US MONETARY-FISCAL POLICY MIX EVIDENCE FROM A QUATROVARIATE VECM

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Abstract

This study investigates the effectiveness of monetary and fiscal policies in the US by employing cointegration and a quatrovariate Vector Error Correction Model together with Granger causality tests. Two models are estimated: (i) nominal national income, the ten-year government bond yield, and two policy variables, the federal government deficit and the federal funds rate; (ii) real national income, and the other same three variables. Monetary and fiscal policies are jointly *in*effective in influencing nominal national income. However, monetary and fiscal policies are jointly effective in influencing real national income. In contrast to the first model, only monetary policy was found to be reactive to changes in real national income and the long-term interest rate. The asymmetric responses of the two policies to changes in real economic activity are attributed to the fact that monetary policy is much more efficient in promptly responding to changes in economic conditions than fiscal policy.

Keywords: Fiscal policy mix, VECM, Granger causality, Real vs nominal income, Interest rates, Fed deficit, Fed rate

JEL Classification: E12, E51

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1. Introduction

Economists are interested in knowing how monetary and fiscal policies influence economic activity. For this reason, they construct economic models analyzing such relations. Most economic models, however, focus only on one of the two policies, assuming the other remains passive or neutral. This approach is inadequate because often both policies are assigned an

active stance as countries pursue either expansionary (easy) or contractionary (tight) policies. The simultaneous employment of the two policies is Prior research on the Indonesian economy used stochastic frontier analysis (SFA) for evaluating a firm's performance but on other than manufacturing sectors: agriculture (see Daryanto, Battese, and Fleming (2002)) on technical efficiencies of rice farmers in West Java; Public and Private referred to, in the economic literature, as monetary-fiscal policy mix or policy mix.

The purpose of this paper is to investigate the joint effectiveness of US monetary and fiscal policies. The study also examines the response of the Federal Reserve System (Fed) and the US fiscal authorities to changes in nominal and real national income. The project constitutes an empirical investigation based on cointegration and the estimation of a quatrovariate VECM. The estimated VECM is employed to test for Granger econometric causality among four macroeconomic variables: a proxy for economic activity, a long-term interest rate and two policy variables, a short-term interest rate, and the US federal deficit. The results of the study are in agreement with studies which found fiscal policy to be less reactive in influencing output than monetary policy and can create contractionary Ricardian effects.

The paper presents evidence that the two policies jointly generate positive effects on real national income but do not affect nominal national income. The empirical results support the view that demand management policies influence the mean real GDP of the US economy. This is in contrast to the natural rate hypothesis model which supports that demand policies affect only the variance of real GDP.[1] In addition, the model examines the reaction of each policy to changes in economic activity, long-term interest rates, and shifts in the other policy. The empirical results are supported and reinforced by diagnostics such as CUSUM and CUSUM of Squares tests. Furthermore, impulse response functions and variance decomposition are utilized to project the separate long-run effects of monetary (fiscal) policy on nominal and real national income, twenty years into the future and beyond. The paper has shown that evidence exists to indicate the lack of fiscal policy efficacy. Particularly, this study shows that fiscal policy in the US, as it was conducted in the 1955-2006 period, generated contractionary effects on real national income. Such findings call for the revamping and re-launching of fiscal policy in the US in order to ensure that it consistently generates positive effects on the economy.

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[1] See De Long , Summers, Mankiw and Romer (1988).

This paper is organized as follows. In Section 2, four episodes of policy mix from recent US history are discussed. Section 3 discusses the relevant economic literature. Section 4 describes the data, presents the stability properties of the variables and discusses the methodology of the paper. The empirical analysis and the results of the paper are presented in Section 5. Section 6 concludes the paper.

2. Four Episodes of US Monetary Fiscal Policy Mix

President Reagan's administration adopted an expansionary fiscal policy during the first half of the 1980s; it pursued this policy by increasing spending and reducing taxes. During this period, the Fed applied contractionary monetary policy by raising interest rates to curtail inflation. High interest rates attracted foreign capital inflows to the US, causing a dollar appreciation that consequently generated large current account deficits. This episode became known as the story of the US twin deficits, since many economists considered the two deficits highly interdependent.

Another important episode of fiscal-monetary policy mix in contemporary US history occurred during the Clinton-Greenspan period. In the 1990s, President Clinton's administration, with the cooperation of a Republican dominated Congress, was successful in reducing large and chronic government budget deficits. This was achieved with an accommodating expansionary monetary policy applied by the Fed and its chairman, Alan Greenspan. Such a policy-mix is associated with the longest business cycle expansion in the US history from 1991 to 2001, which was responsible for reducing the US unemployment rate down to four percent and the inflation rate close to two percent. As a result of this policy-mix, the US was able to generate federal budget surpluses for the years 1998-2001.

Another episode of policy-mix occurred when the Fed, along with the US President and Congress, responded to three negative shocks that struck the US at the turn of the 21st century. Economists identified three distinct events (shocks) responsible for the subsequent US

recession.[2] The Fed's response to the three shocks was a drastic reduction in the target federal funds interest rate (r_{ff}), driving it down to one percent, a 42 year record low. Such an aggressive expansionary monetary policy was accompanied by an expansionary fiscal policy. The US government reduced taxes and increased government spending to cope with the anticipated recession and finance the two wars that the US was simultaneously fighting in Afghanistan and Iraq.

During the 2001-2003 period, expansionary monetary policy was very effective. It boosted consumption of automobiles, as automakers were able to promote sales by offering zero percent interest rates to finance purchases of new vehicles. Expansionary monetary policy mainly contributed to the reduction of the long-term interest rates, inducing families to purchase homes, refinance existing homes, or borrow on existing mortgages and spend on a variety of other items.

The expansionary monetary-fiscal policy mix during the 2002-2003 period was successful in reducing interest rates and simultaneously increasing stock and home prices beyond sustainable levels. A booming stock market and persistently increasing home prices generated a wealth effect, boosting consumption that led the US out of the recession. The consumer euphoria triggered by the monetary-fiscal policy mix, that led the US out of the 2002-2003 recession, is considered to be one of the main causes of the recent US mortgage financial crisis. The rationale of this explanation is based on the fact that a very expansionary US policy-mix during this period created a bubble in the housing and stock markets which encouraged and triggered drastic increases in household indebtedness.

