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Research Technical Paper

MONEY AND UNCERTAINTY IN DEMOCRATISED FINANCIAL MARKETS

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ABSTRACT

Developments in broad money since the start of the new millennium cannot be explained by the traditional determinants of money demand, namely, income, prices and portfolio effects. Households' direct and indirect participation in financial markets have led to the widespread democratisation of these markets in the US since the 1970's. In the pre-democratised era, an increase in uncertainty would have resulted in a fall in the transactions demand for money due to pessimism regarding income and employment prospects. When markets become more democratised, the precautionary, or store-of-value function of money dominates the transactions demand in which case an increase in uncertainty results in a net increase in the demand for money. Our Kalman Filter estimates are consistent with this theory. The money-uncertainty coefficient has been subject to an increasing trend over the whole sample period shifting gradually from significantly negative values up to the mid-to-late-1990s before becoming significantly positive by the early years of the new millennium. There are important repercussions from these new behavioural patterns for both monetary and financial stability which are discussed in this paper.

Non Technical Summary

Until comparatively recently the demand for money was dominated by its usefulness as a transactions medium. The slow revolution in financial markets over the last few decades, especially the growing participation of so-called retailed investors in these markets (i.e., a phenomenon we describe broadly as the democratisation of financial markets) has brought money's role as a store of value to the fore. In periods of financial market turbulence, this role may now dominate the medium of exchange role. Money seen as an asset is increasingly coming to the rescue of investors stricken with fear as financial market prices begin to collapse. The uncertainty generated by a collapse, or even a prospective collapse, in asset prices generates a large demand for money as people have recourse to the only asset whose value is capital certain or close to capital certain. The new post-liberalisation, post-democratisation, patterns of behaviour that have begun to emerge are characterised by rapid growth in the money stock during periods of uncertainty.

A positive correlation between uncertainty and the income velocity of circulation which is observed in the pre-democratisation part of our sample for the US economy (1970 to 1989) is replaced by a strong negative correlation for the post democratisation period (1990 to 2009). An examination of this remarkable reversal of behaviour of the income velocity of money is the objective of this paper.

The policy consequences of this reversal are profound. The money stock is now growing rapidly in periods of heightened uncertainty (where in the pre-democratisation era it would have decelerated). This strong demand does not persist however. Money demand falls again as uncertainty dissipates leaving a large residue of excess money supply (i.e. a monetary overhang) which finds its way back into financial markets via an intense search for yield, re-igniting another asset price boom and bust, endangering the health of the banking system and compromising financial stability.

1. Introduction

Financial markets in the US, as in other advanced industrial countries, have been subject to a systematic evolution that now leaves them radically altered relative, to say, the early 1970s. Waves of financial market liberalisation and innovation have afforded retail investors (such as households and small firms) much easier and cheaper access to financial markets. They have availed of this to an unprecedented extent, especially from around the mid-to-late 1980s up to, and into, the new millennium. It would not be inaccurate to say that, during this time period, financial markets have been democratised. The thesis expounded in this paper is that this evolution has had profound implications for the demand for money and for policies for which the demand for money plays an important role.

To give coherence to our discussion, we divide up the sample, which runs from quarter one of 1970 to the second quarter of 2009, into two sub-periods. The first is chosen to reflect what we are calling the pre-democratisation period which is assumed to run from the start of sample period to the end of the 1980s. The second (what we are calling the post-democratisation period) is assumed to run from the start of the 1990s to the end of the sample period. Of course, since this financial market democratisation process is an amorphous phenomenon, there is no easily identifiable demarcation line dividing pre- and post-democratisation periods. As discussed later, it is determined by looking at the patterns in the data.

The purpose of this paper is to examine how this financial market evolution has affected a key macroeconomic relationship i.e., the demand for money. The paper pays particular attention to the role uncertainty plays in the demand for money and how this role has been completely reversed in the transition between the pre-democratisation and the post-democratisation periods in our sample. This we attribute to the role of democratisation in changing systematically the weights on the relative importance of two of the classical roles of money, namely as a transactions medium and as a store of value[1]. In the pre-democratisation period, the traditional theory of the demand for money, namely that money is used to mediate

[1] The third well-known role is that of a unit if account. This role is not central to the argument here.

transactions subject to a simple portfolio effect, was probably a fairly good description of reality. In this environment, the emergence of uncertainty would have had its main effect on expectations of the conjunctural situation, i.e., the prospects for employment and income, and would therefore have had a negative effect on expectations of future expenditures, depressing the demand for money. What we would have seen is therefore a positive correlation between uncertainty and the income velocity of money.

In what we have designated as the post-democratisation period, money provides an exit facility from financial markets when retail investors, in particular, face episodes of heightened uncertainty. For many of those, a relatively new source of heightened uncertainty takes the form of rapidly falling asset prices. This is resulting in money being called upon to assume a much more important role than heretofore as a safe haven. An increase in uncertainty therefore results in a fall in the velocity of circulation. A positive correlation during the pre-democratisation period followed by a negative correlation for the post-democratisation period is precisely what the data reveal. An examination of this remarkable reversal of behaviour in money in the US, which curiously has not been noted in the literature on the demand for money to date, is the objective of this paper. Our conclusions are that its implications for both monetary policy and financial stability are profound.

The money – uncertainty relationship is not the only one to be affected by the evolution in financial markets. We would also expect the post-democratisation financial market environment to affect some other key parameters of the demand for money function. The possibilities for portfolio substitution involving money have become much richer than in the relatively repressed financial markets of the past, with equities, corporate bonds, commodities and property (via REITs, but even directly) offering attractive and accessible alternatives to money as an asset. We would therefore expect to see the weight on the standard interest rate variable, or interest rate differential variable (reflecting substitution between money and government bonds), fall in size over time as households gain easier and cheaper access to these alternatives.

The expanding role of money as the only safe store of value in periods of financial turbulence has enhanced money's role as a buffer in the post-democratisation period. Money holders may therefore be increasingly hesitant in adjusting their money balances to equilibrium following a shock. We would therefore expect to see the coefficient of mean reversion fall as the economy makes the transition to the post-democratisation landscape. None of these three hypotheses are inconsistent with the data for the US economy.

In this respect it is notable that, as prima facie evidence for the main argument in the paper, that developments in broad money in the US economy since the start of the new millennium cannot be explained by the traditional determinants of money demand, namely, income, prices and portfolio effects. A cursory glance at some stylised facts relating to money and interest rates suggests strongly that there are important new aspects to the way money is behaving over recent times. Specifically, money growth is accelerating when conventional demand-for-money-function orthodoxy would suggest exactly the opposite, i.e., that it should be decelerating. It seems as if this orthodoxy is shaped by what happened in the past and that it needs significant revision in the light of financial market developments.

A stylised fact of the last, albeit shallow, recession in the US in 2001 is that money stock growth accelerated going into, and during, this recession. This, although not flagged in any commentary that the authors are aware of, was a unique development. It had never happened in any of the previous recessions going back at least to the 1960s. At the outset of all the previous business cycle downturns in the US, the rate of growth of money has slowed both in the lead up to the recession itself and for some time into the recession. (See Chart 1) The pattern of money growth was quite different leading into, and in emerging from, the dotcom instigated recession of 2001 than in all these preceding recessions. The emerging pattern of money stock growth in this recession suggests a break in money demand and supply behaviour. A similar pattern has been noted in Japan when the economic situation deteriorated severely there in the wake of a deep financial crisis in the 1990s (see Kimura (2001) who dubbed the case "paradoxical"). This new pattern of behaviour also seems to be emerging during the current severe recession affecting not only the US but almost the entire developed world.

