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Fiscal and Monetary Policies Interrelation and Inflation over the Long Run: Testing Sargent and Wallace's View for the United States

By LOWELL M. GLENN and ABDUS SAMAD*

This paper focuses on long-run estimation of the price equation in the United States for the period of 1973Q1-2011Q3. It was found the Sargent and Wallace view that an easy monetary policy today will result in a lower price level over the long run when debt and deficit exist is true for the United Sates. Furthermore, it was found that, over the long run, a higher real exchange rate, government expenditures, deficit per GDP as well as debt per GDP lead to a higher price level. Finally, it was found neither monetary policy dominates the fiscal policy nor the opposite is true.

Keywords: Sargent and Wallace, Interest Rate, Debt and Deficits

JEL Classifications: E31, E41 E52, E62

I. Introduction

Fiscal and monetary policies are interrelated and must be coordinated. The coordination can be imagined when the monetary authority is powerful enough to determine current and indefinite future rates of seigniorage from money creation. In this setting the monetary authority disciplines the fiscal authority by assigning how much seigniorage can be expected now and in the future. Then monetary policy can permanently affect inflation rate. Alternatively, if the monetary authority is not in a position to influence the government's deficits path but is limited simply to managing the debt that is generated by the deficit path then the fiscal authorities constrain monetary authority. Under this coordination scheme a tight current monetary policy to fight inflation leads to higher future inflation, Sargent and Wallace (1986).

If the real rate of interest on government securities exceeds the economy's growth rate then rolling over a fixed amount interest-bearing debt requires raising revenue from other sources to pay the interest on the debt. "In particular, the government must either levy taxes or reduce purchases or print currency to pay the interest." Sargent and Wallace (1986, P. 159).

The question Sargent and Wallace (1986, P. 158) raises is that "Is it possible for monetary policy permanently to influence an economy's inflation rate? The answer to this question hinges on how monetary and fiscal policies are imagined to be coordinated." A monetary authority can dominate the fiscal authority if it can impose slower rates of growth on high-powered money, both now and into the indefinite future, so that the fiscal authority knows that how much seigniorage it can expect now and in the future. Under this coordination scheme the monetary authority can permanently influence the inflation rate. Alternatively, under a fiscal dominate

*Glenn: Finance and Economics Department, Utah Valley University, 800 West University Parkway, Orem, UT 84058-5999. (E-mail: lowell.glenn@uvu.edu). Phone: (801) 863-8385, Fax: (801) 863-7218; Samad: Associate Professor of Finance and Ecomonics, Utah Valley University, 800 West University Parkway, Orem, UT 84058-5999. (E-mail: abdus.samad@uvu.edu). Phone: (801) 863-8368.

environment when the monetary authority cannot influence the government's deficit path, but is limited to managing the debt created by the deficit path chosen by the fiscal authorities, the monetary authority is not able to influence the inflation rate permanently. Under this scheme the monetary authority may not even influence inflation rate in the short run.

The objective of this paper is two fold: (i) to investigate how the fiscal and monetary policies have been coordinated in the United States. Specifically, the question is which authority imposes discipline on whom and (ii) to test a price equation level, which takes into account, for a given monetary base, whether a lower/higher interest rate leads to a lower/higher price level over the long run when debt and deficits exist. Specifically, in this paper we investigate that if the current quantitative ease which the Fed is adopting will lead to future inflation when the U.S. debt is at a record high. To the best knowledge of the authors, no such study for developing or developed countries exists.

For example, King and Plosser (1985) and Grier and Neiman (1987), found mixed evidence for fiscal dominance in the United States; however, Ashra *et al.* (2004) find no systematic relationship between money and fiscal deficits in India. It is also believed that the uncertainty as to the time the deficits are financed can influence the rate of inflation. For example, Dornbush *et al.* (1990) and Drazen and Helpman (1990) find such an uncertainty creates fluctuation in the inflation rate.

II. Survey of Literature

Darby (1985) contradicted Sargent and Wallace (hereafter SW) (1981) view that monetary policy cannot be manipulated independently when tax rates and government expenditure are fixed. Darby maintained that government can, at least in the United States, independently manipulate "all three instruments, with government debt adjusting in a passive but stable way".

Beetsma and Jenson (2005) explored the interactions between monetary and fiscal policy across the European Union in a micro-founded model with sticky prices and the contribution of public purchases in a stabilization role under demand and supply shock. They found non-trivial gains from fiscal stabilization and commitment. They also found that the interaction between the two polices strengthens and that the time consistency problems deepen when the time profile of taxes and/or transfers is irrelevant and government debt is nominal.