The most recent episode of US monetary-fiscal policy mix, the response to the US subprime mortgage crisis, began unfolding in 2006. This crisis has already caused millions of American families to lose their homes. Furthermore, the crisis is far from over, as it still poses a serious threat to an unprecedented number of home-owners. The US subprime mortgage crisis has had detrimental effects on the entire US economy and has been transmitted to foreign

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[2] The abrupt decline in information technology investment and consumption, the corporate scandals of this period, and the September 11, 2001 terrorist attacks are considered the main causes of the recession. The three events created uncertainty and contributed to the formation of negative expectations regarding the future of the US economy.

countries. During this period both monetary and fiscal authorities adopted an extraordinary expansionary stance. The US government, under the administration of George Bush, adopted a massive fiscal plan to bail out several financial institutions at an initial estimated cost of 700 billion dollars. Furthermore, on February 17, 2009, a new fiscal stimulus bill of 787 billion dollars was signed into law by President Barack Obama. The Fed's response to the crisis was swift, as it reduced the r_{ff} several times. On December 16, 2008, it reduced the r_{ff} to an unprecedented record low within the range of zero to 0.25 percent. It also reduced the discount rate to .50 percent.[3]

3. Literature Review

Empirical studies investigating the relevance and importance of the r_{ff} as a monetary policy instrument in the US differ from study to study. For example, Cook and Hahn (1989) found the r_{ff} very influential in affecting other interest rates. Similarly, Bernanke and Blinder (1992) have shown that the r_{ff} is a good indicator of monetary policy. A few other studies show that r_{ff} is not superior to other short-term interest rates. Garfinkel and Thornton (1995), for example, found the r_{ff} not to contain unique information regarding the conduct of monetary policy.

Kydland and Prescott (1977) were the first to point out that the central banks that are not accountable for their conduct of monetary policy in their effort to increase output in the short-run can fall victim to what is known as the time-consistency problem. This means that a highly expansionary monetary policy, aiming to boost economic activity in the short- run, can trigger long-run inflationary pressure in the economy. Consequently, a countercyclical monetary policy stance aimed at fighting a recession will inadvertently raise prices and nominal, long-term

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[3] European central banks followed the Fed's lead and they slashed their respective key interest rates several times. For example, the Bank of England brought the bank rate to 0.5 percent, the lowest ever since its establishment in 1694. Similarly, the ECB reduced its repo rate to 1 percent, the lowest since its establishment in 1998. The Fed and the Bank of England adopted unorthodox monetary policies (quantitative easing) to provide liquidity to their economies. Similar policy was introduced by the ECB, in May 2010, which began buying national bonds of the weaker Eurozone economies in order to protect these economies and save the Euro.

interest rates. As a result, an easy monetary policy can trigger inflation that may emerge during the expansionary phase of the business cycle.

Most of the early empirical term structure studies of interest rates have employed single-equation econometric estimation models to examine relations between short and long-term interest rates.[4] A few exceptions, however, exist in the literature, such as Harvey (1997) and Clarida and Friedman (1983). The latter employed both short and long-term interest rates within the framework of an IS-LM model.

Turnovsky (1989) criticized the term structure theory of interest rate studies because the vast majority of them employed partial equilibrium models, focusing only on the relation of short- and long-term interest rates in the absence of other macroeconomic variables. Instead, Turnovsky presented a stochastic macroeconomic model that included, in addition to the short- and long-term interest rates, several other macroeconomic variables.

Brimmer and Sinai (1986) used simulation analysis to study projections of the Gramm-Rudman-Hollings Act. This legislation aimed to promote fiscal discipline in the US. Simulation analysis was also employed by Ribe and Beeman (1986) to investigate the long-run joint effects of a monetary and fiscal policy. Some studies utilized the Vector Autoregression (VAR) Model to study the effects of monetary and fiscal policies on the economy using time series variables. Fackler and McMillin (1989) employed a VAR model to investigate possible effects of Federal debt on the US macroeconomy. Using impulse response functions and variance decomposition, the two authors concluded that debt is not perceived as wealth. This finding is related to a topic known in the literature as Ricardian Equivalence.

About two centuries ago, David Ricardo observed that increases in government deficits financed with government bonds can trigger equivalent increases in private savings to enable taxpayers to pay the higher expected future taxes. Under this scenario expansionary fiscal policy becomes neutral, implying that government bonds held by the public are not perceived as

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[4] These reduced form models, however, are valid only if the right-hand side variables are exogenous. It is possible for a right-hand side variable to also depend on the left-hand side variable or for a third variable which was omitted from the model to affect both variables in the equation. In these cases, the reduced form model is incorrectly specified, and thus cannot be employed to analyze the relationship of the term structure of interest rates.

wealth.[5] This proposition has been extensively debated and investigated in empirical studies. Most authors are convinced that Ricardian Equivalence effects exist, but no consensus is provided in the literature regarding the magnitude of these effects. Recently, many macroeconomists hold the view that a contribution by John Taylor, known as the Taylor Rule, accurately describes how monetary policy should be applied. The Taylor rule suggests that monetary policy conducted by central banks is best described by a reaction function of the key interest rate to deviations of the actual from the potential output and the actual from the target inflation rates. After his (1993) multi-country study, Taylor proposed that policy-makers following such a rule would achieve price and output stability. Many studies, however, incorporate fiscal policy within one of the various versions of Taylor's rule.[6]

Recent advances in time series methodologies, such as cointegration, VAR and VECMs, are currently very popular. Kuttner (2002) employed a quatrovariate VAR model that included GDP, inflation, the r_{ff}, and a fiscal variable, which measured either with the actual government surplus or the structural primary balance. Kuttner found that both fiscal variables are informative in predicting GDP[7]. Kuttner (2002) also found that fiscal policy does not affect the r_{ff}; this finding allowed him to conclude that US monetary policy was conducted without constraint from fiscal policy.

It is plausible that a country running significant chronic government deficits will accumulate such a large national debt that its central bank will find it necessary to monetize national debt. In this case, the central bank will lose control of the country's inflation rate. A group of models, known as Fiscal Theory of Price Level (FTPL), deal with this issue.[8]

Granger causality tests performed within the framework of a VAR or a VECM reveal relations among variables in terms of strength of statistical significance and direction of causation. When a VAR or a VECM is employed, no explicit functional form relation of the

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[5] See Barro (1974)

[6] Gonzalez and Martinez (2003) for example, proposed two different rules, one for monetary policy and one for fiscal policy.

[7] The results, however, were weak since the level of the statistical significance was only 10 percent.

[8] See Leeper (1991,2010), Sims (1994), Beetsma (2008). The main idea of these models was introduced by Sargent and Wallace (1983)

variables is *a priori* required; therefore model specification error is avoided.[9] As the VECM employs only cointegrated variables, this suggests that standard asymptotic theory is applicable for statistical inference. A VECM permits a short-run dynamic adjustment following a shock as all variables return to their long-run values, according to the cointegration equation.[10]

To study the effects of US and Canadian monetary policies on nominal and real GDP and the reaction of the central banks to changes in the two variables, Zestos *et al*. (2010), employed the methodology of cointegration and the estimation of a trivariate VECM. Performance of Granger causality tests, within the framework of estimated VECMs, led the authors to conclude that both banks are effective in influencing proxies for nominal and real GDP. Both central banks, however, were found to be either passive or procyclically reactive to real business cycle activity.

