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Monetary Policy and the Jamaican Economy: A Sectoral Analysis

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Abstract

This paper analyses the response of the real sector to monetary policy shocks. The results from a structural VAR model indicate that monetary policy innovations trigger a cumulative decline in the value added of the economy. With the exception of mining, all the goods producing sectors are affected negatively by monetary tightening. The manufacturing sector experiences the largest and quickest decline in response to an interest rate shock, while financial sector appears vulnerable to such increases in the short term. There is little evidence that the credit channel plays any significant role in the transmission of monetary policy to the real sector in Jamaica.

Keywords: transmission mechanism, sectoral analysis
JEL Classification: C2, E23, E52

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1.0 Introduction

The effects of monetary policy on prices and real economic activity lay at the heart of macroeconomic theory. Early classical theorists held the view that the economy could be "dichotomised" into two parts - the monetary sector and the real sector - such that economic forces originating in the monetary sector did not affect the real sector. Whilst the postulate of the "long run neutrality of money" is widely accepted, there is now a considerable amount of evidence which suggests that changes in money and prices (nominal quantities) can and do affect output and employment (real quantities) in the short run (see for example Hayo & Uhlenbrock (1999)). Moreover, there is increasing consensus that different sectors of the economy respond differently to monetary shocks.

As with most central banks, the main objective of the monetary policy of the Bank of Jamaica is price stability, specifically to reduce the rate of inflation to levels comparable to those of Jamaica's trading partners. The operating target is the monetary base and the intermediate target, the changes in the exchange rate. The latter from previous studies on the transmission mechanism is the key nominal anchor for prices and expectations.

In the pursuit of price stability, however, there has been increased concern among policy makers about the impact of monetary policy on real economic activity. This concern arises for two reasons. In the first place, trade cycle fluctuations are important determinants of price setting mechanisms and consequently of underlying inflation. Secondly, for political reasons, it would not be advisable for the monetary authorities to pursue a policy of dis-inflation, regardless of the cost to the real economy. Central banks are therefore putting non-zero weights on the output gap in their loss functions (see for example the ad-hoc Taylor rule considered by Allen et al (2002)). Such considerations largely drive the need to understand how an unanticipated change in monetary policy affects the overall economy as well as the individual sectors of the economy. This knowledge can also provide the financial markets, among others, with helpful perspectives on the effects of monetary policy actions.

The main objective of this paper, therefore, is to provide stylised facts on the response of different sectors of the Jamaican economy to monetary policy shocks. The paper also attempts to briefly evaluate the applicability of the credit channel of money transmission to the Jamaican real sector. The analysis has been facilitated by the recent release of quarterly Gross Domestic Product (GDP) data by the Statistical Institute of Jamaica (STATIN) and Allen's (2002) attempt at interpolating Jamaica's annual GDP series over a fairly long period. The assessment looks at nine sectors of the economy: namely, agriculture, mining & quarrying, manufacturing, construction, electricity & water, transport, storage & communication, distribution, financing & insurance and miscellaneous services.

The results of the impulse response analysis indicate that a monetary policy innovation triggers a cumulative decline in the value added of the economy. With the exception of mining, all the goods producing sectors reflected reductions in value added following the monetary tightening. Among this group, the manufacturing sector experienced the largest and quickest decline in response to the monetary policy shock. With regard to services, financing & insurance is the only sector that experiences a decline in the context of the monetary contraction. Notwithstanding, the value added of the sector increases after the sixth quarter. The cumulative value added of the distributive trade, electricity & water, transport, storage & communication and miscellaneous sectors expands following the monetary policy shock.

The credit channel appears weak or non-existent, corroborating the results of Allen, Hall and Robinson (2002). The findings from the ordinary least squared (OLS) regressions show that a rise in the Central Bank's signal rate causes commercial banks interest spreads to fall, which, in a sense, is inconsistent with theory. In terms of the impact of the shock to monetary policy on the output gap, the result suggests that monetary policy tend to affect the real economy with a lag.

The rest of the paper is organised as follows. Section 2 looks at the monetary transmission mechanism, interspersed with a brief review of similar studies. Section 3 discusses the history of the Jamaican real sector. The empirical methodology is outlined in section 4 and the results presented in sections 5 and 6. Section 7 provides some concluding remarks.

2. 0 Monetary Policy Transmission & The Real Sector

The effects of monetary policy innovations, primarily interest rate adjustments, on inflation have been the subject of extensive theoretical and empirical research (e.g., Dillen 2002, Robinson 1997). However, increased attention has been placed on the short run dynamics between monetary developments and the real economy (Fares and Srour (2001) and Hayo & Uhlenbrock (1999)).

An increase in interest rates affects real sector activities through three channels: the interest rate channel, the credit channel, and the exchange rate channel (see figure 1). With regards to the interest rate channel, contractionary monetary policy will lead to a rise in real market interest rates (including loan rates) and thereby trigger a decline in real investment spending. Interest rates also represent an opportunity cost for investment in fixed assets. If this opportunity cost exceeds the rate of return on viable projects, the investor will prefer to hold her wealth in bonds instead of productive assets.

The above proposition reflects the thinking of Keynes (1936) in regards to the relationship between market interest rates and the marginal efficiency of capital (*mec*) ─ the rate of discount that makes the flow of expected net income over the life of the capital good equal to its price[2]. Recall that the price of capital is equal to the present value of a firm's expected net income stream i.e.

$$P_c = \frac{R_1}{(1+\rho)^1} + \frac{R_2}{(1+\rho)^2} + \ldots + \frac{R_n}{(1+\rho)^n}$$

where P_C is the supply price of the capital good, R_n is the expected net income stream and ρ denotes the *mec*. Firms will compare the *mec* with the market rate of interest (*mri*) to ascertain the profitability of new investments. If the *mec* is greater than the *mri*, then the new investment is profitable. A *mec* that is less than the *mri* indicates that the investment will not be undertaken, as the firm will incur losses on the investment. If the *mec* is equal to the *mri*, the firm is indifferent as to whether it should invest in the capital good or invest in bonds. In figure 2, the equilibrium stock of capital is K_o, given an *mri* of i_o. If interest rates were increased to mec_1, disinvestments equalling $k_0 - k_1$ would occur, as some project would become relatively unprofitable. Given the

[2] The mec can also be thought of as the firm's internal rate of return.

Figure 1

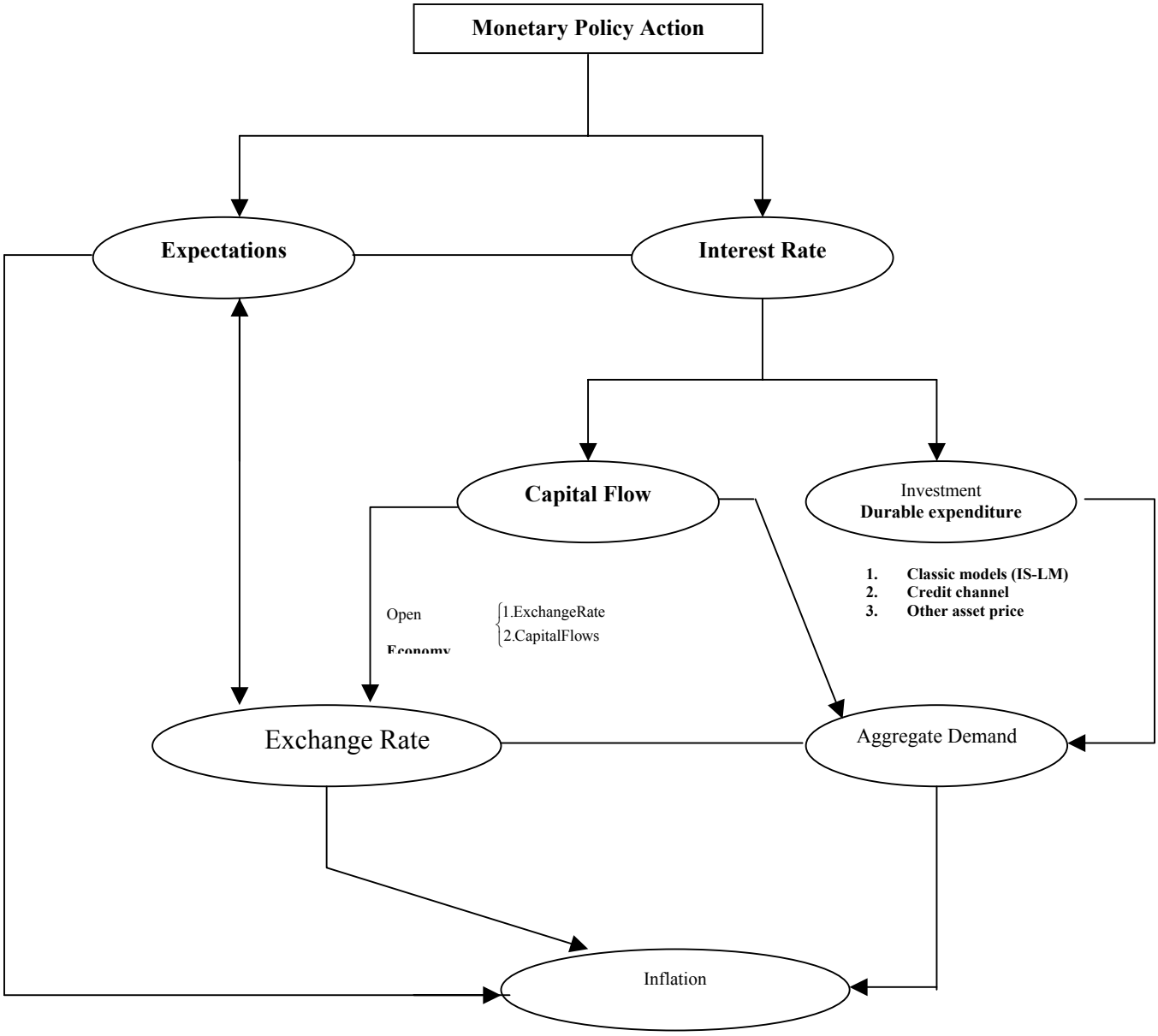
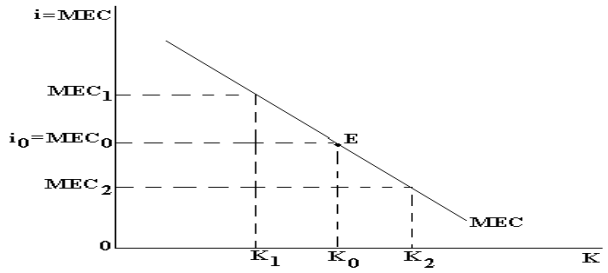

