

# **Money Demand and the Liquidity Accelerator in an Era of Financial Uncertainty and Innovation**

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## **Abstract**

Central banks, including the Federal Reserve, have largely abandoned setting target ranges for monetary growth. Money demand continues, nonetheless, as an important topic in macroeconomics because, in the words of McCallum and Nelson (2010), “the money demand function [in dynamic general equilibrium models] that implies a connection between steady-state money growth and inflation comes from the same private sector optimization that delivers the IS and Phillips curves.” Hence, explorations in money demand can furnish insights not apparent in non-monetary dynamic models, including the effects of structural change due to financial engineering and the importance of a rich spectrum of financial assets, including long-term interest rates and equity returns. This study explores how financial innovation increased the liquidity of less-liquid assets and altered the substitution elasticities that underlie money demand, giving rise to a “liquidity accelerator” effect via money demand. We also find that controlling for the relative effects of regulatory burden on bank versus nonbank financial sources of credit significantly reduces the putative “instability” in the short- and long-run demand for M2.

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*Because of costs in buying and selling income earning assets, because the price of such assets is uncertain, and because money is always readily acceptable in any transaction, it comes to be held.*

-- David Laidler, *The Demand for Money* (1969), p. 42

*Our view is that asset markets are better understood in the context of economies where, because of certain frictions... assets have a role in facilitating the process of exchange. [In] monetary economics assets are valued not only for their rates of return but also for their liquidity services.*

-- Rocheteau and Wright (2013)

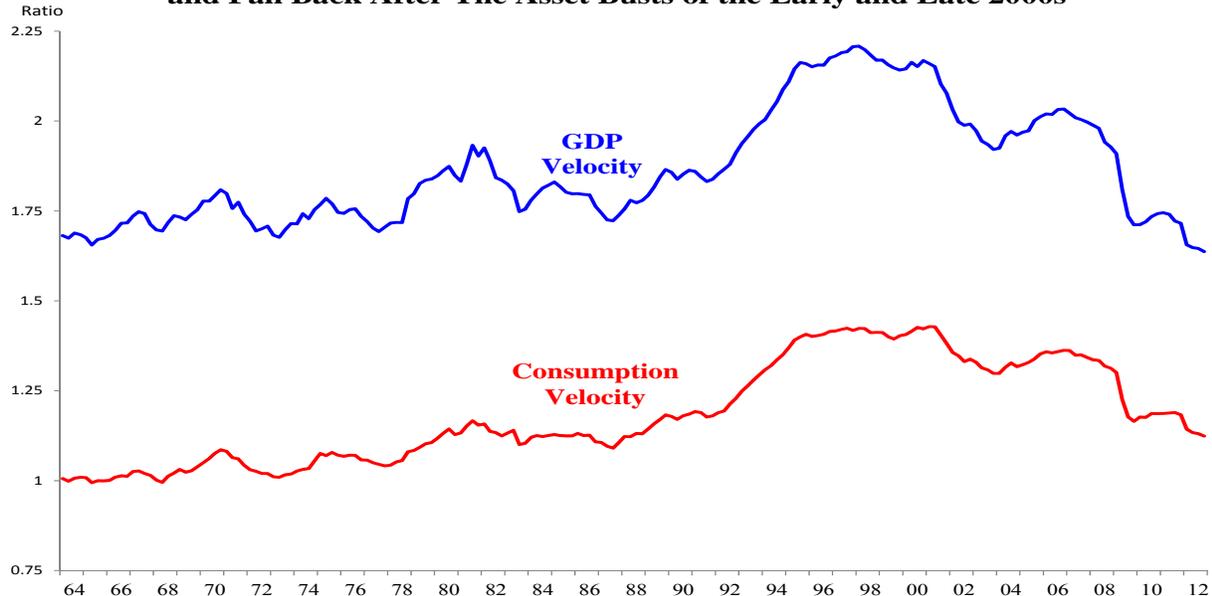
## **I. Introduction**

This study reassesses the demand for broad money in the United States. We combine elements from earlier research that addressed the role of financial innovations with more recent insights from the “new monetarist” and financial intermediation (“I”) literatures that focus on how financial frictions affect the liquidity of various assets, including substitutes to the assets included in the Federal Reserve’s M2 aggregate.

Apparent instability in the demand for narrow money during the early 1980s and the demand for broad money during the early 1990s induced the Federal Reserve to cease using monetary aggregates as policy guides (Duca and VanHoose, 2004). Large swings in M2 velocity, for example (Figure 1), often not closely related to interest rates, made it difficult to sustain the view that monetary aggregates provided valuable supplementary information vis-a-vis market interest rates. .

