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The Monetary Approach to Exchange Rates: A Brief Review and Empirical Investigation of Debt, Deficit, and Debt Management: Evidence from the United States

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This paper reviews the monetary approach to exchange rate determination and gives a brief historical review on the demand for money used in this approach. The monetary approach to exchange rate determination has come a long way. The basic models developed in the 1970s received initial support but did not hold up under further empirical research. With several advances in econometric analysis and improved research design, subsequent studies began to rebuild support for the model at least as a long-run phenomenon. A shortcoming of the monetary approach to exchange rate determination so far in the literature is the effect of fiscal variables, as well as regime changes, on the demand for money. The paper provides some empirical evidence in support of this claim. Future research should use a more comprehensive demand for money in the exchange rate determination.

1. Introduction

Since the implementation of the floating exchange rate system in 1973, considerable volatility has occurred in the behavior of exchange rates. The monetary approach has been used to understand exchange rate movements. In fact, Jacob Frenkel suggested that the conversion to floating exchange rates brought about a "revival of the monetary view, or more generally the asset view, of the role of the rates of exchange" (Frenkel, 1976, p. 200).

Over the past 35 years, the monetary approach to understanding exchange rates has become the dominant model of exchange rate determination (Diamandis and Kouretas, 1996, p. 351). This paper will trace the development of the monetary approach to exchange rate determination and examine how the research support for this model has changed and why.

The paper will also examine the impact of three variables that Kia (2006a) finds to be important in predicting inflation rates, namely; domestic debt, domestic deficits, and foreign debt. To this point in the research on the monetary approach to exchange rate determination, no examination of how regime changes impact the determination of the exchange rate has been done. This paper will investigate the impact of important world events such as the Persian Gulf War of 1990, NAFTA, the war in Afghanistan, and the terrorists' attacks on September 11, 2001. These variables will be included in a revised model used to examine the exchange rate between the U.S. dollar and the currencies of a broad group of major U.S. trade partners.

The remainder of the paper is divided into seven sections. Section II will provide a brief overview of the development of the monetary approach. Section III will outline the elements used in the 1970s to build the

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monetary model of exchange rate determination. Section IV will review some of the key research findings on the relationship between the monetary approach and exchange rates and trace their impact on the subsequent development of the model. Section V will introduce fiscal variables and regime changes into the model. Section VI is devoted to an examination of the data and long-run results. Section VII gives the error-correction test results. Section VIII provides some concluding comments.

II. The Development of the Monetary Model

Three fundamental concepts have influenced the current construction of the monetary model of exchange rate determination–the quantity theory of money, the Cambridge cash-balance approach, and Keynesian monetary theory.

A. The Quantity Theory of Money

During the 15th and into the 16th century, Europe experienced a steady increase in prices. Jean Bodin (1530-1596), a French mercantilist, attributed this increase to the rapid influx of gold and silver from the Americas. The increased supply of precious metals (i.e., the money supply) put upward pressure on goods that could command a higher price. It was believed that the flow of gold and silver could be maintained by controlling imports and exports. John Locke (1632-1704) helped to clarify the relationship between the supply of money and price levels. If the supply of money increases (decreases), prices would increase (decrease). As a result, the price of foreign goods compared to domestic goods would rise.

Adam Smith (1723-1790) saw a fundamental flaw in accumulating wealth by promoting exports and restricting imports. He believed that an excess of money would not increase prices. Rather, an excess of money would be "drained off through the balance of payments without affecting prices" (Humphrey, 1981, p. 3). Smith believed that prices would impact the money supply. This explanation was contrary to the predictions of quantity theory and set up a debate about the causal effect of money.

The Swedish Bullionist controversy of the mid 1700s brought this debate into sharp focus. Sweden moved from a monetary system based on metal and fixed exchange rates to a paper system with flexible exchange rates. The result was a substantial rise in prices. Some believed that an adverse trade balance led to a depreciation of the Swedish currency increasing the price of imported goods and goods in general. Others claimed that rising prices were the result of the Swedish Central Bank issuing too many banknotes (Humphrey, 1978). After a similar bullionist problem in England, David Ricardo, John Wheatley, and others economists concluded that the exchange rate varied proportionately with the relative supply of money.

In 1911 Irving Fisher in the *Purchasing Power of Money* presented his famous "equation of exchange."

$$MV = PT \qquad (1)$$

M is money, V is velocity, P the price level, and T refers to the total number of transactions carried out using money. The supply of money (M) and the speed (V) with which it turns over in the economy equals the price level in the economy times the total number of transactions. V and T are fixed with respect to the money supply. M has a direct relationship to P. The growth of the money supply will increase prices.

B. The Cambridge Cash-Balance Approach

The Fisher model assumes that the total number of transactions and the turnover of money are constant. Money is simply a medium of exchange. However, money is

also a unit of account and a store of value. Several Cambridge economists (Pigou, Marshall, Robertson, and Keynes) saw the significance of expanding the definition of money to include currency in circulation plus current accounts (demand deposits). The amount of money needed to cover current and future needs depends on one's income and interest rates. The Cambridge economists modified Fisher's exchange equation in the following manner:

$$M/P = kY \qquad (2)$$

Y is the real national income rather than total transactions, and M/P is the real demand for money. The addition of *k* (the Cambridge constant) is the desire to hold money as a fraction of annual national income. Money is also endogenous because of the ability of banks and financial institutions to create money through credit.