Another aspect of this puzzling money stock behaviour is that, again at least since the 1960s, never have money and credit aggregates grown so fast, or so persistently, as they have since the turn of the millennium, without having a substantial impact on inflation. Secondly, there has never been an interval of time in this period in which the real rate of interest has been so low for so long in emerging from a recession without it also having some adverse effect on inflation. Chart 2 illustrates the case for the US, where the real interest rate, pre and post the 2001 recession, is compared to the evolution of the same variable emerging from all previous six business cycles going back to the late 1960s. The behaviour of money is equally puzzling at a global level where, despite a very sharp slowdown in real GDP growth, global money growth continued to expand rapidly[2].

The main contention of this paper is that these puzzles can only be understood in the context of a confluence of evolving forces that is gradually transforming the role of money in the economy. The combined effects of financial market liberalisation and innovation, along with the related phenomenon of the gradual and ongoing democratisation of financial markets, is resulting in money being called upon to assume a much more important role as a safe haven stemming from one of its classical functions, i.e., that of a store of value.

Chart 1: Time Series Plot of Nominal M2 Money Growth (%) in the US

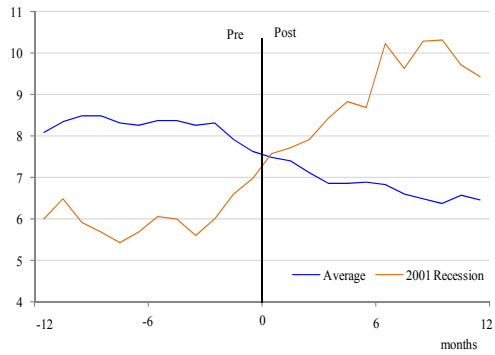
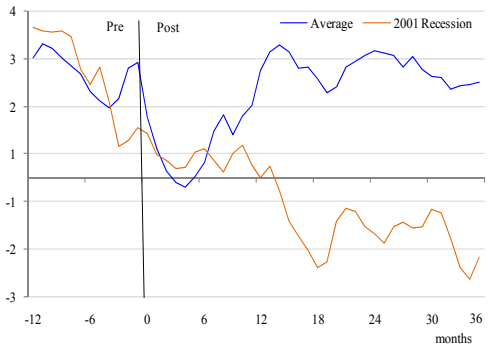


Chart 2: Real Fed Funds through Business Cycles



Sample: 1960 Q1 – 2009 Q1
Source: US Board of Governors

[2] See ECB calculations as reported in its Monthly Bulletin, January 2004. (Chart D, Page 12)

The remaining sections of the paper are organised as follows. Section two discusses the evolution of the money demand – uncertainty relationship as financial markets became more democratised. Section three discusses the theoretical framework and previous literature. Sections four and five analyse empirically the time invariant and time varying behaviour of money demand. Section six extends the analysis to include the monetary base and section seven contains the concluding remarks.

2. Uncertainty in Democratised Financial Markets – Implications for Money

One of the most salient developments affecting the institutional setting of financial markets was the mutual fund revolution, especially in the US. The mutual fund industry has existed since the 1920s. However it still intermediated by only a small proportion of US households' savings by the late 1970s. Chart 3 displays the meteoric growth of mutual funds, especially in the 1990s. In the twenty year interval between 1980 and 2000, the value of total mutual fund holdings (bond and equity) relative to total bank deposits (i.e. checkable, time and savings deposits) and currency increased from less than 5 per cent to 120 per cent (with the largest increase occurring in the 1990s) before falling back to close to 80 per cent following the stock market collapse with the bursting of the high tech bubble in 2000. Post 2001 recession, growth resumed until the 07/08/09 Crash, where many investors substituted mutual fund positions for the safety of deposit accounts.

Asset price inflation could give a misleading impression of volume changes in financial markets. Deflating by total assets should convey a more reliable picture. This is done in chart 4 which draws on US Financial Accounts. It displays the composition of household assets as between currency and deposits on the one hand and total shares and other equity along with total insurance reserve on the other. It is a well known fact that the US financial system is predominantly market based. The level of the ratio of financial assets to total assets is, and has been, significantly higher than for other advanced industrial countries. It has become even more market based since the start of the 1990's with financial assets as a proportion of total assets climbing from about 60 per cent to 80 percent before falling back to 75 per cent at the start of 2003. This is clearly evident in Chart 4. This is mirrored in the evolution of deposits as a percentage of total financial

assets, which fell from 25 per cent in the 1980's to less than 10 per cent in 2000 before rebounding back to 15 percent at the start of 2003. The current financial crisis has amplified this trend, as the proportion of financial assets (deposits) surged (fell) from 2003 through 2007 and fell (rebounded) to early 1990's levels by 2009 Q1. This clearly suggests a safe haven effect at work.

An important element of the argument being propounded in this paper is that the effects of uncertainty on money demand depends on how far progress in the democratisation of financial markets has advanced. From the early 1970's to the mid-1990s (what we will call loosely the pre-democratisation period), the effect of a deterioration in sentiment (interpreted here as an increase in uncertainty) would have been quite different to that of a similar increase in uncertainty in the period from the mid-1990s to the present day (what we are loosely designing as the post-democratisation period). In the pre-democratisation period, the effect would have been to persuade people of the poor prospects for the overall economy, dampening employment and income prospects in the process. This would have caused a retrenchment in aggregate expenditure. The outcome would have been a net reduction in the demand for money because of reduced transactions demand driven, in turn, by heightened uncertainty

Chart 3: Evolution of US Households Mutual Funds and Total Deposits

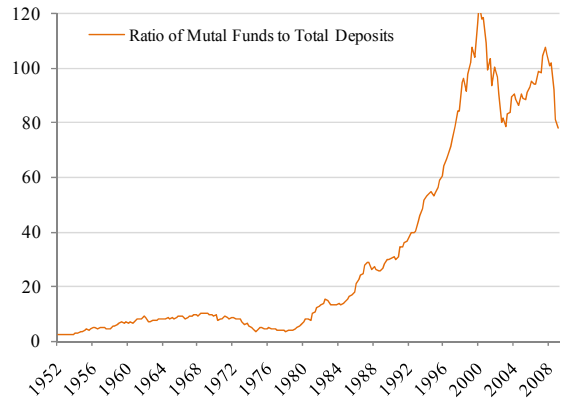
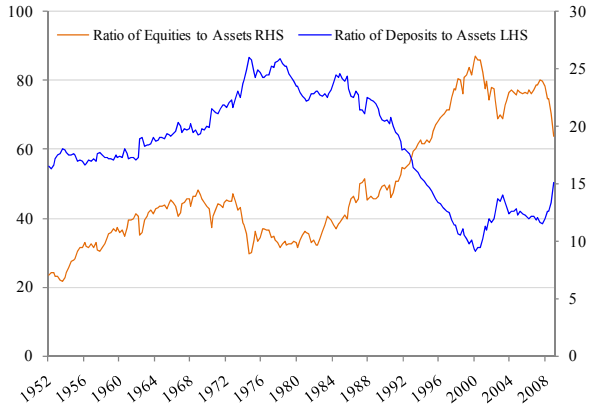


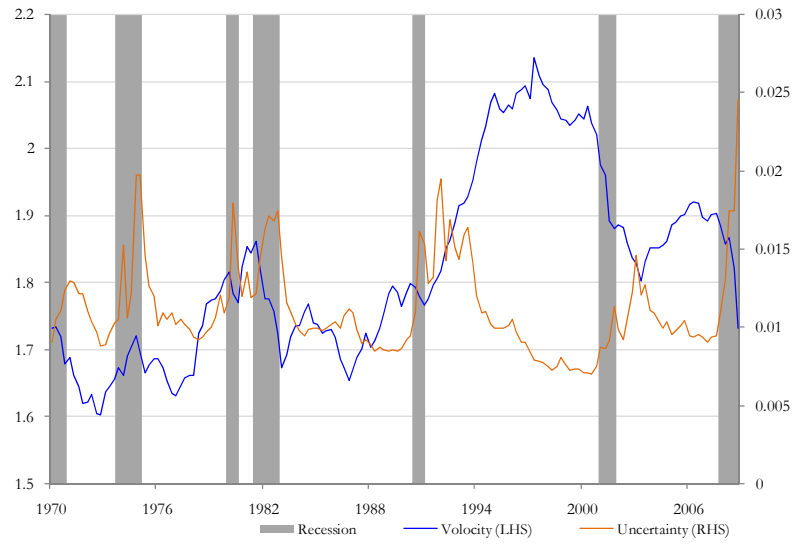
Chart 4: Proportion of US Households Assets held as Total Deposits and Equity Holdings