The de-emphasis of money coincided with the increased acceptance of Wicksellian-based New Keynesian models (e.g., Woodford, 2003). Gradually, the view became accepted that, at least for an inflation-targeting monetary policy, the stance of monetary policy is sufficiently measured by the level of a single overnight interest rate. This new paradigm, however, is not without problems. An important issue is uncertainty regarding the relationships between overnight and longer-term interest rates (both of which presumably affect spending) and, in turn,

**Figure 1: M2's Consumption and GDP Velocity Rise in the 1990s and Fall Back After The Asset Busts of the Early and Late 2000s**



their relationships to prices and yields on a wide range of assets. There is also much uncertainty and difficulty in estimating the Wicksellian neutral real rate (e.g., Clark and Kozicki, 2004; Laubach and Williams, 2004; McCallum and Nelson, 2010). Financial innovations alter not only the quantity of money demanded but also other aspects of economic activity, including consumption and housing (Duca and Muellbauer, 2013). These difficulties suggest that the federal funds rate is not a sufficient statistic to gauge the stance of monetary policy (McCallum, 1997, and Nelson, 2003).<sup>1</sup> As McCallum (2000) and McCallum and Nelson (2010) stress, although the canonical New Keynesian model’s single-interest-rate specification can normally be a “convenient assumption for monetary policy analysis,” there are times when a broader set of asset prices and returns matters—an array that affects, and is reflected in, monetary aggregates. But, until swings in M2 velocity are better understood, it will be difficult to supplement

<sup>1</sup> The zero lower bound on short-term interest rates has spurred research on how central bank purchases of long-term securities alter bond yields. But limited time series data—unlike money data—poses identification problems.

information from interest rates with information from monetary aggregates. A number of previous studies have attributed instability in money demand to technology that lowered financial transaction and portfolio adjustment costs (e.g., Carlson, *et al.* (2000a, 2000b), Duca (2000), Orphanides and Porter (2000)).<sup>2</sup> It is well-known that omitting relevant variables may give rise to demand shifts in estimated regressions when in fact, if correctly specified, there are none. Approaches to addressing such “instability” include (1) estimating regime-switching models, with or without long-run error-correction mechanisms (e.g., Calza and Zagini, 2009; Carlson *et al.*, 2000); (2) redefining money to internalize substitution with formerly outside assets (e.g., Duca, 1994; Orphanides and Small, 1994); and (3) more accurately measuring the attractiveness of alternative assets (e.g., Duca, 2000). The first has the practical difficulty of introducing too many free parameters, while the second usually entails reacting after the relative “moneyness” of other assets has changed and adding price risk and volatility to a monetary aggregate. The third approach addresses the underlying sources of observed money demand instability and accords with the new, common practice in financial economics of measuring “liquidity” by a transaction cost (e.g., Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005), a strategy adopted by few money demand studies owing to a lack of data.

So far as we are aware, this study is the first to incorporate liquidity transaction costs in a money demand model, specifically, the loads of moving in and out of bond and equity mutual funds, the closest M2 substitutes for most households. Changes in loads alter substitution elasticities underlying money demand, causing conventional money demand models that omit such costs to exhibit apparent “shifts.”

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<sup>2</sup> Federal Reserve Governor Gramley (1982) noted money demand became more uncertain as households, “became more adept at economizing on cash balances and more receptive to new kinds of financial investments,” and that, “The increased financial sophistication of households and businesses has been coupled with technological advances

Money demand also depends on the riskiness of alternative assets as stressed by Tobin (1958) and Baba, Hendry, and Starr (1992). This risk theme has been rediscovered in the “New Monetarist” literature (e.g., Williamson and Wright, 2010; Rocheteau and Wright (2013)), and is implicit in intermediation-based (I) theories of money demand (Brunnermeier and Sannikov, 2013). Time-variation in money demand elasticities follows from changes in risk combined with changes in transaction costs. But, for many households, the relevant M2 substitutes are not risky individual stocks and bonds but, rather, are bond and equity mutual funds.

Our conclusion in this study is that including measures of the relative attractiveness and transaction costs of bond and equity mutual funds permits estimation of a well-behaved M2-velocity model. In the long-run, the changing sensitivity of money balances to liquidity premia plays a key role. Liquidity premia also are important in the model’s short-run dynamics, reflected in both maturity-related yield differentials and waves of mortgage refinancing activity driven by changes in long-term interest rates. When transfer costs and the liquidity of non-M2 assets are included, we find there exists a well-defined cointegrating relationship among velocity, transfer costs (mutual fund loads), and risk premia. Weak exogeneity tests imply long-run causality running from transfer costs and risk premia to velocity, but not the reverse. Further, M2 velocity is statistically and economically related to high risk premia only when accounting for how lower asset transfer costs raised the substitutability of bonds and money.<sup>3</sup> Our models are estimated over a long time period (1964-2012) and are robust to omitting the recent financial crisis and the era of deposit regulation.