C. Keynesian Monetary Theory

If individuals hold money to finance current and future transactions, as national income increases, the demand for money to cover transactions will also increase. Thus, the demand for money varies directly with national income. Keynes pointed out that a cost is associated with holding money. It can be placed in financial assets that earn interest. Keynes refers to this as the speculation demand for money. Consequently, a relationship exists between the demand for money and interest rates. The higher the rate of return in interest-bearing assets, the more likely one will invest money.

III. Building the Monetary Model of Exchange Rate Determination

At equilibrium the money supply should be equal to money demand.

$$M_d = M_s \qquad (3)$$

The Cambridge model suggested that real money demand is related to real income. Combine equation (2) and (3) and rearrange the resulting equation to get the following:

$$M_s = kPY \qquad (4)$$

According to the Law of One Price, we have the following:

$$E = \frac{P}{P^*} \qquad (5)$$

Where E is the nominal exchange rate, defined as domestic currency value of a unit of foreign currency; and P* is the foreign price level. Equation (5) implies that a change in P requires a proportional change in P* to keep the exchange rate stable.

Similar to Equation (4) we can write

$$M^*_s = k^*P^*Y^* \qquad (6)$$

Where M^*_s and Y* are foreign money supply and real income; whereas, the k* is a constant parameter. Substitute (4) and (6) in (5) to get

$$E = \frac{Ms\, k^* Y^*}{Ms^* kY} \qquad (7)$$

Taking the log of Equation (7), we will get the following:

$$e = (m\text{-}ms^*) - (y\text{-}y^*) - (\log k - \log k^*) \qquad (8)$$

Where e, m, m*, y, and y* are the logarithm of E, M, M*, Y and Y*, respectively.

As Keynes proposed, k is not constant but will vary negatively with the interest rate which, in turn, is affected negatively by the money supply and will vary positively with income. The cost of holding money is expressed in terms of the interest rate. Specifically, the demand for the real balances may be written as follows:

$$m - p = a + b\,y - c\,i \qquad (9)$$

$$m^* - p^* = a + b\,y^* - c\,i^* \qquad (10)$$

Where i is the nominal interest rate; and a, b, and c are constant parameters. The monetary model for a foreign country is identified with an asterisk. From (5) we have the following:

$$e = p - p^* \qquad (11)$$

Using (9), (10) and (11) we will have the following: $e = (m - m^*) - b(y - y^*) + c(i - i^*)$ (12)

In summary, monetary theory proposes that exchange rates are a monetary phenomenon affected by the money supply, income level, and interest rates.

A. Three Approaches to the Monetary Model of Exchange Rates

Three competing models of the monetary approach to exchange rate determination were developed in the 1970s. The flexible-price monetary model (Frenkel, 1976) incorporates the concepts of the monetary approach outlined by Equation (12). Prices are flexible because they adjust immediately in the money market. The crucial assumptions are that domestic and foreign capital are perfect substitutes and the Fisher equation ($i = r + \pi$) holds in both countries–where r is the real interest rate and π is the expected inflation rate. It is further assumed $r=r^*$ is constant. Substitute for i and i^* in Equation (12), and use the assumption of constant and equal real interest rate to get the following:

$$e = (m - m^*) - b(y - y^*) + c(\pi - \pi^*) \quad (13)$$

If we assume the coefficients of demand for money in home and foreign countries are different, then we will have the following:

$$m_s - p = \alpha_0 + \alpha_1 y - \alpha_2 i \quad (14)$$

$$m_s^* - p^* = \beta_0 + \beta_1 y^* - \beta_2 i^* \quad (15)$$

The parameters α's and β's are constant coefficients. Using PPP equation and equations (14) and (15), we can get the monetary model of exchange rate determination in the following unrestricted form:

$$e_t = \gamma_0 + \gamma_1 m_{st} + \gamma_2 m_{st}^* + \gamma_3 y_t + \gamma_4 y_t^* + \gamma_5 i_t + \gamma_6 i_t^* + u_t \quad (16)$$

Where γ's are constant coefficients and u is the disturbance term. Under the monetary model of exchange rate determination, we should have $\gamma_1 = 1$, $\gamma_2 = -1$, $\gamma_3<0$, $\gamma_4>0$, $\gamma_5>0$ and $\gamma_6<0$.

In his study of the German hyperinflation, Frenkel (1976) found support for the monetary model of exchange rates and the relationship among money, prices, expectations, and the exchange rate. The coefficients were similar to the predictions of the model.

B. The Sticky-Price Monetary Approach to Exchange Rates

Dornbusch (1976) developed a competing model of the monetary approach to exchange rates. Similar to Keynes, he proposed that prices are rigid and would only adjust gradually. He indicated that as domestic money supply decreases relative to domestic money demand, there would not be a matching drop in prices. The domestic interest rate would rise with regard to foreign interest rates creating an inflow of foreign capital. Domestic currency would appreciate immediately. The result would be a negative relationship between the exchange rate and nominal interest rate. Dornbusch stated that a sticky price model would mean that PPP would only hold true in the long run. The result of this restatement of the monetary model suggests that there will be a short-run "overshooting" of the nominal exchange rate. However, in the long run, one would expect prices to adjust as well as output in response to an increase in aggregate demand. Exchange rates would be affected accordingly.

C. The Real-Interest Differential Model

Frankel (1979) examines both the Frenkel and Dornbusch models. He suggests that Frenkel's model is realistic "when variation in the inflation differential is large" and the Dornbusch model is applicable "when variation in the inflation differential is small" (Frankel, 1979, p. 610). Frankel developed an integrative approach that com-

bines the sticky-price concept with the notion of secular rates of inflation. The result is a model that supports a negative relationship between exchange rates and the nominal interest differential and a positive relationship between exchange rates and the expected long-run inflation differential.

