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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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## Abstract

This paper reviews the monetary approach to exchange rate determination. This approach is based on the money market equilibrium and, therefore, the paper also 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 1970's 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. The shortcoming of the monetary approach to exchange rate determination so far in the literature is that demand for money could also be affected by fiscal variables which were ignored in this exchange rate determination. 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.

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## 1. Introduction

The exchange of currency and accompanying rates of exchange are critical factors in the successful operation of international trade. Since the implementation of the floating exchange rate system in 1973, there has been considerable volatility in the behavior of these exchange rates. As businesses and governments tried to understand exchange rate movement, it became apparent that more effective and comprehensive models of exchange rate determination needed to be developed. A popular approach to understanding exchange rates is the monetary approach. Jacob Frenkel suggested that the conversion to floating exchange rates in 1973 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 thirty-five years, the monetary approach to understanding exchange rates "has become the dominant model of exchange rate determination" (Diamandis and Kouretas, 1996, p. 351). The exchange rate is the relative price of one country's currency with respect to another's, and as such, factors that affect price levels are an important focus of analysis. Monetary theory offers significant insight into this analysis. What is the status of the monetary approach to understanding exchange rates today? Is it still a useful approach? How has the monetary model of exchange rates evolved over the years? What monetary factors are most important in determining the exchange rate? To what extent have advancements in statistical techniques contributed to our understanding of the monetary approach to exchange rate determination? This paper will summarize the research in light of these questions and identify avenues for further research.

The remainder of this paper is divided into five sections. Section 2 will provide a brief overview of the evolution of the monetary approach. Section 3 will outline the initial monetary model of exchange rate determination used in the 1970s. Section 4 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 monetary model. Section 5 will introduce the model. Section 6 is devoted to the data and long-run results. The error-correction test results are given in Section 7. The final section provides some concluding results.

## 2. The Evolution of the Monetary Model

The development of the monetary model of exchange rate determination has a long and rich history. Understanding the contributions made by early thinkers can help clarify the conceptual underpinnings of the model and its application today. Three fundamental concepts have influenced the current construction of the monetary model. There are the quantity theory of money, the Cambridge cash-balance approach, and Keynesian monetary theory.

### 2.1 The Quantity Theory of Money

During the 15$^{th}$ and into the 16$^{th}$ century, there was a steady increase in prices in Europe. Jean Bodin (1530-1596), a French mercantilist, attributed this increase in prices 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. Contemporary economic theory claimed that a country could maintain a positive inflow of gold and silver by controlling imports and exports. If a country exported more than it imported, it could continue to build its capital assets indefinitely.

John Locke (1632-1704) helped to clarify the relationship between the supply of money and price levels. If the supply of money increases, prices will rise. If the supply of money decreases, prices will decrease. As a result, the price of foreign goods as compared to domestic goods will rise. Both scenarios are bad for the economy. David Hume (1711-1776) claimed that the accumulation of gold by restricting imports would not increase the wealth of a nation. As the supply of money increases, there might be a corresponding increase in the prices of goods. However, this increase in gold would not necessarily result in greater wealth in the country. Furthermore, any increase in domestic prices would encourage imports with lower prices. This in turn would limit the positive impact of exports.

Adam Smith (1723-1790) also saw the folly 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’s monetary approach rejected “the quantity theory on the grounds that causality runs from prices to money in the small open economy, contrary to the predictions of the quantity theory” (Humphrey, 1981, p. 10). This difference set up an ongoing debate about the causal effect of money. The monetary approach suggests that money supply raises domestic prices which affects the exchange rate. A balance of payments approach proposes that real factors affect the balance of payments which impacts the exchange rate which affects domestic prices.

The monetary approach started to take shape with the Swedish Bullionist controversy that took place in the mid 1700s. Sweden dropped its monetary system based on metal and fixed exchange rates in favor of a paper system with flexible exchange rates. The result of this move was a substantial rise in prices. One political group (the Hat Party) claimed that the cause of the rise in prices was the adverse trade balance which “had produced a depreciating exchange, that exchange depreciation had rendered imported goods more expensive, and that the rise in import prices had spread to the rest of the economy thereby raising the general level of prices” (Humphrey, 1978, p. 2). On the other hand, the Cap Party blamed inflation and the depreciation of the Swedish mark on the Swedish central bank which issued too many banknotes, thus increasing the supply of money. This monetary expansion drove up prices and drove down the exchange rate (Humphrey, 1978). This explanation was a direct application of the quantity theory of money.