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in the computer and telecommunications industries that have reduced the transactions costs of transferring funds.” Other contributions include Hamburger (1966, 1977) and Moore, Porter and Small (1990), *inter alia*.

<sup>3</sup> Flight-to-quality effects on money demand were recognized as far back as 1935, when Federal Reserve Chairman Eccles (1935) noted that uncertainty about the safety and rate of return on alternative assets available to U.S. citizens, relative to residents of Canada and Great Britain, likely had driven the extreme increase in currency demand earlier in the decade (Committee on Banking and Currency, 1935).

The study makes several contributions to the money demand literature. First, it extends our understanding of how alternative assets affect households' short- and long-run demand for money. Our approach is similar to that of the recent financial economics literature which equates the "liquidity" of an asset to its transaction cost (e.g., Aychara and Pedersen, 2005) in that we treat bond and equity mutual funds as the relevant alternative assets. Second, our money demand analysis addresses the controversy regarding the relative importance of bond and equity market volatility (return uncertainty) for macroeconomic performance (e.g., Ulrich, 2013, on Treasury bonds and Corradi *et al.*, 2013, on equities). Default risk of bond mutual funds is negligible, placing at center stage uncertainty about the riskless rate-of-return and the liquidity risk of private paper. Indeed, a time-varying "liquidity accelerator" arises in our model through which innovations have increased the sensitivity of money velocity to shocks that affect the liquidity of alternative, non-M2 assets. Third, from improved money demand models, we can better assess emerging trends in nominal GDP growth,<sup>4</sup> and whether money growth is excessive or noninflationary.

The balance of the paper is organized as follows. Section 2 discusses mutual fund transaction costs and their impact on M2 velocity and the influence of regulations affecting the competitiveness of bank versus nonbank financial firms. Section 3 discusses how mortgage refinancing activity can affect money balances and illustrates the shifting interest sensitivity of refinancing. Section 4 present our empirical strategy and the specifications and variables used. Section 5 discusses our results, which are more broadly interpreted in the conclusion.

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<sup>4</sup> This is a more qualified and nuanced approach to interpreting M2 than in an earlier time when V2 had appeared to be stationary (e.g., as in Hallman, Porter, and Small's (1991) P-star model of inflation).

## **II. The Sensitivity of M2 Velocity to Transfer Costs, Stock Prices, and the Yield Curve**

The money demand literature lacks a fully integrated analysis of how changes in transaction costs affect money holdings. Nevertheless, a number of studies provide insights.

### **A. Transfer Costs and Long-Run Velocity**

In both DSGE (Kim, 1998) and generalized versions of the Baumol-Tobin model (see Brunner and Meltzer, 1967), it is primarily the variable, not the fixed, cost of transfers between money and bonds that affects money demand (Duca, 2000). Brunner and Meltzer (1967) show that if agents face proportional and fixed asset transfer costs and need to reinvest asset income, then as labor income rises, velocity approaches a constant (that is, the income elasticity approaches unity) plus a term which is decreasing in the proportional cost of shifting between bonds and money; the Baumol (1952) and Tobin (1956) models are special cases of this result. Essentially, as the size of the amount transferred increases, fixed transfer costs fade in importance and the conventional Baumol-Tobin model emphasis on fixed transfer costs loses its relevance. In a variant on Kim (1998), Duca (2000) introduces a variable cost of transferring between bonds and money in the household budget constraint, which alters equilibrium velocity.

The Brunner and Meltzer (1967) and Kim (1998) models imply that the log of velocity is increasing in the opportunity cost of money ( $OC$ , the gap between yields on Treasury bills and money) and decreasing in the proportional costs of transferring between bonds and money (i.e., bond fund loads, *bload*). For most middle and lower income families, during our sample period, bond mutual funds are the relevant bond substitute for M2 money: the \$10,000 minimum denomination of most bonds, plus diversification rules faced by the sellers of bonds to households, effectively rule out direct bond holdings by these households. Cointegration results

(Duca, 2000) indicate that the upward shift in M2 velocity in the early 1990s owed to decreases in bond mutual fund loads. Nevertheless, these studies do not address whether transfer costs alter the sensitivity of M2 demand to asset price uncertainty and affect the frequency and magnitude of portfolio shifts between equity and M2 balances.