IV. Empirical Evidence for the Monetary Approach to Exchange Rate Determination

Despite the early support for the monetary approach to exchange rate determination, research in the 1980s turned significantly against the model. To what were these negative results attributed? Ironically, Bilson (1979), who developed one of the original monetary models of the exchange rate, is one of the first to find conflicting results. He suggests that the PPP condition does not apply in the short run. Also, nominal interest rates are not exogenous as originally thought. Caves and Feige (1980) found no statistical support for the model. Huang (1981) found that exchange rates are too volatile to be consistent with the monetary model and/or an efficient market.

Bomhoff and Korteweg (1983) suggest that important variables were actually left out of the model. Much of the variation (upwards of 50 percent) in the unanticipated rate of change of the spot exchange rates of the major European currencies was due to "news" (unanticipated events such as oil shocks). Woo (1985) and Smith and Wickens (1986) state that the poor research findings were the result of faulty specification of the money function. Hoffman and Schlagenhauf (1983) found that expectations about the future exchange rate could impact the current exchange rate.

In the mid 1980s statistical techniques began to shed new light on the monetary model of exchange rates. Work by Engle and Granger (1987) on the co-integration of variables provided a new statistical technique that had promise in reexamining the models of exchange rate determination. Then, Johansen (1988, 1991) developed a multivariate co-integration approach that was superior to the simple regression model of Engle and Granger. Johansen was able to identify the underlying time-series properties of the data and provide tests for the number of co-integrating vectors in a data set.

MacDonald and Taylor (1991) used Johansen's approach to analyze co-integration in their study of three currencies: the pound sterling, the German mark and the Japanese yen. They found at least one co-integrating vector indicating that the monetary model had some long-run validity. MacDonald and Taylor (1993) analyzed the deutsche mark/ U.S. dollar exchange rate for the 1976-1990 period. While the restrictions imposed by the forward-looking monetary model are rejected, there was some support for the flexible-price monetary model particularly as a long-run model.

In the 1990s more research was directed to a broader range of currency exchange rates. McNown and Wallace (1994) applied an expanded monetary model of exchange rates to the currencies of Argentina, Chile, and Israel, which were experiencing high inflation and found strong co-integration among the variables for Chile and Argentina but not Israel. Diamandis and Kouretas (1996) analyzed the movements of the Greek drachma with regard to the U.S. dollar, the German mark, the French franc, and the pound sterling. They concluded that the monetary model is a valid framework to analyze exchange rate determination. Makrydakis (1998) studied the Korean won/U.S. dollar exchange rate and detected three co-integration vectors among the exchange rate and monetary fundamentals suggesting

that the unrestricted reduced form of the monetary model is valid in the long-run.

Miyakoshi (2000), using the flexible price monetary model, found one co-integrating vector indicating the long-run validity of the monetary model. Some of the common monetary restrictions on the model are valid for the Korean won/German mark and Korean won/Japanese yen exchange rate. Cushman (2000) studied the Canadian/ U.S. dollar. Using the longest data set to date, he found no evidence for the monetary exchange rate model but suggested that the time span of the data can decrease the power of unit roots or co-integration. Groen (2002) used panel data sets to avoid this problem. Panel-based co-integration tests can be more powerful for a longer span of data than a time-series based approach. He studied the forward-looking monetary model on panels of exchange rate data for 14 countries from 1973–1994. Co-integration tests on this time-series data provided no evidence for the forward-looking monetary model.

Tawadros (2001) studied the Australian dollar/ U.S. dollar exchange rate and found a single long-run relationship among the exchange rate, money supplies, industrial output, and short-term interest rates. The monetary model outperformed the random walk model with increasing performance over longer time horizons.

Crespo-Cuaresma, Fifrmuc and MacDonald (2005) developed a panel set of six Central and Eastern European countries (Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia) to estimate the monetary exchange rate model with panel co-integration methods. The monetary model is able to explain the long-run exchange rate relationships particularly when this is supplemented by a Balassa-Samuelson effect. An additional variable impacting exchange rates is the stock market. Morley (2007) examined the relationship between equities and the exchange rate through the framework of the monetary model of exchange rates. He found that in the short-run, as well as the long run, stock prices have a significant effect on the exchange rate.

Uz and Ketenci (2008, p 57) expanded the study of the monetary approach to exchange rates by looking at four monetary variables: monetary differential, output differential, interest differential, and price differential. The authors examined these relationships for 10 new EU members (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic, Slovenia, and Turkey). They found that nominal exchange rates are co-integrated with these monetary variables when using panel data.

V. The Model

Despite the stronger support for the monetary approach to exchange rates, some limitations exist. First, measuring money supply with the growth of term deposits, money market mutual funds, and other financial vehicles has become more difficult. Second, the emphasis on purchasing power parity is problematic. If purchasing power parity does hold in all cases, real exchange rates (defined as EP*/P) would not vary from nominal exchange rates; however, some data indicate that this has not been the case (Evans, 1992). Third, the demand for money can also be a function of the expected value of future income and interest rates. Furthermore, the demand for money may also be a function of the risk associated with holding domestic currency. This risk can be a function of federal government debt per GDP and the domestic and foreign composition of the debt. For example, Kia (2006a) showed the demand for money is a function of outstanding domestic debt, deficits, and outstanding foreign debt among other factors. Consequently, a simple Keynesian or Cambridgian demand for money

is not sufficient enough to be used in determining the exchange rate.

