The relative importance of the determinants of the US money supply

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ABSTRACT

This paper examines the changes in the relative importance of the determinants of the US money supply (both narrowly and broadly defined) over the past two decades. Using the cointegration approach and the recently developed technique of dominance analysis, the paper finds the currency ratio to be the main determinant of the US money supply over the sample period, a result in line with others in the literature for earlier periods. However, the findings also indicate that during the peak of the recent financial crisis, 2008-2009, the bank excess reserves ratio emerged as an equally important factor. This was due to the fact that the bulk of the monetary base created by the Fed to counter the crisis ended up as idle bank reserves, thereby significantly limiting the effect of the newly issued monetary base on the money supply.

Keywords: US Money supply, dominance analysis, currency ratio, bank excess reserves ratio, financial crisis

INTRODUCTION

The supply of money is widely heralded as a key determinant of the levels of output and employment in the short run and the level of prices in the long run. As a result, there is a voluminous theoretical and empirical literature on the money supply process, with a view to both examine the changing roles of the determinants of the money supply and to assess the importance of the monetary authorities in major economic and monetary developments. Much of this existing literature, however, predates the recent global financial crisis and its associated massive central bank interventions in the world economy. An updated study of the money supply process, especially in the context of the major industrial countries, should thus provide a more timely assessment of the changing roles of money and monetary policy in the aftermath of the crisis. To this end, this paper conducts an empirical investigation of the major determinants of the money supply in the United States, the epicenter of the crisis, over the past two decades. During this time, both the US money supply and its determinants have experienced substantial changes, unprecedented since the Great Depression of the 1930s. The paper should thus provide an interesting perspective on the role of the US central bank in harnessing the storm unleashed by the Great Recession. A historical examination of the US money supply and its major determinants should also provide useful insights into the changing nature of the US monetary policy against a background of significant institutional changes in the US financial system.

The analytical framework adopted in this paper is the standard money supply model used extensively in the literature (Brunner, 1961; Brunner and Meltzer, 1964; Cagan, 1965). This model expresses the money supply as the product of two key monetary concepts, namely, the monetary base and the money multiplier. Together, these two concepts embrace all the relevant determinants of the money supply, including the policy actions of the Fed, the portfolio decisions of the public and the banking sector, and the effects of the external economic and financial shocks to the financial system. Using some recent advances in the econometrics of time series analysis, the paper makes an attempt to quantitatively measure the relative importance of the major US money supply determinants over the sample period. In particular, the paper is interested in ascertaining whether the US money supply determinants have changed in relative importance during the recent global financial crisis.

The rest of the paper is organized as follows: Section II details the model used in the study and Section III explains the estimation methodology. Section IV presents the money supply process model underlying the study and summarizes the major findings. Section V concludes the study.

MODEL

The basic money supply model used in this paper makes a distinction between the narrow and broad definitions of money, denoted by M1 and M2, respectively. The narrow definition of money, which includes the private holdings of the currency in circulation (C) and the demand deposits (D), refers to the money which is commonly used by the private sector to pay for the purchases of goods and services. Thus:

$$M1 = C + D \quad (1)$$

In contrast, the broad definition of money, which also includes the private holdings of the savings and time deposits (T), refers to the money that is also held as part of the wealth of the private sector. Thus:

$$M2 = C + D + T = M1 + T \quad (2)$$

Furthermore, in a modern economy, and regardless of which definition of money is used, the bulk of the money supply consists of bank deposits. These deposits, which represent the private liabilities of the banking system, are largely issued to acquire financial claims against the private sector. In addition, in a fractional reserve banking system, like the one in the United States, the banking system can create new deposits by lending money as long as they hold reserves (currency) equal to a legally specified fraction of their deposits. This means that the driving force behind changes in the deposits, and, ultimately, the money supply, is the amount of currency issued by the monetary authorities. The monetary authorities, in turn, can create currency by lending money to the various sectors of the economy, as long as this currency creation does not jeopardize the stability of the value of the currency through higher inflation. In addition, as the new loans by the monetary authorities are spent in the economy, a part will stay in circulation as part of the money supply, while the rest is deposited in banks to form bank reserves. To the extent that banks will have more reserves than they need to support their deposits, the new excess reserves can then be used to grant new loans and, hence, create additional deposits.

Based on the foregoing, it is clear that both economic factors and portfolio and policy decisions can ultimately play a role in determining the money supply. To facilitate discussion, it is often found convenient to discuss the factors responsible for changes in the money supply in the context of two separate channels of monetary influence. First, there are some factors which affect the money supply primarily through their impact on the issuance of new currency (monetary base) by the monetary authorities. This is called the monetary base channel. Second, there are those factors which affect the money supply primarily through their effects on the secondary deposit creation abilities of the banking system. This is referred to as the money multiplier channel. These two channels and their corresponding factors in turn will be discussed next.

