How Do Monetary and Fiscal Policy Shocks Explain US Macroeconomic Fluctuations? - A FAVAR Approach*

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Abstract

This paper analyses the role monetary and fiscal policy shocks play in explaining US macroeconomic fluctuations using a Factor Augmented Vector Autoregression (FAVAR) framework. Identification is achieved via the sign restrictions methodology as in Dungey and Fry (2009) and Fry and Pagan (2007), with the federal funds rate ordered last. Several findings emerge from this study. The impact of the government spending shock on output is longer lasting and explains more variability in macroeconomic variables compared to a government taxation revenue shock or monetary policy shock. There is also evidence of an increase in government spending crowding out private activity, leading to an overall decline in output. The potential of the crowding out effect taking place suggests that more government spending does not necessarily stimulate greater economic activity, emphasizing the need for well thought out fiscal packages.

Keywords: Monetary policy, fiscal policy, stimulus package, factor augmented vector autoregression, sign restrictions

JEL Classification: C32, E63

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1 Preface

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Over the past two decades, “globalisation” has become the main theme in the global economy. Three main themes have emerged. First, there has been an increase in economic integration as trade and financial linkages across countries have multiplied. Second, emerging economies have become increasingly important to global growth. Third, emerging economies such as China and India have continued to grow, despite the slowdown in advanced economies since 2008.

In the recent financial crisis of 2008, it became apparent that a crisis in the small United States (US) subprime market can lead to a big crisis within the financial market. Emerging economies continued to grow rather rapidly even though major advanced economies were undergoing significant contractions. The divergence in growth between the emerging economies and the major advanced economies added to the ongoing debate about whether business cycles in emerging economies have “decoupled” from those of the advanced economies. Many economies, particularly the US, implemented huge fiscal stimulus packages to help boost their economies. This resulted in the debate about the nature of government fiscal policies and its effectiveness in stimulating the economies.

These developments highlight the current gaps in the existing literature. First, in analysing the impact of monetary and fiscal policies on the economy, the existing empirical literature typically focuses either on monetary or fiscal policy and not the combination. The transmission mechanism within an economy may be different when both fiscal and monetary variables are included in the system. Second, the emergence of other global economic players such as China and India implies that the transmission mechanisms of the international business cycle to other economies, particularly the advanced economies, may have changed.

The aim of this thesis is to examine the transmission mechanism of shocks, in view of the current gaps in the existing literature. This paper analyses the importance of monetary and fiscal policy shocks in explaining US macroeconomic fluctuations using a Factor Augmented Vector Autoregression (FAVAR) framework.
2 Introduction

During the 2008-2009 financial crisis and the 2009-2010 sovereign debt crisis, many advanced countries around the world reduced their policy interest rates to historically low levels. Most governments around the world put in place economic stimulus packages to help boost their economies, while simultaneously trying to address underlying government debt problems. The fiscal stimulus packages implemented by the governments around the world included different combinations of government spending, investment and tax cuts. Hence, this resulted in the debate about the nature of government fiscal policies and its effectiveness in stimulating the economy. With different competing economic theories providing different conclusions regarding the macroeconomic effects of fiscal policy, there has been no consensus on these effects in theory.

The empirical literature has generally agreed on a consensus view with regards to the empirical effects of monetary policy shocks. However, due to difficulties in accurately identifying fiscal policy shocks, there has been no consensus on the effects of fiscal policy shocks. First, there is the difficulty in identifying whether movements in fiscal variables are due to fiscal policy shocks or are automatic stabilising movements in response to other shocks (Blanchard and Perotti, 2002; Mountford and Uhlig, 2009). Second, for governments striving to maintain the budget and public debt at a stable level, changes in public spending or taxes may then be of an anticipatory nature.

The existing empirical literature typically focuses either on monetary or fiscal policy and not the combination. For example, Romer and Romer (1994), Christiano, Eichenbaum, and Evans (2000, 2005) and Bernanke et al. (2005) focus on monetary policy shocks. These studies come to a consensus on the main macroeconomic effects of a monetary policy shock. Following an increase in the short term interest rate, real activity measures and monetary aggregates such as the M1 money supply decline, prices eventually go down and the exchange rate appreciates.

Ramey and Shapiro (1998), Fatás and Mihov (2001), Blanchard and Perotti (2002), Perotti (2004, 2007), Galí et al. (2007) and Ramey (2011) focus on government spending shocks. It is interesting to note that these studies agree that positive government spending shocks have persistent output effects, regardless of the chosen empirical methodology. A positive output response is consistent with both Keynesian and neoclassical theories.\footnote{In the case of neoclassical theories, a positive output response occurs only if the increase in government spending is financed by non-distortionary taxes.} However, there is no consensus on the effects of government

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spending shocks on macroeconomic variables. For example, different empirical studies have reported different impact of private consumption. Fatás and Mihov (2001), Blanchard and Perotti (2002) and Perotti (2004, 2007) report that private consumption significantly and persistently increase in response to a positive government spending shock. Edelberg et al. (1999) and Mountford and Uhlig (2009) provide evidence that the response of private consumption is close to zero and statistically insignificant over the entire impulse response horizon. Ramey (2011) finds evidence that private consumption persistently and significantly falls over short and long horizons in response to a positive government spending shock. With regards to the responses of the real wage and employment, Perotti (2007) provides evidence that the real wage persistently and significantly increases while employment does not react. Burnside et al. (2004) and Eichenbaum and Fisher (2005) show that the real wage and employment persistently and significantly falls and increases respectively.

Since both monetary and fiscal policy simultaneously affect fluctuations in macroeconomic variables, it is important to qualitatively and quantitatively evaluate their joint impact in explaining these macroeconomic fluctuations. The empirical study of fiscal policy shocks and monetary policy interactions have been limited. Examples of such studies for the US include Muscatelli et al. (2004), Mountford and Uhlig (2009) and Rossi and Zubairy (2011). Mountford and Uhlig (2009) and Rossi and Zubairy (2011) use VAR models to analyse the impact of fiscal policy shocks. In the former, the authors use sign restrictions in a VAR model to analyse the impact of fiscal policy shocks, while controlling for a business cycle and monetary policy shock. In the latter, Rossi and Zubairy (2011) use a VAR model to investigate the relative importance of fiscal and monetary policy shocks in explaining fluctuations in US macroeconomic variables by using historical counterfactual analyses, i.e. what is the impact of GDP if only government shocks are present, vice versa. Two other studies use different approaches. Muscatelli et al. (2004) examine the interaction of fiscal and monetary policies by estimating a New-Keynesian dynamic general equilibrium model. The authors find that fiscal and monetary policies tend to work together in the case of output shocks, while they are used as substitutes following inflation shocks or shocks to either policy instrument. Mélitz (2002) uses two-stage-least squares and three-stage-least-squares and pooled data for 15 members of the European Union except Luxembourg and five other OECD countries to investigate the interaction between fiscal and monetary policies. The author finds that fiscal policy responds to the ratio of public debt to output in
a stabilising manner. An expansionary fiscal policy also appears to lead to a contractionary monetary policy, and vice versa, implying there is some coordination between macroeconomic policies.