To support the view that the exchange rate can be changed by fiscal variables, I used the demand for money equation developed by Kia (2006a) to derive an equation for the exchange rate, which includes fiscal policy variables. Kia (2006a) considered an economy with a single consumer representing a large number of identical consumers. The consumer maximizes the utility function (17) subject to budget constraint (18), where

$$U(c_t, c_t^*, g_t, k_t m_t, m_t^*) = (1-\alpha)^{-1} (c_t^{\alpha 1} c^*_t{}^{\alpha 2} g_t^{\alpha 3})^{1-\alpha} + \xi (1-\eta)^{-1} [(m_t/k_t)^{\eta 1} m^*_t{}^{\eta 2}]^{1-\eta}, \quad (17)$$

$$\tau_t + y_t + (1+\pi_t)^{-1} m_{t-1} + q_t (1+\pi^*_t)^{-1} m^*_{t-1} + (1+\pi_t)^{-1} (1+R_{t-1}) d_{t-1} + q_t (1+\pi^*_t)^{-1} (1+R^*_{t-1}) d^*_{t-1} = c_t + q_t c_t^* + m_t + q_t m_t^* + d_t + q_t d_t^*, \quad (18)$$

where c_t and c^*_t are single, non-storable, real domestic consumption of domestic and foreign-produced goods, respectively. m_t and m^*_t are the holdings of domestic real (M/p) and foreign real (M*/p*) cash balances, respectively. The variable g is the real government expenditure on goods and services, and it is assumed to be a "good." Furthermore, the variable τ_t is the real value of any lump-sum transfers/taxes received/paid by consumers; y_t is the current real endowment (income) received by the individual; q_t is the real exchange rate, defined as $p_t^*/EE_t p_t$; EE_t is the nominal market effective exchange rate (foreign currency value of one domestic currency); p_t^* and p_t are the foreign (weighted average of trading countries' prices, where the weights are the amount of the imports over the total imports per the year); and domestic price levels of foreign and domestic goods, respectively, m^*_{t-1} is the foreign real money holdings at the start of the period; d_t is the one-period real domestically financed government debt, which pays risk-free interest rate R; and d_t^* is the real foreign-issued, one-period bond, which pays a risk-free interest rate R_t^*; where d_t and d_t^* are the only two storable financial assets. π_t and π^*_t are domestic and foreign inflation rates, respectively.

Furthermore, Kia (2006a) assumes variable k_t, which summarizes risk associated to holding domestic money, has the following long-run relationship:

$$\log(k_t) = k_0\, defgdp_t + k_1\, debtgdp_t + k_2\, fdgdp_t. \quad (19)$$

Variables defgdp, debtgdp, and fdgdp are government deficits per GDP, the government debt held by the public per GDP and the government foreign-financed debt per GDP, respectively; where it is assumed government debt pays the same interest rate as deposits at the bank (i.e., R).

Equation (19) is also assumed to be held subject to a short-run dynamics system, which is a function of a set of predetermined short-run (stationary) variables known to individuals (Kia, 2006b). These variables include the growth of money supply, changes in fiscal variables per GDP, the growth in real exchange rate as well as changes in interest rates. Furthermore, it is assumed that the short-run dynamics of the risk variable (log (k)) includes a set of interventional dummies, which account for wars, sanctions, political changes, innovations, and policy regime changes, which influence the services of money. Maximizing the utility function (17) subject to equations (18) and (19) and imposing some stability conditions, Kia (2006a) found the following demand for money relationship:

$$\log(m_t) = m_0 + m_1 i_t + m_2 \log(y_t) + m_3 \log(g_t) + m_4 \log(k_t) + m_5 \log(q_t) + m_6 i^*_t. \quad (20)$$

Where, $i^*_t = \log(R^*_t/1+R^*_t)$, $i_t = \log(R_t/1+R_t)$ and, $m_0 > 0$, $m_1 < 0$, $m_2 > 0$, $m_3 < 0$, $m_4 < 0$, $m_5 = ?$, $m_6 < 0$.

Using the equilibrium condition in the money market, I extend Kia's model to derive the following equation for the nominal effective exchange rate (EE_t =Trade Weighted Exchange Index) in the economy

assuming that the domestic country imports from the different countries.

$$lEE_t = \delta_0 + \delta_1 lp_t + \delta_2 lp^*_t + \delta_3 lms_t + \delta_4 i_t + \delta_5 ly_t + \delta_6 i^*_t + \delta_7 lg_t + \delta_8 defgdp_t + \delta_9 debtgdp_t + \delta_{10} fdgdp_t + v_t, \quad (21)$$

where an l before a variable means the logarithm of that variable, ms is the real money supply, and v is a disturbance term assumed to be white noise with zero mean. δs are the parameters to be estimated. Since the coefficient of log(q) in Equation (19), m_5, cannot be determined a priori, the sign of none of the δs can be determined theoretically. It should be noted that $\delta_1 = \delta_2 = 1$. Let us assume p* is the weighted average of the import prices index, where the weights are the percentage of the import from each country. Since data on such a weighted average price does not exist, we assume p* is a constant proportion of the advanced countries' consumer price index. Specifically $lp^* = \Omega\ lwp^*$, where Ω is a constant parameter, and wp* is advanced countries' consumer price index calculated by the International Monetary Fund. Substituting for lp* in (21), we will have the following:

$$lEE_t = \delta_0 + \delta_1 lp_t + \epsilon\ lwp^*_t + \delta_3 lms_t + \delta_4 i_t + \delta_5 ly_t + \delta_6 i^*_t + \delta_7 lg_t + \delta_8 defgdp_t + \delta_9 debtgdp_t + \delta_{10} fdgdp_t + v_t, \quad (22)$$

where $\epsilon = \delta_2\Omega$.