Monetary Base

The meaning and importance of the concept of the monetary base can best be understood in the context of the central bank (the Fed in the United States) balance sheet:

The Fed Balance Sheet

Assets	Liabilities
FA	C
GA	R
BA	

where,
FA = Net foreign assets (gold + foreign currencies + SDRs – foreign deposits)
GA = Net government assets (government securities – government deposits)
BA = Bank assets (claims against banks)
C = Currency in circulation
R = Bank reserves (currency inside banks + bank deposits at the Fed)
By definition, the two sides of the above balance sheet must balance. Thus:

$$C + R = FA + GA + BA \quad (3)$$

The left hand side of (3), which represents the sum of the currency printed by the Fed and ending up either in circulation or in banks, is commonly referred to as the monetary base (B). This reflects the fact that without the monetary base, there will not be any money in the economy. Thus:

$$B = C + R = FA + GA + BA \quad (4)$$

Or, in terms of the first annual differences (with Δ representing the annual change operator):

$$\Delta B = \Delta FA + \Delta GA + \Delta BA \quad (5)$$

In other words, changes in the monetary base result from changes in the Fed's net foreign assets, net government assets, and claims against the banking sector. Furthermore, under the assumption that the Fed is committed to a policy of price support for the various assets, the right hand side of (5) can be given a clear economic interpretation. For example, should the Fed be committed to defending the external value of the US dollar, the change in the net foreign assets will simply equal the US balance of international payments. Thus, a US balance of payments surplus will result in an inflow of foreign currency into the US, which, in defending the value of the US dollar, the Fed will be forced to buy, hence resulting in an increase in the US monetary base. Similarly, a US balance of payments deficit will cause a decline in the monetary base. Likewise, under a policy of government bond price support, the change in net government assets will reflect the status of the US government budget. For example, a government budget deficit will mean more government bond purchases by the Fed, hence resulting in an expansion of the monetary base. Lastly, should the Fed stipulate a fixed discount rate, the change in claims against the banking sector will reflect the excess demand of the banks for loans from the discount window of the Fed. Clearly, to the extent that the Fed is less than fully committed to her asset price support programs, the foregoing relationships will fail to completely hold. For example, faced by a balance of payments surplus, the Fed may decide to only partially monetize the inflow of foreign currency, thus resulting in both an increase in the monetary base and a strengthening of the value of the US dollar. Of course, the increase in the monetary base will be higher should the Fed decide to prevent an appreciation of the value of the US dollar.

The foregoing should make it clear that the changes in the monetary base are largely caused by the economic forces that mostly reside outside the control of the Fed. Still, the Fed can also initiate her own changes in the monetary base through using some of the powerful monetary policy tools at her disposal. Most of these tools can create changes in the level and composition of the Fed assets. For example, the Fed can initiate the purchase of government securities in the open market, paying for them with the newly issued monetary base, or encourage banks to borrow more from the Fed through lowering the Fed lending rate, again boosting the monetary base. Indeed, in this paper, based on the special conditions in the economy since 1990, the monetary base is largely assumed to be exogenous, that is, under the Fed control. In other words, no attempt will be made to explain the determinants of the monetary base.

Having discussed the concept of the monetary base, now the second key concept in this model of money supply determination, namely, the money multiplier will be explained.

Money Multiplier

To understand the role of the money multiplier in the money supply process, comprehension of the definition of the money supply is essential. To this end, the case for the

narrow definition of money needs to be discussed first, M1, and then turn to the broad definition of money, M2. As stated earlier:

$$M1 = C + D$$

The simple model in this study assumes that the public always holds currency equal to a constant fraction (currency ratio) of their outstanding demand deposits. Clearly, in more realistic models, currency in circulation can be made dependent on the levels of interest rates and income, among other relevant variables. Thus:

$$C = c\ D$$

Hence,

$$M1 = (1 + c)\ D \qquad (6)$$

At the same time, from the definition of the monetary base above, it can be written:

$$B = C + R$$

Also,

$$R = ER + RR \qquad (7)$$

where, ER = excess reserves, and RR = required reserves. That is, total bank reserves consist of their excess and required reserves. Banks hold excess reserves to both accommodate the daily deposit withdrawals of their depositors and to have sufficient cash on hand to meet the unexpected loan demands of their customers. In addition, banks are also obligated to hold mandatory required reserves as both a safeguard against bank runs and as a means of regulating bank lending abilities. The simple model here assumes that banks hold both types of reserves in proportion to their level of demand deposits (since 1990, there are no reserve requirements against the US savings and time deposits), so that:

$$ER = e\ D \qquad (8)$$

and

$$RR = r\ D \qquad (9)$$

where both e (the excess reserves ratio) and r (the reserve requirements ratio) are constant fractions. Again, in more realistic models, the excess reserves ratio can be made dependent on the levels of such economic variables as interest rates and incomes. Thus,

$$R = (e + r)\ D \qquad (10)$$

Furthermore, given the constancy of the reserve requirements ratio against demand deposits over the sample period, it can be essentially ignored in the empirical work. Thus:

$$B = C + R = c\ D + (e + r)\ D = (c + e + r)\ D \qquad (11)$$

Now, dividing (6) by (11), below is obtained:

$$M1/B = (1 + c)D/\ (c + e + r)D = (1 + c)/(c + e + r)$$

or,

$$M1 = [(1 + c)/\ (c + e + r)]\ B \qquad (12)$$

It is customary to refer to the statement inside the brackets on the right hand side of the preceding equation as the money multiplier for M1, and to denote it by m1. That is:

$$m1 = (1 + c)/(c + e + r)$$

Thus,

$$M1 = m1\ B \qquad (13)$$

The above equation, which states that the money supply, narrowly defined, can be written as the product of its corresponding money multiplier and the monetary base is referred to as the Fundamental Money Supply Equation. It is possible to derive a similar equation for the broad definition of money, M2, as follows:

$$M2 = m2\ B \qquad (14)$$

where

$$m2 = (1 + c + t)/ (c + e + r)$$

That is, for both M1 and M2, the money supply always equals the product of the corresponding money multiplier and the monetary base. Thus, the money supply, regardless of how it is defined, can always be influenced either through changes in the monetary base or in the corresponding money multiplier. Furthermore, as shown earlier, changes in the monetary base mostly reflect changes in the economic and financial conditions, such as changes in the balance of payments and the government budget. In contrast, the money multiplier largely captures the effects of changes in the portfolio and policy decisions, as indicated by changes in c, e, t and r. In particular, the effects of the changes in the underlying parameters on the sizes of the money multipliers can be summarized as:

a) $dm1/dc \begin{cases} > \\ = 0 \\ < \end{cases}$ depending on whether: $m1 \begin{cases} < \\ = 1 \\ > \end{cases}$

b) $dm1/de < 0$; $dm1/dr < 0$

Briefly put, the above results predict that the narrow money multiplier generally declines when public decides to carry more currency, banks decide to carry more excess reserves, and the monetary authorities decide to raise the level of reserve requirements. Of course, there is some ambiguity regarding the effect of the changes in the currency ratio on the money multiplier, but for the historically normal values of the narrow money multiplier, even this ambiguity disappears. For example, the above results show that, for values of m1 greater than one, any increase in the currency ratio will lower m1. An examination of the US values for m1 shows that, except for the recent period of the global financial crisis, the value of m1 has indeed always been greater one, resulting in a negative effect of the currency ratio on the narrow money multiplier. Similarly, the following can be written:

c) $dm2/dc \begin{cases} > \\ = 0 \\ < \end{cases}$ depending on whether: $m2 \begin{cases} < \\ = 1 \\ > \end{cases}$

d) $dm2/dt > 0$; $dm2/de < 0$; $dm2/dr < 0$

Again, the above results predict that the broad money multiplier generally declines when public decides to carry more currency or hold less time deposits, banks decide to carry more excess reserves, and the monetary authorities decide to raise the level of reserve requirements. In addition, there is again some ambiguity regarding the effect of the changes in the currency ratio on the broad money multiplier. However, for the historically normal values of the broad money multiplier, greater than one, the currency ratio has again a negative effect on the broad money multiplier.

As it was the case with the monetary base, this paper will only focus on the key determinants of the money multipliers, such as the currency, the time deposit, the excess reserves, and the reserve requirements ratios. In other words, the paper will refrain from explaining the behavior of the afore-mentioned ratios in terms of such other economic variables as interest rates and incomes. There are plenty of precedents in the literature for this approach, and this study just follows their leads (e.g., Brunner and Meltzer, 1964; McCallum, 1989; Garfinkel and Thornton, 1991; and Plosser, 1991).

Having discussed the basics of the simple money supply model in this study, now an application of this model to the money supply process in the United States can be investigated.

Before proceeding any further, however, the estimation methodology is briefly presented in the next section.

ESTIMATION METHODOLOGY

As stated earlier, the main objective of this paper is to identify the chief determinants of the money supply in the United States, and to indicate how these determinants have changed in relative importance over time. To this end, and taking the natural logs of the both sides of (13) and (14) above, it can be expressed the log of the money supply, either M1 or M2, as the sum of the logs of the monetary base and the corresponding money multiplier. In addition, using a linearized version of the money multiplier, the money supply can be approximated by a log-linear function of the monetary base and the determinants of the money multiplier (c, t, e and r). Thus:

$$\text{Ln M1} = \alpha + \beta \ln B + \gamma \ln c + \delta \ln e + \varepsilon \ln r \qquad (15)$$

$$\text{Ln M2} = \alpha' + \beta' \ln B + \gamma' \ln c + \delta' \ln t + \varepsilon' \ln e + \zeta \ln r \qquad (16)$$

The equations (15) and (16) can serve as the relevant regression equations, provided that the underlying data are stationary around a constant or a time trend, with the latter case requiring the inclusion of a time trend in the above equations. However, should the variables be characterized by nonstationarity, that is, if they have unit roots, then the standard regression approach can yield spurious estimation results. Under these conditions, the appropriate approach is the cointegration method with its associated error correction (EC) representations of the money supply equations. More specifically, the empirical methodology follows the assumption that some of the data are nonstationary in levels, but stationary in first differences, that is I(1). This means that the data can be described by a VAR in levels of order p as follows:

$$y_t = \prod_1 y_{t-1} + \prod_2 y_{t-2} + \cdots + \prod_p y_{t-p} + \mu_t \,, \qquad (17)$$

where y_t is a vector of *n* difference-stationary variables and μ_t is a vector of Gaussian white noise errors. The above VAR can be restated in the first differences of the variables as follows:

$$\Delta y_t = \prod y_{t-1} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + \mu_t \qquad (18)$$

