Us Monetary And Fiscal Policy Effectiveness Empirical Evidence From A Quatrovariate Vec Model

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The study investigates the effectiveness of monetary and fiscal policies in the US. We employ the methodology of multivariate cointegration and the estimation of a quatrovariate vector error correction model (VECM) to perform Granger econometric causality tests. Two models were estimated one employing nominal national income, the ten- year government bond yield, and two policy variables; the deficit to nominal GDP ratio and the federal funds rate. The second estimated quatrovariate VECM includes the real national income and the same three variables used in the first model. Both models employed US time series data for the period 1955-2006. The results of the two models are very interesting. Monetary and fiscal policy are jointly ineffective in influencing nominal national income. Fiscal policy is much more reactive to changes in nominal national income and to changes in the two interest rates. Exactly opposite to the results of the first estimated VECM, according the second estimated VECM monetary and fiscal policies are jointly very 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 to changes in the two interest rates. These results can be of great interest to policy makers as they reveal information regarding the effectiveness of the monetary-fiscal policy mix on the economy and vice versa.

Introduction

Economists are interested in knowing how monetary and fiscal policies influence economic activity. For this purpose they construct economic models analyzing such relations. Most economic models, however, focus in one of the two policies assuming the other remains passive or neutral. This approach is nonetheless, incomplete because in the real world both policies are assigned an active stance, as countries pursue either an expansionary (easy), or a contractionary (tight) fiscal and monetary policies. Such rationale leads one to

believe that the separate effects on economic activity attributed to each of the two policies may not be easily distinguished. Since the effects of the two policies are not transparent this also implies that the appropriate conduct of each policy is difficult. The latter is particularly important if one takes into consideration the fact that the two policies in most developed economies are formed and implemented by independent authorities. Fiscal and monetary policies have been combined during some periods in the US and in other countries to achieve certain macroeconomic goals. The combination of the two policies is referred to in the economic literature as the monetary-fiscal policy mix or the policy-mix. A few episodes of a policy mix from the recent US history are discussed below.

Episodes of US Monetary Fiscal Policy Mix

President Reagan's government adopted an expansionary fiscal policy during the first half of the 1980s when it reduced personal taxes in 1981 and requested several times from Congress to increase the national debt limit. The Federal Reserve (Fed) on the contrary during the same period applied a contractionary monetary policy raising interest rates to prevent inflation. High interest rates attracted foreign capital inflows to the US causing a dollar appreciation and simultaneously large current account deficits. This episode became known as the US twin deficits story since many economists considered the two deficits interdependent. A few economists criticized such policy mix as it forced the US to become a more indebted nation and overburdened future generations.

An opposite episode to the US twin deficit in the recent US history is the Clinton-Greenspan policy mix. During the 1990's President Clinton, a democrat, with the cooperation of a republican congress was successful in reducing large and chronic government budget deficits. As a result of these policies the US was able to generate a federal budget surplus for the years1998-2001. This favorable fiscal outcome was only achieved with an accommodating expansionary monetary policy applied by the Fed and its then chairman Alan Greenspan. Such a policy mix was responsible for the longest business cycle expansion in the US history during the 1991-2001 decade which brought unemployment down remarkably, to four percent and inflation close to two percent.

Another episode of policy-mix in the recent US history was the response of the Fed and, the US President and Congress, to three negative shocks during the turn of the 20th century. Economists identified three distinct events that were thought to be the causes of the subsequent recession. The first cause was the abrupt decline in the information technology investment and in sales of both hardware and software. The second cause was the corporate scandals that struck the US during this period. Lastly the third cause was the September 11, 2001 terrorist attacks on the US. These three events contributed to the formation of a pessimistic environment and negative expectations regarding the future of

the US. The Fed responded by drastically decreasing the federal funds rate (r_{ff}) driving it down to one percent to a 42 year record low on June 25, 2003 from 6.5 percent where it stood in May 16, 2000. Only in the year 2001 the Fed reduced r_{ff} eleven times, eight times at increments of one half of one percent or (50 basis points) at a time and three times by a quarter of one percent (25 basis points). Such an aggressive expansionary monetary policy was accompanied by an expansionary fiscal policy. The US government reduced personal tax rates thrice, in 2001, 2002 and 2003, and increased government spending to cope with the expected recession and to finance the two wars that the US was fighting simultaneously in Afghanistan and Iraq.