Another issue in using VAR models to analyse policy effects comes from the fact that central banks and governments around the world routinely monitor a large panel of variables and indicators than what can be analysed within the VAR framework. Hence, it is very likely that parameters estimated from such VAR models suffer from omitted variables bias. In fact, under such frameworks, it is possible for what seems like a policy shock to the econometrician to be simply the response of the monetary authority to the information that is missing from the VAR model.

The objectives of this paper are two-folds. First, this paper seeks to investigate the joint behaviour of monetary and fiscal authorities in the United States (US). Modelling fiscal and monetary policy reactions simultaneously allows for more precision of the effects of each policy and their reciprocal implications. The second objective of this paper is to address the limited information problem associated with small-scale empirical models. A Factor Augmented VAR (FAVAR) framework is used to analyse the effects and interactions of monetary and fiscal policy shocks on US macroeconomic variables. The work in this model extends the FAVAR approach developed by Bernanke et al. (2005). Much of the empirical literature in this area focuses on small-scale empirical models, with some use of the FAVAR framework seen in the empirical literature for monetary policies.

The rest of the paper is organised as follows. Section 3 presents the FAVAR model for analysing monetary and fiscal policy shocks, discusses the identification of the model, and briefly describes the wide set of US macroeconomic variables used in the empirical investigation. Section 4 presents the empirical results, and compares the results with those of the existing literature. The Appendix contains additional information on the empirical methodology and data.

3 Empirical Methodology

The existing empirical literature has investigated the fiscal and monetary policy shocks using small-scale VAR or structural VAR models. These empirical studies have proposed various approaches to identifying these shocks. The first approach is an "event-based" approach introduced by Ramey and Shapiro (1998). This approach uses dummy
variables to capture the effects of large unexpected increases in government spending. For example, one can use a dummy variable to trace the impact of the Reagan fiscal expansion period on output. This approach is not feasible if the fiscal policy shocks the econometrician wants to investigate is anticipated or influenced by other shocks occurring at the same time. The second approach identifies fiscal policy shocks by taking into account of the long decision and implementation lags in fiscal policy and information about the elasticity of fiscal variables to economic activity. This approach is developed by Blanchard and Perotti (2002), and has been implemented in various studies such as Chung and Leeper (2007) and Favero and Giavazzi (2007). Perotti (2004) uses an extension of this approach to investigate the impact of fiscal policy shocks on inflation and interest rates in OECD countries.

The third approach relies on recursive ordering to identify fiscal or monetary policy shocks. In Fatás and Mihov (2001), government spending is ordered first on the assumption that other variables such as output cannot affect government spending contemporaneously. In Favero (2002), government spending is ordered last on the assumption that government spending can affect output contemporaneously. Bernanke et al. (2005) uses a recursive ordering where the policy interest rate is ordered last to identify the monetary policy shock. The fourth approach focuses on using sign restrictions on the impulse responses to identify fiscal policy shocks. This approach is first introduced by Uhlig (2005) and applied to fiscal policy analysis by studies such as Mountford and Uhlig (2009) and Dungey and Fry (2009). The last approach uses cointegrating relationships in VAR models to identify fiscal policy shocks. The use of such a framework implies that steady state relationships such as fiscal policy rules can be identified.

This section proposes a FAVAR model in which a large panel of US macroeconomic variables is used to identify an unanticipated increase in the short term interest rate, government expenditure, taxation revenue and the debt-to-GDP ratio.

3.1 The Empirical Model

This paper analyses monetary and fiscal policy interactions by using an extension of the FAVAR model, first developed by Bernanke et al. (2005). Let $X_t$ denote an N × 1 vector of economic time series that describes the economy, $Y_t$ a vector of M × 1 observable macroeconomic variables that constitutes a subset of $X_t$ and $F_t$ a k × 1 vector of unobserved factors that capture most of the information contained in $X_t$. 
The observable variables in this model include total government expenditure \((G_t)\), total taxation revenue \((T_t)\), real gross national expenditure \((GNE_t)\), the ratio of debt held by the public to GDP \((\text{debt}_t)\), real GDP \((GDP_t)\), CPI inflation \((\text{inf}_t)\) and the federal funds rate \((R_t)\). The federal funds rate is the monetary policy instrument for the US economy. The joint dynamics of \(F_t\) and \(Y_t\) evolve according to the following transition equation:

\[
\begin{bmatrix}
G_t \\
T_t \\
GNE_t \\
\text{debt}_t \\
GDP_t \\
F_t \\
\text{inf}_t \\
R_t
\end{bmatrix} = B(L) \begin{bmatrix}
G_t \\
T_t \\
GNE_t \\
\text{debt}_t \\
GDP_t \\
F_t \\
\text{inf}_t \\
R_t
\end{bmatrix} + u_t, \quad (1)
\]

where \(B(L)\) is a conformable lag polynomial of finite order \(p\), and \(u_t\) is an error term with mean zero and a covariance matrix \(\Omega\).

Equation 1 can be seen as a standard VAR, except that the vector of factors \(F_t\) is unobserved. These unobserved factors can be interpreted as the common forces driving the dynamics of the economy. The relation between the set of economic time series that describes the economy \(X_t\), the observed variables \(Y_t\) and the factors \(F_t\) can be summarised in the following observation equation:

\[
X_t = \Lambda^F F_t + \Lambda^Y Y_t + v_t, \quad (2)
\]

where \(\Lambda^F\) and \(\Lambda^Y\) are \(N \times K\) and \(N \times 1\) matrices of factor loadings, and \(v_t\) is a \(N \times 1\) vector of mean zero and a covariance matrix \(\sigma^2\).

Equations 1-2 then represent an extension of the FAVAR model by Bernanke et al. (2005). \(F_t\) and \(Y_t\) jointly drive the dynamics of \(X_t\). The main advantage of the static representation of the dynamic factor model given by equation 2 is that the factors can be estimated by principal components, as seen in Stock and Watson (1998) and Stock and Watson (2002).

The use of principal component analysis to estimate the factors implies that the model is subject to the standard rotational indeterminancy problem, and remains econometrically unidentified without a normalisation. To solve the rotational indeterminancy problem, this paper uses the standard normalisation implicit in the principal
components and take \( C'C/T = I \), where \( C(.) \) represents the common space spanned by the factors of \( X_t \) in each block.

### 3.2 Identification of the Factors

The estimation of the FAVAR given by equation 1 requires the unobserved factors \( F_t \) to be estimated first. The dynamics of the US variables are captured by \( k \) factors, \( F_t = (F_{1,t},..., F_{k,t}) \), extracted from the panel of US series. The US factors explain the dynamics of the economy but do not have a specific economic interpretation. However, this does not pose a problem since the goal in this paper is to examine the differences in the responses of the US variables resulting from monetary and fiscal policy shocks. The dynamics of each US variable is a linear combination of all US factors, determined by the factor loadings, and linked to the observable variables via the transition equation 1. This implies that the response of any underlying US variable in \( X_t \) to a shock in the transition equation 1 can be calculated using the estimated factor loadings and equation 2.