Elements of y_t are cointegrated if they have linear combinations that are stationary. Clearly, in the presence of cointegration, such linear combinations can be interpreted as the long run equilibrium relationships among the variables, or, in the present context, as the long run supply function for money. Johansen (1988) has shown that if there are *r* cointegrating vectors, the rank of Π equals $r < n$, such that Π can be factored as the product of two *n* x *r* matrices $(\Pi = -\beta\alpha')$, where α represents the matrix of *r* cointegrating vectors and β represents the matrix of adjustment coefficients. Under the cointegration assumption, equation 18 can be expressed in the following error correction model (ECM) form:

$$\Delta y_t = -\beta Z_{t-1} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + \mu_t \qquad (19)$$

where $Z_t \equiv \alpha' y_t$ represents the error correction terms. It is also seen from equation 19 that, again in the present context, the ECM represents the short run behavior of the supply of money in response to short run shocks to the underlying determinants, as well as to any existing disequilibria in the money market, as captured by the error correction terms.

Having estimated the long run supply of money, given by the cointegrating equations and their associated error correction (EC) equations, then the EC equations can be used to assess the relative importance of the various determinants of the changes in the money supply. To achieve

this latter end, the paper uses the dominance analysis (DA) developed by Budescu (1993) and Azon and Budescu (2003), among others. The DA is based on a definition of relative importance that assesses the contribution of each regressor in all subset regression equations. More specifically, the DA calculates the so-called general dominance weight (GDW) for each regressor by averaging the ΔR^2 obtained by adding the regressor to all possible regression equations containing subsets of all the other regressors. Since the GDWs add up to the total model R^2, their sizes relative to the model R^2 can be used as indices of relative importance for their corresponding regressors. As shown in the next section, the use of the GDWs for the determinants of the US money supply can be used to assess the changing importance of these determinants in recent years, especially after the onset of the Great Recession.

US MONEY SUPPLY PROCESS

This section examines the determinants of the US money supply, both narrowly and broadly defined, over the 1990-2012 period, using the methodology outlined in the preceding section. The starting date of the period under review was chosen to coincide with the removal of the reserve requirements against savings and time deposits in the United States, as assumed in the simple model of this study. The data, which are taken from the Federal Reserve publications, are monthly.

As stated earlier, the money supply can be expressed as the product of the monetary base and the money multiplier, with the money multiplier itself being a function of several key parameters, including the currency ratio, the time deposit ratio, and the excess and required reserves ratios. In addition, it is assumed that the natural log of the money supply can be approximated by a linear function of the natural logs of its determinants. To assess the relative importance of the US money supply determinants, the time series properties of the underlying variables need to be identified. To gain a better insight into the behavior of the US money supply and its underlying determinants, Figures 1 through 4 (Appendix) provide a graphic summary of the time profiles for the logs of these variables over the sample period. Specifically, Figure 1 shows that both the narrow and broad money supplies and the monetary base have steadily increased over time, with the increase in the monetary base particularly dramatic after the onset of the Great Recession. The sharp recent increase in the US monetary base reflects, of course, the unprecedented monetary expansion in the US by the Fed to counter the aftermath of the global financial crisis. In fact, as shown by Figure 1 (Appendix) , the recent sharp increase in the US monetary base has outstripped the increases in both the narrow and broad money supplies in the US, resulting in decreases in both the narrow and broad money multipliers (Figure 2, Appendix). In other words, the positive effect of the sharp increase in the monetary base on the US money supplies has been largely offset by an equally dramatic drop in the US money multipliers. At the same time, Figure 3 (Appendix) shows that the recent declines in the US money multipliers owe much to the sharp increase in the excess reserves ratio, indicating that much of the new monetary base injected into the economy by the Fed has in fact been largely held as idle balances by the banking system. Clearly, had the banking system used the new reserves to grant additional loans, the growth in the money supplies would have been much more dramatic. Finally, Figure 4 (Appendix) shows that in recent years the upward trend in the time deposit ratio has been reversed, contributing to a further decrease in the broad money multiplier. This reversal of the time deposit ration can be attributed to the shift of time deposits from the troubled banks into money market funds, as the public seems to have lost faith in the soundness

and safety of the banking system. In addition, the figures show that while the currency ratio was the main determinant of the money multipliers before the recent financial crisis, the excess reserves ratio has clearly emerged as the main determinant of the changes in the money multipliers after the onset of the crisis.

In what follows, a diagrammatic exposition with some quantitative measures of the changing relative importance of the key determinants of the US money supply over the past two decades is supplemented. Since the determinants of the narrow and broad money supply are not identical, the determinants of each definition of money are treated separately.