Liu and Loewenstein (2002) and Zakamouline (2002) analyze how transaction costs change the timing of optimal decisions regarding when to realign portfolios of risky and safe assets. Transaction costs create a zone of “inaction” in which it is optimal not to trade until/unless portfolio misalignment is large enough to warrant incurring the transaction cost. . As proportional transfer costs increase, the zone of inaction generally widens. Davis and Norman (1990) obtained similar results. All three studies imply that a decrease in mutual fund loads increases the likelihood that households will realign their portfolios in response to a given change in opportunity costs or the risk of money relative to non-money assets. These studies imply higher asset uncertainty induce a greater rise in money demand the lower are the costs of transferring, thereby heightening the importance of the speculative/portfolio demand for money or of flights to quality.<sup>5</sup>

In a more complicated model in which fixed and proportional asset transfer costs affect the optimal consumption and portfolio behavior of households with constant relative risk aversion, Liu (2004, p.322) obtains results implying that portfolio shares reflect differentials in pecuniary yields between safer and risky assets (e.g., the Treasury yield premium or a corporate-Treasury bond yield differential) that should be scaled by proportional asset transfer costs. More specifically he finds that portfolio shares reflect approximately negative linear tradeoffs

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<sup>5</sup> Such flights to quality reflect surges in the speculative demand for money to avoid capital losses in Tobin’s framework (Handa, 2008, chapter 5). Such effects were weak during the era that Friedman analyzed because of high transfer costs. Baba, Hendry, and Starr (1992) assess how interest rate risk affects money demand. In a sense, our study extends the analysis of capital losses to include more than interest rate risk on default-free government bonds.

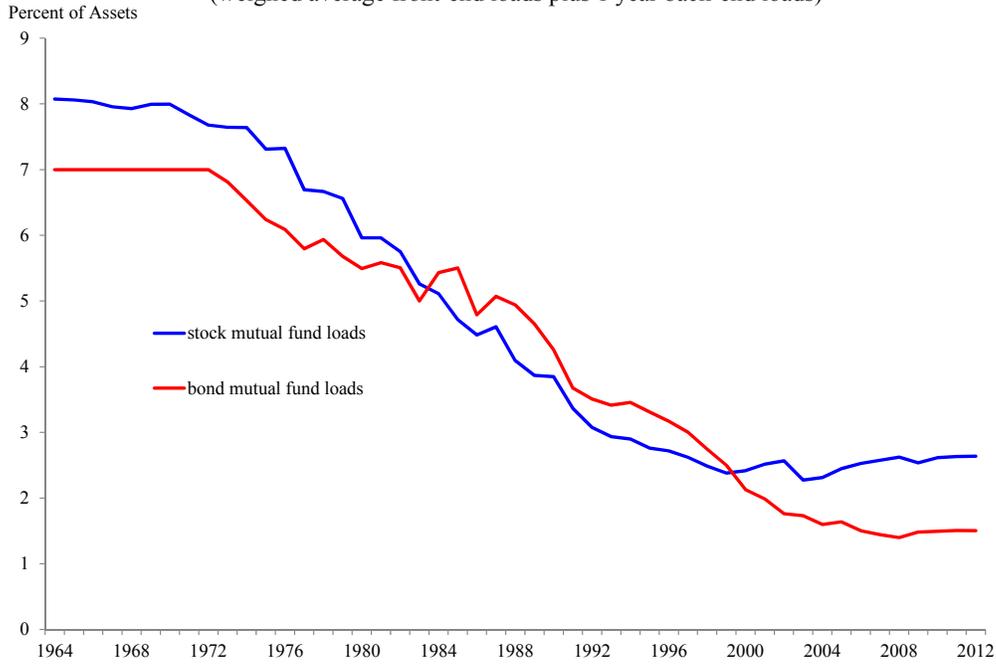
between expected return differentials and proportional asset transactions costs. By implication, if asset transfer costs shift, then models that omit such information will appear to suffer from money demand shifts even if those models include term or default/liquidity risk premia.

A parsimonious way of entering such a risk premium is to include the two-quarter moving average spread between Baa-rated corporate and 10-year Treasury bond yields (*Baa10TR*). Since this spread tends to widen when corporate bond prices and stocks decline, it proxies for flights to quality. Because Treasuries are viewed as a relatively default and liquidity risk free asset, standard money opportunity cost terms are viewed as having a negative effect on the quantity of money demanded and a positive effect on velocity. In contrast, when corporate risk spreads widen, the widening does not reflect a higher certain rate of relative return, but rather a higher liquidity or default premium on private assets, implying a negative effect of *Baa10TR* on M2 velocity.