Claeys (2007) using the VAR approach and incorporating an explicit intertemporal budget constraint, analyzed the effect of US fiscal policy on employment and inflation. Such a model forces the estimated parameters to take values that are consistent with a sustainable national debt. Claeys found that US expansionary fiscal policy generated contractionary effects on US output and inflation. These results can be characterized as negative Ricardian effects as they arise from the public's expectation of higher future taxes. Beetsma (2008), however, who surveyed relevant literature on the effects of fiscal policy, concluded that most studies provide evidence that expansionary fiscal policy has positive effects on output and consumption but negative on trade balance.

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[9] The method of cointegration produces an explicit estimated equation which depicts a long-run stable linear relation among these variables. According to Engle and Granger (1987) cointegrated variables always have an error correction representation.

[10] Futhermore, Granger (1988) proved that if two variables are cointegrated, causality will always exist between them in at least one direction. Starting with Engle and Granger (1987), the methodology of cointegration and the VECM were employed by several authors. Johansen (1991, 1995) extended the cointegration technique to many variables.

4. Data Description and Methodology

4.1 Data description

A US time series data set was constructed for the period 1955-2006, consisting of 52 annual observations. Annual data were chosen for this study because deficits (surpluses) are reported annually. In addition, annual data are not affected by short-run transitive and seasonal shocks, thus the analysis focuses exclusively on the fundamentals.[11]

The data set includes four time series variables: a proxy for economic activity, a long-term interest rate, a monetary policy variable (a short-term interest rate), and a fiscal policy variable. The natural logarithms of nominal and real national incomes, *lnni* and *lnrni*, respectively, are employed as proxies for economic activity.[12] The ten-year US Treasury government bond yield, r_{tb10}, was utilized for the long-term interest rate. For the monetary policy variable, we employed the overnight, effective federal funds rate r_{ff}. The Fed sets the target r_{ff}, which for many years has emerged as the most important monetary operating instrument employed by the Fed for the conduct of monetary policy.[13]Through open market operations the Fed maintains the market or effective r_{ff} close to the target rate.

A long-term interest rate is also included in the VECM because economists are convinced that monetary policy is mainly transmitted through its impact on long-term interest rates. Fiscal

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[11] See Nunes-Correia and Stemitsiotis (1993), and Beetsma (2008). We purposely left out from the sample observations beyond 2006 since it is certain that such observations are outliers as both US monetary and fiscal policies were exceptionally expansionary causing a major structural break.

[12] Note that several proxies of nominal GDP and output were employed in the preliminary study All other proxies, however, either did not possess the required stability properties or were not cointegrated with the other variables of the VECM.

[13] An exception to this policy occurred during the three year period of October 1979 to October 1982, a period during which the Fed tried to control unborrowed reserves in its effort to reduce inflation. Although r_{ff} was not always the main policy instrument during the entire sample period, r_{ff} was always considered as an informative indicator of the monetary policy stance. For practical purposes we will refer to both the target federal funds rate and the effective federal funds rate as r_{ff}.

policy also affects interest rates because as the US Treasury changes the supply of government bonds to finance deficits, or to reduce public debt, it affects interest rates.

Two different measures of the government deficit were utilized, the federal budget deficit (surplus) to GDP ratio *bd,* and the total deficit to GDP ratio, *td*. The latter includes the off budget items, thus providing a more accurate response of fiscal policy to business cycle conditions.

The two fiscal measures, *bd* and *td*, consist of both discretionary revenues and spending along with government revenues and spending triggered because of changes in the business cycle. A few authors employ the structural balance as the fiscal policy variable. This is calculated by simply subtracting the cyclical component from the deficit (surplus) balance. The rationale for employing the structural fiscal balance is that the most relevant fiscal measure should include only the balance determined by the government as a result of discretionary policy. [14]

Data for the r_{ff} and the r_{tb10} were obtained from the Federal Reserve Bank of St Louis. The source of nominal national income and real national income is the Bureau of Economic Analysis (BEA). The two deficits to GDP ratios are from the Economic Report of the President.

4.2 Stability properties of the time series variables

Prior to testing for evidence of cointegration among a set of time series variables, it is required that all variables are integrated of the same order. This requires that the stability properties of the variables must be investigated.

The performance of the unit root test for a variable Y is demonstrated below, in equation (1).

$$\Delta Y_t = \beta_0 + \beta_1 t + \beta_2 Y_{t-1} + \sum_{i=1}^{k} \psi_i \Delta Y_{t-i} + \varepsilon_t \qquad (1)$$

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[14] The remaining component of the fiscal balance is known as cyclical, and is captured by the automatic stabilizers. The Congressional Budget Office, starting in 1962, produces the structural budget balance. The two fiscal measures employed in this study, *bd*, and *td*¸ exceed the span of the structural deficit measure by eight annual observations.

Where, β_o, β_1, β_2 and ψ_1, $\psi_2 \ldots \psi_k$ are parameters to be estimated, and ε_t is the error of the regression assumed to be stationary with a zero mean and a constant variance.

In Table A (see Appendix) the unit root results of all the time series variables are reported. According to the ADF test, the vast majority of the results meet the stability requirements for the variables to be employed in the cointegration tests. The time series variables are non stationary in levels but stationary in first differences.

All unit root results, however, according the Phillips-Perron (PP) test indicate that the hypothesis of nonstationarity cannot be rejected for the levels of all variables, but it can be rejected for the first differences[15]. Since these variables are integrated of the same order we proceed to test for cointegration and the estimation of the quatrovariate VECM presented in section 4.3 below.

4.3 The Vector Error Correction Model (VECM)

Equations (2)-(5) below represent a quatrovariate VECM in four endogenous variables X, Y, Z and W. The variable X represents the two proxies for nominal or real GDP which is measured with the natural logarithms of nominal and real national incomes denoted by *lnni* and *lnrni*, respectively[16]. Variable Y represents the long-term interest rate, r_{tb10}. Variables Z and W represent the two policy variables; Z represents the fiscal policy variable measured either with the budget deficit or with the total deficit to GDP ratios, *bd* and *td* respectively. Lastly, W represents r_{ff}, the monetary policy variable.

A quatrovariate VECM

$$\Delta X_t = \alpha_0 + \alpha_1 t + \alpha_X \theta_{t-1} + \sum_{i=1}^{r_1} \alpha_{1i} \Delta X_{t-i} + \sum_{i=1}^{s_1} \beta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{k_1} \gamma_{1i} \Delta Z_{t-i} + \sum_{i=1}^{p_1} \delta_{1i} \Delta W_{t-i} + \varepsilon_{1t}$$

$$(2)$$

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[15] The PP unit root test is considered more reliable than the ADF test since it is robust in the presence of serial correlation and time dependent heteroskedasticity.