Sample: 1952 Q1 – 2009 Q1
Source: US Board of Governors

In the post-democratisation period, however, an equivalent increase in the degree of uncertainty would have had the exact opposite effect. This shift in behaviour around the early-to-mid 1990's is clearly visible in Chart 5 which plots the income velocity of money and our measure of uncertainty[3]. Velocity would therefore appear to have been transformed from being procyclical to anti-cyclical. Given their extensive holdings of financial assets which are continuously marked-to-market in this latter period, concerns become more ones of a search for a safe haven against financial market turbulence and the prospect of widespread loss of financial capital stemming from a collapse, or a correction, in financial markets rather than those related to the prospects for employment although this would still remain a real concern. The increase in the demand for money stemming from the massive substitution out of a whole range of financial assets and into the safe haven of money is facilitated, indeed has to be facilitated, by the central bank (See next section). Not only would we expect (some measure of) uncertainty to drive money demand positively in the new setting, we would also expect some of the standard arguments in the demand for money function to be affected in specific ways.

Chart 5: Time Series Plot of Money Velocity and Uncertainty in the US from 1970 to 2009



Sample: Jan 1970 – Mar 2009
Source: US Board of Governors Flow of Funds

[3] The simple correlation for a four quarter moving average of these two series goes from +0.2 (for the period 1970Q1 to 1989 Q4) to -0.6 (from 1990 Q1 to the end of the sample period). Indeed, this correlation increases to -0.8 in the last 20 quarters in the sample.

This gradual democratisation of financial markets provides four empirically testable money demand hypotheses,

(i) Uncertainty plays a new role not previously suggested, with its effects changing over time, going from a negative to a positive effect, as markets are democratised.

(ii) The effect of the conventional interest rate differential would also be expected to fall off with time as households gain easier and cheaper access to asset classes other than government bonds with the democratisation process.

(iii) With the growing use of money as a buffer and safe haven, we would also expect to see slower adjustment, or mean reversion, to long run equilibrium.

(iv) Displacing the safe haven behaviour to the wholesale level (financial crisis) reduces the uncertainty effect at the retail level below what it otherwise would have been.

We find all these effects to exist in the data which provides strong support for our theory relating to the effect of uncertainty in a setting in which financial markets are going through a process of democratisation. These findings have significant implications for the demand for money, monetary policy and financial stability.

To test these new insights on the money demand function, we propose a measure of economic uncertainty, capturing the flight to the safe haven provided by money when investor confidence collapses. We use an error correction model to estimate long and short run dynamics for US data over the period 1970 Q1 to 2009 Q1. Estimates also show a positive relationship between real money balances and the level of uncertainty. Important to our analysis is the evolution of the uncertainty - money relationship over time which is beyond the scope of an error correction model. Therefore, we estimate a state space model with time varying parameters using the Kalman filter algorithm.

3. A Model of Money and Economic Uncertainty

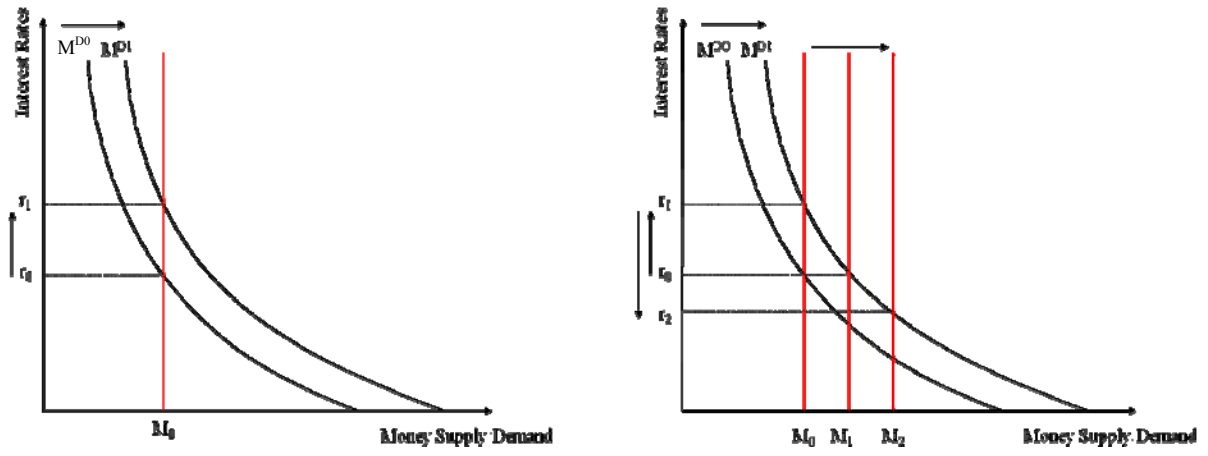
There are three well-known motives for holding money – the transactions, precautionary and speculative motives. The essence of the argument being propounded here is that the relative strengths of these three motives vary over time

and with the democratisation of financial markets have become particularly sensitive to the degree of confidence in the financial market environment.

The traditional transactions demand for money is procyclical with the level of transactions generated by the goods and services industries determined by the real economy.

In normal times, precautionary and speculative demand would be low, with the return *on* principle (yield) dominating investor's decisions. However, in periods of financial distress, the return *of* principle (default) becomes the major concern as investor's substitute out of mark-to-market assets in favour of the security afforded by money. As mark-to-market assets adjust during recessionary periods, undershooting is not uncommon further increasing money demand for speculative reasons.

Figure 1: Shocks, Liquidity Preference and Interest Rates



If a cyclical downturn is associated with an asset price collapse than the effects of the precautionary and speculative motives for holding money, along with the enhanced transactions motive generated by the quickening pace of financial market transactions can collectively more than compensate for the reduction in the

transactions demand coming from any cyclical or post-shock slowing of the real economy. Therefore, a rise in uncertainty will culminate in a shift in the money demand from M^{D0} to M^{D1} (See Figure 1). If the Fed does not want the interest rate to shoot up (from r_0 to r_1) when the economy is hit by a large adverse shock, when it would normally be seeking to bring down rates, so as to underpin economic activity and price stability it has little choice but to accommodate this outward shift in demand arising from an increase in uncertainty. In other words, the only course of action open to the Fed is to meet the demand at r_0 and accommodate the shift in real money demand from M^{D0} to M^{D1} by increasing the supply from M_o to M_1. Additionally, in periods of uncertainty, there is pressure to have interest rates below the pre recession level (r_0). If this is to be achieved, the money supply must be increased further (M_2).

The standard demand for money function, with only bilateral substitution between money and bonds, is specified as,

$$\frac{M}{P} = f(y, r)$$

where the demand for real money balances, M/P is a function of a scale variable (y) and an opportunity cost variable (r). The scale variable captures the transaction demand for money, with transactions typically proxied by some measure of economic activity, such as real GDP. The opportunity cost variable captures the cost of holding money as opposed to some interest earning asset. The choice of opportunity cost is open to some dispute. Many of the measures used take the form of the spread between long and short interest rates. More recently, other measures have been proposed such as the spread between short term interest rates and a constructed measure of the own rate of return on the money supply. Calza et al (2001) show that this measure out performs the traditional long/short run rate approach for the euro area.