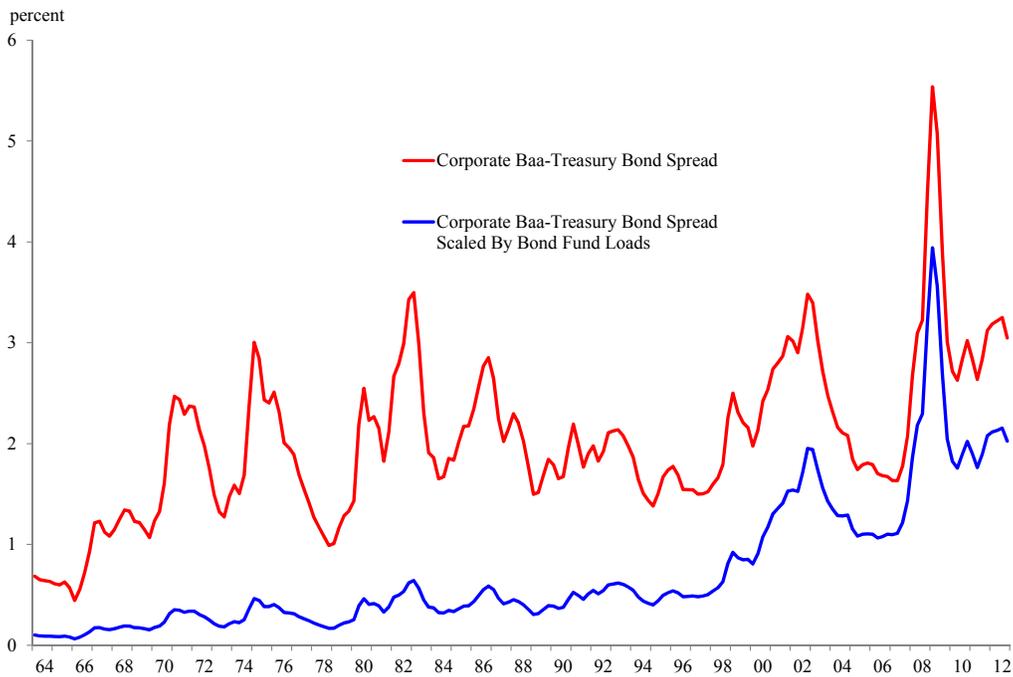
In practice, measures of M2 opportunity cost with respect to short-term and long-term Treasury interest rates are stationary, whereas bond and stock fund loads (Figure 2) and the product of the multiplicative inverse of bond fund loads and the yield spread between Baa corporate and 10-year Treasury bonds (Figure 3) are nonstationary (we acknowledge that these likely are not in truth nonstationary, but  $I(1)$  appears to be a useful approximation) The magnitudes of (*BaaTr/bload*) are sensible insofar as the ratio takes an annual risk premium (*BaaTR*) and scales it by the fixed percentage cost of shifting between bonds and money. For example, while the Baa spread was about 3.5 percentage points in both 1982 and 2002, bond fund loads were a much larger 6.3 percentage points in the earlier period and were less than half as large at 2.4 percentage points in 2002. A household thus faced a transfer cost of slightly less than the overall risk premium in 2002, whereas the cost of getting out of bonds was nearly twice

the size in 1982, implying it would be relatively more attractive to flee to money in 2002 than in 1982. The above considerations imply that the long-run equilibrium consumption velocity of

**Figure 2: Large Declines in Bond and Stock Mutual Fund Loads Over Time**  
(weighed average front-end loads plus 1 year back-end loads)



**Figure 3: Corporate Bond Spreads Rise Relative to Bond Fund Loads**



M2 ( $V2^*$ ) could plausibly take the form of:

$$\ln V2^* = \alpha_0 + \alpha_1 \text{blood} + \alpha_2 (\text{Baa10TR}/\text{blood}), \quad (1)$$

where  $\alpha_1$  and  $\alpha_2 < 0$ , and all three nonstationary variables are usefully modeled as I(1).

## **B. Transfer Costs and Short-Run Velocity**

Empirically, the vast bulk of M2 assets are held by middle-income families and most middle-class equity shareholders own equity via mutual funds. These stylized facts suggest that the sensitivity of broad money balances (for example, MMDAs or MMMFs) to stock market developments depends on the magnitude of equity fund loads. When the transfer cost of shifting between M2 and bond/equity mutual funds is lower, the response of households to any general increase in uncertainty (say, a fear of a sharp fall in equity prices), will be larger. Consistent with this view, much, if not most, of the surges in M2 growth during 2001 and 2009 reflected inflows into Treasury MMMFs and MMDAs. Mutual fund families make it easy to shift assets across their funds, further easing substitution between M2 and equity assets, and likely disproportionately affecting MMMFs. Similarly, shifting between equity funds and MMDAs has become more convenient as bank holding companies expand their offerings of MMDAs and asset management accounts. Indeed, money fund, MMDA, and M2 inflows in 2001 and 2009 were larger than what interest rate spreads and other conventional money demand variables could explain based on past experience. Along with directly affecting M2 by altering the costs of switching between M2 and equities, falling loads likely boost stock ownership rates, thereby making M2 more sensitive to stock market shocks (*Sshock*). As Heaton and Lucas (2000) stress, high transfer costs for households whose utility functions exhibit habit formation can lead to a low stock ownership rate and a high equity premium.. Consistent with this implication, Duca