Determinants of M1

As a first step to examine the determinants of the US narrow money, the time series properties of the underlying variables are assessed using the Phillips-Perron (1988) unit root test. Before testing for unit roots, however, the appropriate number of lags needs to be determined. Following the Akaike (1974) method, an optimal lag length of six months is selected for all subsequent unit root and cointegration tests. The unit root test results, in which the null hypothesis of a unit root is tested against the alternative of stationarity around a linear trend, are presented in Table 1 (Appendix). It can be seen from the table that, with the exception of the reserve requirements ratio which is stationary, all the relevant variables in the model are characterized by unit roots. The reserve requirements ratio is stationary, simply because it has remained essentially constant at around 10 percent for the entire sample period. Given these findings, it is clear that the cointegration method is the appropriate tool of analysis for the money supply process. To this end, the Johansen (1988) trace test is used. The Johansen trace test is based on the null hypothesis that there are at most r cointegrating vectors. As indicated in Table 2 (Appendix), based on the trace test, there is only one cointegrating vector for The US narrow money. In addition, the cointegrating equation, which expresses the long run narrow money supply as a linear function of its determinants, is given below:

$$m1 = 0.758b - 0.250c - 0.088e - 0.441r$$

where all the signs are as expected. As stated earlier, the residual from the above cointegrating equation can be used to estimate the corresponding error correction (EC) equation, which captures the short run dynamics of the narrow money supply process. The EC equation will then be used to assess the changes in the relative importance of the various determinants of the US narrow money over the past two decades. To this end, as indicated before, the paper uses the dominance analysis (DA), in which the relative importance of each determinant is assessed by first averaging the ΔR^2 obtained by adding this determinant to all possible EC equations containing subsets of all the other determinants. By dividing the average $\Delta R2$ for each determinant by the total model R^2, an index of relative importance for that particular determinant can be obtained.

Before conducting a dominance analysis, a breakdown of the growth rate of the narrow money supply in terms of the growth rates of the two key underlying concepts of the monetary base and the narrow money multiplier is shown in Table 3 (Appendix). As the table shows, the monetary base has consistently been an important factor behind the changes in the US supply of narrow money over the sample period. However, during the peak of the crisis, 2008:3-2009:3, the sharp increase in the monetary base, some 64 percent, resulted in an increase of only 12 percent in the narrow money supply. This was caused by a drastic decline in the money multiplier, 51 percent, itself caused by a sharp increase in the excess reserves ratio.

The results of the dominance analysis for the US narrow money supply are presented in Table 4 (Appendix). To determine whether there has been any change in the relative importance of the determinants of the narrow money supply over the past two decades, the indices of relative importance for three subsets of the sample period, namely, the pre-crisis 1990:1-2008:2 period, the crisis 2008:3-2009:3 period, and the post-crisis 2009:4-2012:1 period are presented. The crisis period refers to the peak of the global financial breakdown between March 2008, when the investment firm Bear Sterns went bankrupt, and March 2009, when the global stock markets bottomed out. It can be seen from the table that, with the exception of the crisis period, the currency ratio has been consistently the most important determinant of the changes in the US narrow money supply over the entire sample period, accounting for roughly 58 percent of the changes in the US narrow money. This finding conforms with others in the literature, which have also found the currency ratio to be the dominant factor in changes in the US narrow money, albeit for the earlier periods (e.g., Cagan, 1965). During the crisis period, however, the sharp increase in the US excess reserves ratio somewhat dominated the effects of the currency ratio. Specifically, during the crisis period, the importance of the currency ratio dropped to only 32 percent, while that of the excess reserves ratio climbed from 20 percent to 32 percent. In particular, the increase in the share of the excess reserves ratio is simply indicative of the fact that most of the increases in the monetary base to combat the financial crisis were simply added to bank excess reserves, instead of lending, thus muting the effect of the expansionary monetary policy on the narrow money supply. The sharp increase in the level of excess reserves reflects a combination of two factors. First, given the great uncertainty in the economy, many banks have simply been too risk averse to offer any new loans. In addition, many borrowers, both consumers and businesses, have been busy deleveraging their existing debts and, thus, reluctant to assume any additional debt burdens. At the same time, as the table shows, once the effects of the dramatic and sudden increases in the monetary base were worked out through the banking system, the relative importance of the monetary base and the excess reserves ratio declined during the post-crisis period, as both of these variables continued to remain at their new stable levels. In fact, during the post-crisis period, the relative importance of the monetary base dropped sharply from 24 percent to only 7 percent, while that of the excess reserves ratio declined from 32 percent to only 8 percent.