VI. Data, Long-Run Empirical Methodology and Results

I will estimate Equation (22) on U.S. data, where EE is the average of daily figures. In other words, it is 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.[1] The data on the advanced countries' consumer price index and three-month Euro Offer rate (for R*) are taken from the *International Financial Statistics* (IFS) online. All other data are taken from the St. Louis database FRED. The sample period is 1973Q1-2008Q4. Following Kia (2006a), I used M1 for the money supply and the three-month, treasury bill rate for R, where this rate is adjusted to a 365 basis.

Following Kia's (2006b) suggestion, I also allow the short-run dynamics system to be affected by policy regime shifts and other exogenous shocks, which could affect the exchange rate during the sample period 1973Q1 to 2008Q4.[2] 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 started on August 2007. (iv) Furthermore, I let the short-run dynamics of the system to be affected by the terrorists attacks on September 11, 2001, crisis because this crisis created uncertainty in the financial markets. To investigate whether a different exchange rate policy existed between political parties, which were in power during the sample period, I let the short-

[1] For more information about trade-weighted indexes see http://www.federalreserve.gov/pubs/bulletin/2005/winter05_index.pdf.

[2] Note that since the data on the effective exchange rate is available only from 1973 our sample period starts from 1973Q1.

run dynamics of the system also be affected by the party in power. For example, it is possible that the Republicans who were in power may have used a different strategy toward the exchange rate than the Democrats would have used. Accordingly, the following dummy variables used to represent these potential policy regime shifts and exogenous shocks were constructed: pwar = 1 from 1990Q3-1991Q1, and = 0, otherwise, nafta = 1 since 1994Q1 and = 0, otherwise, awar = 1 since 2001Q4 and = 0, otherwise, credit = 1 since 2007Q3 and = 0, otherwise, . sep11 = 1 for 2000Q1 and = 0, otherwise and rep = 1 for the periods Republicans were in power and = 0, otherwise.

To investigate the stationarity property of all variables, I used Augmented Dickey-Fuller and non-parametric Phillips-Perron tests. Furthermore, to allow for the possibility of a break in intercept and slope, I also used tests developed by Perron (1997) and Zivot and Andrews (1992). According to the test results, all variables, except deficit per GDP, are integrated of degree one (non-stationary). The variable deficit per GDP is stationary according to Augmented Dickey-Fuller and non-parametric Phillips-Perron as well as Perron (1997) test results, but only at a 5 percent level of significance. The variable is not stationary according to the Zivot and Andrews (1992) test result. The first differences of all these variables are stationary, except the domestic interest rate, the debt per GDP and the government foreign-financed debt per GDP, according to the Zivot and Andrews (1992) test result. The graphical demonstration of the changes in these variables indicates these changes are stationary. Furthermore, since rational agents do not hold the debt of a government if its changes are not stationary, let us ignore the result of Zivot and Andrews (1992) test and accept the result of all other tests as reflecting more accurately the reality. For the sake of brevity, these results are not reported but are available upon request.

I analyzed a p-dimensional vector autoregressive model with Gaussian errors of the following form:

$$X_t = A_1 X_{t-1} + \ldots + A_k X_{t-n} + \mu + \phi DUM_t + u_t,\ u_t \sim niid(0, \Sigma), \quad (23)$$

where $X_t = [lp_t, lwp^*_t, lms_t, i_t, ly_t, i^*_t, lg_t, defgdp_t, debtgdp_t, fdgdp_t]$, μ is $p \times 1$ constant vector representing a linear trend in the system. The p-dimensional Gaussian X_t is modeled conditionally on long run weakly exogenous variables lwp^*_t, li^*_t and the short-run set of $DUM_t = (Q1_t, \ldots, Q4_t$, intervention dummies and other regressors that we can consider fixed and non-stochastic), where Q's are centered quarterly seasonal dummy variables.[3] The interventional dummies include variables, which account for the Persian Gulf War, the North American Free Trade Act (NAFTA), the Afghanistan's war, the credit crunch, the September 11 crisis, and the party in power. Therefore, we will have $DUM_t = (Q1_t, \ldots, Q4_t, pwar_t, nafta_t, awar_t, credit_t, sep11_t, rep_t)$. Note that DUM appears only in the short-run dynamics of the system. Parameters $A_1, \ldots, A_k$, ϕ, and Σ are assumed to vary without restriction.

The error correction form of the model is a follows:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{n-1} \Delta X_{t-n+1} + \Pi X_{t-n} + \mu + \phi DUM_t + u_t, \quad (24)$$

where Δ is the first difference notation, the first n data points $X_{t-1}, \ldots, X_0$ are considered fixed and the likelihood function is calculated for given values of these data points. Parameters $\Gamma_1, \ldots, \Gamma_{k-1}$ and Π are also assumed

[3] Note that, being a large country, United States can influence world price and interest rate. However, since our dependent variable is the exchange rate we can assume the variables lwp^*_t, li^*_t are weakly exogenous.

to vary without restriction. However, the hypotheses of interest are formulated as restriction on Π..