The identification of the US interest rate policy shock is achieved by recursively ordering \( G_t, T_t, GNE_t, debt_t, GDP_t, \inf_t, [\hat{C}(F^c_t; \inf_t, R_t) - b_2 R_t - b_3 \inf_t] \) and \( R_t \), with \( R_t \) last. Stock and Watson (2002) show that if \( N \) is large and the number of principal components used is at least as large as the true number of factors, then the principal component consistently recover the space spanned by both \( F_t \) and \( Y_t \). The identification scheme in this paper implies that the unobserved factors, which explain the dynamics of the US economy, do not respond to monetary policy shocks within the same quarter. However, this identifying assumption is not imposed on the idiosyncratic components of the macroeconomic variables.

As in Bernanke et al. (2005), the panel of US variables is divided into slow and fast moving variables. The slow moving variables are variables that are considered predetermined in the current period, and are assumed not to be affected contemporaneously by \( \inf_t \) and \( R_t \). These variables are typically real variables such as the unemployment rate. The fast moving variables are variables that are highly sensitive and will move contemporaneously to economic news or policy shocks. Common factors \( \hat{C}(F^c_t, \inf_t, \inf_t) \) are estimated using principal components on all variables in \( X_t \). The slow moving factors \( \tilde{C}(F^c_t) \) are estimated based on the panel of slow moving variables. Then, the common components \( \hat{C}(F^c_t, \inf_t, R_t) \) are regressed on the estimated slow moving factors.
and the observed policy factor, as shown by the following regression:

\[
\hat{C}(F_t^c, \inf_t, R_t) = b_1 \hat{C}(F_t^c) + b_2 R_t + b_3 \inf_t + \eta_t. \tag{3}
\]

The estimated factors \(\hat{F}_t\) is calculated as the differences between the common components and the product of the observed factors, \(R_t\), \(\inf_t\) and its estimated beta coefficients. Hence, the portion of the space covered by \(\hat{C}(F_t^c, \inf_t, R_t)\) that is not covered by \(\inf_t\) and \(R_t\) is then \(\hat{F}_t\).

### 3.3 Identification of the FAVAR

In this paper, the variables are ordered from first to last as follows: total government expenditure \((G_t)\), total taxation revenue \((T_t)\), real gross national expenditure \((GNE_t)\), the ratio of debt held by the public to GDP \((\text{debt}_t)\), real GDP \((GDP_t)\), Factor 1 \((F_{1,t})\), Factor 2 \((F_{2,t})\), Factor 3 \((F_{3,t})\), CPI inflation \((\inf_t)\) and the federal funds rate \((r_t)\). The relation between the reduced-form disturbances \(u_t\) and the structural disturbances \(e_t\) takes the following form:

\[
\begin{bmatrix}
1 & 0 & \cdots & 0 \\
a_{21} & 1 & \cdots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
a_{91} & \cdots & \cdots & 0 \\
a_{101} & 1
\end{bmatrix}
\begin{bmatrix}
u_G^t \\
u_T^t \\
u_{GNE}^t \\
u_{\text{debt}}^t \\
u_{GDP}^t \\
u_{F_1}^t \\
u_{F_2}^t \\
u_{F_3}^t \\
u_{\inf}^t \\
u_{R}^t
\end{bmatrix}
= \begin{bmatrix}1 & 0 & \cdots & 0 \\
0 & 1 & \cdots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
0 & \cdots & \cdots & 1
\end{bmatrix}
\begin{bmatrix}
e_G^t \\
e_T^t \\
e_{GNE}^t \\
e_{\text{debt}}^t \\
e_{GDP}^t \\
e_{F_1}^t \\
e_{F_2}^t \\
e_{F_3}^t \\
e_{\inf}^t \\
e_{R}^t
\end{bmatrix}. \tag{4}
\]

The standard VAR analysis is unable to associate an increase in GDP with an increase in government expenditure, and a fall in GDP with an increase in taxes. This paper attempts to disentangle the fiscal policy shocks by incorporating the sign restrictions methodology as in Mountford and Uhlig (2008), Canova and Paustian (2007), and Dungey and Fry (2009) in the FAVAR model.

To properly identify fiscal policy shocks, this paper incorporates the sign restrictions methodology as in Dungey and Fry (2009) to the impulses of the government expenditure and taxation shocks, with the remaining shocks identified recursively as in equation 4. This implies that it is possible to have a contemporaneous taxation increase in response to a government expenditure shock, and a contemporaneous government expenditure increase in response to a taxation shock. Three levels of criteria
are examined to disentangle the impulse responses and to assign them to government expenditure and taxation shocks. The standard practice is for the econometrician to report the median of a set of impulse responses that satisfy the set of economic restrictions, corresponding to specified percentile bands, as the impulse response. However, as identified in Dungey and Fry (2009), the reported impulse responses achieved via taking the median across a set of impulse responses no longer guarantees that these shocks are independent. Hence, to overcome this problem, this paper follows the methodology in Dungey and Fry (2009) and Fry and Pagan (2007). A more detailed explanation of the signs restrictions methodology applied in this paper is available in the Appendix.

The recursive ordering of the variables in the FAVAR has implications on the variables in the FAVAR in the first quarter following the shock. Ordering absorption and output after the fiscal variables captures the contemporaneous effects of public spending and tax changes on output and absorption. The debt-to-GDP ratio enters the system as the fourth variable. This implies that government spending and taxation affects the level of public debt in the economy, which subsequently affects GDP. The debt-to-GDP ratio is included in the FAVAR for two reasons. First, the inclusion of a debt variable allows for a feedback loop between fiscal policies and the public debt level as in Favero and Giavazzi (2007). Second, the addition of a stock variable such as the debt-to-GDP ratio contributes to the stability of the system as identified in Fry and Pagan (2005).

Ordering the unobserved factors that represent the dynamics of the US economy after GDP implies that the output of the US economy can affect other US macroeconomic variables such as unemployment. Subsequently, what happens in the US economy results in changes to CPI inflation, which enters the FAVAR as the nineth variable. The interest rate is ordered last, since the central bank reaction function shows that the interest rate is set as a function of the output gap and inflation. Spending and taxation revenue as defined in this paper are net of interest payments and are not sensitive to interest rate changes.

### 3.4 Estimation

This paper uses the two-step procedure as in Bernanke et al. (2005) and Mumtaz and Surico (2009) to estimate the model. In the first step, the unobserved factors and loadings are estimated via the principal components estimator. In the second step, the FAVAR model in equation 1 is estimated as a standard VAR with the true factors, $F_t$,.
replaced with the estimated ones, \( \hat{F}_t \), via Bayesian methods. This two-step approach is chosen for computational convenience. A one-step procedure that simultaneously estimates the unobserved factors, the factor loadings and the VAR coefficients is computationally intensive.\(^2\) Details of the prior and the estimation procedure are given in the Appendix.

Before estimating the FAVAR, it is also necessary to consider the number of factors that are necessary to explain the dynamics of the US economy, allowing for proper modelling of the simultaneous effects of monetary and fiscal policy. Bai and Ng (2002) provide a criterion to determine the number of factors present in the data set, \( X_t \). However, the use of this criterion does not address the question of how many factors should be included in the VAR. Following Bernanke et al. (2005), this paper includes three unobserved factors in the model. This choice implies that the second step in the estimation procedure involves the estimation of a standard VAR with ten endogenous variables.