Monetary Policy Action
Expectations
Interest Rate
Capital Flow
Investment
Durable expenditure
1. Classic models (IS-LM)
2. Credit channel
3. Other asset price
Open
Economy
1.ExchangeRate
2.CapitalFlows
Exchange Rate
Aggregate Demand
Inflation

Figure 2



foregoing, it is usually the case that investment expenditure and the construction sector will be the most sensitive category/industry to monetary shocks.

Fares and Srour (2001), using quarterly and annual data for Canada and the United States, find that investment expenditure adjusts more quickly compared with expenditure on consumption. With regards to real activities viewed in terms of production classifications, they found that the construction sector responds most sharply to a monetary contraction, relative to the other sectors. Hayo and Uhlenbrock (1999), in examining 28 industries in the manufacturing and mining sectors in Germany, find that output in these sectors starts to decline approximately 5 months after a monetary tightening. It falls significantly after 1 year, reaches its lowest level within 2 years and returns to its initial level in less than 3 years. Similarly, Granley and Salmon (1997) compare the response of output in 24 sectors of the UK economy to an unexpected monetary tightening. They find that the construction, distribution, transportation and manufacturing sectors show the greatest responses. Fares and Srour (2001) also found that the manufacturing sector was most adversely affected by a shock to monetary policy.

Bernanke and Gertler (1995), however, do not accept the quantitatively important effects of interest rates through the cost of capital, and promoted a search for another transmission mechanism, broadly referred to as the credit channel. This channel is premised on the existence of frictions in financial markets, such as imperfect information or costly enforcement of contracts, which will hinder the smooth operation of the markets. In that regard, a gap would

exist between the cost of funds raised externally and the opportunity cost of internal funds. Bernanke and Gertler (1995) called this gap the external finance premium (*efp*), which is the deadweight cost related to the principal-agent problem between lenders and borrowers. The balance sheet and the bank-lending channel are two methods proposed to explain the connection between monetary policy actions and the *efp*.

The *balance sheet channel* is premised on the assumption that the *efp* facing a borrower will depend on the borrower's financial position. The greater is the borrower's net worth (sum of liquid assets and marketable collateral) the lower the *efp* should be. Given that borrower's financial positions affect the *efp* and their terms of credit, variations in the quality of borrower's balance sheet tend to influence their investment and spending decisions. Consequent on a monetary tightening, the borrower's net worth deteriorates as higher interest rates foster a decline in stock prices, which trigger a fall in the value of the borrower's collateral. This channel is consistent with Tobin's (1969) view that a firm will reduce its investments / assets when its market value is less than the cost of capital.

The *bank-lending channel* purport that changes in monetary policy that raises or lowers market interest rates tends to change the *efp* in the same direction. An increase in banks' lending rates drives away risk-averse projects, leaving only riskier projects. Given the increased riskiness of banks' portfolios, their monitoring cost will increase. Consequently, there would be an increase in intermediation costs, which would trigger a rise in the *efp*. Moreover, if the supply of loans is restricted, bank dependent borrowers may be cut off from credit. In seeking out new sources of credit, additional costs will be incurred, increasing the *efp* and thereby reducing real activity. Because of this additional effect of policy on the *efp*, the impact of monetary policy on the cost of borrowing and consequently on real spending and real activity is magnified.

A third channel, the *exchange rate channel*, is particularly applicable to economies that are small, open and highly dependent on imports for both production and consumption. Through this channel, a rise in real interest rates causes an appreciation in the real exchange rate, which makes exports less attractive and imports cheaper, thereby fostering a decline in net exports and hence aggregate demand. Longmore and Henry (2003) explored the dynamics of Jamaica's current

account and the real effective exchange rate (REER) and found that the real exchange rate does not play a significant role in determining the major elements of the Jamaican current account, and consequently GDP.

The response of the Jamaican economy to monetary policy changes has been studied by Robinson (1997) and Allen, Hall and Robinson (2002). Robinson (1997) found that the impact of monetary policy on the Jamaican economy was immediate and pervasive, albeit short lived, lasting between two to eight months. He found very strong, albeit temporary real sector effects, as real economic activities declined by approximately 2.0 per cent in four months. Allen et al (2002) found that the impact of an interest rate adjustment on inflation last for two to three years. The response of the exchange rate was immediate with an appreciation of approximately 0.42% in the first quarter and lasting for two quarters. The effect of the shock on the exchange rate lasts for approximately one year. In its transition back to equilibrium the exchange rate exhibited some overshooting. The appreciation in the exchange rate had a dampening effect on inflation with declines of 0.09%, 0.05% and 0.04% in the subsequent three quarters following the shock. The noticeable appreciation in the currency elicited an immediate rise in real money balances, as it completely offset the negative impact of the rise in real interest rates. The impact on the output gap had a lag of approximately two to three quarters. The effect, however, is negligible but persists for a relatively long time (almost three years.) The model simulations revealed the potency of monetary policy and the importance of exchange rate behaviour in macroeconomic stabilization. The main transmission channel of monetary policy was through the exchange rate, with a relatively small role for the credit channel. This paper extends these analyses by examining the response of output to monetary policy at the sectoral level.

3.0 The Jamaican Productive Sectors: Some Stylised Facts

Consistent with the 1986 System of National Accounts (SNA), and the 1987 Jamaica Industrial Classification Manuscript, the Jamaican GDP is broadly disaggregated into the goods producing and services sectors. The goods producing sectors is sub-divided into agriculture, mining & quarrying, manufacturing and construction. The manufacturing sector is further classified into 14 component industries. Services comprise the electricity & water, transport, storage &

communication, distribution, financial & insurance, government, miscellaneous, real estate & business and household & private institutions sectors (see figure 3).