In determining a long-run relation between the effective exchange rate and its determinants, conditional on the foreign price level and the interest rate, we need to test whether the effective exchange rate level contributes to the co-integrating relation. If Π has a reduced rank, we want to test whether some combinations of X_t have stationary distributions for a suitable choice of initial distribution; whereas, others are non-stationary. Consequently, we need to find the rank of Π, i.e., r.

In determining the lag length, one should verify if the lag length is sufficient to get white noise residuals. As was recommended by Hansen and Juselius (1995, p. 26), set p=r in Equation (24) and test for autocorrelation and ARCH. LM(1) and LM(2) will be employed to confirm the choice of lag length. The order of co-integration (r) will be determined by using Trace test developed in Johansen and Juselius (1991). Following Bartlett a correction factor is used to adjust Trace test in order to correct for a potential bias possibly generated by a small sample error. Since we allow the short-run dynamics system to be affected by a dummy set DUM, the critical values of the Trace test should be simulated. CATS 2 in RATS computer package was used to simulate the critical values. The number of replications was 2,500 with a length of random walks of 400. Table 1 reports the result of the Trace test[4].

According to diagnostic tests reported in this table, the lag length 3 was sufficient to ensure that errors are not autocorrelated. Furthermore, according to the LM(2) result, the error is not heteroscedastic. According to the normality test result (not reported but available upon request), the errors are not normally distributed. However, a departure from normality is not very serious in co-integration tests [(see Hendry and Mizon (1998)]. Trace test result reported in Table 1 reject $r \leq 0$ while we cannot reject $r \leq 1$, implying that $r=1$.

The bottom panel of Table 1 reports the long-run co-integrating relationship normalized on lEE. All variables, except outstanding debt per GDP and foreign-financed-debt per GDP are statistically significant. The estimated coefficient of the domestic price is positive implying that a higher domestic price results in a higher value of the effective exchange rate (appreciation of the U.S. dollar). One would expect that as domestic price increases exports fall; and imports increase, which results in a lower value of the U.S, dollar. However, if demand for U.S. exports is price inelastic over the long run, a higher domestic price results in a higher demand for the U.S. dollar and an increase in the value of U.S. dollars. A further support for this inelastic export demand can be seen by the impact of the world price on the effective U.S. exchange rate. The estimated long-run coefficient of this variable is negative indicating that as the world price increases, given the U.S. domestic price, the inelastic long-run demand for U.S. exports results in not as much change in the amount of U.S. exports but at a relatively lower price. This results in a lower cost for the imports from the U.S. and, therefore, less demand for the U.S. dollar. As the demand for the U.S. dollar, over the long run, falls, its foreign currency value will go down as the estimated coefficient indicates.

[4] Note that I allowed δ_1 in Equation (22) to be determined by the data rather than impose $\delta_1=1$ restriction.

Table 1: Long-Run Test Results*

Tests of the Cointegration Rank											
H_0=r	0	1	2	3	4	5	6	7	8	Diagnostic tests** *p-value*	
Trace[(1)]	285.91	140.93	93.32	85.23	57.07	52.61	20.20	15.58	na	Test for Autocorrelation LM(1) 0.02 LM(2) 0.15	
p-value[(1)]	0.00	0.99	1.00	0.99	0.99	0.84	0.99	0.89	na	Test for ARCH LM(1) 0.02 LM(2) 0.09 Lag length = 3	
Normalized	**lp**	**Lwp***	**Lms**	**i**	**ly**	**i***	**Lg**	**defgdp**	**debtgdp**	**Fdgdp**	**constant**
lEE	1.33	-0.66	-0.73	-0.33	4.16	-0.31	-3.28	-4.94	1.02	-1.58	-3.80
(t-statistics)	(4.21)	(-4.02)	(-2.25)	(-2.22)	(5.54)	(-2.07)	(-5.69)	(-3.32)	(1.82)	(-1.90)	(-2.99)

(1) Using Bartlett correction both Trace test and *p-value* have been corrected for small sample. CATS 2 in RATS computer package was used to simulate the critical values. The number of replications was 2,500 with a length of random walks of 400.

* The sample period is 1973Q1-2008Q4. The short-run dynamics system is affected by the interventional dummies which account for the North American Free Trade Act (NAFTA), party-in-power changes and Credit Crunch as well as seasonal dummies. The definitions of the variables are: lEE is the log of nominal effective exchange rate (foreign currency values of $US), lp is the log of CPI, lwp* the log of world's CPI, lms is the log of nominal money supply (M1), i is the log[R/(1+R)] where R is domestic interest rate in decimal points, ly is the log of real GDP, i* is the log[R*/(1+R*)] where R* is foreign interest rate in decimal points, lg is the log of real government expenditures on goods and services, defgdp and debtgdp are deficits and outstanding debt per GDP, respectively, fdgdp is the amount of foreign financed debt per GDP.

** LM(1) and LM(2) are one and two-order Lagrangian Multiplier test.

The estimated coefficient of the money supply is negative, implying that a higher money supply results in a lower value of the U.S. dollar. This result could be because, as the money supply increases, there will be an expected increase in inflation over the long run, which leads to a lower demand for the U.S. dollar; and, therefore, the U.S. dollar depreciates. The estimated coefficient of the interest rate, government expenditure, and deficits per GDP is also negative[5].