Sargent (1999) argued that Fed's administrative independency does imply that monetary policy is independent of the fiscal authority of government. He also argued that monetary policy can be subjected to fiscal policy when the fiscal deficits become large enough to require monetization of government debt. He proposed some economic limitations with regard to what monetary policy can and cannot achieve.

Bhattacharya, Guzman, and Smith (1998) examined the issue: "does monetizing a deficit always result in a higher rate of inflation than the bond financing the same deficit" with a modified model of Sargent and Wallace (1981). While Sargent and Wallace's answer was negative (called unpleasant monetarist arithmetic), Bhattacharya, Guzman, and Smith found that under the condition of the Fed's reserve requirement, unpleasant monetarist arithmetic becomes even higher when the real growth rate of the economy is higher than the real interest rate on bonds.

Further, Bhattacharya and Haslag (1999) examined 'unpleasant monetarist arithmetic' and found that increased interest payments on bond financing forces government to print money at a much faster rate than would have been necessary if the deficit were initially financed by printing money. This increase in monetary growth, to finance the deficit, leads to a more inflationary situation. According to them, conditions under which unpleasant monetarist arithmetic works are: (i) when the Fed is subservient to fiscal authority (ii) the real interest rate on bond financing is higher than the real growth rate of economy, and (iii) seigniorage is possible, i.e. when the Fed is in position to raise money by printing money. Bhattacharya and Haslag did not agree with the assumption of SW (1981) that the real interest rate exceeds the growth rate of economy. In their study, they found that real interest rate during postwar period had been below the growth rate of U.S. and Canada.

Buffie (2003) argued that pleasant monetarist arithmetic is feasible when the interest elasticity of money demand is unity. Pleasant monetarist arithmetic which suggests that tight money under a fixed money growth rule may reduce internal debt to a level compatible with lower money growth and hence permanently lower inflation is not possible if either (i) interest elasticity of money demand is less one or (ii) the growth of money is determined by the rule that "seigniorage should finance a small fraction of the fiscal deficit". He also argued that monetarist pleasant arithmetic depends on public perception about how policy-makers will react to high inflation. If the public realizes that a very short period of high inflation may change a policy reversal, then "both pleasant monetarist arithmetic and the tight money paradox are self-fulfilling equilibria." Public sector credibility on policy is important whether tight monetary policy succeeds or fails. Pekarski (2007) examined "unpleasant monetarist arithmetic" of SW (1991), applying a simple forward looking monetary model (that does not substantially depart from the SW model) and found support in favor of SW. He found that unpleasant monetarist arithmetic follows unambiguously when there is a steady state analysis, i.e., there is an unexpected and permanent decrease in the growth rate of the monetary base. However, when a tight money policy is conducted, either gradually or with preannouncement, it "generates transitional dynamics" and fails to provide unpleasant monetarist arithmetic. That is, in that case pleasant monetarist arithmetic is possible. Dotsey (1996) used a dynamic model of Dotsey (1994) for examining monetarist arithmetic. In his model both money growth and taxes were stochastic variables and assumed that monetary policy is independent when the monetary authority does not respond to debt. On the other hand, when it responds to debt, monetary policy is dependent. Under these assumptions, he found that monetarist arithmetic is not so unpleasant when the tax authority responds to the debt level. When the tax authority responds to the debt level the nominal variable (interest rate and inflation) does not significantly depend on whether the monetary authority reacts to a government financing deficit.

Woodford (1995) and Aigyagari and Gertler (1985) found that when the monetary policy responds to government's inter-temporal budget constraint, nominal variables are sensitive to debt.

In this paper we found, that neither fiscal policy dominates monetary policy and also that reverse is true in the United States. Moreover, it was found that Sargent and Wallace's view that a tight/easy monetary policy leads to a higher/lower inflation over the long run is accepted for the United States. The following section deals with testing how coordination between monetary and fiscal policies occurs in the U.S. Section IV tests Sargent Wallace's view. Section V provides some concluding remarks.