The VAR system consists of these ten endogenous variables, has four lags and no constant or a time trend. The choice of four lags implies a large number of free parameters in the VAR system to be estimated using 154 observations. The VAR system uses the natural logarithm for all variables except the CPI inflation rate and interest rate, where the level is used. The use of four lags is common in fiscal VAR and SVAR models, as in Blanchard and Perotti (2002) and Perotti (2004). This also ensures that the dynamics of the FAVAR is adequately captured.

3.5 Data

This paper uses quarterly data from 1972Q1 to 2010Q4. The dataset for \( X_t \) consist of 115 series, and is a combination of the one used in Bernanke et al. (2005) and Koop and Korobilis (2009). The dataset includes data on real activity, inflation, money, and interest rates.

The dataset for \( Y_t \) consist of 7 series: real government expenditure, real government revenue, real gross national expenditure, debt-to-GDP ratio, real GDP, CPI inflation and the federal funds rate. The two fiscal variables in the VAR are defined in the same way as in Blanchard and Perotti (2002). Thus, total government expenditure is total government consumption plus total government investment and total govern-

\(^2\) Another method in estimating the FAVAR is to use a single-step Bayesian likelihood approach. This approach estimates the factors, factor loadings and parameters of the FAVAR simultaneously. Bernanke, Boivin, and Eliasz (2005) show that both approaches produce qualitatively similar results.
ment revenues is total government revenues minus transfers. The debt-to-GDP ratio is constructed based on the definition outlined in Favero and Giavazzi (2007). Before estimating the FAVAR, all data series are transformed to ensure stationarity and standardised.

A more detailed description of the dataset can be found in the Appendix.

4 Empirical Results

This paper considers the following types of shocks in the FAVAR model: shocks to monetary policy, real government expenditure, real government taxation revenue and debt-to-GDP ratio. This section presents the impulse responses for one standard deviation shocks to the errors. For each shock, the mean, 10th and 90th percentile of the posterior distribution of the impulse responses are plotted in the Figures 1 to 4.\(^3\)

4.1 Monetary policy shock

In this paper, the monetary policy shocks are defined as temporary shocks in the short term interest rate, such as the federal funds rate for the US. The responses of the model in Figure 1 generally have the expected signs and magnitude. The US Federal budget (government taxation revenue less government expenditure) sees a surplus for 1 quarter, before going into deficit, with effects lasting for 27 quarters before the economy returns a budget surplus. Following a positive shock to monetary policy, output and absorption decline immediately. In response, government taxation revenue declines, partly due to the decline in consumption. The increase in the debt-to-GDP ratio after 16 quarters follows from the increase in budget deficit. This result is confirmed by Muscatelli et al. (2004) for the US. The authors find that fiscal variables tend to adjust, with a lag, to the output effects due to a contractionary monetary policy.

Following a contractionary monetary policy shock, prices as indicated by the CPI inflation for all items, and the PPI inflation for finished consumer goods decline after nine and five quarters respectively. Hence, there is some evidence of the price puzzle found in existing structural VARs.\(^4\) However, such a result suggests that the addition

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\(^3\)In practice, the number of gibbs sampling iterations chosen is usually a large number, as in this paper, 10,000 replications. Empirically, the mean and median will be the same.

\(^4\)The "price puzzle" introduced by Bernanke and Blinder (1992) and Sims (1992) is the positive relationship between the federal funds rate and inflation commonly observed in empirical studies that focuses on VAR models. This is considered a puzzle since the price level is expected to decrease rather than increase following an unexpected tightening of monetary policy.
of factors mitigates the severity of the price puzzle.

Figure 1 shows that real activity measures such as consumption, fixed private investment, exports, new orders, and the industrial production index all decline eventually as expected. The increase in the federal funds rate also increases the demand for US currency, causing an appreciation of the Japan/US exchange rate. As a result, US exports are more expensive and fall almost immediately. The fall in imports in Figure 1 seems counterintuitive at first glance, since an appreciation of the exchange rate should lead to an increase in imports. However, there are other forces at work that can explain the decline in imports. The increase in the unemployment rate after 3 quarters and the decline in wages and consumption is indicative of a decline in consumers’ purchasing power. New private housing units also decline after 4 quarters as it becomes more expensive to obtain loans.

The monetary base declines initially, while M1 declines after 11 quarters. Movements in the short term and long term interest rates are within expectations. Short term interest rates such as the 6-month treasury bill rate often moves in the same direction as the federal funds rate since both are often seen as competing short-term instruments in the money market. Hence, the increase in 6-month treasury bill rate is consistent with the rise in the federal funds rate. On the other hand, longer term bonds such as the Moody’s Seasoned Aaa corporate bond is often seen as an alternative option to the federal ten-year treasury bill. Hence, the movement in the Moody’s Seasoned Aaa corporate bond yield is likely to be anticipatory in nature, and possibly move in the opposite direction as the federal funds rate. For example, if investors believes that the Federal Reserve has tightened monetary policy too much resulting in slower economic growth and eventually leading to a lower federal funds rate, this anticipatory attitude of investors will be reflected in the lower bond yields. Hence, the decline in the Moody’s Aaa corporate bond yield is expected.

4.2 Government expenditure shock

Figure 2 displays the responses of the selected macroeconomic variables to a shock in government expenditure. Government expenditure responds positively and persistently to its own shock. Following the shock, GDP increases very slightly on impact as

\[5\text{To construct the Moody’s Seasoned Aaa corporate bond yield, Moody’s tries to include bond with remaining maturities as close as possible to 30 years. There are several cases where bonds are dropped: bonds with remaining lifetime falling below 20 years; if the bond is likely to be redeemed, or if the rating changes.}\]
Figure 1: A one standard deviation shock in Monetary policy
specified by sign restrictions, declines for five quarters, before increasing again. This observation is consistent with the results in several studies. For example, Blanchard and Perotti (2002) find that US output responds positively to a spending shock, while spending reacts strongly and persistently to its own shock. Perotti (2004, 2007) finds similar results for a range of countries, and Claus et al. (2006) for New Zealand. Absorption responds positively and persistently to a shock in government expenditure. Hence, it is likely that part of the increase in government expenditure is spent on imports.

Private consumption falls initially, consistent with neoclassical economic theory. Canova and Paustian (2007) and Perotti (2007) similarly find that private consumption declines in some model specifications. This finding is consistent with the debate about the response of private consumption to higher government expenditure in terms of potential crowding out.

The higher government expenditure also results in a fall in taxation revenue after 3 quarters. This is consistent with the results obtained by Favero and Giavazzi (2007) in their preferred model that allows for debt dynamics. The fall in private consumption would have contributed to a fall in consumption tax revenue and hence an overall fall in taxation revenue. Taxation revenue starts increasing again after 14 quarters in order to finance the government spending. The debt-to-GDP ratio declines for 5 quarters before increasing slightly. This result can be explained by the movements in the US Federal budget, that sees a surplus for 2 quarters, before going into deficit.

Further indications of the crowding out effect can be seen from the eventual decline in other real activity measures such as fixed private investment, exports, new orders, industrial production and new private housing units. The decline in fixed private investment is consistent with the increase in federal funds rate in the first 3 quarters. In this paper, an increase in government spending appears to crowd out private spending, leading to an overall decline in GDP after the initial spike. The decline in real activity measures also result in an increase in the civilian unemployment rate after 3 quarters. However, real wages increase after 3 quarters despite the decline in real activity measures, possibly due to the increase in government expenditure.