More recently, the robustness of money demand functions based on scale and opportunity cost has come under question [Gerlach & Svensson (2003), Greiber and Lemke (2005) and Carstensen (2006)]. Greiber & Setzer (2007) extend the standard specification, with the addition of real house prices and housing wealth.

Boone & Van Den Noord (2008) provide a further framework including both house and equity prices. In both cases, the additional variables lead to stable long run money demand equations. For the US, Bjornland & Leitemo (2008) show the strong interdependence between the interest rate setting and real stock prices. These findings are consistent with democratisation of financial markets yielding additional demand for credit facilities. However, in late 2007/2008 both house and equity prices have fallen sharply while money supply growth is at the fastest rate for over a decade. None of the above models account for the expanding role of money as a store of value.

In periods of pervasive uncertainty like that which existed in the wake of the dotcom bubble and is now repeated with much greater intensity with the 2007/8/9 Crash, not only does objective risk and uncertainty increase sharply, people's aversion to risk or uncertainty is also elevated. Such periods are likely to see a general aversion to holding any marked-to-market assets except those that are issued by governments and are of very short maturity, such as short-dated treasury bills. One would tend to find money flowing into only two places, bank deposits and treasury bills[4].

We propose a money demand function based on scale (y), a opportunity cost ($r-r^0$) and a measure of economy-wide confidence. Uncertainty is difficult to measure. Many studies proxy for uncertainty through implied volatility and/or measures of economic performance [Atta-Mensah (2004)]. However, the first is capturing equity market risk, not uncertainty and caution must be used with the second as monetary policy can be a driving determinant of an economic indicator. We measure uncertainty through consumer confidence surveys and propose a long run demand for money of the functional form

$$(M/P)^d = f(y,(r - r^0),un) \qquad (1)$$

In applied work, a (semi-) log linear form is often found to be an acceptable empirical approximation to equation (1), namely,

[4] Money market funds could be added to the list but the experience of one money market fund breaking the buck may have deterred some investors.

$$m^d - p_t = \gamma_0 + \gamma_1 y_t + \gamma_2 un_t + \gamma_3 (r - r^0)_t \quad (2)$$

where m^d, p, y and un are the natural logarithms of nominal money, the price level, an income variable (real GDP) and uncertainty respectively. The interest rate differential is measured in levels. γ_1 and γ_2 measure the long-run elasticity of money demand with respect to income and uncertainty. The additional transactions associated with income growth suggest $\gamma_1>0$, while the unwinding of investment positions into risk-free money in period of uncertainty suggest $\gamma_2>0$. The gains lost to hold money in periods with high interest rates suggests $\gamma_3<0$. Equation (2) is an empirical representation of the long run money demand. However, some factors may only be relevant to money demand short run dynamics.

4. Empirical Analysis: Time Invariant Behaviour

We estimate the long and short run dynamics of money demand for the US over the sample period 1970 Q1 to 2009 Q1. The real money supply is measured as the M2 aggregate deflated by the GDP deflator. The scale or income variable is real GDP. We follow Calza et al (2001) and model the net opportunity cost variable as the difference between the short run interest rate and the own rate on M2 money supply. The 3-month constant maturity Treasury bill rate is used as the short run interest rate. Uncertainty is measured as inverse of the Consumer Confidence Index (CCI). The Consumer Confidence Index is a sentiment indicator calculated from survey data by The Conference Board. All data are from the Federal Reserve, with the exception of the CCI. All variables with the exception of interest rates are transformed to logarithmic form.

As with all time series studies of this nature, we begin by testing for stationarity using the Augmented Dickey-Fuller test.[5] The test is applied to both the original series and to their first differences. Table A1 reports the ADF results. It reports that all variables are integrated of order I(1), except for the interest rate differential which is I(0). Examining German data, Hubrich (2001) and Lüthephol and Wolters

[5] For further details of unit root testing see Dickey and Fuller (1979 & 1981)

(2003) also detected a stationary interest rate explained by the Fisher effect. Therefore, interest rates only explain the adjustment towards long run equilibrium and not the long run equilibrium. This is consistent with hypothesis (ii) (section 2) as traditional bilateral substitution between money and bonds is replaced with multilateral substitution among many asset classes. More recently, interest rates can be viewed as the cost of borrowing money as opposed to the opportunity cost of holding money.

As discussed above, many studies have found co-integration between the I(1) variables of a money demand function. The Johansen (1995) test is used to detect the cointergration properties of the variables with the results presented in Table A2. Allowing for a constant, there is strong evidence for exactly one cointegrating vector in the (M2, GDP, UN) system, consistent with a long run relationship between these variables.

The cointegration vectors represent the coefficients of the linear combination of non-stationary variables, that are, in fact, stationary. Following the Johanson procedure, estimates of the coinetgrating vectors are presented in Table 1 below. Consistent with previous analysis, an increase in GDP will increase the demand for money. A one per cent increase in income will increase the demand for money by 0.85 per cent. This additional demand for money is driven by the extra transactions associated with economic expansion.

A flight to the safety of money when economic conditions weaken and uncertainty and risk aversion grow leads to a positive relationship between real money balances and economic uncertainty. Estimates show a 1 per cent change in uncertainty, leads to a 0.06 per cent change in real money balances. While this is substantially smaller than the income effect, the consumer confidence indicator is much more volatile than real GDP. These static estimates show negative (rising uncertainty) effect to be stronger than the positive effect. A much richer analysis of the money - uncertainty relationship is undertaken in section four where coefficients are allowed to vary over the sample period. It is important to note that not all short-term shifts in uncertainty and GDP will have the estimated effect, only a longer term shift in the mean of uncertainty and/or GDP.

Table 1: Long-Run Money Demand Equilibrium

Variable	Coefficient	T-Statistics
Constant	0.971	8.456
Real GDP	0.852	72.666
Uncertainty	0.061	3.849

Notes: Following the Engle Granger procedure, this table shows the results of the regression

$$m2_t = \alpha_0 + \alpha_1 gdp_t + \alpha_2 un_t + e_t$$

where M2, GDP and CON are real M2 money supply, real GDP and uncertainty respectively. Engle-Granger estimates misreport standard errors leaving t-statistics incorrect. We also estimate using DOLS, which corrects these standard errors and all coefficients remain significant.

From estimation of the long run relationship, we obtain the error correction term, e_t. This error correction term becomes one of the determinants of the error correction money demand function,

$$\Delta m2_t = \beta_0 + \sum_{i=1}^{n} \varphi_i \Delta m2_{t-i} + \sum_{i=1}^{n} \phi_i \Delta gdp_{t-i} + \sum_{i=1}^{n} \chi_i \Delta un_{t-i} + \gamma\, int_t + \varsigma \hat{e}_{t-1} + \varepsilon_t \qquad (4)$$

Using Akaike's Information Criterion (AIC), the optimal lag length of the short run dynamics is one. Equation (4) is estimated by OLS and the results are presented in Table 2. Lagged changes in money demand also affect current money demand; implying trends in money demand tend to be persistent. This is consistent with deviations from long run equilibrium and a slow adjustment back over time. Estimates show changes in income and uncertainty are not driving the short run money dynamics.

The estimated constant term shows a positive value. Burggeman (2000) and Choudhry (1999) find negative constant terms for their dynamic money supply functions. However, Burggeman (2000) concludes that no direct implication can be taken as it captures both the long and short run constant term. However, one could interpret the positive sign as an increase in the unconditional growth of money during the sample period.