During the 2001-2003 period, expansionary monetary policy was effective in many ways, for example it boosted consumption as automakers were able to increase sales to record highs, by offering zero percent interest rates to finance purchases of new automobiles. Expansionary monetary policy also reduced long-term interest rates inducing families to purchase homes, refinance existing homes or borrow on existing mortgages and spend on a variety of expenditures. Monetary policy, however, during this period did not work through any other channels other than consumption. For example although the US dollar depreciated in the period 2002-04, this did not have a positive impact in the US trade balance. Similarly business investment failed to respond to historically low interest rates.

If prices of homes are broadly defined as equity then according to Tobin's q theory, increases in price of homes in relation to replacement cost raises Tobin's q. An increase in q induces increases in new home investment thus boosting the economy's output. Franco Modiglianni proposed that households smooth out their consumption over time. During the 2002-2003 periods expansionary monetary policy was successful in reducing interest rates and simultaneously increasing stock prices as the two are inversely related. Increased stock prices created a wealth effect that raised consumption and led the US out of the recession. The two theories described, explain well the working of the monetary-fiscal policy mix during the 2001-2003 periods.

The Study

The purpose of this paper is to investigate the effectiveness of US monetary and fiscal policies in influencing economic activity. The study also examines whether the Fed and the US fiscal authorities i.e., the President and the Congress correctly respond to changes in US economic activity. The project is an empirical investigation based on multivariate cointegration and the estimation of a quatrovariate Vector Error Correction Model (VECM). The estimated VECM is employed to investigate Granger econometric Causality. Four macroeconomic variables: a proxy for economic activity measuring the performance of the economy, a long-term interest rate, the US government deficit and a short-term interest rate are employed in the (VECM).

The short-term interest rate used in the study is the federal funds interbank overnight target rate (r_{ff}). The Fed sets the $r_{ff,}$ which for many years has emerged as the most important monetary instrument employed by the Fed to conduct monetary policy[1]. The federal funds rate (r_{ff}) is the interest rate that the Federal Reserve member commercial banks charge each other when they borrow overnight reserves to meet the Fed reserve requirement. The r_{ff} therefore is the price of the borrowed reserves. The government deficit employed in the study is the fiscal policy variable used by the US Congress and the President to conduct fiscal policy aiming to achieve certain macroeconomic objectives. A long-term interest rate is also included in the VECM. The vast majority of economists are convinced that monetary policy is mainly transmitted to the economy through its initial impact on interest rates. Fiscal policy also affects interest rates since changes in government bonds to finance or reduce deficits affect interest rates. Interest rates are determined in the bond market. For these reasons, economists consider long-term interest rates to be the most important interest rates in the economy. Long-term interest rates influence the cost of new capital formation and the cost of government financing for infrastructure. New residential construction is also affected by long-term interest rates since the decision to purchase a home depends mainly on the mortgage rate which is mostly a long-term interest rate. Long term interest rates as a result, are considered central in the transmission of monetary and fiscal policies.

The term structure of interest rates theory explains how short-term and long-term interest rates are related and how this relation affects output. A vast body of literature already exists in this area. Furthermore, interest rates affect capital flows. High domestic interest rates in relation to foreign interest rates, assuming everything else is constant, attract financial capital flow and encourage domestic saving. Low interest rates, in contrast, induce capital outflow and reduce the saving rate. An interesting and crucial question is often raised, regarding the effects of expansionary monetary policy on interest rates output and national income? Economists agree that the initial impact of an expansionary monetary policy is a reduction of the short-term interest rates. Low interest rates are expected to have a positive short-run effect on the economy because they tend to increase consumption and investment, consequently aggregate demand and national income. Low interest rates discourage domestic saving and capital inflows to the country from abroad. As a result the economy can be adversely affected since funding for financing private and public spending is reduced. A reduction in financial capital inflow can be detrimental to capital formation, to labor productivity, and to economic growth. National income increases, however, are frequently accompanied by higher prices. Central banks that are not accountable, when applying expansionary monetary policy in their effort to increase output in the short-run can fall victims to the “time-consistency trap”. The latter implies that an overly expansionary monetary policy for the purpose of

[1] Exception constitute the three year period of October 1979 to October 1982 when the Fed tried to control unborrowed reserves in its sincere effort to reduce inflation. During this period the Fed allowed a wider fluctuation band for r_{ff} and practically stopped to carefully monitoring r_{ff} during this three year period.

boosting economic activity in the short- run can be the cause of deep rooted inflationary pressures in the economy. Every countercyclical monetary policy stance by changing the federal funds rate in order to affect output inadvertently also affects prices and long term interest rates. As a result, monetary policy is mainly responsible for the subsequent and opposite phase of the business cycle.