Determinants of M2

As it was the case for the narrow money supply, before assessing the determinants of the changes in the US broad money supply, the time series properties of the underlying variables need to be examined. This task, however, has already been accomplished in Table 1(Appendix), where the broad money and the time deposit ratio were also found to have unit roots. This means that the Johansen cointegration method needs to be used to find the long run relationship between the broad money and its determinants, which now also includes the time deposit ratio. To this end, once again the Johansen trace test is used. As indicated in Table 5 (Appendix), based on the trace test, there are three cointegrating vectors for the US broad money, although only one of them has the expected coefficient signs. In addition, the cointegrating equations, which express the long run broad money supply as a linear function of its determinants, are given below:

$$m2 = 0.850b - 0.500c + 0.70tt - 0.095e - 0.389rr$$
$$m2 = 0.306b + 0.349c - 0.254tt - 0.045e + 1.211rr$$
$$m2 = 0.810b - 0.183c + 0.107tt - 0.106e + 2.215rr$$

As stated earlier, the residuals from the above cointegrating equations can be used to estimate the corresponding error correction (EC) equation, which captures the short run dynamics of the broad money supply process. The EC equation will then be used to assess the changes in the relative importance of the various determinants of the US broad money over the past two decades. To this end, as indicated before, the paper again uses the dominance analysis (DA).

Once again, before conducting the dominance analysis, a breakdown of the growth rate of the broad money supply in terms of the growth rates of the two key underlying concepts of the monetary base and the broad money multiplier is presented in Table 6 (Appendix). As the table shows, the monetary base has again consistently been an important factor behind the changes in the US supply of broad money over the sample period. As was the case with the narrow money, however, during the peak of the crisis, 2008:3-2009:3, the sharp increase in the monetary base, some 64 percent, resulted in an increase of only 9 percent in the broad money supply. This was caused by a drastic decline in the money multiplier, 54 percent, itself caused by a sharp increase in the excess reserves ratio as well as a sharp drop in the time deposit ratio.

The results of the dominance analysis for the US broad money supply are presented in Table 7 (Appendix). Once again, to determine whether there has been any change in the relative importance of the determinants of the broad money supply over the past two decades, the indices of relative importance for three subsets of the sample period, namely, the pre-crisis 1990:1-2008:2 period, the crisis 2008:3-2009:3 period, and the post-crisis 2009:4-2012:1 period are presented. It can be seen from the table that, with the exception of the crisis period, the currency ratio has again been the most important factor behind the changes in the US broad money supply, though to a far less important extent, accounting for roughly 37 percent of the changes in the US broad money supply for the entire sample period. During the crisis period, however, the sharp decrease in the US time deposit ratio largely dominated the effect of the currency ratio. Specifically, during the crisis period, the importance of the currency ratio dropped to only 18 percent, while that of the time deposit ratio climbed from 15 percent to 31 percent. In addition, the sharp drop in the time deposit ratio during the crisis was largely caused by a massive transfer of savings and time deposits from banks to money market funds and other related short term money market securities, as the US public seems to have lost trust in the banking system. At the same time, based on the table, the monetary base and the excess reserves ratio have together consistently accounted for some 40 percent of the changes in the US broad money.

CONCLUSION

This paper has conducted an empirical investigation of the changing relative importance of the determinants of the US money supply, both narrowly and broadly defined, over the past two decades. The paper has been particularly interested in assessing the changing roles of these determinants during the recent financial crisis. The findings, which seem to corroborate the earlier results in the literature, single out the currency ratio as generally the most important determinant of the US money supply over the sample period. However, during the peak of the

crisis in 2008-2009, when the Fed injected massive amounts of the monetary base into the economy to counter the adverse effects of the crisis, the bank excess reserves ratio emerged as an equally important factor. This can be explained by the fact that the bulk of the newly injected monetary base ended up as idle cash balances in the banking system, thus severely limiting the effect of the expansion in the monetary base on the money supply. To encourage banks to reduce their excess reserves holdings, and thus raise the level of the money multiplier, the Fed needs to take a number of actions. The most prominent of these actions include eliminating the interest paid by the Fed on bank excess reserves (Bernanke, 2011), imposing a tax on excess reserves (Sumner, 2009), or placing a cap on the amount of excess reserves banks are allowed to hold (Dasgupta, 2009).

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APPENDIX

Tables

Table 1 - The Phillips-Perron Unit Root Test

	Levels	First Differences
Narrow money (M1)	0.59	-14.43*
Broad money (M2)	-2.16	-11.87*
Monetary base (B)	-0.74	-7.41*
Currency ratio (c)	2.15	-16.70*
Time deposit ratio (t)	0.06	-15.24*
Excess reserves ratio (e)	-1.52	-18.39*
Reserve requirements ration (r)	-7.66*	-23.97*

*Indicates significant at the 5 percent level.

Table 2 - The Johansen Cointegration Test (Narrow Money)

Number of Cointegrating Vectors	Trace Test
$k = 0$	95.55*
$k \leq 1$	60.65
$k \leq 2$	37.84
$k \leq 3$	18.50
$k \leq 4$	8.34

*Indicates significant at the 5 percent level.