Table 2: Short-Run Dynamics of US Money Demand

Variable	Coefficient	Standard error	T-Statistics
Constant	0.007*	0.001	5.099
$\Delta M2_{t-1}$	0.594*	0.066	8.935
ΔGDP_{t-1}	-0.099	0.075	-1.318
$\Delta Uncertainty_{t-1}$	0.003	0.005	0.726
Interest rate	-0.193*	0.054	-3.572
ECT	-0.031*	0.012	-2.484

Note: This table shows the results of the regression

$$\Delta m2_t = \beta_0 + \sum_{i=1}^{n} \varphi_i \Delta m2_{t-i} + \sum_{i=1}^{n} \phi_i \Delta gdp_{t-i} + \sum_{i=1}^{n} \chi_i \Delta un_{t-i} + \gamma\, int_t + \varsigma \hat{e}_{t-1} + \varepsilon_t$$

where ΔM2, ΔGDP and ΔUN is the change in real M2 money supply, real GDP and uncertainty respectively. The appropriate number of lags (in this case 1) is selected according to AIC. * denotes different from zero at 0.05 significance level.

Estimates show a negative coefficient on the error correction term, ς, which is consistent with theory. Therefore, any deviations from the long run equilibrium are corrected by ς in each time period through the short term dynamics discussed above. Although significantly negative, ς is small indicating a slow speed of adjustment towards the long run equilibrium. One reason often given for slow adjustment is the small cost of being out of equilibrium or the high cost of adjusting the money holding to equilibrium [Thornton (1983)]. Also, real side shocks such as natural disasters, terrorism and oil prices are often said to be responsible for the long term persistence of disequilibrium [Thornton (1983)].

In the next section, we take up the main point of the paper that money demand behaviour has evolved over time in systematic ways arising from the now widespread involvement of money holders in financial markets. We use a Kalman Filter estimation technique to capture this time varying behaviour.

5. Time Varying Relationship: Time varying Behaviour

There are two approaches suitable to modelling the changing dynamics between money and uncertainty: (i) a Markov Switching approach and (ii) a Kalman Filter approach. Adopting the Markov Switching would allow us to characterise two or more states and attach probabilities to each. However, the democratisation process took place over more than a decade and the gradual change cannot be captured in the Markov Switching setting. We therefore adopt a Kalman Filter approach.

Although the concept of correction towards long term equilibrium is fundamental to the cointegration literature, it is possible that over time policy changes and/or real side shocks could shift the long run equilibrium. Therefore, a time varying parameter approach is used to detect the evolution of the relationship between money demand and its determinants in the evolving financial market environment. The process of financial market democratisation discussed above suggests that money demand behaviour changes systemically over time. By specifying the above error correction model in state space form, the time varying properties can be estimated using the Kalman filter algorithm [Kalman (1960)]. The evolution of the long run relationship is given as,

$$m2_t = \lambda_0 + \lambda_{GDP,t} gdp_t + \lambda_{UN,t} un_t + e_t, \qquad e_t \sim N(0, \sigma_e) \tag{5}$$

$$\lambda_{GDP,t} = \lambda_{GDP,t-1} + \eta_{GDP,t} \qquad \eta_{GDP,t} \sim N(0, \sigma_e) \tag{6}$$

$$\lambda_{UN,t} = \lambda_{UN,t-1} + \eta_{UN,t} \qquad \eta_{UN,t} \sim N(0, \sigma_e) \tag{7}$$

State space models are formulated over two equations. Equation (5), the signal equation, specifies the relationship between the observable variables ($M2_t$, GDP_t, UN_t) and the non-observable (λ). Equations 6 and 7, the state equations, govern the evolution of the time varying coefficients (λ_i), which in this case, are assumed to follow a random walk. e_t, η_{GDP} and η_{UN} are assumed to be normally distributed independent error terms with constant variance. The factor loadings are assumed to follow a random walk allowing for considerable variation over time. Barassi at al (2005) shows this framework allows us, with the cointegrating relationship unchanged, to detect any structural changes that occur between the variables.

The λ_{GDP} coefficient, reflecting the evolution of the real money and real income relationship over time is shown in Chart 6. Consistent with the static estimate above, a 1 per cent change in real income leads to a 0.80 per cent change in real money demand. The relationship shows a great deal of stability from the early 1980s onwards after a period of slight decline in the late 1970s. The stronger relationship recorded in the late 1970s could be related to real side oil shocks resulting in the highest M2 growth on record at close to 14 per cent.

The dynamics of the money uncertainty relationship, as reflected in our estimate of the time varying pattern, λ_{UN} is shown in Chart 7. Early in the sample, the relationship is driven by the economic climate. A negative coefficient is recorded for much of the 1970s and 1980s. During this period, there was little emphasis on unwinding of investment positions with money demand almost exclusively driven by transactions demand. During the 1990s, there was a huge upward shift in the relationship, which went from being significantly negative to being significantly positive. This pattern is consistent with our argument in relation to the democratisation in financial markets. The timing of the transition is fully consistent progress on the process of democratisation and the pattern revealed on Chart 5 above. There was some levelling off around 1999/2000 but levels remained well above those recorded earlier in the sample.

The dramatic decline in economic confidence throughout 2001 yields the second large increase in the relationship. A mixture of uncertainty after 9/11 and falling technology share prices caused the demand for money to increase. This was the first time in recent history that US money stock growth accelerated going into, and during a recession as revealed in Chart 1 above. Post-2003, there was some levelling off of the relationship. This represents a period of high confidence, with a large demand for credit through the sub-prime mortgage market. There was a particularly sharp increase around 2007, driven by the 'store of value' feature of money. This was period of high economic uncertainty, with large falls in prices in all asset classes causing an uncertainty driven shift in the demand for money. Overall, since the early nineties, this relationship has grown consistently stronger. In periods of expansion, there tends to be a levelling effect of the money – uncertainty relationship and then further growth whenever the economic outlook becomes more uncertain.

Chart 6: Time Varying Relationship between Money Balances and Real GDP

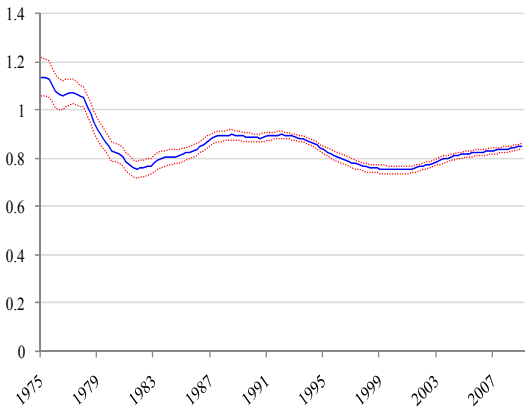
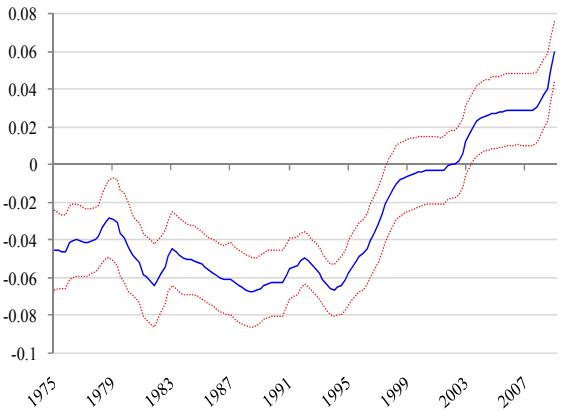


Chart 7: Time Varying Relationship between Money Bl



Notes: The above charts are the time varying states from the Kalman Filter estimed state space model,

$$m2_t = \alpha_0 + \alpha_1 gdp_t + \lambda_t un_t + e_t \qquad e_t \sim N(0,\sigma_e)$$
$$\lambda_{GDP,t} = \lambda_{GDP,t-1} + \eta_{GDP,t} \qquad \eta_{GDP,t} \sim N(0,\sigma_e)$$
$$\lambda_{UN,t} = \lambda_{UN,t-1} + \eta_{UN,t} \qquad \eta_{UN,t} \sim N(0,\sigma_e)$$

Where M2t is the real income and UN_t is a measure of economic uncertainty. λ_{GDP} and λ_{UN} are the time varying GDP and UN coefficients.