Time series data plots of various interest rates indicate that all nominal interest rates move together. This implies that when the Fed sets r_{ff}, all other interest rates follow a similar pattern. The most relevant interest rate for businesses, consumers, and to large extent governmental decisions for borrowing purposes is the real interest rate. The latter, however, is not an observable variable.[2] Loan contracts of a specific amount for a given time period assure the lender repayment of the principal plus the earned interest at the end of the contract period. Because the prevailing end of the period inflation rate is unknown a priori, this entails that knowledge of the exact ex ante real interest rate is not possible. When a few central banks starting in 1989 began announcing an inflation target rate, it is highly likely that they had multiple objectives to achieve with this new monetary policy. Other than stabilization of prices and nominal interest rates it is likely that these central banks aim was also the stabilization of real interest rates.

Literature Review

The importance and usefulness of monetary and fiscal policies in promoting secular economic stability was demonstrated by Warren L Smith (1957). Smith using a relatively simple growth model demonstrated that appropriate coordination of monetary and fiscal policies can assure secular growth in the economy without inflation. According to David C. Smith (1960) early Keynesian macro models do not provide support to opposing views on how monetary and fiscal policies affect the economy. Smith using an open economy macroeconomic model found that a correct monetary-fiscal policy mix can stabilize national income and employment consistent with various rates of economic growth. Smith demonstrated that appropriate fiscal and monetary policies can have a positive effect on a small open economy which is dependent on a large foreign country experiencing stagnation.

In his 1962 classic article Robert Mundell concluded that under a fixed exchange rate regime monetary policy should be assigned to correct the external objective (balance of payments) and fiscal policy should be assigned to internal objectives (output and price level). Attiat & Attiat (1967), who investigated Mundell's findings in a similar open economy macro model, found that the assignment of policies problem depends also on the initial values of the monetary and fiscal policy instruments i.e., the interest rates, the tax rates, and government purchases. Shaw (1967) pointed out that any fiscal policy that affects interest rates and

[2] According to Fisher's equation the real interest rate is equal to the nominal interest rate minus the expected rate of inflation.

determines the rate of growth of the economy must also take into consideration the balance of payments constraint. Under a fixed exchange rate system Shaw claims countries will find it necessary to raise interest rates to maintain a desired level of foreign reserves. High interest rates, however, will reduce economic growth. As a result Shaw (1967) suggested that for a monetary-fiscal policy mix to be effective it must be accompanied by policy measures aiming to a permanent overall structural improvement in the balance of payments.

Under a flexible exchange rate system and free capital mobility Robert Mundell (1963) found that fiscal policy is not very effective in increasing output and employment, this is unlike monetary policy which is very effective. Contrary to the above results under fixed exchange rate regime fiscal policy is effective but monetary policy is ineffective, unless complete sterilization insulates the country from capital flows. The above results can be reversed if the assumption of capital mobility is relaxed as Johnson (1966) has shown. Takayama (1969) by introducing additional assumptions to the Hicksian-IS-LM model obtained results different than those of Mundell and Johnson. Hellwell (1969) summarized results regarding the appropriate use and assignment of the two policies under the fixed and flexible exchange rate regimes to domestic and external objectives. Hellwell's analysis is based on five simple open economy macro models that took into consideration various assumptions. The two exchange rate regimes, Hellwell pointed out are not necessarily different if under fixed exchange rate regime policy makers do not allow substantial fluctuation of reserves and if under flexible exchange rate regimes do not permit large movement of exchange rates. The final effects of fiscal and monetary policies depend on many factors including the openness of the economy and the reaction of the central bank to changes in domestic money supply as a result of capital flows and trade imbalances.

Data

For the study 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 annual concepts. Furthermore annual data are not affected by short run transitory and seasonal shocks thus placing more emphasis on the fundamentals. The data set includes four time series variables: 1) A proxy for economic activity 2) a long-term interest rate 3) a short-term interest rate monetary policy variable set by the Fed and 4) the federal government budget deficit (surplus), a fiscal policy variable determined by the President and the US Congress. Six different proxies for economic activity were initially employed, two nominal and four real. The two nominal variables employed are, the natural logarithms of national income (lnni), and of disposable personal income (lndpi). The other four variables are real proxies of output, these are the natural logarithms of real national income (lrni), the real personal income (lnrpi), the real disposable personal income (lnrdpi) and the index of industrial

production (ip)[3]. Inclusion of such variables offers alternatives regarding the breadth in the measurement of real economic activity, and of nominal national income. Therefore they provide a test for the sensitivity of the empirical results, to changes in the proxy measure of economic activity.