III. Fiscal and Monetary Policies Coordination in the United States

In this section we investigate how the fiscal and monetary policies have been coordinated in the United States. Specifically, the question is which authority imposes discipline on whom. To check the situation, following Sargent and Wallace (1986) we assume the entire government debt consists of one-period debt so that the consolidated (the treasury and Federal Reserve) government budget constraint can be written as:

$Debt_t = Debt_{t-1}[1 + R_{t-1}$(=interest rate on debt)] + gc_t (=government spending on goods and services and transfer payments) - T_t(=government tax revenues) - ΔMB_t (=change in monetary base) = $Debt_{t-1}$ + $deficits_t$ (=R_{t-1} $Debt_{t-1}$ + gc_t - T_t) - ΔMB_t. From here we will have $\Delta MB_t = deficits_t - \Delta Debt_t = fis_t$. We will investigate if during our sample period the change in the monetary base in the United States was caused by the federal deficits net of the change in federal outstanding debt (fis_t), a fiscal-dominate environment. The alternative would be the federal deficits net of the change in outstanding debt is caused by the change in monetary base, a monetary authority-dominate environment. It is also, of course, possible that these two variables be independent. Furthermore, it is possible that the changes in the monetary base have been mostly for the accommodation purpose rather than for the monetization of debt. In this case there is no coordination between monetary and fiscal policies.

The sample period is 1973Q1-2011Q3. The choice of the sample period is based on the availability of all variables. The sources of data, unless specified, are the *International Financial Statistics* (IFS) online as well as the Federal Reserve Bank of St. Louis data base (FRED®). Some of the variables were available on monthly basis and, therefore, using the monthly average, quarterly observations were calculated.

Table 1 reports the stationarity test results on these variables. We used three stationarity tests on which Zivot and Andrews' (1992) unit-root test allows for unknown breaks in intercept and Phillips-Perron's (1988) test allows for the unknown break in both the slope and the intercept. As we can see according to all tests results, both variables fis and ΔMB are homogeneous of degree zero (stationary).

The next question is to investigate the Granger-Causality between fis and ΔMB. We can investigate the causality between these two stationary variables by estimating each variable on its 6 lagged values (a year and half) as well as the lagged values of the other variable.[13] By doing so, we found the Wald test on the coefficients of six lagged values of ΔMB in a regression of ΔMB on its six lagged values as well as six lagged values of fis is 8.86 (p-value=0.18), while the Wald test on six lagged values of fis is 17.03 (p-value=0.01). At the same time, the Wald test on the coefficients of six lagged values of fis in a regression of fis on its six lagged values as well as six lagged values of ΔMB is 22.37 (p-value=0.00), while the Wald test on six lagged values of ΔMB is 49.76 (p-value=0.00). This result implies that fis and ΔMB Granger causing each other. Specifically, we conclude during our sample period that we don't have any fiscal or monetary dominate environment in the United States.

[13] Note that using both Akaike and Schwarz final prediction error the lag length was determined.

Table 1: Stationarity Test Results*

Variable	ADF[1] (k)	PP[2](k)	ZA[3](k)-Break
fis	-5.06[a] (4)	--9.18[a] (4)	-6.57[a] (3) - 2005Q4
ΔMB	-4.00[a] (4)	-10.72[a] (4)	-5.72[a] (3) – 2006Q1
lMs	-1.95 (4)	-1.15 (4)	-3.38 (3) – 1995Q4
ΔlMs	-5.15[a] (0)	-5.11[a] I(4)	-3.71 (3) – 1994 – Q1
lq	-2.23 (4)	-1.88 (4)	-2.37 (3) – 1980Q4
Δq	-4.94[a] (4)	-12.87[a] (4)	-5.74[a] (3) – 1985Q2
i	-0.92 (4)	1.65 (4)	-1.08 (3) – 2006Q1
Δi	-5.01[a] (4)	-9.17[a] (4)	-3.79 (3) – 2006Q1
ly	-1.77 (4)	-09.4 (4)	-3.07 (3) - 2006Q1
Δly	-4.93[a] (4)	-8.45[a] (4)	-5.67[a] (3) – 1983Q1
i*	-4.26 (4)	-0.18 (4)	-3.03 (3) - 1980Q4
Δi*	-4.16[a] (4)	-8.02[a] (4)	-4.34 (3) – 2006Q1
lg	-2.09 (4)	0.61 (4)	-2.92 (3) - 2001Q1
Δlg	-3.31[b] (4)	-11.84 (4)	-4.34 (3) - 1998Q2
defgdp	-2.60 (4)	-1.74 (4)	-3.063 (3) -2006Q1
Δdefgdp	-4.35[a] (4)	-11.60 (4)	-5.31[b] (3) - 2000Q2
debtgdp	-1.96 (4)	1.66 (4)	-2.15 (3) - 1996Q2
Δdefgdp	-4.36[a] (4)	-11.60 (4)	-5.31[a] (3) - 2000Q2
fdgdp	-1.52 (4)	3.03 (4)	-1.92 (3) - 2005Q3
Δfdgdp	-3.58[a] (4)	-8.63[a] (4)	-3.96 (3) - 2001Q3
lcp	-2.43 (4)	-7.18[a] (4)	-4.42 (3) – 1979Q2
Δlcp	-3.10[b] (4)	-4.55[a] (4)	5.39[a] (3) – 1981Q4

The sample period is 1973Q1-2011Q3. Δ means the first difference and l before a variable means the log of the variable. fis is the deficits net of the change in the outstanding debt. MB is the monetary base, Ms is the nominal money supply, q is the real effective exchange rate, i is the gross interest rate, y is the real GDP, i is the gross foreign interest rate, g is the government expenditure on goods and services, defgdp is the federal government deficits per GDP, debtgdp is the Federal debt per GDP and fdgdp is the foreign-financed debt per GDP.

