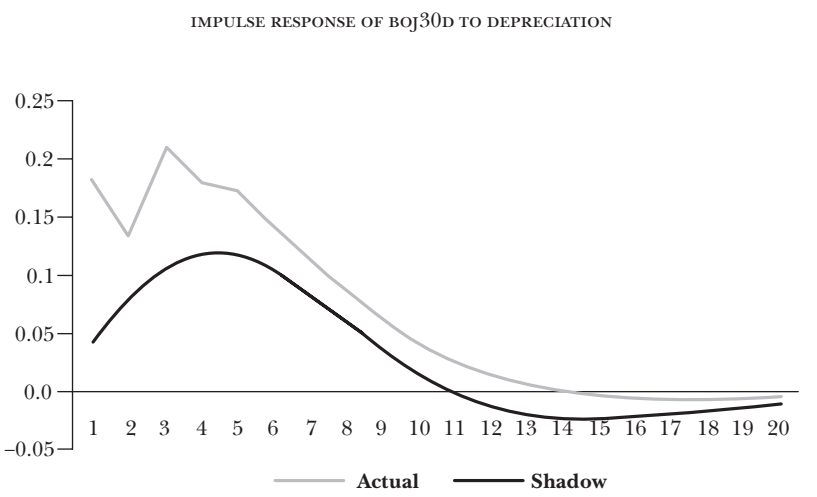


Figure A.2

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO DEPRECIATION



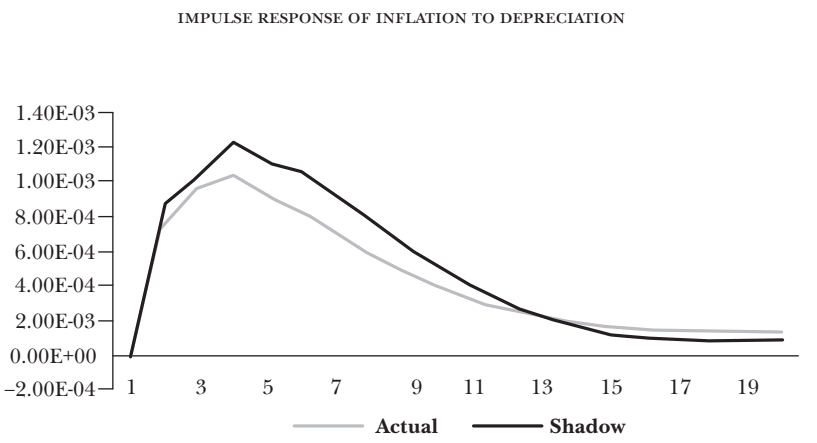
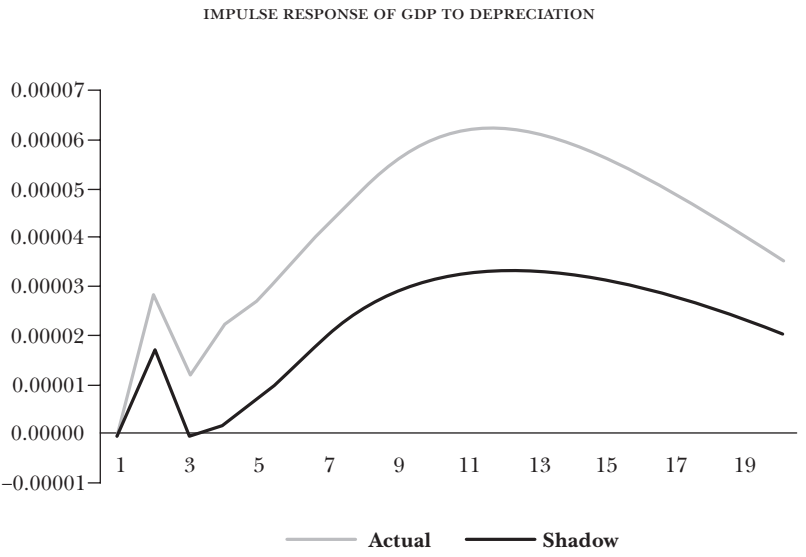


Figure A.2

IMPULSE RESPONSE TO ONE STRUCTURAL STANDARD DEVIATION SHOCK TO DEPRECIATION



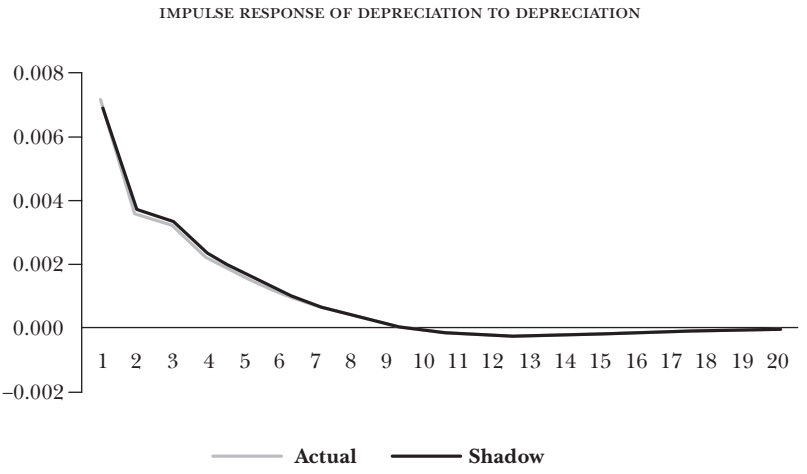


Table A.1

VAR LAG ORDER SELECTION CRITERIA

Endogenous variables: DLUSRGDP1 DFFR_USA DLUSCPI DLRGDP1 DLCPI DLEXRATE DJAM_30D DLMB
Exogenous variables: JDX NDX DFC DFC2
Sample: 1994M02-2015M07
Included observations: 244

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	5110.725	NA	1.23e-28	−41.56332	−40.99001	−41.33242
1	6276.316	2206.981	1.47e-32	−50.59276	−49.10216	−49.99243
2	6477.609	367.9372	4.80e-33	−51.71811	−49.31022[a]	−50.74835[a]
3	6575.525	172.5560	3.65e-33[a]	−51.99611[a]	−48.67093	−50.65691
4	6613.432	64.31846	4.57e-33	−51.78223	−47.53977	−50.07360
5	6666.286	86.21230	5.08e-33	−51.69087	−46.53111	−49.61281
6	6708.918	66.74320	6.19e-33	−51.51572	−45.43867	−49.06822
7	6769.749	91.24727	6.55e-33	−51.48975	−44.49541	−48.67282
8	6830.998	87.85702[a]	6.97e-33	−51.46720	−43.55557	−48.28083

Notes: [a] indicates lag order selected by the criterion. LR stands for sequential modified LR test statistic (each test at 5% level); FPE, for final prediction error; AIC, for Akaike information criterion; SC, for Schwarz information criterion; and HQ, for Hannan-Quinn information criterion.

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