Figure 3
A Sectoral Breakdown of GDP

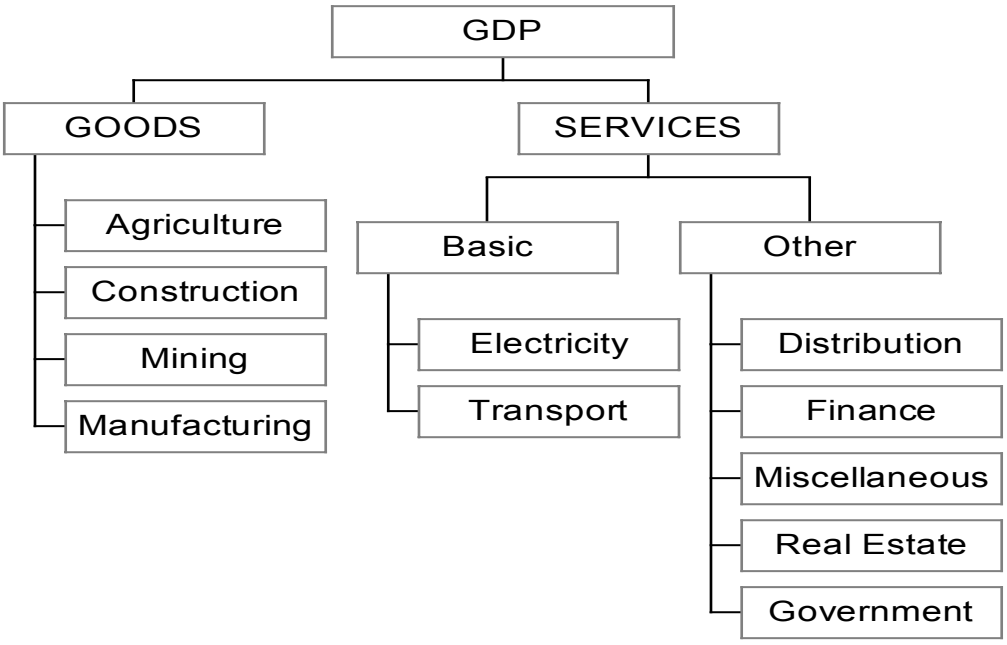
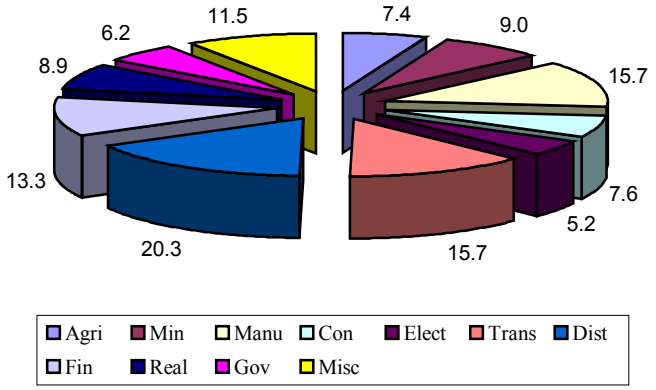


Figure 4 shows the average contribution of the nine sectors to real GDP between 1997 and 2002. The distributive, manufacturing, transport, storage & communication and financial services sectors were the largest sectors, contributing approximately 20.3 per cent, 15.7 per cent, 15.7 per cent and 13.3 per cent of GDP, respectively, over the period. Electricity & water contributed the least, accounting for 5.2 per cent of GDP. Imputed service charges (not represented in the chart), accounted for approximately 21.3 per cent of GDP.

Figure 4
Average Contribution to Real GDP (%)
(1997 - 2002)



Between 1990 and 2002, Jamaica's GDP in real terms grew by an average of 1.0 per cent. For the first six years of the review period, GDP growth was relatively strong, averaging 2.1 per cent (see table 1 and figure 5). This growth, it must be noted, occurred in the context of relatively high inflation, which coincided with the liberalisation of the capital account and foreign exchange market in the early 1990s. In response to the inflationary episode, monetary policy in the mid 1990s shifted focus to inflation stabilization through direct targeting of the monetary base. Of such, 1996 represented a watershed in the design and implementation of monetary policy when the Authorities resolved to reduce inflation to the levels of Jamaica's major trading partners. The focus on low inflation arose in the context of the completion of a borrowing programme with the IMF, an increasingly healthy NIR position and the need to accelerate growth in the real sector of the economy.

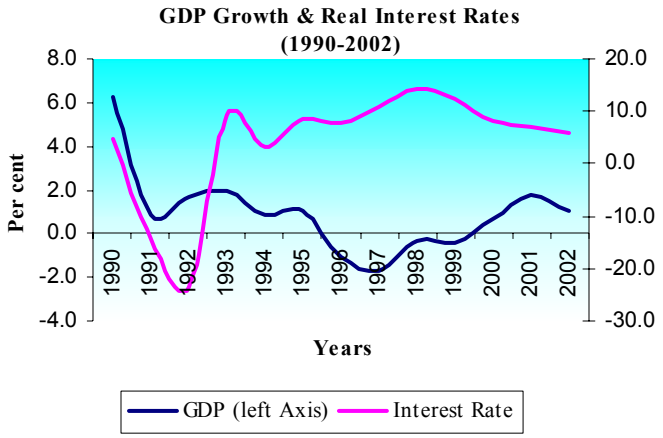
Against this background, the stance of monetary policy became increasingly geared at maintaining relative stability in the exchange rate, given the sensitivity of domestic prices to adjustments in the nominal rate. Real interest rates rose progressively between 1996 and 1999 as liquidity conditions were regulated more strictly by the Central Bank. Real GDP growth became negative in 1996 and the stagnation persisted for three years thereafter. It could be inferred that interest rates, and more specifically monetary policy shocks, appear to have affected the economy's growth prospect over the period.

Table 1: Jamaica; Selected Statistics (%)

Year	GDP Growth	Inflation *	Reverse R Rate**	Real In t Rate
1990	6.3	22.0	27.6	4.6
1991	0.8	51.1	29.5	-14.3
	1.7	77.3	35.5	-23.5
1993	2.0	22.1	33.5	9.4
1994	0.9	35.1	39.6	3.3
1995	1.0	19.9	30.1	8.5
1996	-1.1	26.4	36.4	7.9
1997	-1.7	9.7	21.8	11.0
1998	-0.3	8.6	24.3	14.4
1999	-0.4	6.0	19.1	12.4
2000	0.7	8.2	16.8	8.0
2001	1.7	7.0	14.6	7.1
2002	1.0	7.1	13.2	5.8

** Annual Average*

Figure 5



The principal goods producing sectors that accounted for the decline between 1996 and 1999 were the manufacturing and construction sectors. For the manufacturing sector, trend declines were apparent in the textile industry as general competitiveness considerations, particularly after the formation of NAFTA, induced a relocation of firms from Jamaica to other countries. The decline in the construction sector could be partly attributed to the high real interest rates that

prevailed during the period[3]. Within services, the financial sector experienced fairly dramatic reversals in growth in the context of a crisis that ensued in the sector (see Foga (1997)). Green (1999) observed that, while the dis-inflationary policies of the monetary authorities were precipitating factors for the distress in the financial sector over the latter part of the 1990s, management deficiencies and regulatory loopholes were also responsible for the problems that arose in the sector.

The economy was also subjected to a number of shocks in the latter part of the 1990s. Adverse weather conditions in the forms of floods, drought and other natural pestilence negatively affected the agricultural sector. A significant contraction occurred in the mining sector between 1999 and 2000 and was attributed to the partial closure of the Kaiser bauxite plant in those years. The partial closure was necessary given the explosion at the Gramercy processing plant in Louisiana, U.S.A., in July 1999 that resulted in a reduction in demand for bauxite from Jamaica.

Role of Banking System Credit

Traditionally, commercial bank loans have been the main source of financing for working capital and fixed capital investments in Jamaica. A dis-aggregation of the loan portfolio of the banking system reveals that between December 1998 and December 2002, the tourism (miscellaneous services), distribution and manufacturing sectors accounted for the largest portion of commercial bank loans. Construction, transport, storage & communication and agricultural sectors accounted for somewhat smaller shares. The mining & quarrying and electricity & water sectors were least financed by bank loans (see table 2).

Between 1998 and 2002 interest rates declined consistently, as the economy stabilized. The rate of growth of loans to tourism, manufacturing and transport, storage & communication[4], however, declined during 1998 and 1999 but increased significantly between 2000 and 2002. Loans to the agriculture sector declined consistently between 1998 and 2001 and increased sharply in 2002. For construction, reductions in loan balances were observed between 1998 and 2000, with huge increases during 2001 and 2002.

[3] The Planning Institute of Jamaica consistently related the performance of the sector over the period to interest rates. See Economic and Social Survey 1997 – 1999.

[4] This is partly explained by the rehabilitation process following the financial sector crisis.