A similar debate occurred in England around 1800 when the British had their own bullionist controversy. This time David Ricardo, John Wheatley and other economists continued the emphasis on the quantity theory of money as the foundation of the monetary approach to exchange rates. They were able to show that the exchange rate varied proportionally with the relative supply of money. In 1911 Irving Fisher in the *Purchasing Power of Money* presented his now famous “equation of exchange.”

$$MV = PT \tag{1}$$

$M$ 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. Fisher proposed that since *V* and *T* were fixed with respect to the money supply, therefore, *M* has a direct relationship to *P*. The growth of the money supply will increase prices. From this brief overview of the development of the quantity theory of money, we have the fundamental concepts that are the underpinnings of the contemporary monetary model of exchange rates.

## 2.2 The Cambridge Cash-Balance Approach

The Fisher model assumes that the total number of transactions and the turnover of money are constant. Money is seen as solely 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 used in Fisher's equation of exchange. Money (M1) is defined as currency in circulation plus current accounts (demand deposits). It is a store of value for future use, or a hedge against uncertain events. How much money is needed to cover current, as well as future, needs depends on one's income and other factors such as 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.

**2.3 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. This is the Keynesian transaction demand for money. Keynes also pointed out that there is a cost to holding money. It can be placed in financial assets that earn interest. Keynes refers to this as the speculation demand for money. Consequently, there is a relationship 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.

**3. The Monetary Model and Exchange Rates**

In an attempt to explain the volatility in the exchange rate after 1973, economists turned to the three theories outlined above. The quantity theory suggests that at equilibrium the money supply should be equal to money demand.

$$M_d = M_s \tag{3}$$

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:

$$M_s = kPY \tag{4}$$

According to the Law of One Price we have:

$$E = \frac{P}{P^*} \tag{5}$$

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:

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

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

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

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

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

Where e, m, m*, y, and y* are the logarithm of E, M, M*, Y and Y* respectively.  According to Equation (8), a given percentage increase in the home money supply leads to an exactly equivalent depreciation of the currency, while a give percentage increase in the foreign money supply leads to an exactly equivalent percentage appreciation of the currency. As the money supply at home goes up the price will go up by the same proportion and the domestic currency depreciates by the same proportion. Similarly, as the income at home goes up, demand for money will increase, which results in a fall in the demand for good and services as well as prices. This leads to an appreciation of domestic currency.

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:

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

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

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

$e = p – p^*$ (11)

Using (9), (10) and (11) we will have:

$e = (m – m^*) – b(y – y^*) + c(i – i^*)$ (12)

A higher domestic interest rate leads to a fall in demand for money which means an increase in demand for goods and services. This in turn leads to a rise in domestic prices and an increase in the exchange rate (depreciation of domestic currency).

In summary, monetary theory proposes that exchange rates are a monetary phenomenon affected by the money supply, income level and interest rates. Section 4 will outline the development of the research on the monetary model of determining exchange rates since the 1970’s

**3.1 The Flexible-Price Monetary Approach to 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 $\pi$ is the expected inflation rate. It is further assumed $r=r^*$ and are constant. Substitute for i and $i^*$ in Equation (12) and use the assumption of constant and equal real interest rate to get:

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

In sum, the flexible-price monetary model is based on the assumptions that prices are fully flexible, bonds are perfect substitutes and what matters for exchange-rate determination is the demand for money in relation to the supply of money. Under this model, countries with a higher growth of money have high inflationary expectations which lead to a reduction in the demand for real balances. This in turn results in an increase in expenditures on goods and services, a rise the domestic price level and a depreciation in the domestic currency in order to maintain Purchasing Power Parity (PPP)

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

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

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

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 its unrestricted form:

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

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 $\gamma_6 < 0$.

Frenkel (1976) uses the concepts of the monetary approach outlined above to examine the determinants of the exchange rate during the German hyperinflation. In his study of the German hyperinflation, he found support for the monetary model of exchange rates and the relationship between money, prices, expectations and the exchange rate. The coefficients were similar to the predictions of the model.

**3.2 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. As domestic money supply decreases relative to domestic money demand, there will not be a matching drop in prices. The domestic interest rate will rise with regard to foreign interest rates creating an inflow of foreign capital. Domestic currency will appreciate immediately. The result is a negative relationship between the exchange rate and nominal interest rate. Dornbusch states 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.