It is worth noting, our measure of confidence only measures sentiment from one sector. If a more comprehensive measure of Knighting uncertainty were available, then it is likely that it would show an even stronger structural shift in the money - uncertainty relationship following democratisation.

We employ a similar Kalman Filter framework to the short run dynamics. The evolution of the interest rate and error correction coefficients are of the most interest. The short run dynamics in a state space framework is given as:

$$\Delta m2_t = \beta_0 + \sum_{i=1}^{n} \varphi_i \Delta m2_{t-i} + \sum_{i=1}^{n} \phi_i \Delta gdp_{t-i} + \sum_{i=1}^{n} \chi_i \Delta un_{t-i} + \gamma_t int_t + \varsigma_t \hat{e}_{t-1} + \varepsilon_t$$
$$\gamma_t = \gamma_{t-1} + \eta_{INT,t} \qquad \eta_{INT,t} \sim N(0,\sigma_e)$$
$$\varsigma_t = \varsigma_{t-1} + \eta_{ECT,t} \qquad \eta_{ECT,t} \sim N(0,\sigma_e)$$

The evolution of the short run real money - interest rate relationship is described in Chart 8. Consistent with the opportunity cost theory, a negative relationship is maintained over the entire sample period. There has, however, been a significant weakening of the relationship since the 1970's, a lot of which occurred between

mid 1970's and early 1980's and again in the early 1990's. A falling interest rate differential effect is consistent with the democratisation of financial markets story as the household sector gained much easier access to a whole array of financial assets in different asset classes. Access would not only be easier but also cheaper as the transactions costs of participating in financial markets continued to fall over time. The interest rate variable is defined as the yield on short-dated treasuries relative to the own rate of interest on money. But this reflects only very limited portfolio substitution possibilities which may have been a fairly reliable description of reality before financial markets began to be liberalised and financial innovation began to take hold. Instead of this restricted unilateral substitution between money and short-term treasuries, liberalisation and innovation ushered in an era of multilateral substitution possibilities between cash and a whole array of financial assets, including corporate bonds, equities, commodities and property. Exploiting these relatively new substitution possibilities would have meant that the extent and frequency of the previous unilateral substitution would have become less. The size of the estimated coefficient on the interest-rate differential would, therefore, also be expected to have fallen over time with growing grass roots participation in financial markets, which is exactly what we find.

This would have happened mostly during the period of time we have designated as "pre-democratisation". We would, therefore, expect the interest-rate differential parameter to fall in absolute value leading up to the period we are calling the "post-democratisation" period, ie., roughly between the mid-1990s and the present day[6]. It has fallen from about -0.45 in the 1980's to approximately -0.18 in the mid 1990's, remaining constant until the present day. This represents a 60 per cent fall and 10 fold decrease since the early 1970s.

[6] There is an unavoidable element of arbitrariness in drawing a line between the pre- and post democratisation periods as this was a gradual process, although likely to have been subject to significant bouts of acceleration.

Chart 8: Time Varying Short Run Dynamics between M2 and Interest Rates

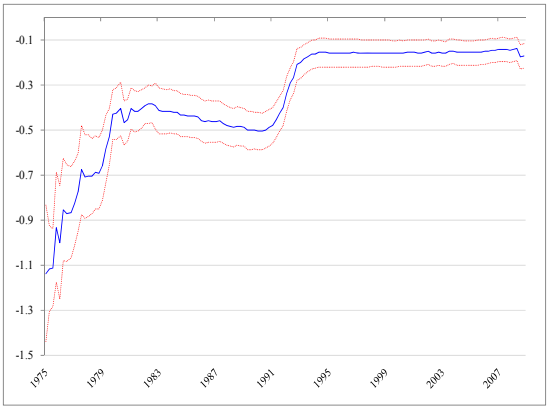
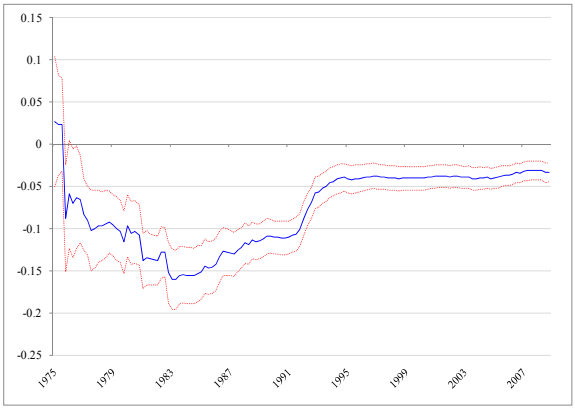


Chart 9: Time Varying Error Correction Term



Notes: The above charts are the time varying states from the Kalman Filter estimed state space model,

$$\Delta m2_t = \beta_0 + \sum_{i=1}^{n} \varphi_i \Delta m2_{t-i} + \sum_{i=1}^{n} \phi_i \Delta gdp_{t-i} + \sum_{i=1}^{n} \chi_i \Delta un_{t-i} + \gamma_t\, int_t + \varsigma_t \hat{e}_{t-1} + \varepsilon_t$$

$$\gamma_t = \gamma_{t-1} + \eta_{INT,t} \qquad \eta_{INT,t} \sim N(0, \sigma_e)$$

$$\varsigma_t = \varsigma_{t-1} + \eta_{ECT,t} \qquad \eta_{ECT,t} \sim N(0, \sigma_e)$$

Where M2t is the real income and UN_t is a measure of economic uncertainty. λ_{GDP} and λ_{UN} are the time varying GDP and UN coefficients.

There is yet another systematic effect stemming from the process of democratisation, and its interactions with uncertainty, which we would expect to see in the data. This relates to money demand dynamics. Since the post-democratisation period is characterised by much greater money hoarding than the pre-democratisation period, it would be reasonable to expect that the speed with which money demand adjusts to its (evolving) equilibrium would be significantly slower in the post-democratisation period.

We do, indeed, find that the size of the error correction effect falls in the latter period. As we see above in chart 9, it reaches a new lower level at the start of this post-democratisation period and stays remarkably stable at this level (-0.04) for the remainder of the sample period up to 2009 Q1. This is significantly less than half its value (i.e., -0.1) for what we have designated broadly as the pre-democratisation period. This is further significant confirmation of the much expanded role of money as a store of value.

6. Uncertainty and the Monetary Base

There is another consideration stemming from the ongoing financial crisis which also has implications for our analysis. The current financial crisis has seen the first manifestation of extreme safe-haven demand for money behaviour at the wholesale level. Since the mid- to late 1990s, banks have become increasingly dependent of wholesale funding. The increase in counterparty and liquidity risk arising from the financial crisis has led to a large step increase in the demand for money. This increase has been enormous and has caused interbank markets to seize up, draining the banking system of a transactions medium. So the kind of effects which has been episodically present at the retail level migrated to the interbank market for the first time in the current financial crisis. Therefore, money's store-of-value driven effects has manifested itself with a vengeance at the wholesale interbank level during this current crisis.

Central banks have direct control of the monetary base, which provides a fairly good picture of their response to the recent economic uncertainty. Since the start of the crisis, the monetary base has almost doubled from $936 billion to $1,730 billion in the three months up to January 2009. The sharp acceleration in M2 is usually associated with such a rapid rise in the monetary base did not occur due to significantly weaker lending growth.[7] Therefore, this rapid surge in monetary base would seem to have been almost entirely accumulated in excess reserves of commercial banks. There is a danger that banks will use these reserves to expand their lending once economic conditions improve and hence further inflate the ratcheting effect of the M2 money stock. However, the October 2008 congressional bill allowing the Fed to pay interest on both required reserves and excess reserve balances provides a mechanism to control future lending expansion. By increasing this rate, the Fed encourages the banks to hold more deposits at the Fed. By reducing this rate the Fed provides an incentive for banks to expand their lending and the M2 money supply.