[16] Two VECMs are estimated; the first employing the nominal national income, *lnni*, and the variables, r_{tb10}, r_{ff}, and *td*, whereas the second VECM uses the real national income, *lnrni*, with the variables, r_{tb10}, r_{ff}, and *bd* instead of *td*.

$$\Delta Y_t = \beta_0 + \beta_2 t + \beta_Y \theta_{t-1} + \sum_{i=1}^{r_2} \alpha_{2i} \Delta X_{t-i} + \sum_{i=1}^{s_2} \beta_{2i} \Delta Y_{t-i} + \sum_{i=1}^{k_2} \gamma_{2i} \Delta Z_{t-i} + \sum_{i=1}^{p_2} \delta_{2i} \Delta W_{t-i} + \varepsilon_{2t} \tag{3}$$

$$\Delta Z_t = \gamma_0 + \gamma_3 t + \gamma_Z \theta_{t-1} + \sum_{i=1}^{r_3} \alpha_{3i} \Delta X_{t-i} + \sum_{i=1}^{s_3} \beta_{3i} \Delta Y_{t-i} + \sum_{i=1}^{k_3} \gamma_{3i} \Delta Z_{t-i} + \sum_{i=1}^{p_3} \delta_{3i} \Delta W_{t-i} + \varepsilon_{3t} \tag{4}$$

$$\Delta W_t = \delta_0 + \delta_4 t + \delta_W \theta_{t-1} + \sum_{i=1}^{r_4} \alpha_{4i} \Delta X_{t-i} + \sum_{i=1}^{s_4} \beta_{4i} \Delta Y_{t-i} + \sum_{i=1}^{k_4} \gamma_{4i} \Delta Z_{t-i} + \sum_{i=1}^{p_4} \delta_{4i} \Delta W_{t-i} + \varepsilon_{4t} \tag{5}$$

The left-hand side variables of the VECM presented in equations (2) − (5) are expressed in terms of first differences. The right-hand side of each equation include an optimum number of lagged differences for each of the four variables. In addition to the lagged differences, each equation includes the one-period lagged error term of the cointegrating equation θ_{t-1} as a right-hand side variable. Furthermore, each equation includes a constant represented by α_0, β_0, γ_0, and δ_0, in each of the four equations respectively and a time trend variable denoted by t, where, α_1, β_2, γ_3, and δ_4 are the constant coefficients of the time trend variable in each equation. A random error term ε_{it}, where $i=1,2,3,4$, is assumed to be a white noise, is also included in every equation.

4.4 Granger causality tests

Three different types of Granger causality tests are performed in every one of the four equations of the quatrovariate VECM.[17] A test for long-run non-causality is carried out by testing the null hypothesis that the coefficient of θ_{t-1} is zero. This test examines whether the three right-hand side variables in each equation, which are cointegrated with the left-hand side variable, Granger, cause this variable. In equation (2), this test is performed by testing the null hypothesis $\alpha_x=0$, versus the alternative $\alpha_x \neq 0$.

Four short-run Granger causality tests are also performed in each equation. Three of these tests are carried out by setting the coefficients of all order-lagged differences of each of the right-hand side relevant variables equal to zero. For example, in equation (2) a test for short-run non-causality from Y to X is carried out by testing whether the coefficients of the lagged differences of the Y variable are all equal to zero, i.e., $\beta_{11} = \beta_{12} = \ldots = \beta_{1s1} = 0$. This is a Wald F-

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[17] Based on Granger (1988).

test for short-run non-causality from Y to X since the lagged coefficients of Y capture the short-run dynamic adjustment of the system. A similar test for short-run-non-causality from Z and W to X is also performed.

Lastly, a test for overall causality from each right-hand side variable to the left-hand side variable is performed by setting all the coefficients of each right-hand side variable and the coefficient of θ_{t-1} jointly equal to zero. The null hypothesis for overall non-causality from Y to X for example, is stated as $\alpha_x = \beta_{11} = \beta_{12} = \ldots\ldots\beta_{1S1}=0$. Similar tests are performed for the other two right-hand side variables, in each of the four equations.

5. Empirical Analysis

5.1 An estimated quatrovariate US VECM with nominal national income

In this section, a quatrovariate VECM is estimated using natural logarithms of nominal national income, $lnni$, the ten year government bond yield, r_{tb10}, the total deficit to GDP ratio, td, and the federal funds rate, r_{ff}.

Table 1: Johansen Cointegration Test

0	igenvalue	nax	ritical alue 5%	·value	race	ritical alue 5%	·value
= 0	57	3.02	3.58	00	7.42	4.07	00
≤ 1	54	5.83	2.29	00	).40	5.19	00
≤ 2	24	2.63	5.89	15	3.57	).26	02

Cointegration tests were performed according to Johansen (1991, 1995) methodology. The number of cointegrating vectors was determined using the two maximum likelihood tests λ_{max} and λ_{trace}. According to Table 1 above, there were three cointegrating vectors based on λ_{trace} and two cointegrating vectors based on λ_{max}.

Equation (6) below is the first cointegrating vector of the variables $lnni$, r_{tb10}, td, and r_{ff}.

$$lnni = 5.307445+1.271532\ r_{tb10} + 1.419449\ td - 0.185706 r_{ff} + \theta_t$$
t-stat   (3.2)   (1.85)   (4.8)   (-.30)   (6)

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The cointegration equation above indicates that *lnni* is positively related to r_{tb10} and *td*, but negatively to the r_{ff}. The negative relation between *lnni* and r_{ff} is plausible because the Fed conducts monetary policy by reducing r_{ff} to induce increases in consumption and investment and to raise national income. On the contrary, the Fed increases r_{ff} to discourage private spending and prevent the economy from overheating. Cointegrating equation (6) also shows that *td* is positively related to *lnni*[18]. This relation indicates that an expansionary fiscal policy is associated with reduced national income. On the other hand a contractionary fiscal policy increases *lnni*. This finding is in line with the neoclassical view that expansionary fiscal policy leads to rising interest rates that crowds out private investment and generates contractionary fiscal Ricardian effects.

According to cointegrating equation (6), *lnni* and r_{tb10} are positively related. The co-movement of *lnni* and r_{tb10} is empirically supported by time series data on business cycles activity and interest rates. During expansionary periods, economies experience both increases in prices and nominal interest rates. An explanation for this positive relationship is that during the expansionary phase of the business cycle, investors request a higher nominal interest rate to maintain a constant real rate of return. This is achieved by adding an inflation premium to r_{tb10}. The positive relation between *lnni* and r_{tb10} is also explained by focusing on the bond market. During expansionary periods, the supply of bonds increases as governments and businesses choose to raise capital to finance various investment projects. An increase in the supply of bonds, *ceteris paribus*, leads to higher interest rates.[19] The estimated VECM is presented below in Table 2 using the first cointegrating vector.[20]

Table 2 above presents the estimated VECM for *lnni*, r_{tb10}, *td* and r_{ff}. According to equation (7), monetary and fiscal policies are jointly ineffective in influencing nominal

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[18] Note that *td* is defined as government revenue minus expenditures to nominal GDP. This ratio is negative for the vast majority of the observations in the sample. In this model the total deficit to GDP ratio (*td*) was employed since *td* was cointegrated with the other three variables.