For the long-term interest rate, the US Treasury ten-year government bond yield, r_{tb10}, was utilized. As for the short-term interest rate we employed the overnight, federal funds rate targeted by the Fed for the conduct of monetary policy. Two measures of the government deficit were utilized, these are, the federal budget deficit (surplus) to GDP ratio (bd) and the total deficit to GDP ratio. The latter besides the federal budget deficit (surplus) includes the off budget items, thus providing a more accurate response of the federal government to business cycles.[4] The federal funds rate and the ten-year bond yield were obtained from the Federal Reserve Board of Governors. The nominal and real disposable personal income (lndpi and lnrdpi), and the index of industrial production (ip) are from the International Financial Statistics (IFS) CD Rom electronic database published by the International Monetary Fund (IMF). The natural logarithms of national income (lnni), of real national income (lnrni) and real disposable personal income (lnrdpi) were obtained from the Bureau of Economic Analysis of the US Department of Commerce. The two deficits to GDP ratios, (bd) and (td), are from the Economic Report to the President.

Stability Properties Of The Time Series Variables

Investigating cointegration among a set of time series variables requires that these variables are integrated of the same order. For economic variables this almost always implies that the variables are non-stationary in levels, but stationary in their first differences, i.e., all the variables are integrated of order I(1). If this condition is met, a cointegration test can be performed for these variables. Cointegrated variables depict a long-run stable linear equilibrium relation. If cointegration is statistically supported a VECM can be estimated for these variables. Three different Granger Causality tests are performed within the framework of the estimated VECM, to reveal the direction of causality among the variables.[5]

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[3] A few other proxies for economic activity were initially used in the study, these are, the nominal gross domestic product, the real gross domestic product, personal income, and the natural logarithm of these three macroeconomic variables. The national income, the real personal income, and the disposable personal income were also initially employed but all of these variables did not meet the required time series properties, for cointegration and estimation of the VECM.

[4] The study initially employed the federal budget, and total deficits expressed in absolute nominal dollars. None of these measures were finally included in the study, because the variables either did not have the required stability properties or they were not cointegrated with the other variables of the model.

[5] The Augmented Dickey-Fuller (ADF) tests and the Phillips Peron (PP) tests were performed on all the variables both in their levels and first differences. The ADF test was performed twice, first with only a constant and second including both 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.

The unit root equation for a variable Y is shown below.

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

Where β_o, β_1, β_2 and Ψ_1, $\Psi_{2.....}\Psi_k$ are parameters to be estimated, and ε_t is the error of the regression assumed to be stationary with zero mean and constant variance[6].

Table 1
Unit Root Tests
Levels

	ADF						Phillips-Perron					
Level	constant			constant & trend			constant			constant & trend		
	t lags	p lags		*t* lags	p lags		*t* lags	p lllllllllags	lags	*t* lags	p lagslalagslags	
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						
ip	.97	1	0	-1.67	.75	0	1.41	1	6	-1.71	.73	2
	.97	1	0	-1.67	.75	0						
ln*dpi*	-1.12	.7	1	-.24	1	1	-1.04	.73	3	-.73	.96	4
	-1.12	.7	1	-.24	1	1						
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						
rni	2.75	1.0	2	2.84	1.0	9	4.56	1.0	6	-.12	-.99	5
	3.78	1.0	0	-2.0	.99	0						
lnrni	-.97	.75	2	-2.7	.21	1						
	-.65	.84	0	2.76	.21	1	-.711	.83	0	-2.38	.38	0
ln*rdpi*	-2.00	.28	0	-1.05	.92	0	-1.93	.31	1	-1.12	.91	1
	-2.00	.28	0	-1.05	.92	0						

[6] 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 row and second row according to AIC and SIC criteria for each variable respectively in Table 1.