Table 2	Commercial Banks Loans & Advances (Percentage Shares)							
Sector	**Dec-97**	**Dec-98**	**Dec-99**	**Dec-00**	**Dec-01**	**Dec-02**	**(5-Yr) Average**	**Rank**
Agriculture & Fishing	5.8	5.5	5.2	4.7	3.8	3.6	4.6	8
Mining & Quarrying	0.6	0.5	0.3	0.3	0.3	0.2	0.3	11
Manufacturing	13.5	11.2	9.8	9.2	8.1	6.5	9.0	5
Construction & Land Development	9.3	7.1	6.6	6.1	6.1	6.8	6.6	7
Transport, Storage, & Communication	8.8	5.3	4.7	4.6	11.4	11.2	7.5	6
Tourism	9.9	11.9	11.6	14.3	13.4	14.5	13.2	2
Distribution	8.6	10.1	9.3	10.8	8.4	9.3	9.6	4
Professional & Other services	16.2	18.0	14.7	14.3	9.2	8.7	13.0	3
Personal Loans	26.3	29.5	36.7	32.9	35.7	35.0	33.9	1
Electricity	0.2	0.2	0.2	2.3	3.3	3.7	2.0	9
Entertainment	0.5	0.3	0.5	0.4	0.2	0.4	0.4	10
Overseas Residents	0.2	0.2	0.2	0.2	0.2	0.2	0.2	12

4.0 Methodology and Data

Following Fares & Srour (2001), Christiano, Eichenbaum, and Evans (1999) and Granley & Salmon (1997), this paper uses a Structural Vector Autoregression (SVAR) model to estimate the sectoral responses to monetary policy innovations. To motivate the discussion on SVARs, recall that a VAR for a *k*-dimensional vector of variables, Z_t, is given by the following:

$$Z_t = B_1 Z_{t-1} + \ldots + B_q Z_{t-q} + u_{t,} \quad \mathrm{E} u_t u_t' = V \tag{1.1}$$

Here, q is a non-negative integer and u_t is uncorrelated with all variables dated t-1 and earlier. If we assume that the B_i's, and u_t's are known, it would not be possible to compute the dynamic response function of Z_t to the fundamental shocks in the economy, because u_t is the one step ahead forecast error in Z_t. Normally, each element of u_t reflects the effects of <u>all</u> the fundamental economic shocks. There is therefore no reason to assume that any element of u_t corresponds to a particular economic shock.

Assume that the relationship between the VAR disturbances, u_t and the fundamental economic shocks, ε_t, is given by $A_o u_t = \varepsilon_t$. Here, A_o is an invertible square matrix, $E\varepsilon_t\varepsilon'_t = D$, and D is a positive definite matrix. Premultiplying (1.1) by A_o gives the following:

$$A_0 Z_t = A_1 Z_{t-1} + \ldots + A_q Z_{t-q} + \varepsilon_t \tag{1.2}$$

Where A_i is a $k \times k$ matrix of constants, $i = 1,\ldots q$ and hence

$$B_i = A_0^{-1} A_i, i = 1,\ldots q, \; and \; V = A_0^{-1} D \left(A_0^{-1}\right)' \tag{1.3}$$

The response of Z_{t+h} to a unit shock in ε_t is defined as $\gamma_h = \tilde{\gamma}_h A_0^{-1}, h = 0,1,\ldots$, where $\tilde{\gamma}_h$ is the solution to the difference equation $\tilde{\gamma}_h = B_1 \tilde{\gamma}_{h-1} + \ldots + B_q \tilde{\gamma}_{h-q}, h = 1, 2\ldots\ldots$, with initial conditions $\tilde{\gamma}_0 = \mathrm{I}, \; and \; \tilde{\gamma}_{-1} = \tilde{\gamma}_{-2} = \ldots = \tilde{\gamma}_{-q} = 0$. The ($j$, l) element of γ_h gives the response of the jth component of Z_{t+h} to a unit shock in the lth component of ε_t. The impulse response function of the elements of Z_t to the elements of ε_t is therefore characterised by the γ_h's.

Without any restrictions on A_0, it is the usual practice to set D = I, so that $V = A_0^{-1} (A_0^{-1})'$. Let Q_v be the set of solutions to this equation defined as:

$$Q_v = \left\{ A_0 : A_0^{-1} \left(A_0^{-1}\right)' = V \right\} \tag{1.4}$$

This set contains many elements as A_0 has k^2 parameters and the symmetric matrix, V, has at most k (k + 1) / 2 distinct members. In this regard, Q_v is the set of solutions to k (k + 1) / 2 equations in k^2 unknowns. If $k > 1$, there will be many solutions to this set of equations, meaning the system will not be identified.

To solve the identification problem, restrictions must be placed on A_0 so that there is only one element in Q_v satisfying them. One option, given that A_0 is an invertible square matrix, is to adopt the recursive ordering suggested by the Cholesky factorisation, whose restrictions make the A_0 matrix lower triangular, with 1's along the principal diagonal. This set of restrictions has been criticised by Sims (1986), who argued that they produced "incredible identification restrictions". As an alternative, "structural restrictions" were popularised by Bernanke (1986), Blanchard and Watson (1986) and Sims (1986). There are two types of restrictions that are imposed in the literature: a set of linear restrictions on the elements of A_0 and a requirement that the diagonal elements of A_0 be positive[5]. If there are l linear restrictions on A_0, this can be presented as the requirement $\tau \mathrm{vec}(A_0) = 0$, where τ is a matrix of dimension $l \times k^2$ and $\mathrm{vec}(A_0)$ is the $k^2 \times 1$ vector composed of the k columns of A_0. All the l rows of τ represent a different restriction on the elements of A_0. The set of A_0 satisfying these restrictions can be denoted by

$$Q_\tau = \{ A_0 : \tau \mathrm{vec}(A_0) = 0 \} \qquad (1.5)$$

Of note, identification can be achieved by selecting a full row rank τ satisfying the condition that $l \geq k\,(k-1)\,/\,2$ (the order condition). Along with the order and sign conditions, the necessary and sufficient condition for identification is that the matrix derivative with respect to A_0 of the equations defining (1.5) is of full rank.

The identifying restrictions embodied in the relation $A_o u_t = \varepsilon_t$ are commonly referred to as short-run restrictions. Shapiro and Watson (1988) and Blanchard and Quah (1989) proposed an alternative identification method based on restrictions on the long-run properties of the impulse response functions. The (accumulated) long-run response to structural innovations takes the form $C = \Psi_\infty A_o$, where $\Psi\infty = (I - \hat{A}_1 - \ldots\ldots - \hat{A}_q)^{-1}$ is the estimated accumulated responses to the reduced form (observed) shocks. Long-run identifying restrictions are specified in terms of the elements of this C matrix, typically in the form of zeroes or ones. For example, the restriction $C_{i,j} = 0$ means that the (accumulated) response of the ith variable to the jth structural shock is zero in the long run.

[5] The latter restriction is referred to as the sign condition.

Separate VARs are estimated in levels[6] for each sector. The Z_t vector includes the 30-day repo rates ($\boldsymbol{i_t}$) (the proxy for monetary policy), overall GDP ($\boldsymbol{y_t}$), the CPI ($\boldsymbol{p_t}$) and the value added for the individual sectors ($\boldsymbol{is_t}$), in that order $\{\mathbf{Z_t}' = (\boldsymbol{i_t}, \boldsymbol{y_t}, \boldsymbol{p_t}\ \boldsymbol{is_t})\}$[7]. Gertler and Gilchrist (1994) noted that $\boldsymbol{p_t}$ and $\boldsymbol{y_t}$ are necessary to capture the impact of other macroeconomic influences on sectoral developments. For the overall economy, $\mathbf{Z_t}' = (\boldsymbol{i_t}, \boldsymbol{y_t}, \boldsymbol{p_t})$. A common lag length of four is used in each system[8].

The paper proceeds by first estimating unrestricted VARS as an initial basis for comparison with the SVARS. For the SVARs, the following are the restrictions imposed on the C matrices for the sectoral and overall GDP models, respectively:

$$\overset{Sectors}{C = \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} \\ 0 & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ 0 & 1 & 1 & a_{44} \end{bmatrix}} \qquad \overset{GDP}{C = \begin{bmatrix} 1 & a_{12} & a_{13} \\ 0 & 1 & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}}$$

The principal restriction is that the long run neutrality of money (LRNOM) holds; i.e. changes in monetary policy do not affect the economy's output in the long run. The LRNOM restriction is achieved in the sectoral models by setting a_{21} and a_{41} to zero, that is monetary policy (interest rates) does not affect either overall GDP or output for the individual sector in the long run. To achieve global identification, the effects of monetary policy, and GDP on themselves, as well as the effect of the individual sector on GDP were set to unity ($a_{11} = a_{22} = a_{42} = 1$). The first restriction means that a monetary shock is a permanent one unit increase in $\boldsymbol{i_t}$. The second and

[6] Sims (1980) recommends against differencing the variables in a VAR, even if they contain a unit root. The main argument against differencing is that it 'throws away' information concerning the co-movements in the data.

[7] We used nominal interest rates to avoid issues to do with multicollinearity. This, because the CPI is also included in the model.