1. ADF is the conventional augmented Dickey-Fuller test statistics and k is the optimal lag length, which was determined by the minimum of AIC, as well as SC. The critical value for ADF τ test is -2.88 at 5% and -3.46 at 1%.
2. PP is Phillips-Perron non-parametric Unit Root Test. The critical value is -2.88 at 5% and -3.474at 1%.
3. ZA is Zivot-Andrews Unit Root Test. The test allows a break in only intercept. The critical value is -4.80 at 5% and -5.34 at 1%.

a=Significant at 1%.
b=Significant at 5%.

IV. Does Current Easy Monetary Policy Lead to Future Inflation? Testing Sargent-Wallace Hypothesis

In the previous section we found that the monetary authority is not in a position to influence the government's deficits path in the United States but its authority is limited simply to managing the debt that is generated by deficit path, implying that the fiscal authorities constrain monetary authority. Under this coordination scheme the current quantitate easing to fight recession/slow-growing economy/financial crisis should lead to lower future inflation according to Sargent and Wallace (1986). Specifically, adjusting for the money supply, there should be a positive long-run relationship between the interest rate and the price level. In other words, a lower interest rate (an easy monetary policy) leads to a higher inflation during the short run, but leads to a lower price over the long run. Note that Sargent and Wallace (1986) states that under above condition a tight current monetary policy to fight inflation leads to higher future inflation. If this relationship holds the reverse should also hold.

A. The Model

We will use Kia's (2006a) model to estimate the long-run relationship between the price level and money supply in the United States. To the best knowledge of the authors, Kia's model is the only model in the literature which is capable to test the impact of the money supply and interest rate (monetary policy) on the price level over the long run (Sargent and Wallace view) while debt, deficit and debt management are also included. That is, this model is a monetary approach to an inflation model which also considers fiscal variables. This model also used by other studies, e.g., Wilson (2009). The price relationship in this model is:

$$lp_t = \beta_0 + \beta_1 \, lMs_t + \beta_2 \, i_t + \beta_3 \, ly_t + \beta_4 \, lq_t + \beta_5 \, i^*_t + \beta_6 \, lg_t + \beta_7 \, defgdp_t + \beta_8 \, debtgdp_t + \beta_9 \, fdgdp_t + u_t. \quad (1)$$

In this equation lp is the log of the price level, lMs is the log of nominal money supply, i is the log of the domestic gross interest rate ($i_t = \log(R_t/1+ R_t)$), R is the risk-free domestic interest rate, ly the log of real income, lq is the log of the real exchange rate, i* is the log of the gross foreign interest rate ($i^*_t = \log(R^*_t/1+ R^*_t)$), R* is the foreign risk-free interest rate, lg is the log of the real government expenditure on goods and services, defgdp, debtgdp and fdgdp are real government deficits per GDP, the government debt outstanding per GDP and the government foreign-financed debt per GDP, respectively. Trend is a linear trend. Since $\beta_1 = 1$, the model is a pure monetary approach and, in fact, β_2, the coefficient of i_t, reflects the impact of monetary easing/tightness on the price level.

In Equation (1) βs are the parameters to be estimated, where $\beta_0 <0$, $\beta_1 = 1$, $\beta_2 >0$, $\beta_3 <0$, $\beta_4 = ?$, $\beta_5 >0$, $\beta_6 >0$, $\beta_7 >0$, $\beta_8 >0$, $\beta_9 >0$. Since we expect all variables in Equation (1) to have a unit root this equation can be is a long-run cointegrating equation. In such a case, according to this model a monetary easing should result in a higher inflation rate (priced level) over the long run as $\beta_1 = 1$. However, since $\beta_2 >0$ a lower current interest rate, for a given money supply, should result in a lower inflation rate (price level) over the long run, i.e., Sargent and Wallace's view is satisfied.