Table 3 -Breakdown of the Annualized Growth Rate of the US Narrow Money Supply

	1990:1 – 2008:2	2008:3 – 2009:3	2009:4 - 2012:1
Money supply (M1)	3.05%	12.20%	12.18%
Monetary Base (B)	6.16	63.84	16.75%
Money multiplier (m1)	-3.11	-51.64	-4.57

Table 4 - Relative Importance of the Determinants of the US Narrow Money Supply

Determinant	1990:1– 2008:2	2008:3 – 2009:3	2009:4 2012:1
Monetary Base	23.3%	24.4%	7.4%
Currency ratio	48.1	32.1	67.2
Excess reserves ratio	20.2	32.5	8.2
Required reserves ratio	8.5	11.0	17.2
Total	100.0	100.0	100.0

Table 5 - The Johansen Cointegration Test (Broad Money)

Number of Cointegrating Vectors	Trace Test
k = 0	135.81*
k ≤ 1	78.50*
k ≤ 2	49.42*
k ≤ 3	27.21
k ≤ 4	10.31
k ≤ 5	0.96

*Indicates significant at the 5 percent level.

Table 6 - Breakdown of the Annualized Growth Rate of the US Broad Money Supply

	1990:1– 2008:2	2008:3 – 2009:3	2009:4 2012:1
Money supply (M2)	4.84%	9.18%	5.28%
Monetary Base	6.16	63.84	16.76
Money multiplier (m2)	-1.32	-54.66	- 11.48

Table 7 - The Relative Importance of the Determinants of the US Broad Money Supply

Determinant	1990:1 – 2008:2	2008:3 – 2009:3	2009:4-2012:1
Monetary Base	18.6%	22.9%	20.4%
Currency ratio	32.0	17.7	22.0
Time deposit ratio	14.7	31.3	15.9
Excess reserves ratio	26.7	15.6	20.7
Required reserves ratio	8.0	12.5	8.3
Total	100.0	100.0	100.0