[8] The imposition of a common lag length introduces two types of errors into the estimation process. In the first instance, if there are too few lags for some VARs this could introduce bias into the results. In the second place, too many lags could reduce the efficiency of the estimation process. Given the importance of the first errors, a longer common lag length is preferred. Granley and Salmon (1997) suggested calculating the optimal lag length for each VAR and interpreting the results with differing lag lengths. However, it would be difficult in that case to determine whether or not differences in the sectors' responses to monetary policy shocks merely reflected differences in the lag lengths of each VAR.

third restrictions imply that a unit increase in GDP, or a sector of GDP (which are flows), translates into a new level of output per time period that will persist forever. To ensure identification, $a_{43} = 1$, which would imply that a shock to overall prices permanently increases a sector's output in the long run[9].

A second line of investigation is to assess the relevance of the credit channel of monetary policy shocks to the Jamaican economy, by examining the response of the *efp* to a monetary policy shock. In this regard, the paper estimates an equation, using OLS, which includes the commercial banks interest rate spread (a proxy for the *efp*), the real ex-ante signal rate, changes in the nominal exchange rate and a proxy for the output gap. For the first hypothesis regarding the monetary policy shock and the spread, the explanatory variables included in the regression are the spread (i_l-i_d), the change in the nominal exchange rate (Δs) and the real ex-ante signal rate (r), calculated as the difference between the Bank's 30-day reverse repurchase rate and expected core inflation. For the latter term we invoke the usual rational expectations hypothesis that expected inflation is coincident with the current inflation rate.

The paper goes one step further to examine the impact of changes in *efp* on the output gap. For this, the regression includes the real ex-ante signal rate and the output gap (y-y_p)[10].

The data set spans the period 1990 to 2002 at a quarterly frequency. The GDP series used is provided by the Statistical Institute of Jamaica (STATIN) over the period 1996:01 to 2002:04. This series was extended backwards to 1990:01 by applying the growth rates estimated by Allen (2002) to the data produced by STATIN.

[9] This is restriction may be counterintuitive as an increase in economy wide prices will not change relative prices. While the producer in a sector might believe that his price has increased, relative to the rest of the economy and thereby increase output in the short run, this expansion would not prevail in the long run. This restriction could be justified on the assumption that the learning process takes a fairly long time or that the economy has been largely characterised by imperfect markets. From a more practical perspective however, the model cannot be uniquely identified with any other restriction. Several other restrictions were attempted without success.

[10] Potential output was constructed from total GDP using the Hodrick-Prescott Filter. The potential output end points were not included in the regression due to the bias of the Hodrick-Prescott Filter. In addition, the estimated potential output series was adjusted upwards by an arbitrary constant to ensure that actual output did not exceed potential.

5.0 The Effects of Monetary Policy on Sectoral Value Added

Table 3 presents the cumulative short-run real effects of a monetary policy shock, showing the maximum reduction in each sector's output following a one standard deviation increase in the Bank's signal rate, the length of time it takes to reach that maximum level and the cumulative decline after one year.

Table 3

Magnitude and Timing of Sector Output Responses						
Industry	**Maximum Output Reduction (%)**		**Timing of Maximum Reduction (Quarter)**		**Reduction after 1 Year (%)**	
	VAR	SVAR	VAR	SVAR	VAR	SVAR
GDP	-	0.02	-	3	-	0.01
GDP (Excluding Agri)	0.001	0.001	6	14	-	-
Components of GDP						
Goods	-	0.04	-	3	-	0.03
Services	0.01	-	30	-	0.001	-
Sectors						
Agriculture	-	0.04	-	14	-	-
Mining	0.004	-	15	-	0.001	-
Manufacturing	0.01	0.07	6	2	0.002	0.04
Construction	0.01	0.03	11	9	0.01	0.01
Electricity	0.04	-	24	-	0.01	-
Transport	0.02	-	30	-	0.01	-
Distribution	0.001	-	13	-	-	-
Finance	-	0.06	-	4	-	0.06
Miscellaneous	0.03	-	27	-	0.003	-

The unrestricted VAR indicates that the monetary policy shock does not initiate a decline in overall real GDP[11], *in fact GDP increases following the shock*. This curious response reflects the response of the agriculture and financing & insurance services sector, which reflected increased value added in the context of the monetary shock. With the exclusion of the agriculture sector, the monetary policy shock results in a maximum decline of 0.001 per cent in GDP by the sixth quarter following the shock. Broadly speaking, the services sector appears to be more susceptible to a monetary policy shock, compared with the goods producing sectors. The manufacturing

[11] The focus of this paper is to evaluate the extent of reduction in GDP. To avoid confusion therefore, increases are represented as dashes.

sector, however, responds the quickest to the monetary innovation, while the largest reductions in value added were experienced by the electricity & water and transport, storage & communication sectors.

The simulation from the structural VAR confirms that the manufacturing sector exhibits the fastest response to the monetary policy innovation. However, contrary to the results from the unrestricted VAR, the electricity, transport and distributive sectors expand in the short run, in response to the increase in interest rates. The contraction in the manufacturing sector is the largest for all the sectors, followed by the financial sector. Overall GDP declines after about three quarters in response to monetary tightening, due to the goods sector, as services tend to increase.

5.1 Impulse Responses

This section discusses the impulse responses from the SVAR model, which are presented in figures 2 and 3 in the appendix[12]. Total GDP initially declines sharply in response to a monetary tightening, but rebounds temporarily between the sixth and seventh quarters. The rebound appears to mimic the responses of the mining, construction, manufacturing, miscellaneous and financial services sectors over that period. There is an overall decline in GDP in response to the monetary shock after three years, suggesting that long-lived shocks in interest rates have an unambiguously negative impact on the real economy in the short run. The fact that the cumulative impulse response function for GDP (and indeed for all the sectors) asymptotes to zero over the medium term is a direct result of the LRNOM restrictions in the model.

The value added of the agricultural sector does not decline initially in response to a monetary tightening. This is consistent with our prior expectations as production in the Jamaican agricultural sector is largely weather driven and tends to be less responsive to the vicissitudes of the financial markets. The initial increase in the impulse response function is consistent with the behaviour of agricultural production between 1991 and 1992. During that period, agricultural output increased significantly, despite the fact that the largest increases in real interest rates occurred over that time. Output in the sector may have been influenced by non-monetary factors

[12] For completeness, the responses from the unrestricted VAR are also included in the appendix in figures 4 & 5.

such as improved efficiency or expansions in the acreage of arable lands under cultivation. In addition, the sector is rain-driven, a variable that is not explicitly accounted for in the model. Finally, the sector benefits from concessionary loans rates, as well as significant government support through state agencies such as the Rural Agricultural Development Agency (RADA). Output in the sector declines in the third quarter following the shock, suggesting that the cost of credit will ultimately affect agricultural production, particularly the export sub-sector.

In relation to the construction sector, there is a strong decline in output, up to around the 9th quarter in response to the interest rate hike. This is wholly consistent with our expectations and confirms the general view about the sensitivity of investment expenditure to monetary shocks. The impact dissipates by the eightieth quarter and looses significance as it approaches the end of the forecast horizon. The relatively large response of the sector is expected given the strong relationship between the housing market and the performance of the construction sector. An increase in the Bank's signal rate will trigger increases in building societies loan rates, thereby affecting mortgage decisions by potential homeowners and homebuilders. The subsidised loans offered by the National Housing Trust (NHT)[13] are likely to partly offset this impact, as money market rates typically affect NHT's rate structure with a lag. However, the available resources from the Trust are usually limited, which tend to force prospective beneficiaries to access additional mortgages from other building societies. The Government's road construction and infrastructure development programs could also have partly offset the impact of interest rate shocks on the sector.

The response of the manufacturing sector to the permanent increase in interest rate is also consistent with theory. An immediate and strong decline in output is evident in response to the interest rate hike. The impact dissipates by the seventy-fifth quarter, loosing significance over time. The most susceptible industries within manufacturing to increases in interest rates tend to be the food processing, alcoholic and non-alcoholic industries, given their heavy dependence on credit to finance their operations. It should be noted that, to the extent that companies in the sector hold a large proportion of fixed income securities in their portfolios, an increase in interest

[13] This is a wholly owned GOJ entity that has the power of forced contributions to a fund, which is then used to build low cost houses or provide subsidised loans for the acquisition of, or improvement to, real estate by qualified contributors.

rates might well improve the balance sheet positions of these companies. In this context, a credit crunch will probably be short lived because bank's risk exposure to these companies would not be high. Consistent with the balance sheet channel, operations in these companies may normalise relatively quickly, and this may well account for the relatively sharp turn around in the sector after the second quarter.

The balance sheet effect of increases in interest rates is applicable to selected companies in the Jamaican manufacturing sector. Table 4, which summarises the asset positions of three large, publicly listed manufacturing firms, reveals that, in all cases, a relatively large proportion of their assets are held in short-term investments. These investments include local registered stocks, Treasury Bills and commercial banks deposits.