[7] See Chart 10 for the US

Table 3: Error Correction for US Monetary Base

Long Run

Variable	Coefficient	T-Statistic
Constant	-4.239	-16.282
Real GDP	1.210	45.507
Uncertainty	0.107	3.041

Short Run Dynamics

Variable	Coefficient	T-Statistic
Constant	0.032*	4.168
ΔMB_{t-1}	0.339*	4.147
ΔGDP_{t-1}	-0.421	-1.084
$\Delta Uncertainty_{t-1}$	-0.016	-0.607
Interest Rate (FFR)	-0.343*	-3.504
ECT	-0.093*	-2.801

Notes: (Long Run) Following the Engle Granger procedure and dynamic OLS, this table shows the results of the regression

$$m2_t = \alpha_0 + \alpha_1 gdp_t + \alpha_2 un_t + e_t$$

where M2, GDP and UN are real M2 money supply, real GDP and uncertainty respectively. α_0, α_1, α_2 are coefficients to be estimated.

(Short Run) This table shows the estimates of the error correction model, regression

$$\Delta m2_t = \beta_0 + \sum_{i=1} \varphi_i \Delta m2_{t-i} + \sum_{i=1} \phi_i \Delta gdp_{t-i} + \sum_{i=1} \chi_i \Delta un_{t-i} + \gamma int_t + \varsigma \hat{e}_{t-1} + \varepsilon_t$$

where ΔM2, ΔGDP and ΔUN is the change in real M2 money supply, real GDP and uncertainty respectively. The appropriate number of lags (in this case 1) is selected according to AIC. * denotes different from zero at 0.05 significance level.

Using the same error correction framework as section 4, the effect of economic uncertainty is analysed in both a static and time varying setting. Table 3 outlines the static results. Fundamentally, the estimates complement those derived in the case of the M2 analysis, with both income (real GDP) and uncertainty displaying a positive long run relationship with the real monetary base. A one per cent increase in income will increase the demand for monetary base by 1.21 per cent, significantly higher than the case with M2. The monetary base is also more sensitive to economic conditions as a 1% change in the CCI index results in a 0.10% increase in money demand compared to 0.06% increase for M2

The Kalman Filter time varying technique from section 5 is applied to the monetary base, with estimates mostly consistent with M2 results. However, since mid-2008, there was a much sharper increase in the money base-uncertainty

relationship (See Chart 11). This difference can be explained by the large increase in the monetary base relative to the M2 aggregate during the current crisis.

There are, therefore, two money demand effects at work. One related to commercial bank money circulating at the retail level (affecting households and firms) and the other to central bank money at the wholesale level (affecting banks). These have reinforced each other during the current crisis helping to propagate and amplify the crisis in the process.

It would, therefore make sense to try to get a combined estimate of these two effects. In an attempt to quantify the dual effects, it is assumed the money multiplier did not collapse (which it did) with the hugely expansionary liquidity policies pursued by central banks at various times since the start of the financial crisis but especially since the collapse of Lehman brothers. The money multiplier itself was very stable from 1993 Q1 to 2008 Q2. Taking the average value of the multiplier for this period ($\overline{m}$) and multiplying it by the actual observed monetary base would give an approximate measure of the evolution of M2 (from the start of the crisis to the end of the sample period) if monetary policy has been successfully transmitted to the retail sector. The idea here is that hoarding would have been much greater at the retail sector if household and firms had been able to access money more easily. The assumption is that the paralysis at the interbank level would simply have been displaced to the retail level. The re-estimated demand for money function how was actual M2 from 1975 Q1 to 2008 Q2 (inclusive) and $\overline{m}$*mbase as a proxy measure for actual plus displaced M2 from 2008 Q3 to the end of the sample period (2009 Q1). The evolution of the constructed M2 money - uncertainty relationship is displayed in chart 12 below. It is notable that the size of the money-uncertainty effect has increased by two and a half times relative to that base on the standard M2 money aggregate.

Chart 10: Evolution of US Households Mutual Funds and Total Deposits

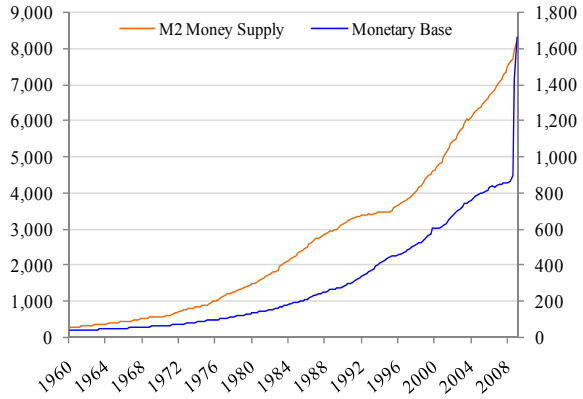
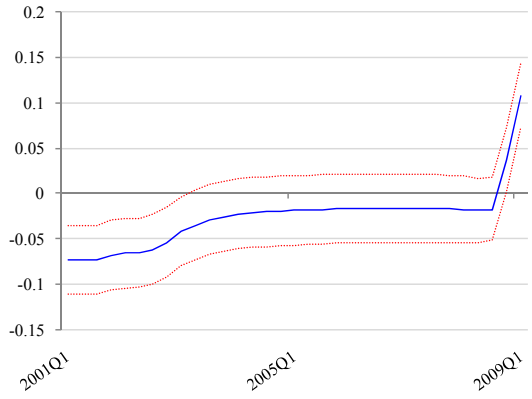


Chart 11: Time Varying Relationship between Uncertainty and Monetary Base



Sample: 1952 Q1 – 2009 Q1
Source: US Board of Governors

Chart 12: M2 Money Supply Multiplier

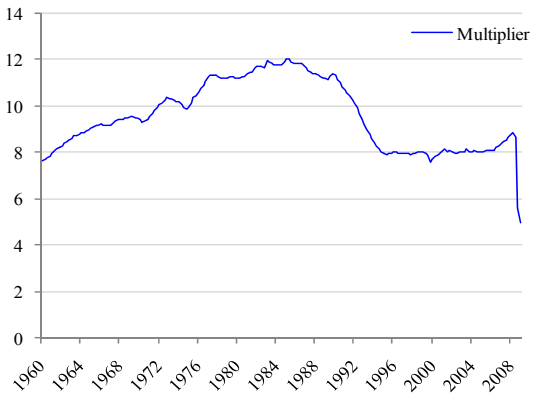
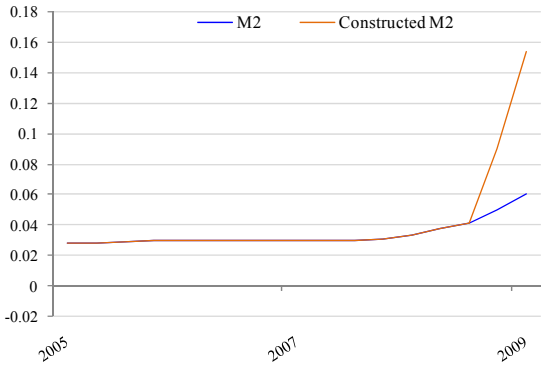


Chart 13: Time Varying Relationship between Uncertainty and (i) Monetary Base and (ii) Constructed M2



Sample: 1952 Q1 – 2009 Q1
Source: US Board of Governors

7. Concluding Remarks

Once inside money is created from outside money via the banking system, it cannot be easily sterilised. The central bank typically does not use non-banking entities as counterparts in monetary policy operations. So it cannot sterilise what it might deem to be too rapid a rate of growth of say the wide money stock (i.e., M2).