CPI inflation for all items and PPI inflation for finished goods fall eventually. While the response of prices to the increase in government spending appears to be counter-intuitive, it should be noted that this negative relationship between prices and government spending has been noted in US based studies of Chung and Leeper (2007),
Mountford and Uhlig (2008) and the majority of Favero and Giavazzi (2007) results. Here, the federal funds rate declines after 3 quarters in response to the decline in real activity measures and the decline in GDP. This is also consistent with the results in these papers, although Mountford and Uhlig (2008) find an initial rise in the interest rate when the increase in expenditure is delayed for a year. Similarly, Dungey and Fry (2009) find that interest rates increases initially due to higher GDP, but quickly falls to stimulate a recovery in gross national expenditure and higher inflation for the case of New Zealand.

Following the shock, the Japan/US exchange rate appreciates in the first quarter, before depreciating. As a result, US exports are more expensive and hence falls initially. The fall in imports is consistent with the decline in consumers’ purchasing power due to an increase in unemployment rate and the decline in private consumption.

The monetary base increases in the second quarter, consistent with the decline in federal funds rate. The decline in M1 is theoretically inconsistent with the initial decline in federal funds rate, but appears to describe the current situation in the US economy. The monetary base is typically the foundation for the M1 money supply. Historically, the M1 money supply generally increases by a similar proportion when the monetary base increases. However, in recent years, commercial banks have kept a large share of the massive injection of reserves by the Federal Reserve as excess reserves, rather than using them to extend more loans and make more investments.

The 6-month treasury bill rate declines with the decline in federal funds rate. On the other hand, the Moody’s Aaa corporate bond yield increases from the fourth quarter following the shock. The decline in the federal funds rate can result in higher bond yields if investors believe that the decline will overheat the economy, eventually leading the Federal Reserve to increase the rate.

4.3 Government revenue shock

Following a shock in government taxation revenue, government expenditure decreases as reflected in Figure 3. The shock in government taxation revenue appears to be temporary in this model, returning to the initial value after ten quarters. Hence, impulse response of the selected macroeconomic variables mostly return to the initial value within a few quarters. The US Federal budget (government taxation revenue less government expenditure) sees a surplus for the 14 quarters following the shock, before the economy sees a budget deficit. The initial budget surplus is sufficient to lower the
Figure 2: A one standard deviation shock in Government expenditure.
debt-to-GDP ratio six quarters following the shock. This observation suggests that fiscal policy is stabilising in this model. This is similar to what Favero and Giavazzi (2007) find in their paper, where debt stabilisation appears to be a concern for the US fiscal authorities in the second part of the sample (after 1980). A tax increase thus result in a compensating change in the budget. GDP increases for 5 quarters before declining, largely consistent with the taxation shock and the stability feature of fiscal policy in our model. The decline in absorption is consistent with the shock in government taxation revenue and the decline in government expenditure and real activity.

Prices as indicated by CPI inflation for all items and PPI inflation for finished consumer goods increase on impact. While PPI inflation for finished consumer goods decline six quarters following the shock, CPI inflation for all items appear to be sticky and show no signs of decline. The higher CPI inflation results in monetary policy tightening. Hence, the federal funds rate increases. Mountford and Uhlig (2008) also find an increase in prices for the case of US after a taxation shock. On the other hand, Favero and Giavazzi (2007) find that inflation declines after a taxation shock, with interest rate declining as a result.

Real activity measures such as consumption, exports, imports, new orders and the industrial production index all show signs of decline from the fifth quarter following the shock. Fixed private investment and new private housing units decline on impact. The increase in the federal funds rate leads to an expected appreciation of the Japan/US exchange rate, leading to a decline in exports. On impact, real wage declines for the first 13 quarters before returning to the initial value, consistent with the initial decline in real activity. The civilian unemployment rate responds to the decline in government expenditure and real activity, increasing 14 quarters after the shock.

The monetary base increases, while the M1 money supply declines following the shock. The 6-month treasury bill rate mimics the movements in federal funds rate, while the Moody’s Aaa corporate bond yield moves in the opposite direction of the federal funds rate.

4.4 Debt-to-GDP ratio shock

The responses of the selected macroeconomic variables to a shock in the debt-to-GDP ratio is reflected in Figure 4. The immediate impact is an increase in government expenditure and taxation revenue. However, taxation revenue return to equilibrium in
Figure 3: A one standard deviation shock in Government taxation revenue
the third quarter, but increase again after. The debt-to-GDP ratio increases for six quarters, before declining. This result is similar to what Dungey and Fry (2009) find. The authors find that the debt-to-GDP ratio returns to its initial value after a few quarters.

The debt-to-GDP ratio increases for six quarters, and remain largely unchanged for a few quarters before declining. This result is consistent with the budget deficit in the first two quarters, followed by the 13 quarters of surplus. Dungey and Fry (2009) similarly find that the debt-to-GDP ratio returns to its initial value after a few quarters.

Most real activity measures (consumption, exports, imports, new orders and the industrial production index) in Figure 4 decline after a few quarters following the shock, and hence lead to a decline in GDP after six quarters. This result is consistent with the Ricardian Equivalence theory, where consumers reduce spending in anticipation of future taxes. On the other hand, absorption continues to increase. This again indicates that a large amount of government expenditure may be spent on imports. The decline in real activity measures also result in a decline in CPI inflation for 10 quarters before returning to its initial value. Hence, the federal funds rate decline, acting to aid the recovery in output.

The monetary base and M1 increase briefly on impact. The 6-month treasury bill rate eventually decline and the Moody’s Aaa corporate bond yield increases. These results are consistent with the decline in federal funds rate.

4.5 Forecast Error Variance Decomposition

This paper performs a forecast error variance decomposition exercise to determine the fraction of the forecasting error of a variable that is due to a particular shock at a given horizon. The fraction of the variance of of $X_{t+k} - \hat{X}_{t+k}$ due to a particular shock, say $\epsilon_t$, can be expressed as:

$$\frac{\text{var}(X_{t+k} - \hat{X}_{t+k}|\epsilon_t)}{\text{var}(X_{t+k} - \hat{X}_{t+k}|\epsilon_t)}.$$  \hspace{1cm} (5)

However, as shown in equation 2, part of the variance of the macroeconomic variables comes from their idiosyncratic component which might partly be due to measurement error. As pointed out in Bernanke et al. (2005), it is unclear that the standard VAR variance decomposition gives an accurate measure of the relative importance of
Figure 4: A one standard deviation shock in Debt-to-GDP ratio
a structural shock. The variance decomposition exercise performed within the FAVAR framework is more appropriate, where the relative importance of a structural shock is assessed only to the portion of the variable explained by the common factors. This variance decomposition for $X_t$ is denoted as:

$$\frac{\Lambda_i \text{var}(X_{t+k} - \hat{X}_{t+k|t} | \epsilon_t) \Lambda_i'}{\Lambda_i \text{var}(X_{t+k} - \hat{X}_{t+k|t}) \Lambda_i'}$$

where $\Lambda_i$ is the $i^{th}$ line of $\Lambda$ and $\frac{\text{var}(X_{t+k} - \hat{X}_{t+k|t} | \epsilon_t)}{\text{var}(X_{t+k} - \hat{X}_{t+k|t})}$ is the standard VAR variance decomposition based on equation 1.