B. Long-Run Empirical Methodology and Results

lp is the logarithm of CPI and following Kia (2006a) and Wilson (2009), lMs is the logarithm of nominal M1 and i is the logarithm of (R/1+R), where R is three-month Treasury Bill rate at the annual rate, in decimal points. Variable y is the real GDP, which is the nominal GDP divided by GDP deflator. Following Wilson (2009), E is the average of daily figures of a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of the major U.S. trade partners. The broad currency index includes the Euro Area, Canada, Japan, Mexico, China, United Kingdom, Taiwan, Korea, Singapore, Hong Kong, Malaysia, Brazil, Switzerland, Thailand, Philippines, Australia, Indonesia, India, Israel, Saudi Arabia, Russia, Sweden, Argentina, Venezuela, Chile, and Colombia. Following Kia (2006a) and Wilson (2009), foreign interest rate i* is the logarithm of (R*/1+R*), where R* is the LIBOR (3-month London interbank) rate at the annual rate, in decimal points. The industrial countries unit value export price index was used as a measure for the foreign price p*. Variables defgdp, debtgdp and fdgdp are deficits, outstanding debt and foreign debt per GDP, respectively. All variables are seasonally adjusted, some at the source of the data and some were seasonally adjusted.

Following Kia's (2006b) suggestion, we also allow the short-run dynamics system to be affected by policy regime shifts and other exogenous shocks, which could affect the U.S. price level (inflation rate) during the sample period. These policy regime changes and other exogenous shocks include the following: (i) The Persian Gulf War, which began on August 2, 1990, and ended on February 28, 1991. (ii) The North American Free Trade Act (NAFTA), which went into effect on January 1, 1994. This act provided unprecedented freedom in trade among the United States, Canada, and Mexico. (iii) On October 7, 2001, the U.S. declared war on Afghanistan. (iv) The credit crunch and financial crisis which started on August 2007 and ended the third quarter of 2009.

Accordingly, the following dummy variables used to represent these potential policy regime shifts and exogenous shocks: pwar = 1 from 1990Q3- 1991Q1, and = 0, otherwise, nafta = 1 since 1994Q1 and = 0, otherwise, awar = 1 since 2001Q4 and = 0, otherwise and uscrisis = 1 from 2007Q3 to 2009Q3, and = 0, otherwise.

According to the results reported in Table 1, variables lMs, i, ly, lq, i*, lg, defgdp, debtgdp, fdgdp and lcpi are not stationary, but all have a unit root. However, the variables lMs, i, i*, lg and fdgdp are not homogeneous of degree one according to Zivot test result. But since the other two test results confirm these variables are homogeneous of degree 1 we accept this result.

To estimate the long-run relationship (1) we estimate trace test developed by Johansen and Juselius (1991). Note that the set of dummy variables that constitutes the policy regime changes and exogenous shocks explained above is allowed to affect the short-run dynamic of the system. In determining a long-run relation between the domestic price level and its determinants, conditional on the foreign price level and the interest rate, we need to test whether the price level contributes to the cointegrating relation.

In determining the lag length one should verify if the lag length is sufficient to get white noise residuals. As it was recommended by Hansen and Juselius (1995, p. 26), set number of endogenous variables (p) equal to the number of cointegration number (r) and test for autocorrelation and ARCH. LM(1) and LM(2) will be employed to confirm the choice of lag length. According to both LM(1) test (p-value=0.06) and LM (2) test (p-value=0.17), a lag length of five quarters was sufficient to guarantee the lack of autocorrelation. Furthermore, according to both LM(1) test (p-value=0.25) and LM (2) test (p-value=0.07) the error is not heterskedasic. The critical values, using the procedure in CATS in RATS Version 2.01, with 2500 replications and length of random walks of 400 are simulated. According the trace result, adjusted for small-sample error, using Bartlett Small Sample Correction method, 128.88 < 145.92 (p-value=0.27) we cannot reject the rank r=3 among the variables, see Table 2. Note that the foreign price was assumed to be weakly exogenous.

Table 2(1): Long-Run Test Result

Tests of the Cointegration Rank										
H_0= r	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Diagnostic tests** *p*-value
Trace(2)	365.38	253.06	188.63	**128.88**[a]	93.42	61.33	37.44	18.88	4.94	**Autocorrelation** LM(1)(4) 0.06 LM(2)(4) 0.17 **ARCH** LM(1)(4) 0.25 LM(2)(4) 0.07 **Normality** 0.00
Trace 95(3)	264.31	221.37	182.97	145.92	113.87	85.58	59.85	38.49	20.19	
***p*-value(4)**	0.00	0.00	0.03	0.27	0.40	0.62	0.71	0.78	0.90	**Lag length = 5**

Identified Long-Run Relationships for r=3.