If the monetary base is growing too rapidly, then this can be sterilised by the simple device of the central bank not rolling over maturing loans to the banking system. Although increasing the liquidity of the banking system has, during the financial crisis, been a policy of the central bank (what John Taylor (2009) calls the industrial part of what he dubs the mondustrial policy of the central bank), confining the increase to the reserves of the banks cannot be seen as a success since the ultimate objective of the central bank is to target economic activity and obviate deflationary pressures. But once this objective is achieved, banks start to use their reserves as a funding base for loan supply and boost the money stock in the process. If credit and money were to grow too fast, the central bank would have no direct means of mopping this up. It can of course increase market interest rates and the cost of holding money but this does not reduce the actual stock of money but only see it being passed around by agents in the economy until a new equilibrium is reached. This may not, in any case, be an effective means of targeting a reduction in money demand in light of the sharp fall in the sensitivity of money demand to market interest rates (falling by around three fold since the time of the end of the pre-democratisation period).

In any case, even if the central bank deployed the full arsenal of financial assets at its disposal (i.e., the assets side of the balance sheet), it would leave little impression on non-bank private portfolio behaviour. This is by virtue of the very small size of the central bank balance sheet relative to the consolidated balance sheet of the non-bank private sector of the economy. As Friedman (1999) points out, the Fed can make a major difference in financial markets totalling over $14 trillion, when buying or selling less than $5 billion over an entire year.[8]

This means that there is a danger that, over cycles of heightened uncertainty and growing confidence/exuberance, the money stock will tend to ratchet up over time. This will also increasingly tend to drive financial asset prices in synchronised bubbles. This would endanger financial stability and threaten to render monetary policy impotent as has happened to varying degrees in the current turmoil.

[8]Friedman (1999) brought attention to this issue in another context. His puzzlement was with respect to the enormous leverage of conventional monetary policy despite the central bank's tiny balance sheet relative to the non-banking private sector.

Households' direct and indirect participation in financial markets has grown very rapidly since the 1970s in the US. However, the democratisation of financial markets has not been smooth. It was subject to bouts of acceleration which was especially pronounced in the 1990s. Although it is clearly not possible to draw a clear chronological demarcation line between when financial markets could be described as democratised or pre-democratised, if there were such a period, that between the early and mid-1990s could best be described as it. This process of democratisation has had a profound effect on money demand behaviour especially during episodes of heightened uncertainty. It has led to a permanent re-weighting of the relative influences of the transactions and precautionary (i.e., store-of-value) motives for holding money.

In the pre-democratised era, an increase in uncertainty would have resulted in a fall in the demand for money. It would have led households to assume a more pessimistic perspective on the prospects for the real economy, including income and employment prospects. This would have led to a fall in the transactions demand for money, which dominated at the time, and accordingly in total money demand. Our theory says that, post-democratisation, the precautionary, or store-of-value function of money dominates the transactions demand in which case an increase in uncertainty results in a net increase in the demand for money. Our Kalman filter estimates are consistent with this theory. The money-uncertainty coefficient has been subject to an increasing trend over the whole sample period shifting gradually from significantly negative values up to the mid-to-late-1990s before becoming significantly positive by the early years of the new millennium.

The theory propounded here also argues that the increasingly easy and cheap access to financial markets especially throughout the 1990s would have resulted in a fall in the net (quasi) interest rate elasticity of the demand for money, again a prediction supported by our time-varying results. The consistently greater access to a much wider array of financial asset classes, including equities, commodities and property for example, would have reduced the sensitivity of money demand to bond yields, i.e., to interest rates and interest rate differentials. This effect has

indeed fallen and by about 60% between the 1980s as a whole and the mid-1990s to the present, haven fallen by a multiple of this since the mid-1970s.

The third prediction from our theory about the demand for money is that households and non-financial corporations are having greater and greater recourse to money hoarding during periods of heightened uncertainty as money starts to dominate all other financial assets as a store of value. Increased hoarding means slower speed of adjustment to equilibrium. This points to a falling coefficient of error correction – another prediction of our theory which is supported by the data. Our estimate of the coefficient of error correction fell by an amount between two-thirds and half between recent time (i.e., from the mid-1990s to the present) and the 1980s as a whole.

Our data sample straddles the period of the financial crisis. However, the full effect of the hugely heightened uncertainty on the demand for money at the retail level cannot emerge fully since wholesale money market paralysis prevented the very loose stance of monetary policy from impacting the money stock at the retail level. If we assume, counterfactually, that the money multiplier had not collapsed after Lehmanns, then the safe haven effect at the retail level would, according to our results, have been even higher.

The democratisation of financial markets has made the store-of-value function of money much more important relative to its medium-of-exchange function of money. If the central bank is to avoid having short-term nominal interest rates being driven sharply upwards following an uncertainty driven jump in liquidity preference, it has little alternative but to accommodate these money demand pressures. The bottom line is that the cycle in uncertainty has the effect of racheting up the money stock over time. Central banks may take a relaxed attitude to this if it believes that it can subsequently sterilise these effects on the money stock. Unfortunately, it is very doubtful if they can.

À preliminary assessment of these results suggests that a worrying dynamic could be developing. This is driven by an asymmetry in the way uncertainty drives money demand in the new financial market environment. An uncertainty-driven increase in the demand for money has to be accommodated by the central bank or

else short-term interest rates will soar just when a reduction in rates would have been warranted. In other words, an increase in uncertainty increases money growth. By way of contrast, a diminished uncertainty-driven reduction in the demand for money does not reduce the money stock growth. There is therefore a dangerous asymmetry.

The policy consequences of this reversal are profound. The money stock is now growing rapidly in periods of heightened uncertainty (where in the pre-democratisation era it would have decelerated). This strong demand does not persist however. Money demand falls again as uncertainty dissipates leaving a large residue of excess money supply (i.e. a monetary overhang) which finds its way back into financial markets via an intense search for yield, re-igniting another asset price boom and bust, endangering the health of the banking system and compromising financial stability.

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Appendix

Table A1: Unit Roots Tests

	ADF (Level)	ADF (Difference)
Critical Value	-2.88	-2.88
Real Money (M2)	-0.111 (0.945)	-5.936* (0.000)
Real Income (GDP)	-1.334 (0.6132)	-8.924* (0.000)
Uncertainty (UN)	-2.391 (0.000)	-5.668* (0.000)
Interest Rate (R^{Short} - R^{Own})	-3.899* (0.002)	
Monetary Base	1.655 (0.999)	-8.264* (0.000)

Notes: ADF-Augmented Dickey Fuller Test

$$\Delta y_t = \alpha + \rho y_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta y_{t-i} + \varepsilon_t$$

(H_0: Series has a root.) * and ** denotes rejection of the null hypothesis at the 0.05 and 0.10 level respectively. Constant included in tests and p-values in parentheses.

Table A2: Cointergration Tests

M2 Money Aggregate (AIC Optimal Lag Length = 4)

	Maximal Eigenvalue		Trace	
	Eigen Statistic	Critical Value	Trace Statistic	Critical Value
r = 0	39.074*	22.299	52.547*	35.193
r ≥ 1	9.229	15.892	13.501	20.262
r ≥ 2	4.272	9.165	4.271	9.165

Monetary Base (AIC Optimal Lag Length = 6)

	Maximal Eigenvalue		Trace	
	Eigen Statistic	Critical Value	Trace Statistic	Critical Value
r = 0	28.335*	22.299	47.238*	35.193
r ≥ 1	10.903	15.892	18.903	20.262
r ≥ 2	7.999	9.165	7.999	9.165

Notes: Employed Variables = M2, GDP, UN and MB, GDP, UN, Lag length from 1 to 12 tested and is chosen based on AIC. * denotes rejection of the null hypothesis at the 0.05 level. Critical values due to MacKinnon-Hang-Michelis(1999)