[19] It is theoretically possible, however, for r_{tb10} not to increase if the demand for bonds increases proportionately with the supply of bonds, or if the demand for bonds is perfectly elastic with respect to the interest rate.

[20] The VECM, however, was estimated with two and three cointegrating vectors, respectively. The results of these VECMs were not economically plausible and could not be interpreted in any meaningful way; therefore, these results are not reported.

national income. This result is supported because there is a lack of statistical evidence for long-run causality from the three variables r_{ff}, r_{tb10} and *td* to *lnni*.

Table 2: An Estimated VECM With Nominal National Income (*lnni*)

Dependent Variable	θ_{t-1}	$\sum_{i=1}^{r_1} \Delta \ln ni_t$	F_1	$\sum_{i=1}^{s_1} \Delta r_{tb10\,t-i}$	F_2	$\sum_{i=1}^{k_1} \Delta td_{t-i}$	F_3	$\sum_{i=1}^{p_1} \Delta r_{ff\,t-i}$	F_4
(7) $\Delta lnni$	.005 (1.14)	1.18 [10.6]***	67.1***	.028 [.57]	.56	.006 [.30]	.46	-.01 [.87]	.94
(8) Δr_{tb10}	.25 (1.19)	8.90 [.63]	.54	.12 [.59]	.76	.006 [.25]	.51	.78 [1.54]	1.7
(9) Δtd	.68 (4.59)***	22.6 [6.6]***	6.2***	1.22 [1.87]	5.87***	1.82 [4.72]***	4.9***	.704 [1.83]	5.27***
(10) Δr_{ff}	.75 (1.86)*	25.5 [1.11]	.98	4.69 [.78]	.84	2.14 [.69]	.71	-1.73 [.67]	1.25

***, **,* denote significance at 1%, 5%, and 10% levels, respectively.

The figures in parentheses and brackets are t and F statistics, respectively.

This is indicated by the statistically insignificant coefficient of θ_{t-1} (0.005). Similarly, a lack of statistical evidence exists for short-run and overall causality from each of the three right-hand side variables to *lnni*. This is shown by the low values of the F-statistic, below the summation terms of the three variables, and by the low F statistic values under the columns F_2, F_3, and F_4. The latter three tests indicate a lack of overall Granger causality, from any of the three variables to *lnni*.

Equation (8) indicates that no statistical evidence of any type of Granger causality is statistically supported from *lnni*, r_{ff}, and *td* to r_{tb10}. Strong statistical evidence for long-run causality, however, is supported from *lnni*, r_{tb10}, and r_{ff} to *td* in equation (9). This result indicates that fiscal authorities are reactive to changes in nominal national income and changes in the two interest rates. It also indicates that the fiscal authorities counter-cyclically (correctly) react to changes in national income. Equation (9) further indicates that statistical evidence exists for short-run and overall causality from *lnni* to *td* at a one percent level of significance. Such results indicate a very responsive fiscal policy in *lnni*.

Equation (10) supports statistical evidence only at a ten percent level of significance for long-run causality from *lnni*, r_{tb10} and *td* to r_{ff}. This finding suggests that the Fed mildly reacts to changes in *lnni*, r_{tb10}, and *td*. No statistical evidence, however, exists for short-run and overall

causality from *lnni*, r_{tb10} and *td*, to r_{ff}. These statistical tests suggest that the Fed does not react to any short-run changes in any one of the three variables. The finding that r_{ff} is not Granger caused by *td* is also supported by Kuttner (2002) who found that fiscal policy does not affect r_{ff}. We conclude that US monetary policy during the sample period of 1955-2006 was exercised without constraint by fiscal policy. This is a plausible result because this period is characterized by fiscal stability as it is supported by historical US data of deficit and national debt to GDP ratios.

By observing cointegrating equation (6) in conjunction with the VECM equation (7) it can be inferred that fiscal policy is very effective in influencing *lnni*, and it reacts counter-cyclically to changes in national income. Similar claims, however, cannot be made for monetary policy by examining cointegration equation (6) in conjunction with the estimated equation (7) of the VECM. In this case, monetary policy is pro-cyclical[21].

To examine evidence of possible structural breaks in the model, the CUSUM and the CUSUM of Squares tests were performed in each of the four equations. According to these two tests there is no evidence for structural break(s) in seven out of the eight tests performed in the four equations of the VECMs[22]. Despite the fact that fiscal policy is exercised counter-cyclically in regard to nominal national income (*lnni*), its long-run effects are contractionary. This finding was based on the results of the impulse response function (see Figure 1 below).

According to the generalized impulse response function, one standard deviation innovation on *td* reduces *lnni* in the first 20 years but afterwards *lnni* oscillates with cycles of increasing phase and amplitude.[23] The long-run effects of monetary policy, according to the impulse response function, on nominal income are positive, increasing *lnni* by approximately one percent. Examining the variance decomposition of *lnni,* fiscal policy as measured with *td* accounts for a greater percentage contribution in affecting *lnni* than r_{ff}. Fiscal policy is responsible for a greater contribution than monetary policy in affecting all other variables, other than r_{ff}, which are not reported in this study.

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[21] These results, however, are discounted because the coefficient of θ_{t-1} is statistically insignificant.

[22] According to the CUSUM of Squares test, a minor structural break was revealed in equation (10).

[23] The graph of the impulse response function beyond 20 periods is not shown in Figure 1. The cycles, however, appear when the Impulse Response Function graph is increased to 100 periods (years).

Figure 1: Impulse Response Function and Variance Decomposition of lnni

| Response to Generalized One S.D. Innovations on lnni | Variance Decomposition of lnni Due to td and r_{ff} |
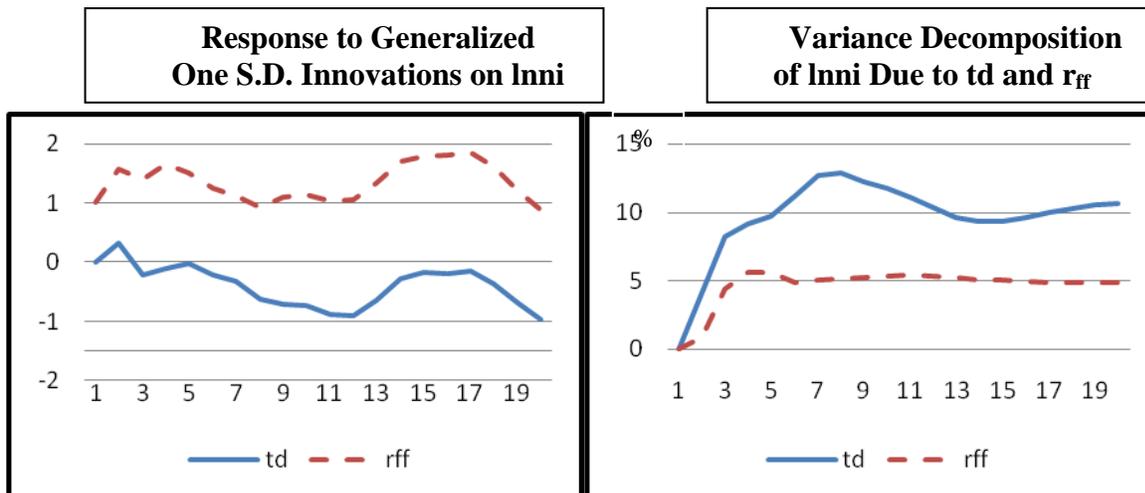
5.2 An estimated quatrovariate VECM with real national income *(lnrni)*