### 3.3 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 develops an integrative approach that combines 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.

## 4. Empirical Evidence for the Monetary Approach to Exchange Rate Determination

Frenkel (1976), Bilson (1978) and Frankel (1979) were among the first to provide empirical support for the monetary approach to exchange rate determination. The period from the mid-1970s to the early 1980s has been referred to as "the heroic age of exchange theory" Krugman (1993, p. 6). Despite the early support for the monetary approach to exchange rate determination, research in the 1980s turned significantly against the model to the point that Krugman suggested "the theory of exchange rate determination has never recovered from the empirical debacle of the early 1980s" (Krugman, 1993, p. 7).

Ironically Bilson, who developed one of the original monetary models of the exchange, was one of the first to find conflicting results (Bilson, 1979). He attributed these negative results to the fact that the PPP condition does not apply in the short-run. Also, nominal interest rates are not exogenous as originally thought. Other studies revealed an absence of statistically significant coefficients specified in the model. Caves and Feige (1980) tested the monetary model and found no statistical support for it. Huang (1981) looked at the volatility of the exchange rates in an efficient market model of the monetary approach. The empirical results indicated that exchange rates are too volatile to be consistent with the monetary model and/or an efficient market.

Bomhoff and Korteweg (1983) found that important factors affecting the determination of the exchange rate were actually left out of the model. Much of the variation (upwards of 50%) 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) suggested that the poor research finding were the result of faulty specification of the money function. On the other hand, Hoffman and Schlagenhauf (1983) examined the role of expectations about future exchange rates. Perceptions about the future exchange rate can impact the current exchange rate. The monetary model is applied to the dollar/Deutsche mark, dollar/French Franc and dollar/British Pound exchange rates. They conclude that the parameter constraints of the monetary model and the rational expectations hypothesis are consistent with the data.

In the mid 1980s a new focus of attention on the limitation of the monetary model arose – the level of statistics used to evaluate the model and analysis of the data. Baillie and Selover (1987) proposed that the failure of the research to support the monetary approach was due to the statistics used. Work by Engle and Granger (1986) on the cointegration of variables provided a new statistical technique that had promise in reexamining the models of exchange rate determination. Later, Johansen (1988, 1991) developed a multivariate cointegration 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 cointegrating vectors in a data set.

MacDonald and Taylor (1991) used Johansen's approach to analyzing cointegration in their study of three currencies: the pound sterling, the German mark and the Japanese yen. They found at least one cointegrating vector indicating that the monetary model had some long-run validity. In 1993 MacDonald and Taylor, using the cointegration methodology developed by Engle and Granger (1987) and Johansen (1988), analyzed the deutsche mark/US dollar exchange rate during 1976-1990. 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. McKnown and Wallace (1994) applied an expanded monetary model of exchange rates to the currencies of Argentina, Chile and Israel which were experiencing high inflation. Their model included various definitions of money, its opportunity cost, and restrictions on model coefficients. They found strong cointegration 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 Deutschemark, the French franc, and the pound sterling. They concluded that the monetary model is a valid framework to analyze exchange rate determination. Makrydakis (1998) tested the monetary approach to exchange rates with regard to the Korean won-dollar exchange rate. He concludes that the detection of three cointegration vectors among the exchange rate and the monetary fundamentals is evidence of the unrestricted reduced form of the monetary model as a long-term equilibrium theory in the case of the Korean won-U.S. dollar rate.

Diamandis, Georgoutsos, and Koureatas (1998) applied the monetary model of exchange rate determination to examine three key exchange rates: the German mark/ US dollar, the Yen/US dollar and the pound/US dollar. They found two cointegrating vectors between the three bilateral exchange rates. One was related to the monetary model and the other to the uncovered interest parity (UIP). They determined that the monetary model in its forward-looking solution does not hold because the UIP condition did not hold in the long run. However, the unrestricted monetary model is a valid approach to explaining the long run movements of these exchange rates.

Miyakoshi (2000), using the flexible price monetary model, found one cointegrating vector which indicates the long run validity of the monetary model. Also, some of the common monetary restrictions on the model are valid for the Korean Won/German Mark and Korean Won/Japanese Yen. Cushman (2000) studied the Canadian/US dollar. He used the longest data set for this exchange rate, but found no evidence for the monetary exchange rate model. The time span of the data can decrease the power of unit roots or cointegration. Groen (2002) used panel data sets to avoid this problem. Panel-based cointegration 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 fourteen countries from 1973 – 1994. Cointegration tests on the time series data did not provide evidence for the monetary model.