Table 4

Components of Assets as a Percentage of Total Assets*

Company	**A**	**B**	**C**
Fixed Assets	14.32	18.55	51.66
Short-term Investments	79.90	56.50	21.67
Other	5.78	24.94	26.67

* Data obtained from the most recent balance sheet published for 2002

The impulse responses indicate that among the goods producing sectors, production in the mining sector is not negatively affected by changes in the Central Bank's interest rates. This is to be expected as production and financing decisions are made by multi-national corporations that either own, or have controlling interests, in these companies. Further, investments are typically financed through retained earnings, allocated on the basis of relative rates of return in the major mining regions of the world. As such, domestic monetary conditions have little or no weight in investment decisions in this sector.

The impact of the sustained monetary shock on the electricity & water, transport storage & communication, distribution and miscellaneous services sectors is positive, albeit very small. Output in these sectors increases over the short horizon. This is also consistent with our

expectations in that output in these sectors have behaved counter cyclically over much of the sample period. One would therefore expect, at minimum, positive responses to a monetary tightening. Moreover, while the transport storage and communication industry, particularly the communication industry, relies on commercial bank financing, the sector is not highly leveraged (see Table 5). This suggests that incremental production decisions are not likely to be influenced by monetary conditions. Finally the concentrated nature of the industries tends to make it relatively easier for companies to pass cost increases on to the consumer.

Table 5: Leverage Indicator: Selected Firms

Company	Commercial Banks Loan as a Percentage of Shareholders Equity
A	36.19
B	29.50

With regard to the miscellaneous sector, which is principally driven by the performance of the tourism industry, it is expected that this sub-sector would respond more to external factors, such as foreign inflation, movements in the real exchange rate and growth in Jamaica's main source markets, rather than to domestic interest rate changes[14].

For the financing and insurance services a strong decline in output is evident in response to the interest rate hike up to the first six quarters. The maximum output reduction of 0.06 per cent occurs one year after the policy shock. The relatively large and quick response of the sector is expected given the strong relationship between the Central Bank's reverse repurchase rate and commercial bank's weighted average loan rates. A plausible explanation for the reduction in value added in the near term is that commercial banks net interest margin tends to fall in the context of a monetary shock. This occurs for two reasons. Firstly, banks tend to pay more on their liabilities when market rates increase to prevent or curtail the substitution of deposits for money market instruments. Secondly, some loan rates are fixed, some government securities are re-priced with a lag, while a significant portion of banks' long term assets are fixed income

[14] The tourism sector also benefits from subsidized loans facilitated by the development bank.

securities. Notwithstanding the initial decline, value added of the sector increases after the sixth quarter, probably reflecting the lags in the re-pricing of bank assets.

The paper also explored a five variable structural VAR (results not presented) by including commercial banks interest rate spread and an intervention dummy variable to capture the financial crisis between in 1997. The results were largely consistent with the results of the initial SVAR.

5.2 Variance Decomposition

Table 6 shows the 10-step ahead forecast error variance decomposition associated with the nine sectors and overall GDP from the structural VAR model. The overall impact of monetary policy innovations on GDP is very small, explaining approximately 0.01 per cent of the variation in total output. Conversely, GDP is predominantly explained by itself.

Variations in monetary policy have the largest impact on the electricity & water sector. In regard to the impact of economy wide shocks (captured by variations in GDP), transport, storage & communication, financing & insurance services and agriculture are, as expected, among the more sensitive sectors.

Table 6 Variance Decomposition (SVAR)
(10-step ahead forecast error)

	MP	GDP	CPI	DV*
Agriculture	0.05	72.79	27.11	0.04
Mining	0.06	52.11	47.79	0.02
Manufacturing	0.02	59.35	40.61	0.01
Construction	0.04	52.65	47.27	0.04
Electricity	0.13	69.01	30.82	0.04
Distribution	0.03	52.50	47.42	0.04
Transport	0.04	95.39	4.43	0.13
Financial Services	0.02	82.45	17.51	0.02
Miscellaneous	0.01	53.82	46.13	0.03
GDP	0.01	99.93	0.06	n/a

* Dependent Variable

Table 7 gives the results of the variance decomposition when the interest rate spread is included to account for the effects of credit. The overall impact of monetary policy innovations on GDP is larger than in the four-variable VAR, but the impact of variations in the spread is not very large. Nonetheless, the spread has the relatively largest impact on the agricultural and manufacturing sectors. We further investigate the importance of the credit channel in the next section.

Table 7 Variance Decomposition (10-step ahead forecast error)

	MP	SPREAD	GDP	CPI	DV*
Agriculture	0.06	0.41	41.98	54.95	2.59
Mining	0.06	0.1	50	49.76	0.08
Manufacturing	0.49	0.33	36.63	62.23	0.31
Construction	0.08	0.04	47.97	51.73	0.18
Electricity	0.05	0.23	37.35	62.21	0.15
Distribution	0.1	0.03	50.38	49.32	0.16
Transport	0.12	0.12	0.58	98.53	0.66
Financial Services	0.04	0	14.78	85.13	0.04
Miscellaneous	0.02	0.02	45.65	54.1	0.21
RGDP	12.05	0.84	3.44	83.67	n/a

*Dependent Variable

6.0 Monetary Policy, the Interest Rate Spread and Economic Activity

Table 8 shows the results of three regressions[15]. The first equation evaluates the impact of changes in the real signal rate on commercial banks spreads, while the second and third look at the relationship between interest rates and the output gap. Equation (1) confirms that, contrary to the postulate of the credit channel, changes in the central bank's signal rate foster a fall in commercial bank interest rate spreads. Jamaican banks typically tend to increase their deposit rates faster than their loan rates in the context of a monetary policy shock. In relation to the *efp*, while the external cost for some firms (probably some in manufacturing) may increase, the overall lending rate reacts relatively slowly and the economy wide *efp* falls. Adverse selection

[15] The variables were I(1), and hence the estimation was done in first differences.

does not hold and it is therefore possible that commercial banks may fail if there is a significant monetary tightening. In terms of the impact of the shock to monetary policy on the output gap, equation (2) suggests that monetary policy tend to affect the real economy after a fairly long lag (four quarters). The impact however, while significant, appears to be marginal and is consistent with the findings of the SVAR models. The introduction of the spread [equation (3)] does not change the size and significance of the monetary policy shock[16]. While the spread is itself significant, it has a positive sign, which is inconsistent with theory.

Table 8: The Effect of Changes in Real Interest Rate on Interest Rate Spreads and the Output Gap

Eqns	*(1)*	*(2)*	*(3)*
	S	$(y-y_p)$	$(y-y_p)$
a_0	-0.002	-0.160	-0.207
	(-0.004)	(-3.272)*	(-9.647)*
r	-0.240		
	(-4.014)*		
$r_{(-4)}$		-0.003	
		(-2.395)*	-0.002
			(-1.893)^
ΔS			0.006
			(3.301)*
Adj. R^2	0.29	0.11	0.35
N	42	38	34
LM Serial Correlation	0.221**	0.250**	0.111**
White's Heteroskedasticity	0.350**	0.279**	0.914**

Notes:

1) T Statistics in parenthesis

2) * significant at 5%

3) ^ significant at 10%

4) ** Probability indicating acceptance of null

[16] Equation 3 was corrected for 3rd order serial correlation.

7.0 Conclusion

The results from the structural VAR model indicate that a monetary policy innovation triggers a cumulative, albeit small, decline in the value added of the economy. Further this marginal impact tends to be long lived. However, the analysis revealed that output is driven predominantly by non-monetary shocks.

More importantly, monetary policy has disparate effects on the performance of the different sectors and that manufacturing, construction, agriculture and financial & insurance services are among the more sensitive sectors to monetary policy shocks. Monetary policy innovations do not appear to have an adverse impact on services such as distribution, utilities, transportation and communication. The structure of these industries imply that costs are easily passed on to consumers relative to the more competitive goods producing sectors. There is very little evidence that the credit channel plays a significant role in the transmission process.

The foregoing results imply that monetary policy makers can continue to place a greater weight on inflation stabilization as against output stabilization. However, recognition has to be given to the most vulnerable sectors, namely finance and insurance services and manufacturing. As the economy becomes more competitive, particularly in basic services, and as financial markets develop, it is anticipated that monetary policy will have a greater real sector impact.