(2005, 2006) showed that average equity fund loads and stock ownership rates from the irregular Surveys of Consumer Finances (SCFs) had a significant negative correlation of about  $-1$  for both overall and indirect (e.g., mutual fund) stock ownership rates (Figure 4). These SCFs show that higher equity participation stemmed from greater mutual fund stock ownership and had risen the most for middle-income families, whose median holdings of transaction accounts and certificates of deposits grew more slowly relative to total financial assets than did the deposits of high-income families during the transition to higher stock-ownership rates. Thus, cross-section data support the view that decreasing mutual fund loads have made M2 balances more susceptible to equity-related portfolio shifts.<sup>6</sup>

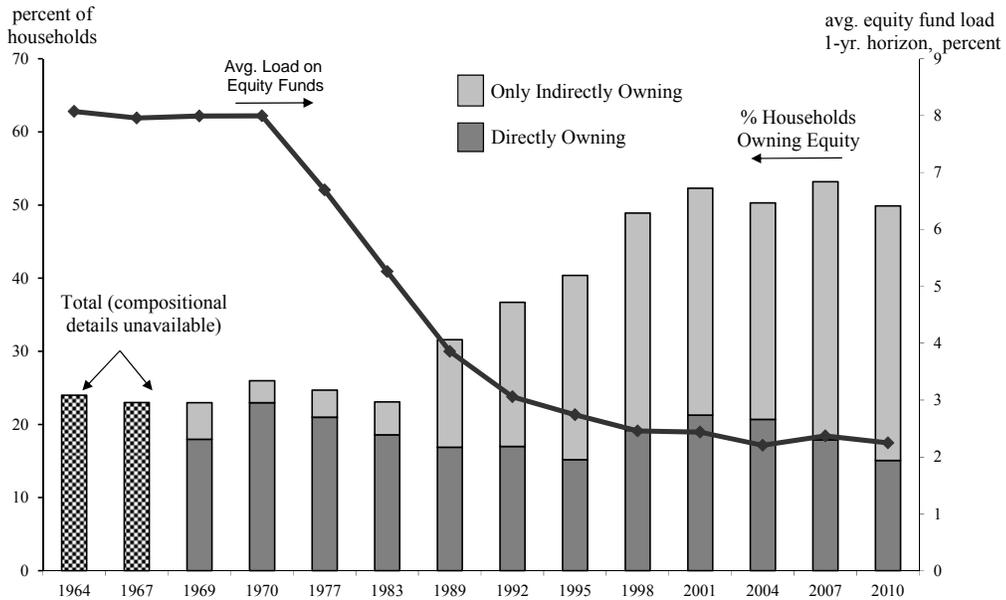
Beyond the direct transfer cost effects on portfolio composition examined by Liu (2004), an equity shock variable that is scaled by stock mutual fund loads [ $Sshock*(1/sload)$ ] could be significant in M2 regressions because loads track the stock ownership share. This effect is analogous to deposit participation in the models of Mulligan and Sala-i-Martin (1996, 2000), in which the share of households owning deposit accounts affects aggregate money holdings.

Because M2 is dominated by zero maturity (MZM) components, Treasury bills are more substitutable for M2 than are bonds, making M2 demand and its velocity more sensitive to opportunity costs defined by the gap between 3-month Treasury bill rates and average yields on MZM (“ $OC$ ”) than by the gap between yields on Treasury bonds and M2 yields. To avoid multicollinearity,  $OC$  and the slope of the yield curve ( $YC \equiv 10$  year Treasury note – 3 month Treasury bill rates) can separately enter the long-run M2 velocity function with the coefficient on the former expected to be larger in absolute size.

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<sup>6</sup> Duca (2005) found that loads mainly reflect evolving financial technology and in vector error-correction models, that loads were weakly exogenous to the mutual fund use but not vice versa, while loads were not weakly exogenous to financial sector productivity, but the converse was true. Granger and Lin (1995) would view such results as evidence that mutual fund use is caused, in a long-run sense, by loads, which are caused by financial technology.