Francis, Hasan and Lothian (2001) point to the role of improved statistical techniques and appropriate research design for the recent evidence supporting PPP and the monetary model of exchange rates. Early studies used whatever monthly and quarterly data were available in addition to simple regression techniques. Recent studies have used long-time series or panel data and more powerful statistical techniques. Studying the Canadian/US dollar exchange rate, they found strong support for the long-run model of exchange rate. Tawadros (2001) studied the Australian dollar/US dollar exchange rate and found a single long-run relationship between 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. The evidence was clear that the monetary model of exchange rate determination is a useful tool to forecast exchange rates.

Expanding the use of panel studies, Rapach and Wohar (2004) found substantial support for the monetary model. These panel tests indicated that the US dollar exchange rates, relative money supplies, and relative income levels are cointegrated. Chin, Azali and Matthews (2007) studied the ringgit-USD exchange rate using the three basic models: the flexible-price monetary model of Frenkel (1976) and Bilson (1978), the sticky-price monetary model of Dornbusch (1976), and the real interest differential model of Frankel (1979). They found that the cointegration results showed that a long-run relationship exists between the variables of the monetary model for the ringgit-USD exchange rate. The estimated coefficients are in line with the Bilson (1978) version of the monetary approach to exchange rates.

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) expand 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 examine 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 cointegrated with these monetary fundamental as well as support for the monetary model when panel techniques.

**5. The Model**

Despite the stronger support for the monetary approach to exchange rates, there remain some limitations. First, it has become more difficult to measure money supply with the growth of term deposits, money market mutual funds and other financial vehicles. 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 expected value of future income and interest rates. Finally, the demand for money may be a function of the risk associated with holding domestic currency. This risk can be a function of public debt per GDP, 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 demand for money equation of Kia (2006a) to derive an equation for the exchange rate which include the fiscal policy variables. Kia (2006a) considers an economy with a single consumer, representing a large number of identical consumers. The consumer maximizes the utility function (16) subject to budget constraint (17), where

$$U(c_t, c_t^*, g_t, k_t m_t, m_t^*) = (1-\alpha)^{-1} (c_t^{\alpha 1} c^{*\,\alpha 2}_t g_t^{\alpha 3})^{1-\alpha} + \xi (1-\eta)^{-1}[(m_t/k_t)^{\eta 1} m^{*\,\eta 2}_t]^{1-\eta}, \quad (16)$$

$$\tau_t + y_t + (1+\pi_t)^{-1} m_{t-1} + q_t (1+\pi^*_t)^{-1} m^*_{t-1} + (1+\pi_t)^{-1} (1+R_{t-1}) d_{t-1} + q_t (1+\pi^*_t)^{-1} (1+R^*_{t-1}) d^*_{t-1} = c_t + q_t c_t^* + m_t + q_t m_t^* + d_t + q_t d_t^*, \quad (17)$$

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 $\tau_t$ 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 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 over 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 R rate of return 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. $\pi_t$ and $\pi^*_t$ 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:

$$\log(k_t) = k_0\, defgdp_t + k_1\, debtgdp_t + k_2\, fdgdp_t. \qquad (18)$$

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 (18) is also assumed to be held subject to a short-run dynamic system, which is a function of a set of predetermined short-run (stationary) variables known to individuals. 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 as well as policy regime changes which influence services of money. Maximizing the utility function (16) subject to equations (17) and (18) and imposing some stability conditions Kia (2006a) finds the following demand for money relationship:

$$\log(m_t) = m_0 + m_1\, i_t + m_2 \log(y_t) + m_3 \log(g_t) + m_4 \log(k_t) + m_5 \log(q_t) + m_6\, i^*_t. \qquad (19)$$

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

I extend Kia's model, using the equilibrium condition in the money market, to derive the following equation for the nominal exchange rate in the economy.

$$lEE_t = \delta_0 + \delta_1\, lp_t + \delta_2\, lp^*_t + \delta_3\, lms_t + \delta_4\, i_t + \delta_5\, ly_t + \delta_6\, i^*_t + \delta_7\, lg_t + \delta_8\, defgdp_t$$

$$+ \delta_9 \text{ debtgdp}_t + \delta_{10} \text{ fdgdp}_t + v_{t,} \qquad (20)$$