A higher deficit per GDP results in a lower demand for U.S. dollars, see equations (19) and (20); and, therefore, the U.S. dollar depreciates. From equation (20), a higher government expenditure results in a lower demand for money, which in turn leads to a higher demand for goods and services—including foreign-produced goods and services. This leads to a higher demand for imports and consequent demand for foreign currencies. Consequently, the U.S. dollar depreciates. The estimated coefficient of the real income is positive implying that a

5 A potential explanation is that as interest rates increase, the cost schedule of each firm will go up and results in higher cost-push inflation, leading to a depreciation of US dollar.

higher income causes the U.S. dollar to appreciate. This result contradicts the conventional belief that a higher income results in a higher demand for imports and depreciation in the currency. One possible explanation for a positive estimated coefficient of the real income is that a higher income in the U.S. over the long run may be seen, by foreign investors, as evidence of future growth in the economy. This perceived growth may further increase the belief that the U.S. dollar is a safe haven, which causes a higher demand for the U.S. dollar and a higher value of the currency.

The estimated coefficient of the foreign interest rate is negative. As the foreign interest rate increases, there will be an outflow of capital resulting in a depreciation of the U.S. dollar. The estimated coefficient of the outstanding debt per GDP is positive, a wrong sign; but it is statistically insignificant. The estimated coefficient of the debt financed by foreign funds is negative, but weakly significant (at 10 percent level of significance). One possible explanation for this result is that as the debt financed externally increases, the demand for U.S. dollars increases and results in its appreciation.

Are these long-run coefficients stable? Figure 1 plots the calculated values of the recursive test statistics for the long-run relationship. The figure shows the time paths of the test of the hypothesis that the full-sample estimate of the coefficients is spanned by the estimate of the coefficients for each subsample. The line X(t) plots the estimate of all parameters in each step; whereas, the line R1(t) plots re-estimating only the long-run parameters, concentrating out the short-run dynamics using the full sample estimates of the parameters. I hold up the first 21 years for the initial estimation. As Figure 1 reveals, except for the beginning of the recursive, but from 1997Q3 onward, the hypothesis is accepted in each step for all estimated coefficients. As for the estimated long-run coefficients adjusted for the short-run dynamics [R1(t)], the coefficients are stable over the entire recursive period. Figure 2 depicts recursive estimate of each parameter. As we can see, all coefficients are within their confidence intervals and are, therefore, stable.

Figure 1: Cefficients' Constancy Tests

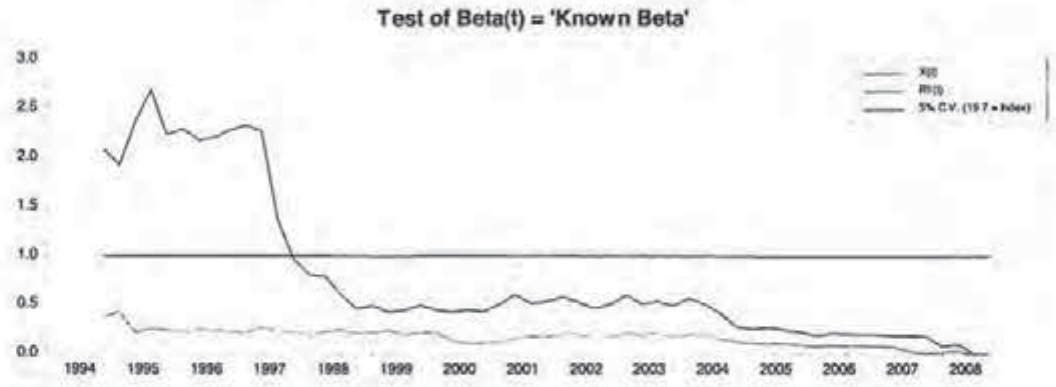
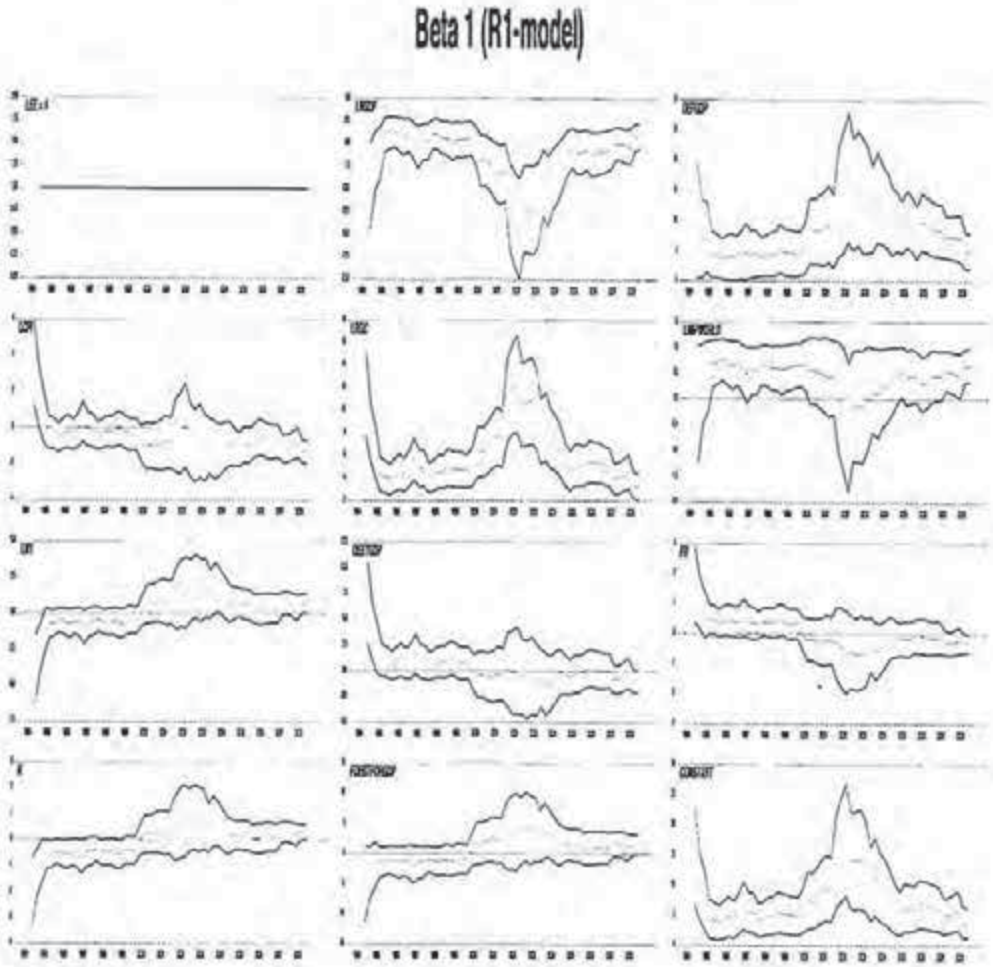