**Figure 4: Equity Fund Loads Fall and Stock Ownership Rates Rise**



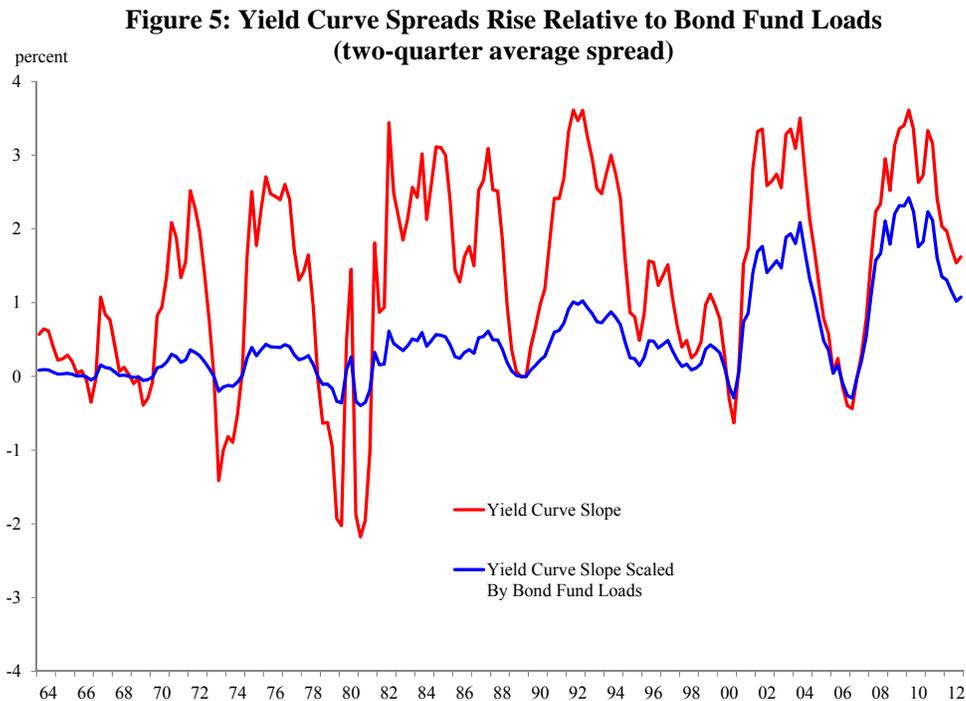
Another factor limiting the sensitivity of  $V2$  to the yield curve is that for most of the sample, the feasible bond substitute for  $M2$  is a bond mutual fund. For middle-income families, the ratio  $(YC/bload)$  likely proxies for the benefits of shifting into bonds. For example, the spread between the 10-year and 3-month Treasury rates was about 3.6 percentage points in 1992 and 2010, but relative to the average load, the incentive was much higher to shift to bonds in 2010 (Figure 5). Thus, if the yield spread stayed at 3.6 in 1992, it would take almost one and a half years for a household to recoup the 4.5 percentage point average load, whereas in 2010, it would take less than one-half year to recoup the average 1.5 percentage point load. Much lower transfer costs have visibly altered the tradeoffs facing households.

Combining the long-run effects of loads on velocity with the short-run effects of stationary stock market shocks, the yield curve slope, and  $M2$  opportunity costs implies the following error-correction model of short-run changes in velocity:

$$\Delta \ln V2_t = \beta_0 + \beta_1(V2_{t-1} - V2^*_{t-1}) + \beta_2 \Delta OC_t + \beta_3 OC_{t-1} + \beta_4 (YC_t / \text{load}_t) + \beta_5 (S\text{shock}_t / \text{load}_t)$$

$$\ln V2^*_t \equiv \alpha_0 + \alpha_1 \text{load}_t + \alpha_2 (Baa10TR_t / \text{load}_t), \quad (2)$$

where  $\beta_1, \beta_5 < 0$ ;  $|\beta_1|$  is the quarterly speed of adjustment; and  $\beta_2, \beta_3$ , and  $\beta_4 > 0$ . A semi-log specification is used because the opportunity cost of money vis-à-vis short (*OC*) and long-term (*YC*) Treasuries have been negative in absolute levels.<sup>7</sup>



### C. Empirical Difficulties in Identifying Stock Wealth Effects on Money Demand

Aside from changes in asset transfer costs, attempts to analyze stock market effects on money have been hindered by two sources of difficulty. One is that equity shocks have both positive wealth and negative substitution effects on money demand. The second concerns defining equity market shocks. Hamburger (1966, 1977) found that money demand is negatively

<sup>7</sup> While most bond and stock funds do not charge back-end (redemption) load fees, the average of front- and back-end load fees matter if households eventually plan to rebalance their portfolios after asset market turmoil subsides.

related to equity returns, as tracked by the dividend-price ratio. But later Friedman (1988) found that this ratio is insignificant when wealth is included as a scale variable, and Allen and Connolly (1989) found it insignificant in a more standard money demand model. The mixed pattern of these results could reflect the ambiguous net impact of positive scale (wealth) and negative substitution effects. Further, the dividend-price ratio's link to stock returns has loosened over time due to changes in the equity premium (Blanchard, 1993, and Siegel, 1999) and corporate efforts to reward investors with capital gains to avoid the double-taxation of dividends (Fama and French, 2001).