Figures

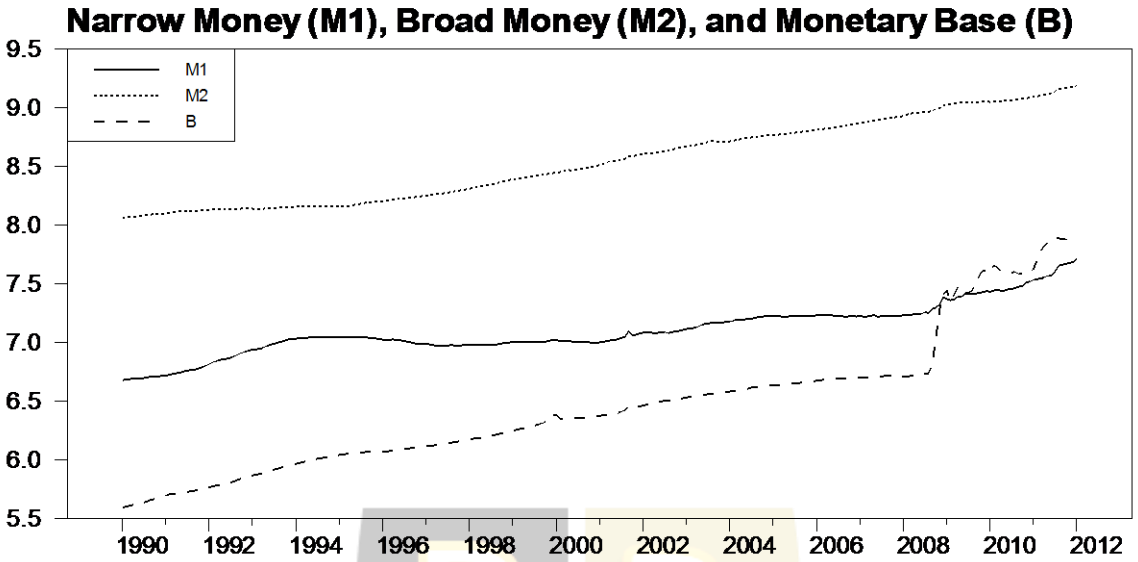

Figure 1

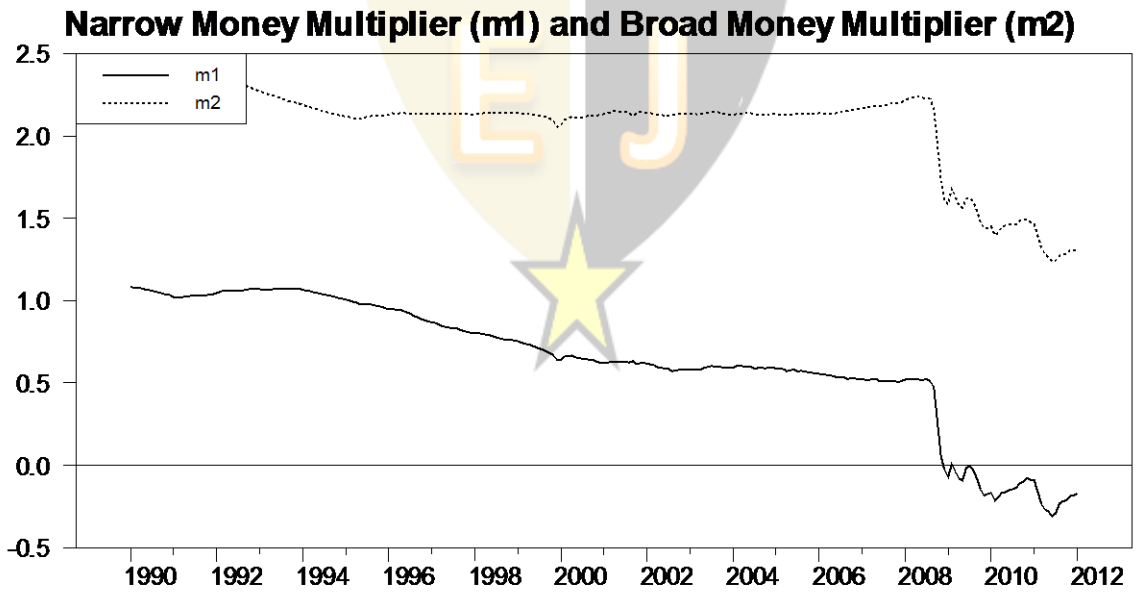

Figure 2

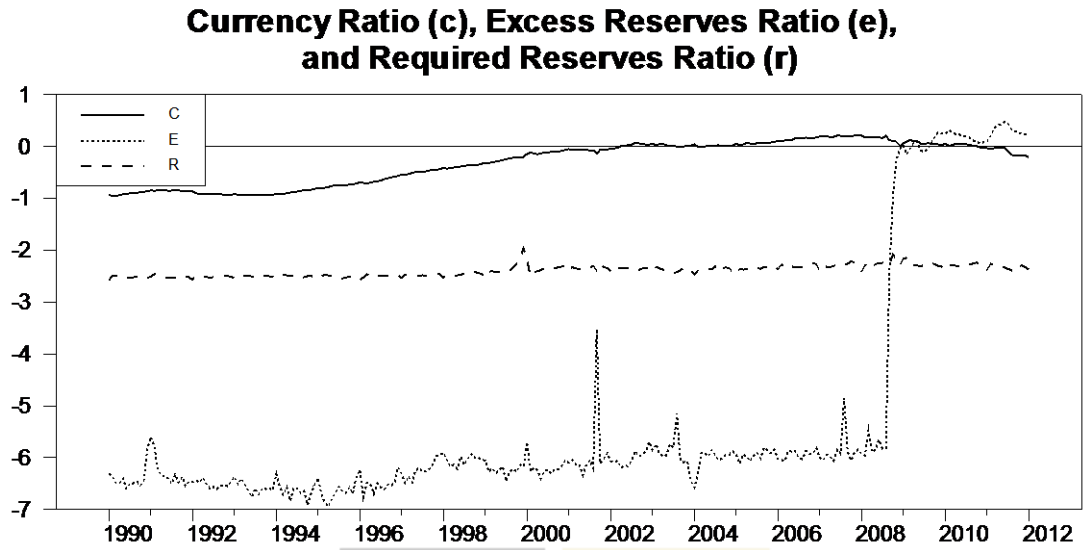

Figure 3

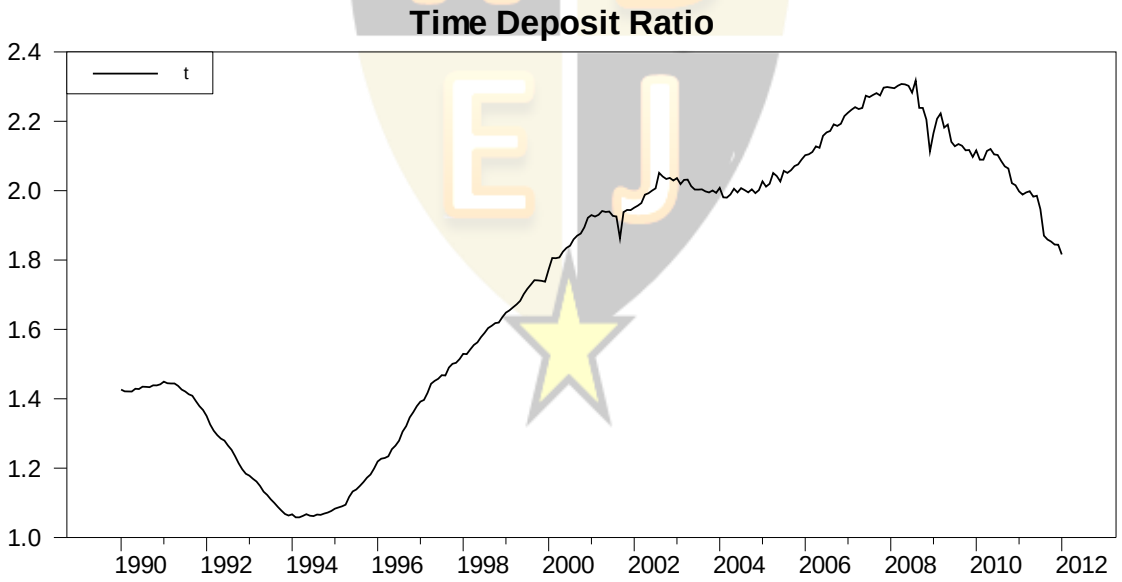

Figure 4