Appendix

Table 1: ADF Unit Root Test

	T Statistics		
Variables	**Levels**	**First Difference**	**Lag**
AGRI	-1.88	-11.45	2
CONSTR*	-2.89	-4.89	4
DISTRI	-2.5	-9.42	3
ELECT*	-1.55	-4.56	4
FIN	-3.53	-7.69	1
MANU*	-5.83	-8.33	4
MIN*	-5.44	-6.38	1
MISC	-2.95	-11.01	4
RGDP	-8.16	-6.31	3
TRANS*	-7.63	-8.1	1
CPI*	-1.74	-2.45	2
BASIC	-2.98	-9.95	3
GOODS	-7.16	-5.37	6
SERV*	-5.26	-7.96	2
MP*	-4.34	-6.92	1
5% critical value	-2.93	-2.93	
1 % critical value	-3.58	-3.58	
5% critical value*	-3.50	-3.50	
1 % critical value*	-4.17	-4.17	

*with trend

Figure 1

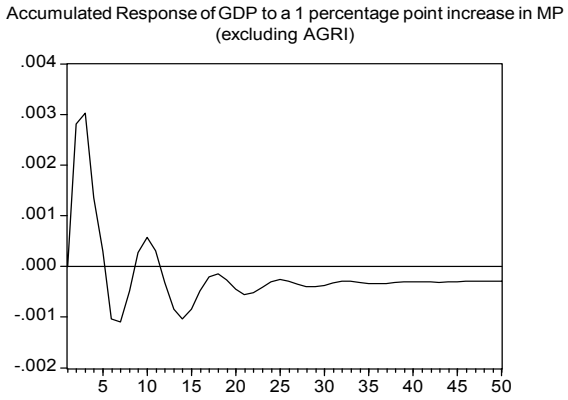


Figure 2

Structural Impulse Responses of the Goods Producing Sectors to a 1 std. dev. increase in MP

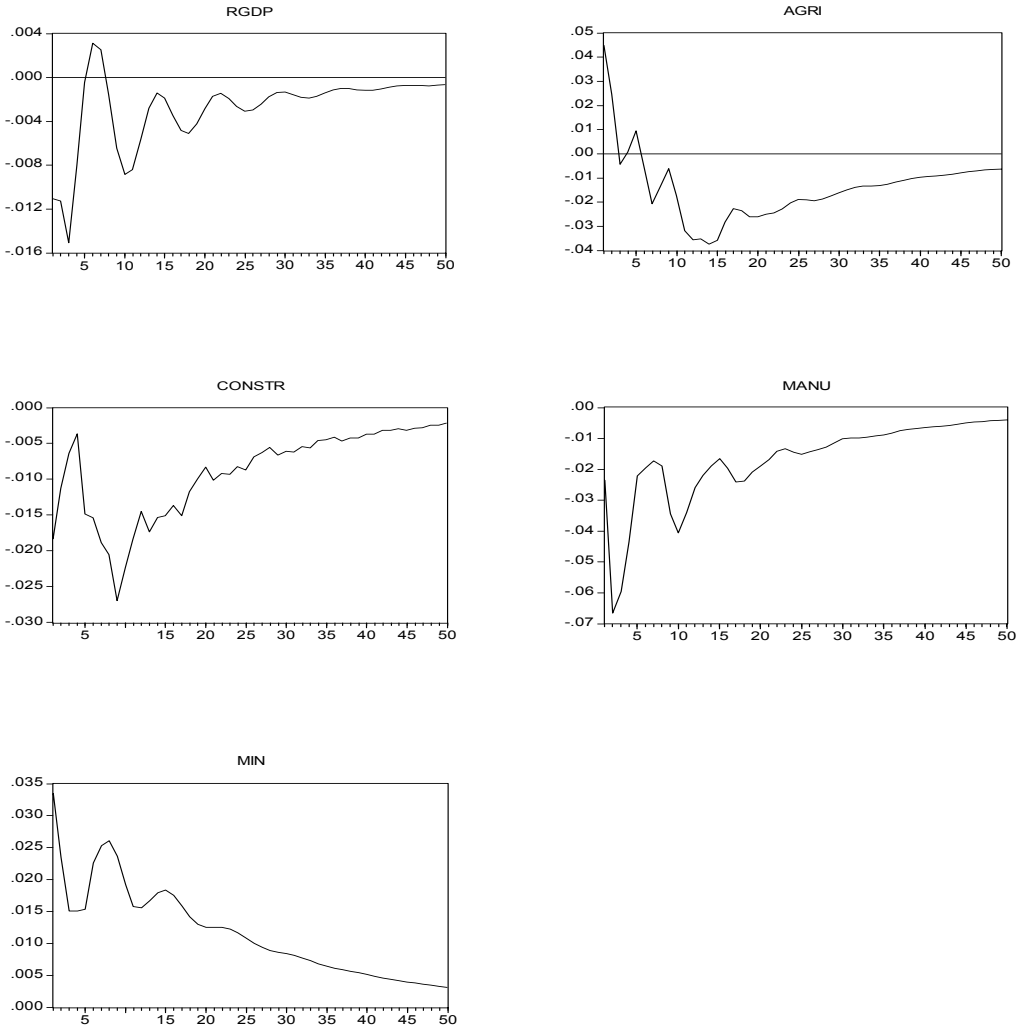


Figure 3

Structural Impulse Responses of Services to a 1 std. dev. increase in MP

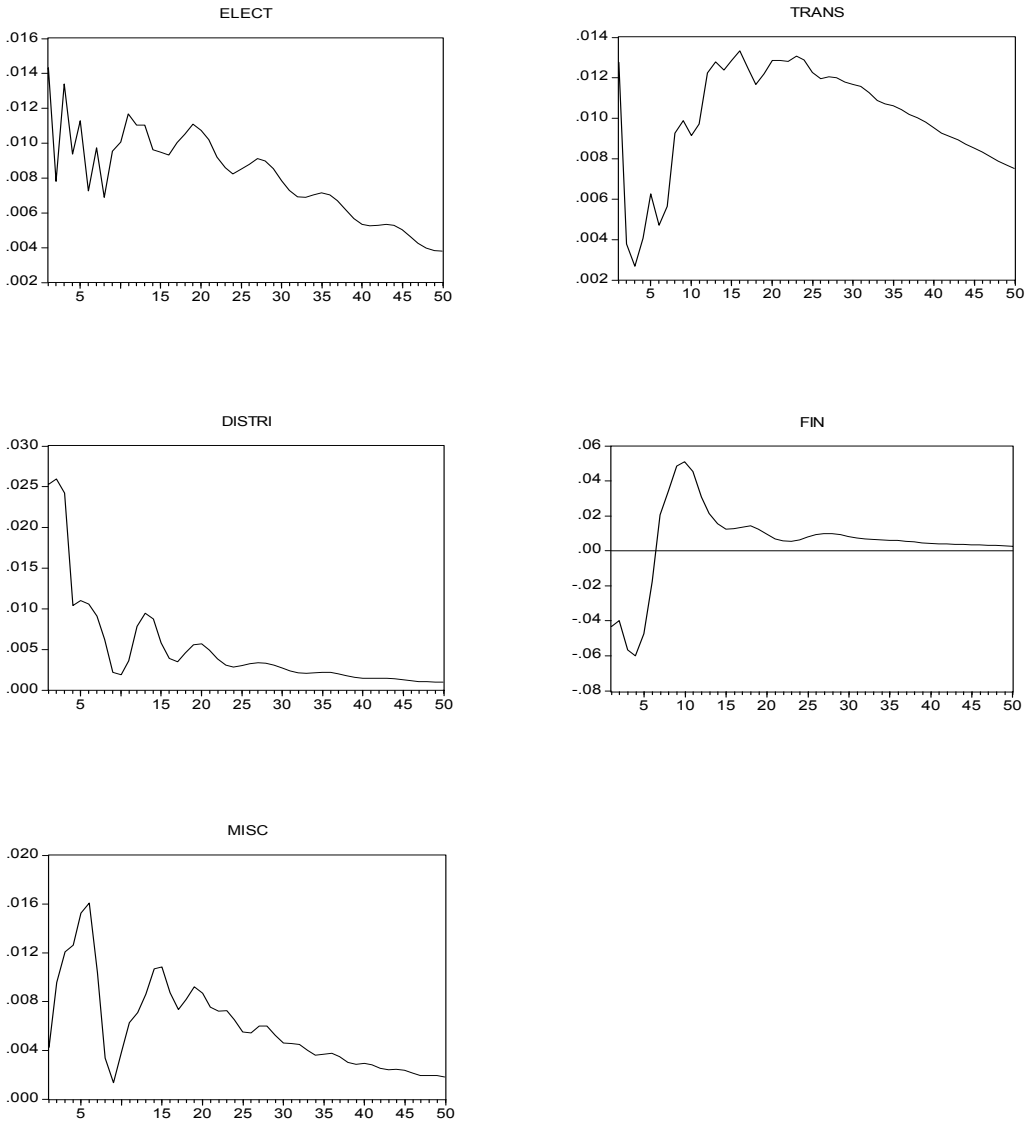


Figure 4

Unrestricted Impulse Responses of the Goods Producing Sectors to a 1 per cent increase in MP