We now proceed with the estimation of the quatrovariate VECM, which employs the log of real national income (*lnrni*), r_{ff}, r_{tb10}, and the budget deficit to GDP ratio, bd[24]. Table 3 below reports the results of the Johansen (1991, 1995) cointegration test. According to λ_{trace} and $\lambda_{max,}$ there exists one cointegrating vector at the 1% level of significance. A second cointegrating vector is supported only by λ_{trace} at the 10% (p=.09) level of significance. Consequently, the VECM is estimated using only one cointegrating vector.[25]

Equation (11) below is the cointegrating equation of *lnrni*, the two interest rates r_{tb10}, r_{ff}, and the budget deficit *bd*.

$$lnrni = 7.706834+.033236*trend-.139390*r_{tb10}-.035089*bd+.119452*r_{ff} + \theta_t \qquad (11)$$

t-stat   (-7.46)   (-4.34)   (8.1)

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[24] Replacing nominal national income with real national income in the VECM makes it possible to abstract from price effects (inflation) and focus on the real effects of monetary and fiscal policy.

[25] The estimated VECM with the two cointegrated vectors did not produce meaningful results.

Table 3: Johansen Cointegration Test

0	igenvalue	nax	ritical alue 5%	·value	race	ritical alue 5%	·value
= 0	64	l.69	3.58	00	l.38	l.07	00
≤ 1	32	).79	2.29	16	2.69	5.19	09
≤ 2	15	70	5.89	46	2.89	).26	37

According to the cointegration equation (11), *lnrni* is inversely related to r_{tb10}. This result is a theoretically correct behavioral relation because a decline in r_{tb10} induces increases in investment and consumption of durable goods and purchases of homes[26]. The negative relation of *lnrni* and r_{tb10}, however, is exactly opposite the relation between nominal national income (*lnni*) and r_{tb10} obtained from the cointegrating equation (6) of the first estimated VECM. It is highly likely that the positive relation between *lnni* and r_{tb10} in cointegration (6) is driven by the presence of inflation, as both *lnni* and r_{tb10} are expressed in nominal terms.

In cointegration equation (11), *lnrni* is inversely related to the government budget deficit, *bd*. An expansionary fiscal policy according to this relation increases *lnrni*, whereas a contractionary fiscal policy reduces *lnrni*. The relation between *lnrni* and *bd* is also opposite to the one between *lnni* and td as discussed in the previous VECM. As nominal and real national incomes are not perfectly correlated, it is possible that both relations are valid.

Cointegration equation (11) also indicates that r_{ff} is positively related to *lnrni*.[27] This relation, although counter-intuitive, is still plausible because the Fed does not respond to changes in real national income, as the latter is not observed when the Fed applies monetary policy through changes in r_{ff}. A countercyclical expansionary monetary policy implemented with a reduction in r_{ff} to reverse a decline in nominal national income is often followed by a rising r_{ff}

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[26] This claim can be made as r_{tb10} is closely related to corporate long-term bond yields, mortgage rates and all other long-term interest rates.

[27] This is the most statistically significant relation in the cointegration equation as indicated by the t-statistic value of r_{ff} (8.1), the highest one in this equation. This implies that monetary policy is much more important than fiscal policy because the t-value of *bd* is only about half in magnitude (-4.54) of the t-value of r_{ff}.

when real national income eventually increases. As a result, a positive long-run relation between *lnrni* and r_{ff} is possible. The relations of the variables in the cointegrating equation do not depict the final long-run relationship among these variables. The final long-run relation among the four variables can only be revealed if the cointegrating relation is analyzed in conjunction with the estimated VECM and particularly by focusing on the value of the one-period lagged error term θ_{t-1} and its estimated coefficient. It is interesting to note that a sign of the coefficients of the variables on the right-hand side of the cointegrating equation are identical with the respective coefficients shown under the summation terms in the estimated VECM. This indicates that long-run causality is related to short-run causality.

Table 4: An estimated VECM with Real National Income

	Dependent Variable	trend	C	θ_{t-1}	$\sum_{i=1}^{r_1} \Delta \ln rni_{t-i}$	F_1	$\sum_{i=1}^{s_1} \Delta r_{tb10t-i}$	F_2	$\sum_{i=1}^{k_1} \Delta bd_{t-i}$	F_3	$\sum_{i=1}^{p_1} \Delta r_{ffi-i}$	F_4
(12)	$\Delta lnrni$	-.0008 (-.28)	.05 (2.5)**	.31 (2.06)**	-.74 (1.78)	3.12**	-.11 1.91	1.59	-.03 (2.03)	2.06*	.101 (2.6)**	(2.55)**
(13)	Δr_{tb10}	-.009 (-.65)	2.41 (1.98) *	16.3 (2.07)**	-65 (1.84)	1.57	-6.06 (2.58)*	2.29*	-1.7 (1.16)	1.12	5.9 (2.46)*	3.5**
(14)	Δbd	-.003 (-.21)	1.65 (1.27)	12.02 (1.4)	-49 (2.3)*	2.44*	-4.9 (1.21)	1.51	-1.1 (1.45)	1.2	4.2 (2.2)*	2.04*
(15)	Δr_{ff}	.01 (.71)	4.29 (1.99)	54.2 (3.89)***	-148 (1.79)	3.61**	-16 (3.47)**	3.2**	-5.4 (3.43)**	3.6***	16.2 (4.91)***	4.1***

***, **,* denote significance at 1%, 5%, and 10% levels, respectively. The figures in parentheses and brackets are t and F statistics, respectively.