Normalized	**lMs**	**i**	**lp**	**ly**	**Lq**	**i***	**lg**	**defgdp**	**debtgdp**	**fdgdp**	**constant**
Lcp (Price Eq.) (***t*-statistics).**	Restricted =1	0.18 (17.05)	-	-0.39 (-20.58)	0.15 (6.52)	-0.09 (8.09)	0.62 (9.84)	1.70 (9.71)	0.10 (4.38)	0.03 (0.70)	Restricted =0
i (Mon. Demand Eq.) (***t*-statistics)**	-9.46 (-24.09)	-	9.46 (24.09)	0.68 (1.84)	Restricted =0	Restricted =0	Restricted =0)	Restricted =0	Restricted =0	Restricted =0	12.55 (3.61)
Ly (Agg. Supply Eq.) (***t*-statistics)**	Restricted =0	Restricted =0	0.36 (10.82)	-	Restricted =0	Restricted =0	Restricted =0	Restricted =0	Restricted =0	Restricted =0	7.59 (43.03)

(1) a =means accept the null of r=3.
(2) By using Bartlett correction the Trace test statistic is corrected for the small sample error, see Johansen (2000 and 2002).
(3) Because of the inclusion of the dummies in the short-run dynamics of the system the limit distribution of the rank statistics should be simulated. The CATS 2 in RATS computer package was used to simulate the critical values. The number of replications was 2500 with a length of random walks of 400.
(4) The approximate *p*-value using the corrected test statistic. LM(1) and LM(2) are one and two-order Lagrangian Multiplier test, respectively.

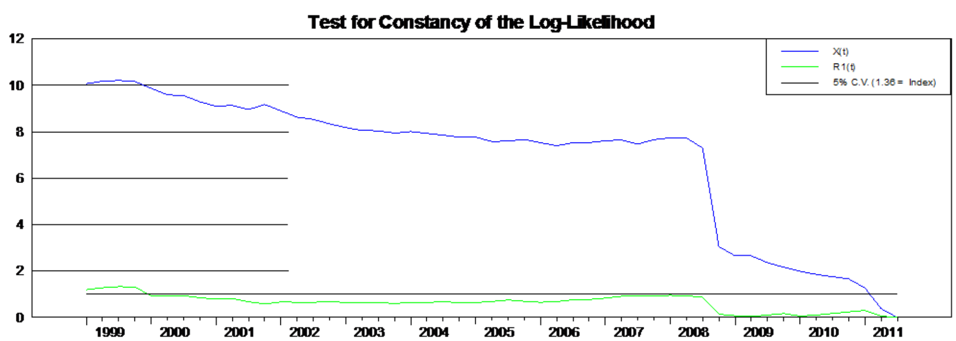
The sample period is 1972Q1-2011Q3. lq is the log of the real effective exchange rate, where q is the real effective exchange rate, lrm1 is the log of real M1 and i is the log[R/(1+R)], where R is three-month TB rate in decimal points. ly is the log of the real GDP, lrg is the log of real government expenditures on goods and services, defgdp and debtgdp are deficit and outstanding debt per GDP, respectively. fdgdp is the amount of foreign financed debt per GDP and lcom is the log of commodity price. i* = log(R*/1+ R*), where R* is the (3-month London interbank) rate at the annual rate, in decimal points. Con is the constant term.

Since we found more than one cointegrating relationship we need to identify the estimated cointegrating vectors. Namely, in order for the estimated coefficients of cointegrating equations to be, in fact, economically meaningful, identifying restrictions must be imposed to ensure the uniqueness of the coefficients. In this case, we need three identifying conditions to be satisfied in order for the uniqueness of coefficients to be ensured. Furthermore, the normalization of a variable, when there is more than one cointegrating rank, makes the resulting equation interpretable and meaningful if these conditions are satisfied. These conditions include generic identification, empirical identification and economic identification. As explained by Johansen and Juselius (1994) the generic identification is related to the linear statistical model and requires the rank condition, which is given by their Theorem 1, to be satisfied. The empirical condition is related to estimated parameters values and finally, the economic identification is related to the economic interpretability of the estimated coefficients of an empirically identified structure.

Following, e.g., Johansen and Juselius (1994 and 1991) and Johansen (1995), we can test for the existence of possible economic hypotheses among the cointegrating vectors in the system. The bottom panel of Table 2 reports the identified relationships.