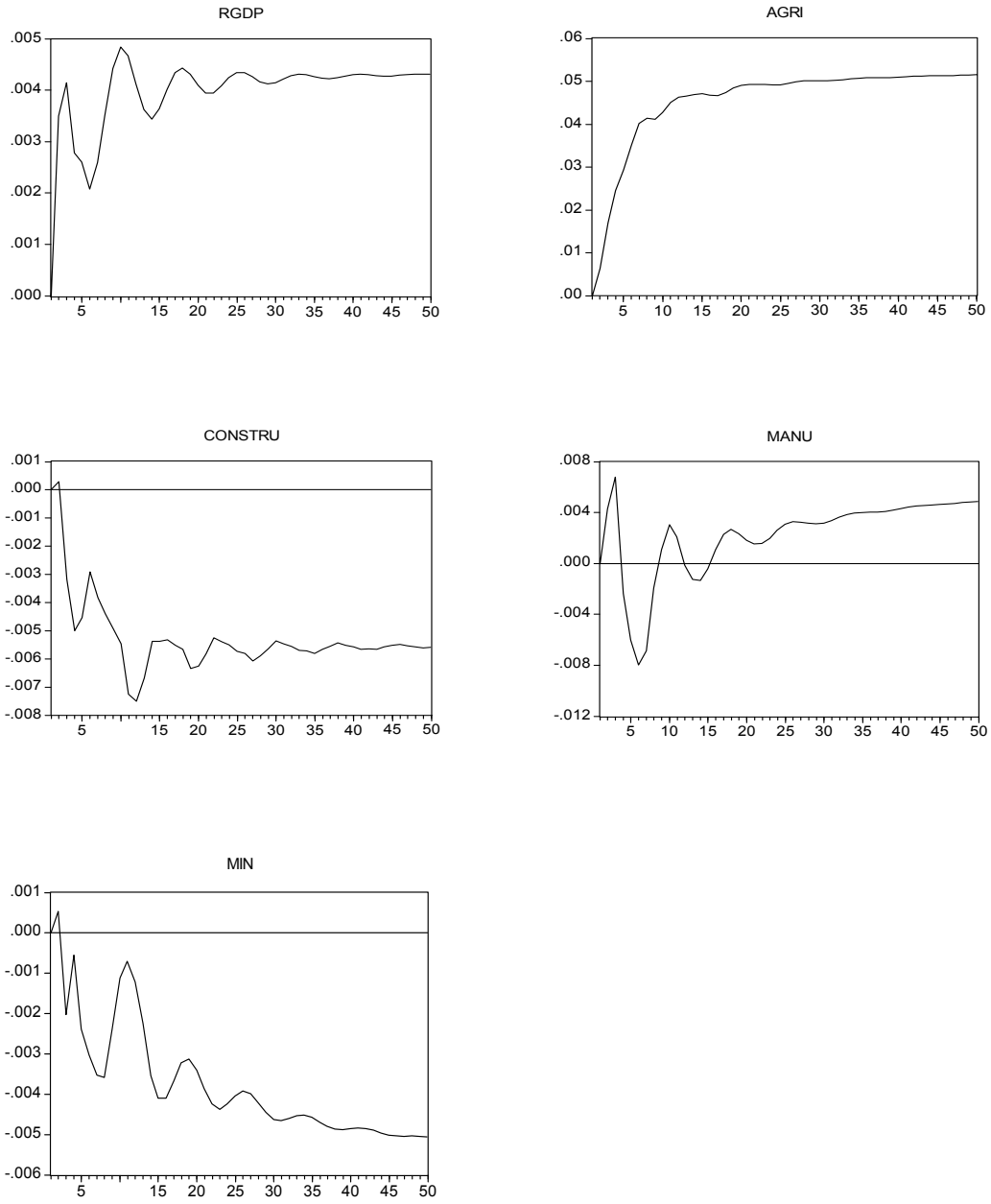
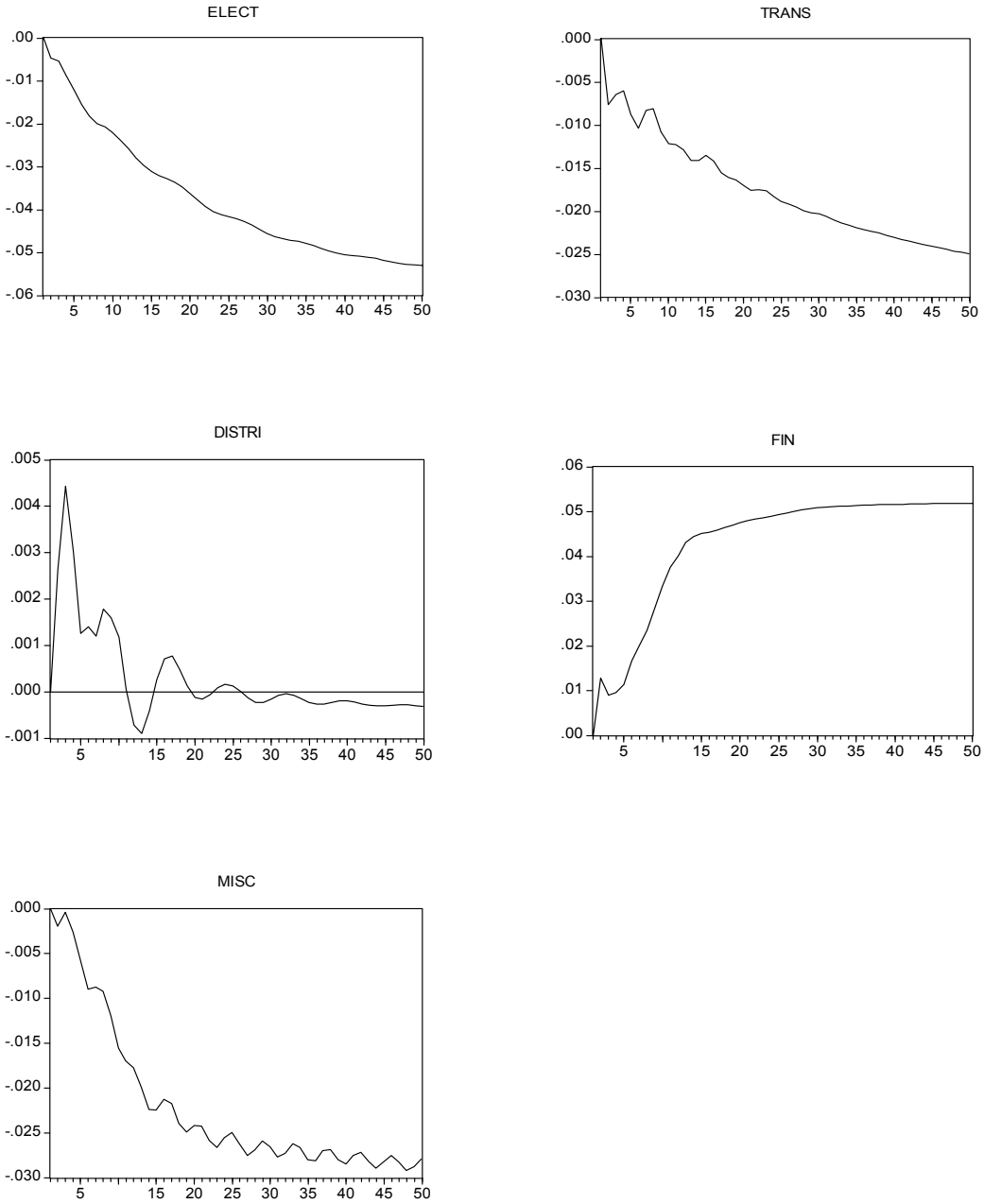


Figure 5

Restricted Impulse Responses of Services to a 1 per cent increase in MP



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Data Annex

GOODS	Goods Producing Sectors
SERV	Services Sectors
AGRI	Agriculture, Forestry and Fishing
MIN	Mining and Quarrying
MANU	Manufacturing
CONSTR	Construction and Installation
ELECT	Electricity and Water
TRANS	Transport, Storage and Communication
DISTRI	Distributive Trade
FIN	Financing and Insurance Services
MISC	Miscellaneous Services
Y-Yp	Output Gap
DMP	Real Exante Signal Rate
EXR	Nominal Exchange Rate Depreciation
MP	Bank's signal rate
EXATB	Real Exante Signal Rate
DS	Spread