<table>
<thead>
<tr>
<th>Shocks</th>
<th>4 quarters ahead</th>
<th>8 quarters ahead</th>
<th>30 quarters ahead</th>
<th>60 quarters ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gov Rev</td>
<td>1.416</td>
<td>1.878</td>
<td>2.041</td>
<td>1.917</td>
</tr>
<tr>
<td>Debt</td>
<td>3.758</td>
<td>7.102</td>
<td>5.359</td>
<td>5.924</td>
</tr>
<tr>
<td>Monetary policy</td>
<td>0.092</td>
<td>0.090</td>
<td>0.115</td>
<td>0.112</td>
</tr>
</tbody>
</table>

Three main messages become apparent from this exercise. First, as reflected in Table 1, fiscal policy shocks explain a reasonable fraction of output variability. Government expenditure and taxation revenue shocks jointly explain between 20 to 24 percent of the variance of output at the 4, 8, 30 and 60 quarter horizon. The government expenditure shock has the largest impact on output, explaining between 18 to 22 percent of the variance of output at all horizons. On the other hand, a shock in taxation revenue only explain around one to two percent of the variance of output at all horizons. The impact of an increase in government spending on output appears to be longer lasting than the impact of increases in government revenue taxation and federal funds rate on output. Second, the government expenditure shock has more impact on the US macroeconomic variables, compared to the taxation, debt and monetary policy shocks. Third, fiscal policy shocks explain more variability in macroeconomic variables than a monetary policy shock. The contribution of the monetary policy shocks to the selected macroeconomic variables is mostly around one percent. This suggests a relatively small effect of the monetary policy shock. Tables 2-5 in the Appendix report the results of the variance decomposition exercise for the selected macroeconomic variables.
4.6 Sensitivity tests

In unreported results, this paper also investigates the robustness of our main findings to the model specification. A 2nd order lag polynomial instead of a 4th order lag polynomial is used. The use of two lags is based on the Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). The use of two or four lags in the model only changes the impulse responses quantitatively but not qualitatively.

This paper does not attempt to verify that the results are robust to other identification schemes of fiscal variables, as the alternative which is the recursive cholesky identification scheme cannot properly disentangle the government expenditure and government taxation revenue shocks. This paper also does not verify the results are robust to the number of iterations employed of the Gibbs sampling procedure due to computational constraints.\footnote{This paper employs 10,000 iterations of the Gibbs sampling procedure with 2,000 burn-ins. This procedure takes approximately 26 hours to complete. Due to the computationally intensive nature of the procedure, increasing the number of iterations is not feasible.}

5 Conclusion

This paper investigates the behaviour of monetary and fiscal authorities in the US by using a new approach. The paper uses a FAVAR framework to analyse the effects and interactions of monetary and fiscal policy shocks on US macroeconomic variables. Identification is achieved via the signs restriction methodology as in Dungey and Fry (2009) and Fry and Pagan (2007), with the federal funds rate ordered last. Several important findings emerge from this study.

First, the impact of increase in government spending on output appears to be longer lasting than the impact of increases in taxes and federal funds rate on output. Second, this paper finds evidence that fiscal policy shocks, in particular a government expenditure shock, explain more variability in macroeconomic variables than a monetary policy shock. Third, this paper also finds evidence of an increase in government spending crowding out private spending, leading to an overall decline in output. The potential of the crowding effect taking place suggest that more government spending does not necessarily stimulate greater economic activity as this paper has shown. Last, this paper finds evidence that monetary and fiscal policies are generally used as substitutes following a shock to one policy instrument, and hence emphasizes the importance of analysing monetary and fiscal policies jointly.
References

Bai, J. and S. Ng (2002). Determining the number of factors in approximate factor models. *Econometrica 70*(1), 191–221.


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### 6 Appendix

#### 6.1 Estimation Methodology

This paper uses a two-step procedure to estimate the model. In the first step, the unobserved factors and factor loadings are estimated via the principal components estimator. In the second step, the estimated factors along with the observed factors are used to estimate the VAR model in equation 4 via Bayesian methods. Gibbs sampling is used to approximate the posterior distribution in the model. The parameters in the VAR model are sampled conditional on the final estimate of the factors obtained via the principal components estimator (i.e. just as if the factors were observed data). The paper uses 10,000 Gibbs replications, and discard the first 2,000 replications as the burn-in sample.

This paper closely follows Bernanke et al. (2005) in using a diffuse conjugate Normal-Wishart prior (a non-informative version of the natural conjugate prior) to
estimate the standard VAR equation 2. The use of the non-informative prior leads to a posterior distribution and predictive results based on familiar OLS quantities, i.e. the results from estimating a bayesian FAVAR using a non-informative prior will be largely similar to a FAVAR estimated by the frequentist method. The drawback of the non-informative prior is that it does not do any shrinkage which can be important for VAR modelling. Shrinkage is found to be of great benefit in reducing over-parameterisation problem VAR frameworks face. However, this paper has already attempted to reduce the high dimensionality problem VAR models face by using a FAVAR framework. This paper uses a non-informative prior and Bayesian estimation methods for the FAVAR over a frequentist approach as their interpretations differ even though the results are going to be very similar.\footnote{For example, using the frequentist approach, a 95% confidence interval implies the notion of repeating an experiment many times and being able to capture the true parameter 95% of the times. On the other hand, using the bayesian approach, a 95% credible (confidence) interval implies there is a 95% chance that the interval captures the true value.}

**Step 1 - Sample $\tilde{B}$.**

Draw $B_i$ from $f(B|\tilde{\Omega},y_i)\sim N(\mu,\sigma^2)$.

**Step 2 - Sample $\tilde{\Omega}$.**

Draw $\Omega_i$ from $f(\Omega|y_i)\sim IW(\sigma,T-K)$.

where T-K is the degrees of freedom. T is the total number of time series observations used in this study, which is 154, and K is the dimensionality of this FAVAR which is 10.

**Step 3 - Return to Step 1**

### 6.2 Imposing sign restrictions

In this paper, the variables are ordered from first to last as follows: total government expenditure ($G_t$), total taxation revenue ($T_t$), real gross national expenditure ($gne_t$), the ratio of debt held by the public to GDP ($debt_t$), real GDP ($GDP_t$), Factor 1 ($F_{1,t}$), Factor 2 ($F_{2,t}$), Factor 3 ($F_{3,t}$), CPI inflation ($inf_t$) and the federal funds rate ($r_t$).

Equation 4 provides the relation between the reduced-form disturbances $u_t$ and the structural disturbances $e_t$. To implement the sign restrictions methodology as in
Dungey and Fry (2009), a Q matrix needs to be chosen. The chosen matrix $Q_{12}$, based on the Given’s rotation, is:

$$
\begin{bmatrix}
\cos \theta & -\sin \theta & \cdots & 0 \\
\sin \theta & \cos \theta & \cdots & 0 \\
\vdots & \vdots & \theta & \vdots \\
a_{91} & \cdots & \cdots & 0 \\
a_{101} & 1
\end{bmatrix},
$$

(7)

where $\theta$ is chosen randomly and takes on a value between 0 and $\pi$.