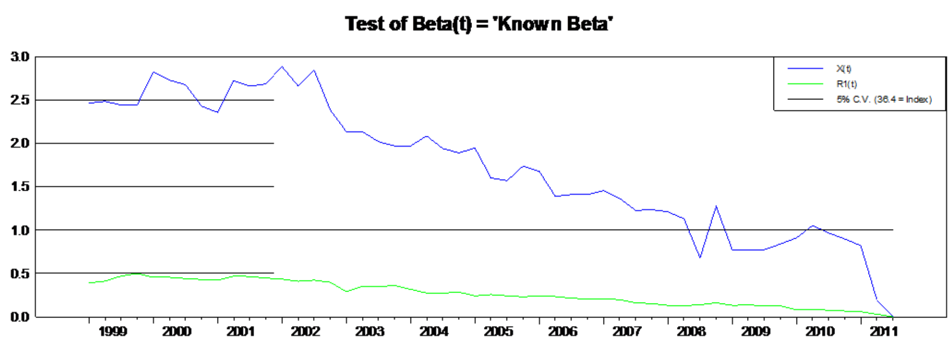
Figures 1 to 5 plot the calculated values of the recursive test statistics for the long-run identified relationships. Note that these figures respectively show recursive likelihood-ratios, constancy of all betas and coefficients of all identified equations, all normalized by the 5 percent critical value. Thus, calculated statistics that exceed unity imply the rejection of the null hypothesis and suggest unstable cointegrating vectors. The broken line curves plot the actual disequilibrium as a function of all short-run dynamics variables, while the solid line curves plot the "clean" disequilibrium that corrects for short-run effects. We hold up the first 27 quarters for the initial estimation. As these figures show, all these identified equations appear stable over the long run when the models are corrected for the short-run effects. Having established that the long-run equations are stable, we will analyze the identified long-run equations.

Figure 1: Recursive Likelihood Ratio Tests*



*X(t) = the actual disequilibrium as a function of all short-run dynamics and dummy variables.
R1(t) = the "clean" disequilibrium that corrects for short-run effects.

Figure 2: Test for the Hypothesis that Betas of Each Sub-Period Equal to Betas of the Entire Sample of Model*



*X(t) = the actual disequilibrium as a function of all short-run dynamics and dummy variables.
R1(t) = the "clean" disequilibrium that corrects for short-run effects.