Equation (12) of the estimated VECM model indicates that monetary and fiscal policies are jointly effective in influencing real national income *lnrni* in the long-run. This is demonstrated by the positive coefficient, .31, of θ_{t-1}, the one-period lagged error term, which is significant at the 5% level. This result provides evidence for long-run causality from the three right-hand side variables r_{ff}, *bd*, and r_{tb10} to *lnrni*. The interpretation of this result is that monetary and fiscal policies are jointly effective in influencing real national income. This result is exceptionally important for policy purposes because it shows that an active policy mix has positive (negative) effects on real output. New Keynesian models with "frictions," such as a

government budget constraint, support favorable effects of monetary- fiscal policy mix on output.[28] The effect on output, nonetheless, cannot be exclusively attributed to any one of the two policies by simply observing the estimated VECM equations (12)-(15). If, however, we examine the cointegrating equation together with equation (12), it is clear that only expansionary monetary policy affects positively real national income; in contrast, expansionary fiscal policy has a negative effect on output.[29] This implies that contractionary fiscal policy can increase *lnrni*.

Levy (2002) provides empirical evidence from the US that a sequence of government deficit reductions had positive effects on real national income during the Clinton administration period. These results were robust to the type of deficit measure employed in Levy's model. Furthermore, Levy indicated that, contrary to Keynesian theory, the *Omnibus Reconciliation Act of 1993* has resulted in surpluses which contributed to economic growth. Similar results are supported by a group of models dealing with fiscal contractions adopted in response to severe economic or fiscal crises.[30] A possible alternative explanation of how contractionary fiscal policy can increase *lnrni* is also suggested here. Since fiscal policy works with lags, it is possible for current deficits to be associated with increases in future *lnrni* but with decreases in current *lnrni*; i.e., government deficits can lead to real national income. Such an explanation supports a modified version of the Keynesian theory allowing for lagged effects between changes in fiscal balances and real national income.

Evidence is also supported for short-run and overall causality from r_{ff} to *lnrni* at the 5% significance level, as this can be seen by the two significant coefficients shown in the last two columns of equation (12). This result indicates that in the short-run an expansionary monetary

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[28] In this study an implicit government budget constraint is incorporated in the VECM as the government deficit must be in a permanent stable long–run linear relation with real national income and the long-term interest rate.

[29] To see this, assume that you express equation (11) in terms of the lagged error term θ_{t-1}, you can do this by lagging all variables by one period, then a reduction of r_{ff} will make θ_{t-1} positive. Thus a positive value of θ_{t-1} multiplied by the positive coefficient .31 of θ_{t-1} in equation (12) of the VECM will increase *lnrni*. On the other hand, if *bd* increases (i.e. larger deficit) this will make θ_{t-1} negative and when multiplied by the positive coefficient of θ_{t-1} will result to a negative number implying that real national income declines.

[30] These models show that large fiscal consolidations for high deficit countries can raise consumption and output, see Perotti (1999) and Giavazzi, and Pagano (1990).

policy negatively affects *lnrni*. Lastly, weaker evidence is supported at the 10% significance level for overall causality from *bd* to *lnrni* as shown by the reported statistic under F_3.

Statistical evidence of long-run causality is supported in equation (13) from *lnrni*, *bd* and r_{ff}, to r_{tb10} at the 5% significance level, indicated by the coefficient of θ_{t-1} in this equation. The meaning of this result is that joint fiscal and monetary policies affect long-term interest rates. Equation (13) also provides evidence of short-run and overall causality from r_{ff} to r_{tb10} at 10% and 5% significant levels respectively, shown on the last two columns of this equation. No statistical evidence, however, is supported for short-run and overall causality from *bd* to r_{tb10}. These results imply that only monetary policy in the short-run affects long-term interest rates.

Equation (14) indicates that no evidence for long-run causality from *lnrni*, r_{tb10}, and r_{ff} to *bd* is supported. This is indicated by the coefficient of θ_{t-1}, which is statistically insignificant. This result suggests that fiscal policy is not reactive to changes in the real business cycle and the two interest rates. No short-run or overall causality is supported from r_{tb10} to *bd*, which indicates that fiscal policy is not reactive to changes in the long-term interest rates. Short-run causality is only supported at the 10% significance level from *lnrni* to *bd*. This implies that fiscal policy mildly and counter-cyclically responds to changes in *lnrni*, in the short-run. This result is in line with the belief of the vast majority of economists who are convinced that fiscal policy is not very efficient in stabilizing output. Fatas and Mihov (2003), for example, demonstrated that fiscal policy is a source of instability that may even lead to negative economic growth.

Long-run causality is strongly supported in equation (15), indicating that *lnrni*, r_{tb10}, and *bd* Granger cause r_{ff} at a 1% significance level. This result indicates that the Fed is reactive to changes in the three variables by changing r_{ff}. It can also be seen that strong statistical evidence exists for short-run and overall causality from *lnrni*, *bd*,[31] and r_{tb10} to r_{ff}. The results provide substantial statistical evidence that monetary authorities are very responsive to changes in any of the three variables *lnrni*, r_{tb10} and *bd*.

The findings from the estimated VECM indicate that monetary and fiscal policies are effective in influencing real national income. Monetary policy is much more reactive than fiscal

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[31] An expansionary fiscal policy triggers increases in r_{ff} to curtail raising prices. This is shown by the negative coefficient of the summation term *bd*.

policy in responding to changes in the other three variables. These results are plausible because decisions regarding shifts and implementation of monetary policy are quick.

Figure 2: Impulse Response Function and Variance Decomposition of lnrni
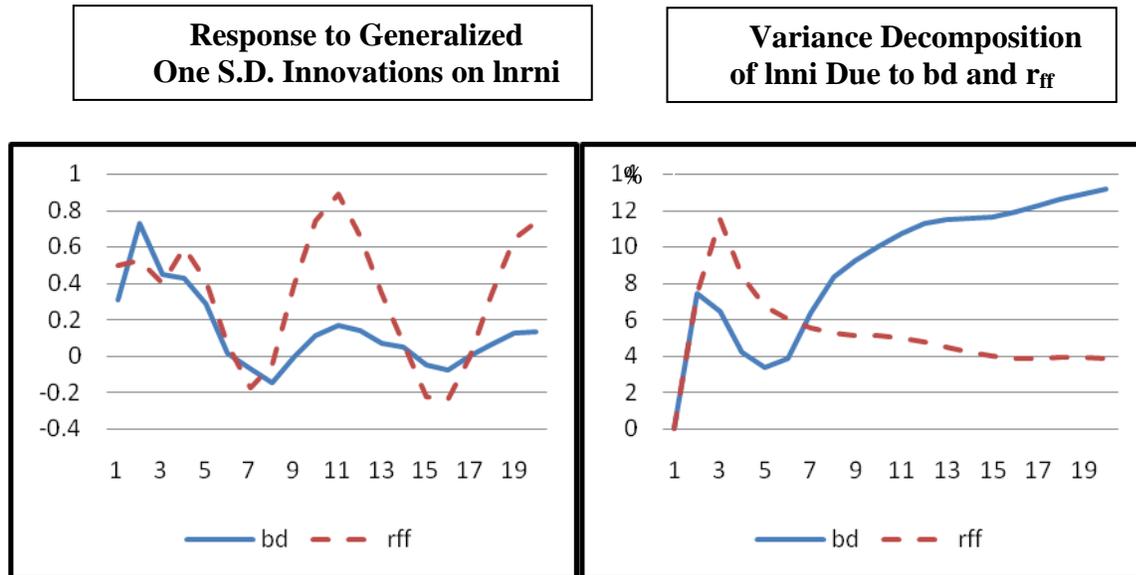
In contrast to monetary policy, adoption and implementation of fiscal policy programs is slow because fiscal policy works with time lags. It is thus plausible for fiscal policy to be responding to changes in nominal national income but to consistently be missing its purported target of stabilizing real national income.