First Differences

	ADF						Phillips-Perron					
First Difference	constant *t* lags	lags	p	constant & trend *t* lags	lags	p	constant *t* lags	lags	p	constant & trend *t* lags	lags	p
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						
ip	-6.62	0	0	-6.78	0	0	-6.6	0	4	-6.9	0	6
	-6.62	0	0	-6.78	0	0						
ln*dpi*	-8.5	0	0	-8.67	0	0	-8.44	0	4	-8.5	0	4
	-8.5	0	0	-8.67	0	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						
rni	-4.2	0	0	-5	0	1	-4.1	0	3	-4.9	0	9
	-4.2	0	0	-5.2	0	0						
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						
ln*rdpi*	-5.84	0	0	-6.12	0	0	-5.90	0	2	-6.12	0	0
	-5.84	0	0	-6.12	0	0						

In Table 1 the unit root results of all the time series variables are reported. According to these results when the ADF test was performed on the levels of the variables with a constant and a trend all the variables were found to be nonstationary. Using the Phillips Perron (PP) test whether this was carried out with a constant only or with a constant and a trend all variables were found to be nonstationary. All these tests produced a p-value above .1 as this is a necessary condition for the null hypothesis of nonstationarity in order not to be rejected at any plausible value of the probability type I error. There was, however, an exception when the unit root test was preformed with only a constant for r_{ff}, bd, and td in these cases the test produced inconclusive results. This is shown by the relatively low p-values of .06, .06, and .04 respectively. Since these values fall between 0 and .1, the decision whether these variables are stationary depends on the value α, the type I error, selected by the researcher. Unit root results on the first differences indicate that most variables are stationary, as this is a requirement of all variables tested for cointegration. An exception, however,

were the two interest rates r_{ff} , $r_{tb10,}$and the lnni that produced p-values that were not zero according to one of the six tests performed. The p-values for r_{ff}, $r_{tb10,}$ and lnni were .03 .05 and .14 respectively. Since the vast majority of the unit root tests support the hypothesis that the variables are non-stationary in levels but stationary in first differences we proceed with the cointegration tests and the estimation of the VECM.

Vector Error Correction Model (VECM)

Equation (2)-(5) below represent a quatrovariate model on the four endogenous variables X, Y, Z and W. The variable X represents various proxies of nominal GDP and proxy measures of economic activity. The variable Y refers to the ten year US treasury government bond yield r_{tb10}, the most frequently used long-term interest rate. The last two variables Z and W represent the two policy variables; Z is the fiscal policy variable measured either with the budget deficit (bd) or with the total deficit (td) to GDP ratios respectively. Similarly the monetary policy variable W is the federal funds rate (r_{ff}).

A Quatrovariate VECM

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

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

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

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

The left-hand side variables of the VECM are expressed in terms of first differences. The right-hand sides of each equation include an optimum number of lagged differences for each of the four variables. The lagged differences are expressed in the form of summation for the purpose of facilitating the presentation of the model in a more compact form. The estimated model includes as many terms of lagged differences as the researcher specifies in the estimation process. In addition to the lagged differences each equation includes as a right-hand side variable the one-period lagged error term of the cointegrating equation θ_{t-1} [7]. Furthermore each equation includes a constant represented by α_1, β_2, γ_3,

[7] The error term θ_t is constructed as a time series variable based on the cointegrating equation and the historical data of the four variables.

and δ_4 , in each of the four equations respectively and a time trend variable denoted by t. Where α_t, β_t, γ_t, and δ_t are the coefficients of the time trend variable in each equation respectively. It is possible, however for a VECM not to include a time trend variable or a constant. Each equation also includes a random error term assumed to be a white noise i.e., having a mean of zero and a constant variance. In equation (2) this is denoted by ε_{1t}.

Granger Causality Tests

Three causality tests are performed in every one of the four equations of the quatrovariate VECM. A test for long-run causality is carried out by testing the null hypothesis that the coefficient of the lagged error term is zero. This test examines whether the three right-hand side variables in each equation are characterized by a long-run linear relation with the left hand side variable. In equation (2) this test is performed by testing the null hypotheses $\alpha_x=0$, versus the alternative $\alpha_x \neq 0$. Short run causality tests are also performed. Four such tests are performed in each equation. Three of these tests are performed by setting the coefficients of the lagged differences of each of the right-hand side variables equal to zero. For example in equation (2) a test for short-run noncausality from Y to X is carried out by testing whether the coefficients of the lagged difference of the Y variables are equal to zero, i.e., $\beta_{11} = \beta_{12} = \ldots..=\beta_{1s1} = 0$. This is a Wald F test for short run causality from Y to X since the lagged coefficients of Y capture the short-run dynamics of the system. A similar test for short run causality is performed for Z and W by setting their respective coefficients of the lagged difference of each variable equal to zero. A test for short run causality is also performed to examine whether the lagged differences of each left-hand side variable cause the present value of that variable. In equation (2) for example this is carried out by testing the null hypothesis $\alpha_{11} = \alpha_{12} = \ldots\ldots\alpha_{1r1} =0$. 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 the one period lagged error term equal to zero. The null hypothesis for overall causality from Y to X 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.