Figure 3: Test for Constancy of the Parameters of the First Restricted Model

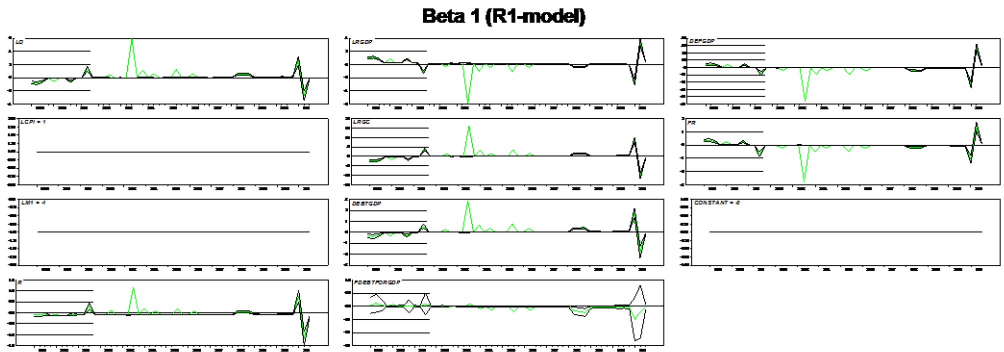


Figure 4: Test for Constancy of the Parameters of the Second Restricted Model

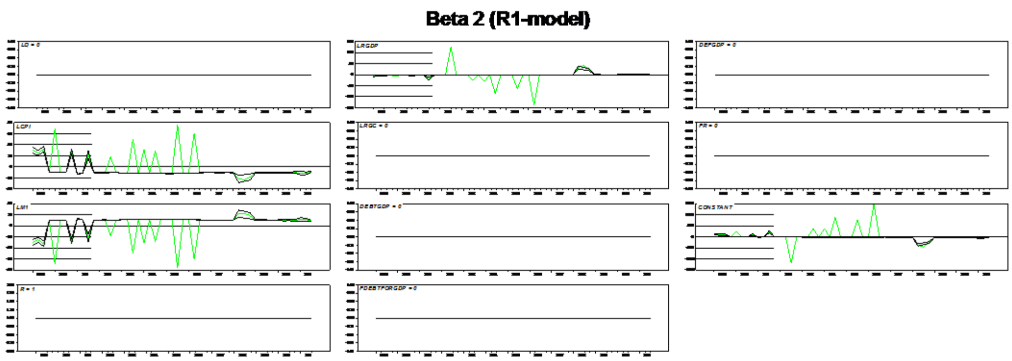
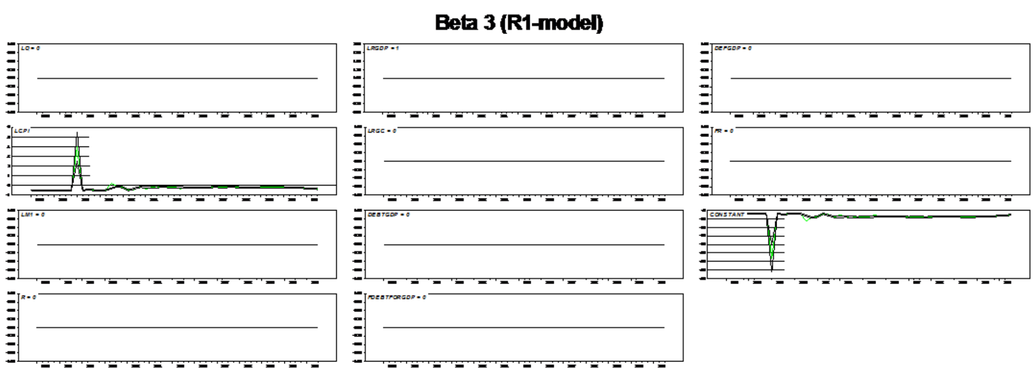


Figure 5: Test for Constancy of the Parameters of the Third Restricted Model



(A) Long-Run Price Determination

The first row of the bottom panel in Table 2 reports the identified long-run price determination.

(i) Monetary policy: According to our model, Equation (1), we would expect the level of interest rate to have a positive influence on the price level over the long run. Based on our estimation result, the estimated coefficient of interest rate is statistically significant and is positive, implying current monetary easing leads to a lower price level over the long run. This

result is consistent with Sargent and Wallace's view. Considering the effective real exchange rate as a monetary instrument, a depreciation of the domestic currency leads to an increase in the price level.

(ii) Fiscal policy: The long-run estimated coefficient of the log of real government expenditures is positive, as our model predicts, and statistically significant. The long-run estimated coefficient of all fiscal variables is positive and, except foreign-financed debt per GDP, is statistically significant. The positive estimated coefficients of these variables justify our model. This result implies that fiscal policy in the United States can significantly reduce inflation over the long run. Specifically lowering government expenditure, deficits per GDP and debt per GDP can effectively reduce the price level in the United States over the long run.

(iii) External factors: Foreign interest rate, contrary to what our theoretical model predicts, has a negative impact on the price level in the U.S. and is statistically significant. One possible explanation for this result is that as foreign interest rate increases demand for foreign deposits/bonds will go up and the demand for goods and services, therefore, will fall with a depressing impact on price.

In general, so far we found domestic factors, controlled by monetary and fiscal authorities, can be very effective in curbing inflation in the United States. Finally, the impact of real GDP as expected theoretically is negative and statistically significant.

(B) A Long-Run Demand for Money

The second row of the bottom panel in Table 2 reports a long-run demand for money. Since the demand for money is the demand for the real balances we restricted the coefficient of lp to be equal to the negative coefficient of lMs. The scale variable (ly) has a correct sign (positive) and is statistically significant.

(C) Long-Run Aggregate Supply

The third identified equation, last row of the bottom panel of Table 2, resembles an aggregate supply relationship. The estimated coefficient of lp is, as it is expected positive and statistically significant.

V. Conclusions

This paper focuses on long-run estimation of the price equation in the United States. The monetary model of price level developed by Kia (2006a), which is capable of incorporating both monetary and fiscal policies as well as other internal and external factors, was used and tested on the U.S. data. The main objective of the study is first to investigate if there is any coordination between monetary and fiscal policy in the United States and then to test the Sargent and Wallace's view that an easy monetary policy today will result in a lower price level over the long run when debt and deficit exist. It was found there was not a fiscal or monetary dominate environment in the United States during our sample period (1973Q1-2011Q3). Furthermore, the estimation results proved the validity of the Sargent and Wallace's view as it was found a positive and statistically significant relationship between domestic interest rate and price level over the long run.

Furthermore, it was found that, over the long run, a higher real exchange rate (lower value of domestic currency) leads to a higher price level. It was also found that the fiscal policy is very effective in the United States to fight inflation as the increase in the real government expenditures, deficit as well as debt cause inflation. Finally it was found, the foreign interest rate has a depressing impact on the price level over the long run.

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