The chosen $Q_{12}$ matrix implies that only the impulse responses from the shocks corresponding to government expenditure (G) and government taxation revenue (T) in the system are rotated. The remaining variables are identified recursively. To disentangle the impulse responses of the two fiscal shocks, three levels of criteria are examined. In this paper, the government expenditure and government taxation revenue impulses are denoted as $\tau = 1$ and $\tau = 2$ respectively. Sign restrictions are only imposed for the first period. In this paper, the number of draws of Q matrix is set to 1,000.

**Criterion 1**

The first criterion is purely based on the sign of the impulse responses. The sign restrictions are summarised in the following table.

<table>
<thead>
<tr>
<th>G shock</th>
<th>T shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>+</td>
</tr>
<tr>
<td>T</td>
<td>+</td>
</tr>
<tr>
<td>GDP</td>
<td>+</td>
</tr>
<tr>
<td>GNE</td>
<td>-</td>
</tr>
</tbody>
</table>

For a positive G shock, both government expenditure and GDP respond positively for the first period following the shock. For a positive T shock, taxation revenue increases and GNE falls in the first period following the shock.\(^8\) There are no restrictions on the signs of the remaining variables in both set of impulse responses.

**Criterion 2**

After using the first criterion, it is possible to have some draws that remain entangled. For example, in the case where a T shock is identified, it is possible to observe

\(^8\)Given that the US is not a small open economy, the GDP and GNE data series are not very much different. Hence, this paper also initially attempted to identify a taxation shock via a decline in GDP for 1 period following the shock. However, no taxation shocks could be found in all the iterations. Hence, this implies that the US external sector remains important when it comes to identifying taxation shocks.
a positive response for government expenditure and GDP as well. In this case, the T shock could be labelled as a G shock as well. Hence, to further disentangle the impulse responses, the second criterion, a magnitude restriction, is implemented on these draws.

In each set of impulses, if the magnitude of the response of government expenditure is greater than the magnitude of the response of taxation, then the shock is a G shock. However, if in a set of impulses, the magnitude of government expenditure is less than the magnitude of the response of taxation, then the set of impulses is considered a T shock.

**Criterion 3**

In the case where both set of impulse responses appear to be both G or both T shocks, this paper imposes criterion 3. This criterion examines the ratio of the absolute value of the response of government expenditure to the response of taxation in period 1 for both set of impulse responses. The absolute value of the impulse responses for the G and T shocks in the first period following the shock can be denoted as $|\left(\frac{I_{G,1}}{I_{T,1}}\right)|$ and $|\left(\frac{I_{T,1}}{I_{G,1}}\right)|$ respectively.

Hence, comparing the ratios in the G shock impulses, if $|\left(\frac{I_{G,1}}{I_{T,1}}\right)| \geq |\left(\frac{I_{T,1}}{I_{G,1}}\right)|$, then this implies that the G shock impulses is a G shock, while the T shock impulses is a T shock. Comparing the ratios in the T shock impulses, if $|\left(\frac{I_{T,1}}{I_{G,1}}\right)| \geq |\left(\frac{I_{G,1}}{I_{T,1}}\right)|$, then the T shock impulses is a T shock, and the G shock impulses is a G shock.

### 6.3 The Data

All the data in this paper are taken from the Bureau of Economic Analysis, Federal Reserve Board of St Louis and Thomson Reuters Datastream. The data on components of US national income is taken from the National Income and Product Accounts (NIPA), which are made publically available by the Bureau of Economic Analysis on their website: http://www.bea.gov/iTable/index_nipa.cfm/. The remaining data are taken from the Federal Reserve Board of St Louis website (http://research.stlouisfed.org/fred2/) and Thomson Reuters Datastream.

**Definitions of Variables in the FAVAR**
All the components of national income are in real terms and are transformed from their nominal values by dividing them by the GDP deflator (taken from Datastream). The table and row numbers refer to the organisation of the data by the Bureau of Economic Analysis.

The definitions of Total Government Expenditure and Total Government Revenue follow Mountford and Uhlig (2009).

**Total Government Expenditure:** This is ‘Federal Defense Consumption Expenditures’, NIPA Table 3.9.5 row 12, plus ‘Federal Non Defense Consumption Expenditures’, NIPA Table 3.9.5 row 17, plus ‘State and Local Consumption Expenditures’, NIPA Table 3.9.5 row 22, plus ‘Federal Defense Gross Investment’, NIPA Table 3.9.5 row 13, plus ‘Federal Non Defense Gross Investment’, NIPA Table 3.9.5 row 18, plus ‘State and Local Gross Investment’, NIPA Table 3.9.5 row 23.

**Total Government Revenue:** This is ‘Total Government Receipts’, NIPA Table 3.1 row 1, minus ‘Net Transfer Payments’, NIPA Table 3.1 row 17, and ‘Net Interest Paid’, NIPA Table 3.1 row 22.

**Gross National Expenditure:** This is ‘Personal Consumption Expenditures’, plus ‘Gross Private Domestic Investment’, plus ‘Government Consumption Expenditures & Gross Investment’.

**Debt-to-GDP ratio:** The definition of Debt-to-GDP ratio follows Favero and Giavazzi (2007). This is ‘Federal Debt Held by the Public’ (FYGFDPUN in FRED) divided by GDP. When the government spending exceeds its taxation revenue, it borrows to finance the debt. Hence, the federal debt held by the public represents the value of all federal securities sold to the public. The public includes a wide range of investors outside of the federal government, including international and domestic private investors, the Federal Reserve, and state and local governments.

**Real GDP:** This is ‘Real Gross Domestic Product, 3 decimal’ (GDPC96) taken from FRED.

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9This definition follows Blanchard and Perotti (2002) regarding transfer payments as negative taxes.
**CPI Inflation: All Items**: This is the change in ‘Consumer Price Index for All Urban Consumers: All Items’ (CPIAUCSL) taken from FRED.