An Estimated Quatrovariate US VECM Based on Nominal National Income

(6) $\ln rni = 5.307445+1.271532\ r_{tb10} + 1.419449\ td - 0.185706 r_{ff}$
(model 2, 6 lags)

(7) (8) (9) (10) Equation (6) above is the cointegration equation for the natural logarithm 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}). The cointegration equation indicates that the natural log of nominal national income is positively related to long term interest rate and negatively to the federal funds rate. Such a relation seems plausible because the Fed conducts monetary policy by reducing r_{ff} in order to induce increases in consumption and investment and thus raises national income. Similarly the Fed increases r_{ff} to discourage spending in an

Dependent Variable	θ_{t-1}	$\Sigma\ \Delta$lnni	F_1	$\Sigma\ \Delta r_{tb10t-i}$	F_2	$\Sigma\ \Delta$td	F_3	$\Sigma\ \Delta r_{fft-i}$	F_4
Δlnni	0.005 (1.14)	1.18 10.67***	67.14***	8.90 .56	.55	22.62 .3	.46	25.55 .87	.94
Δr_{tb10}	0.25 (1.19)	0.028 .63	.54	0.12 .59	.76	1.22 .25	.51	4.69 1.54	1.7
Δtd	0.68 (4.59)***	0.006 6.6***	6.25***	0.006 1.8	5.87***	1.82 4.7***	4.9***	2.14 1.83	5.27***
Δr_{ff}	0.75 (1.86)*	-0.01 1.11	.98	0.51 .78	.84	0.61 .69	.71	-1.48 .67	1.25

overheating economy and thus reduce national income in its effort to prevent inflation. Cointegrating equation (6) also shows that the total deficit to GDP ratio (td) is positively related to lnni[8]. This relation indicates that expansionary fiscal policy is associated with reduced national income thus large governmental sectors reduce nominal national income. One explanation suggested for this relation is that large government deficits tend to increase interest rates thus crowding out private investment. A second explanation for this relation is that fiscal policy works with lags, therefore current deficits increase future national income and present surpluses reduce future national income. Cointegrating equations (6) also indicates that nominal national income and long-term interest rate r_{tb10} are positively related. This relation is empirically supported by historical time series data of business cycles activity and interest rates. During expansion periods most often, economies experience increases in nominal interest rates. One explanation for this relationship is that investors in government and other debt instruments request a higher interest rate in order to be compensated for holding securities of which the real value is expected to decline because of expected inflation. Thus an inflation premium is incorporated to the interest rates of these securities.

[8] td is defined as total government expenditures minus total revenues and is negative for almost all of the observations (years).

Another explanation offered for the positive relation between national income and nominal long-term interest rates arises from the fact that during expansionary periods the supply of bonds increases as governments and businesses seek funding to finance various projects. The increase in the supply of bonds usually leads to higher interest rates unless demand for bonds increases proportionally or is perfectly elastic with respect to interest rate. The latter implies that bond buyers are always ready to buy all bonds offered at the market long-term interest rate. This is a rather rare phenomenon; a few economists, however, recently have pointed out the possibility of a global saving glut. If a global saving glut is a reality then long-term interest rates will be and remain low for long periods of time. In this case potential bond investors will not request higher interest rates in order to supply additional amounts of financial capital.

Equations 7-10 constitute the estimated VECM. According to equation 7, the three variables $r_{ff,}$ $r_{tb10,}$ and td together are positively related to lnni. This relation is revealed by the coefficient of the one period lagged error term which is positive. Based on equation (7) monetary and fiscal policies are not jointly effective in influencing nominal national income, despite the indicated positive relation. This result is supported by the lack of evidence of long-run Granger causality from the three variables $r_{ff,}$ $r_{tb10,}$ and td to lnni, because the coefficient of θ_{t-1} is statistically insignificant. Similarly there exists lack of evidence for short run and overall causality from each of the three variables to lnni, as is shown by the low F values below the summation terms of the three variables and by the low F test statistic values under the columns F_2 , F_3 , and F_4. The latter three tests are Granger Causality test for overall causality.