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 and since the coefficient of log(q) in Equation (4), $m_5$=?,could not be determined a priori, the sign of none of the δ s can be determined theoretically. It should be noted that $\delta_1 = \delta_2$. Assuming that the domestic country imports from the different countries and, therefore, we need to assume EE is the effective exchange rate (Trade Weighted Exchange Index) and p* is the weighted average of 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* = **Ω** lwp*, where **Ω** is a constant parameter and wp* is a the world consumer price index calculated by International Monetary Funds. Substituting for lp* in (20) we will have:

$$\text{lEE}_t = \delta_0 + \delta_1 \text{ lp}_t + € \text{ lwp}^*_t + \delta_3 \text{ lms}_t + \delta_4 \text{ i}_t + \delta_5 \text{ ly}_t + \delta_6 \text{ i}^*_t + \delta_7 \text{ lg}_t + \delta_8 \text{ defgdp}_t$$
$$+ \delta_9 \text{ debtgdp}_t + \delta_{10} \text{ fdgdp}_t + v_{t,} \qquad (21)$$

where **€** = $\delta_2$**Ω**.

## 6. Data, Long-Run Empirical Methodology and Results

I will estimate Equation (21) on the US data, where E is the average of daily figures. A weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners. 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] Except the data on the advanced countries consumer price index and three-month Euro Offer rate (for R*) which were taken from the *International Financial Statistics* (IFS) online, all other data is taken from St-Louise data base FRED. Because the data on effective exchange rate is available only from 1973 our sample period is 1973Q-2008Q4. Following Kia (2006a) I use M1 for money supply and the Three-month Treasury Bills rate is used for R, where this rate is adjusted to 365 bais.

I also allow the short-run dynamics system will be affected by policy regime shifts and other exogenous shocks which could affect the exchange rate during our sample period 1973Q1 to 2008Q4.[2] These policy regime changes and other exogenous shocks include: (i) The Persian Gulf War which began on 2 August 1990 and ended on 28 February 1991. (ii) The North American Free Trade Act (NAFTA) went into effect on January 1st 1994. This act provided unprecedented freedom in trade among the United States, Canada and Mexico. (iii) On October 7, 2001 the US declares war on Afghanistan. (iv) Credit crunch started in August 2007. Furthermore, I also let short-run dynamics of the system to be affected by the September 11, 2001 Crisis as well as the party which was in power during our sample period. This is because the September 2001 Crisis created uncertainty in the financial market and republicans may have had a different strategy toward the exchange rate than democrats in the US. Accordingly, the following dummy variables 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

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[11] 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 1973Q.

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 the 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 5% level of significance. The variable is not stationary according to 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 only Zivot and Andrews (1992) test result. The graphical demonstration of the changes in these variables indicates these changes are stationary. Furthermore, since, in fact, rational agents do not hold the debt of a government if it is 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.

We analyze a p-dimensional vector autoregressive model with Gaussian errors of the form:

$$X_t = A_1 X_{t-1} + \ldots + A_k X_{t-k} + \mu + \phi \, DUM_t + u_t, \; u_t \sim niid(0, \Sigma), \qquad (22)$$

where $X_t = [lp_t, lwp^*_t, lms_t, i_t, ly_t, i^*_t, lg_t, defgdp_t, debtgdp_t, fdgdp_t]$, $\phi$ 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 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), Afghanistan's war, Credit crunch, and September 11 Crisis. 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 $A_1, \ldots, A_k$, $\phi$, and $\Sigma$ are assumed to vary without restriction.

The error correction form of the model is

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-n+1} + \Pi X_{t-n} + \mu + \phi\, DUM_t + u_t, \tag{23}$$

where $\Delta$ is the first difference notation, the first k 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 $\Pi$ are also assumed to vary without restriction. However, the hypotheses of interest are formulated as restriction on $\tilde{\Pi}$.

Note that the set of dummy variables that constitutes the set of DUM affects only the short-run dynamic of the system. They account for institutional and policy regime changes, which could affect inflation rate in the country. 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 effective exchange rate level contributes to the cointegrating relation. If $\Pi$ has a reduced rank we want to test whether some combinations of $X_t$ have stationary distributions for a suitable choice of initial distribution, while others are non-stationary. Consequently, we need to find the rank of $\Pi$ i.e., r.

[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.