**Federal Funds Rate**: This is the ‘Effective Federal Funds Rate’ (FEDFUNDS) taken from FRED.
<table>
<thead>
<tr>
<th></th>
<th>4 quarters ahead</th>
<th>8 quarters ahead</th>
<th>30 quarters ahead</th>
<th>60 quarters ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Expenditure</td>
<td>0.009</td>
<td>0.002</td>
<td>0.016</td>
<td>0.018</td>
</tr>
<tr>
<td>Government Revenue</td>
<td>0.048</td>
<td>0.192</td>
<td>0.195</td>
<td>0.068</td>
</tr>
<tr>
<td>Gross National Expenditure</td>
<td>0.003</td>
<td>0.015</td>
<td>0.025</td>
<td>0.015</td>
</tr>
<tr>
<td>Debt-GDP ratio</td>
<td>0.143</td>
<td>0.124</td>
<td>0.145</td>
<td>0.144</td>
</tr>
<tr>
<td>GDP</td>
<td>0.092</td>
<td>0.090</td>
<td>0.090</td>
<td>0.112</td>
</tr>
<tr>
<td>CPI inflation: All Items</td>
<td>0.408</td>
<td>0.341</td>
<td>0.090</td>
<td>0.067</td>
</tr>
<tr>
<td>Federal Funds Rate</td>
<td>1.108</td>
<td>0.948</td>
<td>0.218</td>
<td>0.151</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.211</td>
<td>0.184</td>
<td>0.096</td>
<td>0.086</td>
</tr>
<tr>
<td>Fixed Private Investment</td>
<td>0.382</td>
<td>0.129</td>
<td>0.234</td>
<td>0.152</td>
</tr>
<tr>
<td>New Private Housing Units</td>
<td>0.446</td>
<td>0.137</td>
<td>0.132</td>
<td>0.135</td>
</tr>
<tr>
<td>Exports</td>
<td>0.236</td>
<td>0.126</td>
<td>0.121</td>
<td>0.117</td>
</tr>
<tr>
<td>Imports</td>
<td>0.126</td>
<td>0.093</td>
<td>0.103</td>
<td>0.101</td>
</tr>
<tr>
<td>New Orders</td>
<td>0.267</td>
<td>0.147</td>
<td>0.148</td>
<td>0.141</td>
</tr>
<tr>
<td>Industrial Production Index</td>
<td>0.129</td>
<td>0.098</td>
<td>0.105</td>
<td>0.102</td>
</tr>
<tr>
<td>PPI: Finished Consumer Goods</td>
<td>0.011</td>
<td>0.046</td>
<td>0.085</td>
<td>0.096</td>
</tr>
<tr>
<td>Nonfarm Business Sector: Real Compensation Per Hour</td>
<td>0.113</td>
<td>0.033</td>
<td>0.107</td>
<td>0.119</td>
</tr>
<tr>
<td>Civilian Unemployment Rate</td>
<td>0.162</td>
<td>0.038</td>
<td>0.114</td>
<td>0.121</td>
</tr>
<tr>
<td>Monetary Base</td>
<td>0.261</td>
<td>0.118</td>
<td>0.100</td>
<td>0.088</td>
</tr>
<tr>
<td>M1</td>
<td>1.270</td>
<td>0.996</td>
<td>0.201</td>
<td>0.129</td>
</tr>
<tr>
<td>6-Month Treasury Bill Rate</td>
<td>1.135</td>
<td>0.870</td>
<td>0.282</td>
<td>0.209</td>
</tr>
<tr>
<td>Aaa Corporate Bond Yield</td>
<td>0.447</td>
<td>0.353</td>
<td>0.170</td>
<td>0.156</td>
</tr>
<tr>
<td>Japan/US Exchange Rate</td>
<td>0.014</td>
<td>0.061</td>
<td>0.095</td>
<td>0.104</td>
</tr>
<tr>
<td>Variable</td>
<td>4 quarters ahead</td>
<td>8 quarters ahead</td>
<td>30 quarters ahead</td>
<td>60 quarters ahead</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>38.286</td>
<td>24.493</td>
<td>17.699</td>
<td>15.748</td>
</tr>
<tr>
<td>Government Revenue</td>
<td>9.751</td>
<td>11.424</td>
<td>10.572</td>
<td>13.120</td>
</tr>
<tr>
<td>Gross National Expenditure</td>
<td>91.355</td>
<td>89.165</td>
<td>19.824</td>
<td>6.977</td>
</tr>
<tr>
<td>Debt-GDP ratio</td>
<td>10.033</td>
<td>7.116</td>
<td>4.901</td>
<td>4.664</td>
</tr>
<tr>
<td>GDP</td>
<td>22.471</td>
<td>19.608</td>
<td>19.154</td>
<td>17.704</td>
</tr>
<tr>
<td>CPI inflation: All Items</td>
<td>10.753</td>
<td>9.325</td>
<td>8.294</td>
<td>10.757</td>
</tr>
<tr>
<td>Federal Funds Rate</td>
<td>0.011</td>
<td>0.006</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.413</td>
<td>1.300</td>
<td>12.696</td>
<td>17.788</td>
</tr>
<tr>
<td>Fixed Private Investment</td>
<td>65.463</td>
<td>65.587</td>
<td>29.530</td>
<td>21.009</td>
</tr>
<tr>
<td>New Private Housing Units</td>
<td>5.445</td>
<td>2.307</td>
<td>1.043</td>
<td>1.160</td>
</tr>
<tr>
<td>Imports</td>
<td>20.990</td>
<td>16.175</td>
<td>12.450</td>
<td>12.147</td>
</tr>
<tr>
<td>New Orders</td>
<td>17.658</td>
<td>11.281</td>
<td>10.200</td>
<td>9.704</td>
</tr>
<tr>
<td>Industrial Production Index</td>
<td>22.343</td>
<td>16.708</td>
<td>11.620</td>
<td>11.329</td>
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<tr>
<td>PPI: Finished Goods</td>
<td>5.940</td>
<td>14.409</td>
<td>10.113</td>
<td>10.135</td>
</tr>
<tr>
<td>Nonfarm Business Sector: Real Compensation Per Hour</td>
<td>6.138</td>
<td>17.400</td>
<td>10.050</td>
<td>9.191</td>
</tr>
<tr>
<td>Civilian Unemployment Rate</td>
<td>0.382</td>
<td>4.502</td>
<td>2.296</td>
<td>7.351</td>
</tr>
<tr>
<td>Monetary Base</td>
<td>3.057</td>
<td>11.233</td>
<td>7.059</td>
<td>5.834</td>
</tr>
<tr>
<td>M1</td>
<td>1.556</td>
<td>8.523</td>
<td>12.390</td>
<td>13.446</td>
</tr>
<tr>
<td>6-Month Treasury Bill Rate</td>
<td>1.362</td>
<td>2.836</td>
<td>2.669</td>
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<tr>
<td>Aaa Corporate Bond Yield</td>
<td>4.620</td>
<td>5.714</td>
<td>8.802</td>
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<tr>
<td></td>
<td>4 quarters ahead</td>
<td>8 quarters ahead</td>
<td>30 quarters ahead</td>
<td>60 quarters ahead</td>
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<tr>
<td>--------------------------</td>
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<tr>
<td>Government Expenditure</td>
<td>22.502</td>
<td>4.722</td>
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<tr>
<td>Government Revenue</td>
<td>13.917</td>
<td>6.282</td>
<td>1.352</td>
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<td>Gross National Expenditure</td>
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<td>0.823</td>
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<tr>
<td>Debt-GDP ratio</td>
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<td>GDP</td>
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<td>1.878</td>
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<td>CPI inflation: All Items</td>
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<td>13.132</td>
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<tr>
<td>New Private Housing Units</td>
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<tr>
<td>Exports</td>
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<td>Imports</td>
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<td>New Orders</td>
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<td>Nonfarm Business Sector: Real Compensation Per Hour</td>
<td>2.658</td>
<td>2.557</td>
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<tr>
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<td>13.097</td>
<td>5.291</td>
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<td>4 quarters ahead</td>
<td>8 quarters ahead</td>
<td>30 quarters ahead</td>
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<td>--------------------------------------------------------</td>
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<tr>
<td>Government Expenditure</td>
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