Figure 2: Recursive Test for Each Coefficient



VII. Short-Run Dynamic Model of Effective Exchange Rate

In this section we specify the ECM (error correction model) that is implied by our co-integrating vector, which was estimated in the previous section. Following Granger (1986), we should note that if small equilibrium errors can be ignored, while reacting substantially to large ones, the error correcting equation is non linear. All possible kinds of non linear specifications, i.e., squared, cubed and fourth powered of the equilibrium errors (with statistically significant coefficients) and the products of those significant equilibrium errors were included.

To avoid biased results, I allowed for a lag profile of four quarters. To ensure parsimonious estimations, I selected the final ECMs on the basis of Hendry's General-to-Specific approach. Since there are nine endogenous variables in the system, we may have eight error-correction models. However, for the sake of brevity, I only report the parsimonious reduced form of ECM for the effective exchange rate. Table 2 assembles the estimation result. In Table 2, White is White's (1980) general test for heteroskedasticity, ARCH is five-order Engle's

(1982) test, Godfrey is five-order Godfrey's (1978) test, REST is Ramsey's (1969) misspecification test, Normality is Jarque-Bera's (1987) normality statistic, L_i is Hansen's (1992) stability test for the null hypothesis that the estimated ith coefficient or variance of the error term is constant, and L_c is Hansen's (1992) stability test for the null hypothesis that the estimated coefficients as well as the error variance are jointly constant.

None of these diagnostic checks is significant. According to Hansen's stability test result, all of the coefficients, individually or jointly, are stable. Both level and interactive combinations of the dummy variables included in the set DUM were tried for the impact of these potential shift events in the model. As was mentioned in the previous section, DUM also appeared in the short-run dynamics of the system in our co-integration regression.[6] As we can see, only the error-correction term and the lag dependent variable are statistically significant. This result implies that over the short run the effective exchange rate is independent of debt, deficits, domestic and foreign inflation rates, as well as the debt management, i.e., the outstanding debt financed domestically or by foreign investors. However, as it was reported in Table 1, the effective exchange rate is highly influenced by these variables over the long run.

VIII. Concluding Remarks

The monetary approach continues to be one of the important tools used to explain the variation in exchange rates. In the early 1980s, it appeared certain that no research support for this approach was available. However, with improved statistical tools and a more precise specification of the model, recent research has established the long-term validity of the monetary approach to exchange rate determination.

This paper presented an expanded model of the monetary approach, which includes three fiscal variables that were shown to have an impact on inflation (Kia, 2006). This model was used to examine the exchange rate between the U.S. dollar and currencies from a group of U.S. trade partners. The results provide support for the long-term validity of the monetary approach to exchange rate determination. In addition, deficits and outstanding debt financed domestically or by foreign investors do impact the effective exchange rate in the long run, but not in the short run. Specifically, over the short run, the effective exchange rate is independent of debt and deficits. Despite initial discouraging support for the monetary model of exchange rate determination, recent support for the model continues to mount.

[6] Note that, since none of our dummy variables was found to be statistically significant it seems the recent financial crisis did not have any effect on the effective exchange rate. Furthermore, we could not find any support for the view that the republican party, when it is in power, follow a policy of weak U.S. dollar to improve the balance of trade.

Table 2: Error Correction Model for the Effective Exchange Rate*

Dependent Variable	**ΔIEE**		
Independent Variables	**Coefficients**	**Standard Error**	**Hansen's (1992) Li stability test *p*-value**
ΔIEE_{t-1}	0.33	0.08	0.50
EC_{t-1}	-0.02	0.007	0.43
L_i test on variance	*p*-value = 0.64		
Joint L_c test	*p*-value = 0.59		
$\bar{R}^2$=0.13, σ=0.02, DW=1.66, Godfrey(5)=0.88 (significance level=0.51), White=3.42 (significance level=0.63), ARCH(5)=0.51 (significance level=0.99), RESET=0.03 (significance level=0.99) and Normality, Jarque-Bera = 4.99 (significance level=0.08).			

* The estimation method is the Ordinary Least Squared. The sample period is 1973Q1-2008Q4. Δ means the first difference, Δ IEE is the change in the log of effective exchange rate. EC is the error-correction term.

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