Equation (8) indicates that there exists lack of evidence for long-run Granger causality from lnni, r_{ff} , and td to $r_{tb10.}$ Similarly there exists no evidence of short-run or overall Granger causality from each of the three variables when their effects on r_{tb10} are considered separately. Such a result indicates that fiscal and monetary policies do not independently or jointly affect nominal interest rates. An explanation for these results is that the two policies may have counter balancing effects on the interest rate thus making the relations statistically insignificant.

Equation (9) provides strong statistical evidence for long run causality from lnni, $r_{tb10,}$ and r_{ff} to td. This result is interpreted that fiscal authorities are reactive to changes in nominal national income and changes in the short and long-term interest rates. The relation is statistically supported at 1% significance level. This result indicates that the fiscal authorities react to changes in national income counter-cyclically as they are expected to do. The latter can be seen by observing cointegrating equation (6). If lnni increases, ceteris paribus, then θ_{t-1} will become positive and from equation (9) it can be inferred that a positive θ_{t-1} multiplied by its positive coefficient (.68) will lead to an increase the government surplus or reduction in the deficit. Equation (9) also indicates that there exist statistical evidence for short and overall causality from every one of the three variables, lnni, r_{tb10} and r_{ff} to td at one percent level of significance.

From equation (10) it is seen that there exist statistical evidence at ten percent level of significance for long-run causality from lnni, r_{tb10} and td to r_{ff}. This finding is interpreted that the Fed reacts to changes in national income and the long term interest rate r_{tb10}. There is no evidence, however for short run and overall causality from lnni, r_{tb10} and td to r_{ff}. Such a result suggests that the Fed does not react to any short-run separate changes in any one of the three variables. The Fed, however, responds to changes in the overall performance of the economy by observing income in conjunction with both short and long-run interest rates. We conclude that fiscal and monetary policies respond to changes in economic conditions as those are revealed by changes in the national income and the two interest rates. Fiscal policy reacts much more strongly than monetary policy does. Monetary and fiscal policy, however, are not jointly effective in causing nominal national income as this is depicted by lack of evidence for long-run Granger Causality shown in equation (7). It is very likely that lack of the long-run

Dependent Variable	trend	c	θ_{t-1}	$\Sigma \Delta$lnrni	F_1	$\Sigma \Delta r_{tb10t-i}$	F_2	$\Sigma \Delta$bd	F_3	$\Sigma \Delta r_{fft-i}$	F_4
Δlnrni	-.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) **
Δr_{tb10}	-.009 (-.65)	2.41* (1.98)	16.3 (2.07)**	-65 (1.84)	1.57	-66 (2.58)*	2.29*	-1.7 (1.16)	1.12	5.9 (2.46)*	3.5**
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*
Δr_{ff}	.01 (.71)	4.29 (1.99)	54*** (3.89)***	-148 (1.79)	3.61**	-16 (3.47)**	3.2**	-5.4 (3.43)**	3.65**	16.2 (4.91)***	4.1***

causality may be due to the counter reaction of the two policies as it is often observed that the two policies are employed in pursuit of different or even conflicting objectives. Consequently our results support that the two policies do not affect long-term interest rates and nominal national income. Fiscal policy is, by far, much more reactive than monetary policy to changes in economic activity as this is measured by national income and the two interest rates.

An Estimated Quatrovariate VECM Based on Real National Income

(11) lnrni = 7.706834+.033236*trend-.139390*rtb10-.035089*bd+.119452*rff
(Model 5, lags 5)

(12) (13) (14) (15) Equation (11) above is the cointegrating equation of the variables lnrni, $r_{tb10,}$ bd and r_{ff} for our second estimated US VECM. According to this equation real national income increases at an annual rate of growth of 3.32[9]. The real national income based on the cointegrating equation is inversely related to ten-year government bond yield. Such a relation denotes that decreases in long term interest rates are associated with increases in real output and vice versa. This relation is theoretically expected because a decline in interest rates induces increases in investment and consumption in durable goods and new homes.

[9] This is the interpretation of the coefficient of the time trend of any semilogarithmic equation such as (11).