To test for the possibility of structural breaks, model diagnostics were performed for this VECM. According to CUSUM and CUSUM of Squares tests, seven out of eight tests provide no evidence of a structural break at the 95% confidence level[32]. Thus, these test results provide evidence for parameter stability in the estimated VECM.

To study the long-run effects of the two policies on national income we also employed the methodology of impulse response functions and variance decomposition. According to the generalized response of one standard deviation in *bd*, we found that it permanently reduced *lnrni* after small oscillation during the first ten years. This result supports the view that fiscal

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[32] In the third equation, which employs *bd* as a left-hand-side variable, there was evidence of a minor structural break.

policy generates recessionary effects. Contrary to fiscal policy, monetary policy produces positive long-run effects on real national income, although it created more volatility in *lnrni* during the first 20 years. This finding is in agreement with the estimated VECM of Table 4 in equation (15). Looking at the variance decomposition, monetary policy is more influential in effecting real national income up to the first six years; thereafter, fiscal policy dominates having more lasting effects, as shown in Figure 2 below.

6. Conclusion

The study found that fiscal and monetary policies are jointly ineffective in influencing nominal national income. A possible explanation of this unexpected result is that the two policies may counterbalance each other, as it is possible for fiscal and monetary policies to be non-coordinated and even pursue conflicting objectives for certain sub-periods.

Strong statistical evidence, nonetheless, exists supporting the hypothesis that monetary and fiscal policies are jointly effective in influencing real national income. Similarly, statistical evidence is provided supporting a reactive monetary policy to changes in the real national income and to long-term interest rates. Fiscal policy, on the contrary, is found to be passive. Despite the fact that the Fed cannot observe changes in real national income on a contemporaneous basis, it still reacts correctly (counter cyclically) to changes in it. This may be the case as the Fed observes several other real variables such as the number of jobs lost, unemployment claims, and other leading economic indicators. The long-run effects of an expansionary fiscal policy on real national income are negative. This means that partial negative Ricardian Equivalence and some crowding out effects are present during the period of the study. Contrary to the Fed response, fiscal authorities were found to be passive to changes in real national income and to the long-term interest rate. The asymmetric responses of the two policies are attributed to the fiscal time lags which render fiscal policy inefficient in quickly responding to real business cycle fluctuations.

Employment of impulse response functions suggests that monetary policy generates mainly positive effects on both *lnni* and *lnrni*. Fiscal policy, however, creates contractionary

effects on *lnni* and *lnrni*. Such partial results are in agreement with the empirical findings of the two estimated VECMs.

The technique of variance decomposition, in contrast to the impulse response function, attributes greater contribution to fiscal policy in affecting both nominal and real national income than monetary policy. This means fiscal policy effects cannot be underestimated as they explain approximately 15% of changes in both nominal and real national income. The policy lesson of this study is that economists and policy makers must seek new ways to improve fiscal policy to make it more efficient whenever this is possible (see Leeper, 2010). Since the study covers the period 1955-2006, it will be interesting to extend this research to cover the most recent years after 2006 in order to examine the effects of the monetary-fiscal policy mix on nominal and real national incomes and the reaction of the two policies to the Subprime Mortgage Crisis.

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Table A1: Appendix, Unit Root Test Results[33]

Level	ADF						Phillips-Perron					
	constant			constant & trend			constant			constant & trend		
	t	p	lags	t	p	lags	t	p	lags	t	p	lags
r_{ff}	-2.85	.06	1	-2.8	.2	1	-2.9	.21	6	-2.05	.56	7
	-1.97	.3	2	-1.86	.66	2						
r_{tb10}	-1.62	.46	0	-1.28	.88	0	-1.72	.42	3	-1.31	.87	2
	-1.93	.32	3	-1.08	.92	4						
lnni	-.97	.75	1	-.53	.97	1	-.84	.79	5	-.74	.96	5
	-1.21	.66	0	.11	.99	0						
bd	-2.44	.14	0	-2.75	.22	0	-2.47	.13	2	-2.84	.19	2
	-2.85	.06	1	-3.04	.13	1						
td	-2.51	.12	0	-2.51	.32	0	-2.54	.11	3	-2.6	.28	2
	-2.97	.04	1	-2.88	.19	1						
lnrni	-.97	.75	2	-2.7	.21	1						
	-.65	.84	0	2.76	.21	1	-.711	.83	0	-2.38	.38	0

First Difference	constant			constant & trend			constant			constant & trend		
	t	p	lags	t	p		t	p	lags	t	p	lags
r_{ff}	-6.41	0	1	-6.42	0	1	-5.69	0	19	-6.01	0	22
	-6.41	0	1	-3.46	.05	7						
r_{tb10}	-6.01	0	0	-6.16	0	0	-5.96	0	2	-6.17	0	1
	-3.52	.01	3	-3.72	.03	3						
lnni	-2.42	.14	2	-4.7	.00	0	-4.82	.00	4	-4.86	.00	4
	-4.65	.00	0	-4.7	.00	0						
bd	-6.9	0	0	-6.87	0	0	-7.24	0	6	-7.18	0	6
	-6.12	0	1	-4.32	.00	5						
td	-6.75	0	0	-6.71	0	0	-7.15	0	7	-7.17	0	7
	-6.75	0	0	-4.41	.00	5						
lnrni	-5.6	0	1	-5.6	0	1	-5.8	0	6	-5.8	0	7
	-5.6	0	1	-5.6	0	1						

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[22] The Augmented Dickey-Fuller (ADF) tests and the Phillips Peron (PP) tests were performed on all the variables in their levels and first differences. The ADF test was performed twice, first with only a constant and second including a constant and a linear trend. To assure that the error term in the unit root test equation is a white noise, a number of lagged differences of each tested variable were included in the equation. A unit root test is based on the null hypothesis: $\beta_2 = 0$ versus the alternative $\beta_2 \neq 0$. The optimum number of lagged differences included in the ADF unit root test equation was determined according to both the Akaike Information Criterion (AIC) and also according to the Schwarz Information Criterion (SIC). As a result the ADF unit root test was performed twice, first based on the AIC and second based on the SIC. These results are presented in the first and second rows according to AIC and SIC criteria respectively for each variable in Table 1, in the Appendix.

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