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 p=r in Equation (23) and test for autocorrelation and ARCH. LM(1) and LM(2) will be employed to confirm the choice of lag length. The order of cointegration (r) will be determined by using Trace test developed in Johansen and Juselius (1991). Following Bartlett correction factor is used to adjust Trace test in order to correct a potential bias possibly generated by a small sample error. Since we allow the short-run dynamics system to be affected by dummy set DUM the critical values of Trace test should be simulated. 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. Table 1 reports the result of Trace test.

According to diagnostic tests reported in this table, the lag length 3 was sufficient to ensure that errors are not autocorrelated. Furthermore, according to 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, as it was mentioned by Johansen (1995a), a departure from normality is not very serious in cointegration tests, see also, e.g., 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 cointegrating relationship. All variables, except outstanding debt per GDP and foreign-financed-debt per GDP are statistically significant. The estimated coefficient of domestic price is positive implying that a higher domestic price result in a higher value of the effective exchange rate (appreciation of the US dollar). One would expect that as domestic price increases the exports fall and imports increase which results in a lower value of US dollar. However, if demand for the US exports is price inelastic over the long run, a higher domestic price results in a higher demand for US dollar and an increase in the value of the US dollars. A further support for this inelastic export demand can be seen by the impact of the world price on the effective US exchange rate. The estimated long-run coefficient of this variable is negative indicating that as the world price increases, given the US domestic price, the inelastic long-run demand for the US export results in not as much change in the amount of

## 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*** <br> ***p-value*** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | **Test for Autocorrelation** |
| **Trace(1)** | 285.91 | 140.93 | 93.32 | 85.23 | 57.07 | 52.61 | 20.20 | 15.58 | na | **LM(1) 0.02** <br> **LM(2) 0.15** <br> **Test for ARCH** |
| ***p-value(1)*** | 0.00 | 0.99 | 1.00 | 0.99 | 0.99 | 0.84 | 0.99 | 0.89 | na | **LM(1) 0.02** <br> **LM(2) 0.09** <br> **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 2500 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 US exports, but at a relatively lower price. This results in a lower cost for the import from the US and, therefore, a less demand for the US dollar. As the demand for the US dollar, over the long run, falls, its foreign currency value will go down as the estimated coefficient indicates.

The estimated coefficient of the money supply is negative, implying that a higher money supply results in a lower value of US dollar. This result could be due the fact that, as the money supply increases there will be an expected increase in inflation over the long run which lead to a lower demand for US dollar and its price. This is also true for the estimated coefficient of the interest rate, government expenditure and deficits per GDP. The coefficient of these variables estimated to be negative.[4] The estimated coefficient of the real income is positive implying that a higher income causes the US dollar to appreciate. This result contradicts the conventional believe that a higher income results in a higher demand for imports and a depreciation in the currency. One possible explanation for this result is that a higher income in the US over the long run may be considered, by foreign investors, a further future growth in the economy. Such a growth makes a further increase in the belief that the US dollar is a safe haven which causes a higher demand for the US dollar and a higher value of the currency. The estimated coefficient of the foreign interest rate is negative. As foreign interest rate increases there will be an outflow of capital resulting in a depreciation of the US 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 is negative, but weakly significant (at 10% level of significance). One possible explanation for this result is that as the debt financed externally increases the demand for US dollar increases and result in its appreciation.