This result is exactly opposite to the relation between nominal national income and the ten-year government bond yield obtained in the first VECM which was positive. According to equation (11) real national income (lnrni) is inversely related to government budget deficit (bd). This relation suggests that an expansionary fiscal policy is effective in raising real national income and a contractionary fiscal policy reduces real national income. Such a result is exactly opposite with the one between nominal national income (lnni) and total deficit (td) discussed in the previous model. Because nominal and real national income do not move together i.e., they are not synchronized it is highly likely for deficits to be associated with expansions of the real business cycle and surpluses with real business contractions. This explanation is not obvious as it is unlikely for fiscal authorities to promptly respond to real business cycles. It can happen however if households smooth out their life time consumption and consumers and businesses act upon expected governmental fiscal actions. Such behavior of firms and consumers is behind the negative relation between lnrni and td.

Cointegration equation (11) also indicates that the federal funds rate is positively related to real national income. This relation is plausible because the Fed does not employ r_{ff} to affect real national income, as the latter is not an observable variable in the very short-run when monetary policy is conducted. According to cointegrating equation (11) there exists a positive long-run linear relation between lnrni and r_{ff}. This means that countercyclical expansionary monetary policy initiated with a reduction in r_{ff} to fight reduction in nominal national income will be followed by a rising r_{ff} when the real national income also increases. This scenario gives rise to a positive long-run relation between lnrni and $r_{ff.}$ This relation is exactly opposite than the one presented in the first model of equations 6-10.

Equation (12) of the VECM model indicates that monetary and fiscal policy are jointly effective in influencing real national income. This is shown by the positive coefficients, of 2.06, at five percent level of significance, of the one period lagged error term θ_{t-1}in this equation. The statistical significance of the coefficient of the one period lagged error term denotes that there is evidence for long-run causality from the three right hand side variable r_{ff}, r_{tb10}, and bd to lnrni. This empirical result is interpreted that monetary and fiscal policy jointly are effective in increasing real national income. Evidence also exists for short-run and overall causality from r_{ff} to lnrni at the five percent level of significance as this can be seen by the two significant coefficients shown in the last two columns of equation (12).

Lastly, there exists weaker evidence for short run and overall causality from bd to lnrni as shown by the coefficient under $\sum\Delta$bd column and under F_3 which is supported only at ten percent level of significance. Equation (13) indicates that there exists evidence of long run causality from lnrni, bd and r_{ff} to r_{tb10} at ten percent level of significance as this is indicated by the coefficient of θ_{t-1} in this equation. Equation (13) provides evidence of short-run and overall causality

from r_{ff} to r_{tb10} at ten and five percent levels of significance respectively shown on the last two columns of this equation. There is no statistical evidence, however, for short and overall causality from bd to r_{tb10}. These results imply that only monetary policy is independently influential in affecting long-term interest rates.

Equation (14) indicates that there is no evidence for long-run causality from lnrni, r_{tb10}, and r_{ff} to bd. This is indicated by the coefficient of the error term θ_{t-1} which is statistically insignificant, but positive, implying that if fiscal authorities were to react they would have reacted countercyclically to changes in lnrni. For example if lnrni increases, θ_{t-1} will become positive and when multiplied by a positive coefficient 12.02 will result to an increase in the budget surplus or a reduction in the budget deficit. This result although plausible is not relevant since it is not statistically supported. It can be seen from equation (14) there exists evidence of short-run and overall causality from r_{ff} to bd at a ten percent level of significance. There exists also evidence for overall causality from lnrni to bd but supported only at ten percent level of significance. These findings show that fiscal policy is not very reactive to changes in real business conditions and to the long-term interest rates. It is nonetheless more reactive to change in the $r_{ff.}$. Long -run causality is strongly supported by equation (15) as lnrni, r_{tb10}, and bd Granger cause r_{ff} at one percent level of significance. This result indicates that the Fed is reactive to changes in the three variables by changing r_{ff}. It can be seen from the same equation that there exist strong statistical evidence for short-run and overall causality from lnrni, bd, and r_{tb10} to r_{ff}. This indicates that monetary policy is very reactive by changing the federal funds rate as a response to changes in the other three variables lnrni, r_{tb10} and bd.

Conclusion

Summarizing the results of the second estimated VECM we conclude that there exists strong statistical evidence that monetary and fiscal policies are jointly effective in influencing real national income. Strong statistical evidence was also found that monetary policy is reactive to changes in real national income but fiscal policy is not. These results strongly contrast with the result of the first model according to which fiscal and monetary policies are jointly ineffective in influencing nominal national income and only fiscal policy was found to be reactive to change in nominal national income.

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