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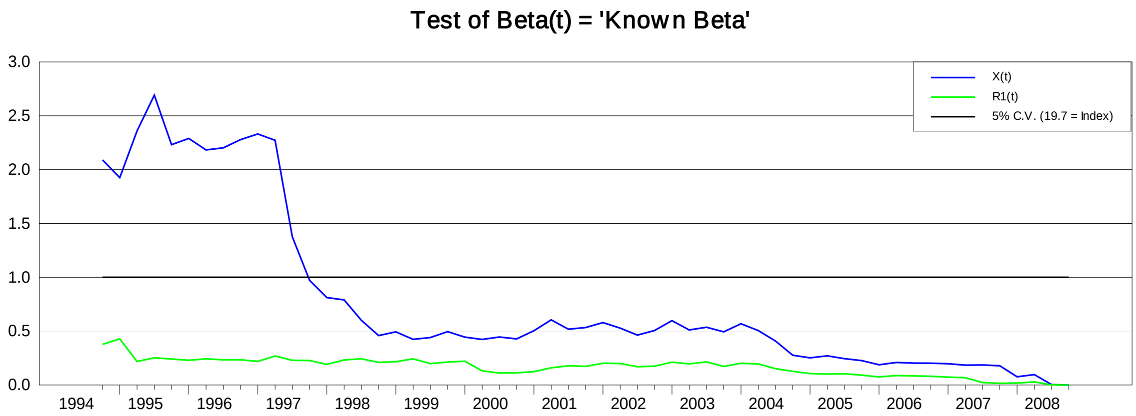
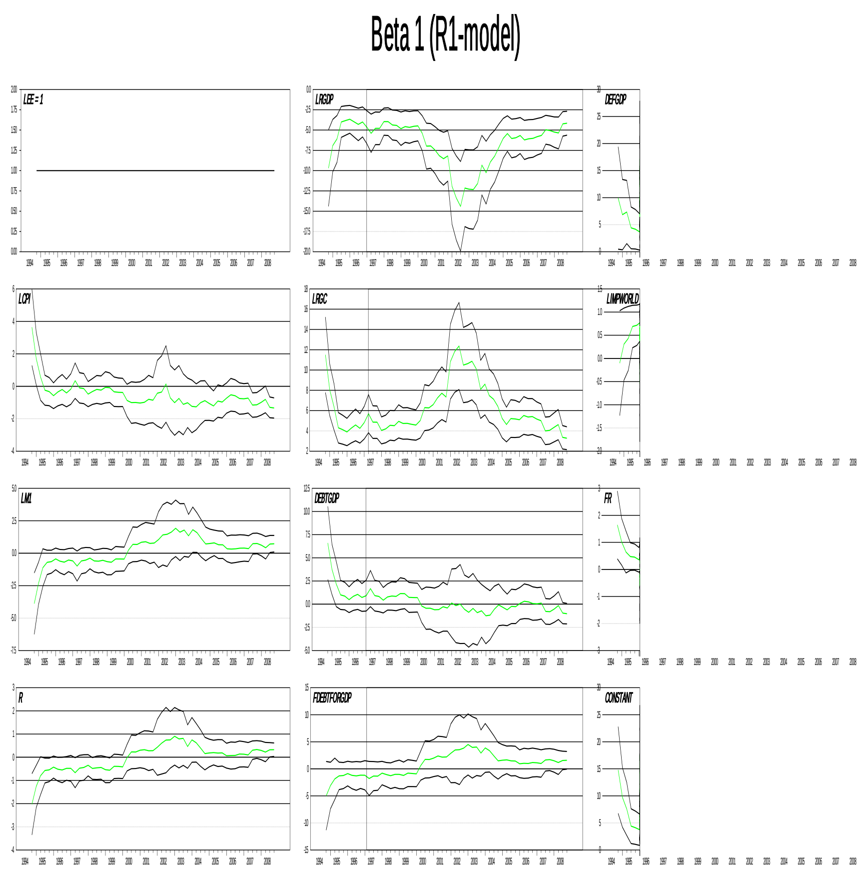
[4] Note that as interests increase the cost schedule of each firm will go up and results in higher cost-push inflation.

The next question is if these long-run coefficients are 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 black line (X(t)) plots the estimated of all parameters in each step, while the broken 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. We hold up the first twenty one years for the initial estimation. As Figure 1 reveals, except for the beginning of the recursive, but from 1997Q3 onwards, 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 so are stable.

## Figure 1: Coefficients' Constancy Tests




## Figure 2: Recursive Test for Each Coefficient



## 7. Short-Run Dynamic Model of Effective Exchange Rate

In this section we specify the ECM (error correction model) that is implied by our cointegrating vector, estimated in 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) as well as the products of those significant equilibrium errors were included.

To avoid biased results, I allowed for a lag profile of four quarters. And, 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 models. As it was mentioned in the previous section, DUM also appeared in the short-run dynamics of the system in our cointegration regression. [5] 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 is financed domestically or by foreign investors. However, as it was reported in Table 1 the effective exchange rate is highly influenced by these variables.

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

| **Dependent Variable** | **ΔlEE** | | |
|---|---|---|---|
| **Independent Variables** | **Coefficients** | **Standard Error** | **Hansen 's (1992) Li stability test *p*-value** |
| $\Delta lEE_{t-1}$ | 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** lEE is the change in the log of effective exchange rate. EC is the error-correction term.

## 8 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 there was no research support for this

[5] 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 they are in power, follow a policy of weak US dollar to improve the balance of trade.

approach. 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, 2006a). This model was used to examine the exchange rate between the US dollar and currencies from a group of US trading 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, support for the model continues to mount.

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