Another approach, based on the random walk hypothesis, is to use stock price changes to gauge equity shocks (Dow and Elmendorf, 1998, and Carlson and Schwartz, 1999). However, it is unclear what horizon should be used. Measuring equity-market innovations using VARs or other techniques is subject to concern that such terms are too sensitive to model specification, especially given large equity premium shifts (see Blanchard, 1993, and Siegel, 1999, 2002). To avoid such problems, Lange (2001) and Carpenter and Lange (2002) use revisions to future stock earnings from IBES's survey of analyst 12-month ahead S&P 500 earnings per share (EPS). Lange (2001) finds EPS revisions have significant and negative effects over 1995-2001, but not over longer periods.<sup>8</sup> Nevertheless, Duca (2003) found stock price changes were more significant in M2 models estimated over longer periods, while Sharpe (2002) casts some doubt over the accuracy of analyst forecasts.

Sample sensitivity characterizes the Dow and Elmendorf (1998) finding that stock price changes asymmetrically affect household money market mutual funds (MMMMF) since the early

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<sup>8</sup> Carpenter and Lange (2002) found that EPS revisions and stock price volatility were significant in samples covering 1995:4-2002:2, but do not report results for longer samples.

1990s, but not in earlier samples.<sup>9</sup> Reflecting mixed evidence on whether changes to stock price or earnings forecasts are better, and recognizing that the sample would be overly restricted using earnings forecasts, the percent change in the S&P 500 is used to proxy stock market shocks. A reasonable proxy is the symmetric change in stock prices, denoted here as *DSP*. Alternative proxies include all positive (denoted *DSPPO*) and all negative changes (*DSPNEG*). Note that the lagged first differences of  $(Baa10TR_t/bload_t)$  tend to be correlated with  $(DSPNEG_t/sload_t)$  because of negative correlations of stock price changes and corporate-Treasury spreads and because of positive correlations of bond and stock fund loads. The inclusion of  $\Delta(Baa10TR_t/bload_t)$  in the VEC (equation 2) tends to strip out the corporate bond risk premia effect from changes in stock prices, effectively leaving a risk premium of equities over corporate bonds.

#### **D. The Impact of Financial Regulation on Bank vs. Shadow Bank Intermediation**

Thus far, we have focused on how changes in financial technology can effect money demand by altering the liquidity (“moneyness”) of non-monetary assets (at least, those that are not medium of exchange or not extremely inexpensive to convert to medium of exchange). An additional influence comes from shifts in the relative regulatory burden on bank and nonbank financial intermediaries. An increase in capital regulations on banks relative to nonbanks, for example, will induce a shift in the locus of intermediation toward nonbank or shadow bank sources (Duca, 2013).<sup>10</sup> Such shifts reduce both sides of depository balance sheets at roughly the

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<sup>9</sup>They found that positive and negative stock price changes boost MMMF growth, the former is consistent with a positive wealth effect, and the latter, with a positive flight to quality effect outweighing a negative wealth effect. Carlson and Schwartz (1999) obtain similar results for M2, but in contrast, find stock price changes were statistically significant over 1980-98. But these variables are insignificant over 1979-01 and 1979-02 using a Fed model similar ours in which M2’s sensitivity to equity shocks vary with stock fund loads or the MMMF share of M2.

<sup>10</sup> We recognize that the shadow banking system could not exist, in its current form, without a symbiotic relationship with the traditional regulated banking system. To a large extent, the shadow banking system may constructively be

same time as they bolster both sides of nonbank balance sheets. As argued in Duca (1994), such portfolio movements may not be manifested in traditional spreads between bank and Treasury yields, resulting in shift in the money demand curve. Following Duca (2013), we augment the components of the long-run money demand vector in equation (2) to include a long-run shift variable, *Basel12DFA*, which equals 1 starting in 1989:q4 until 2010:q3. Since the error-correction term enters the short-run money demand equation with a t-1 lag, its implied effect runs from when the Basel 1 capital standards were imposed in January 1990 up until the quarter immediately following the passage of the Dodd-Frank financial reform act in late July 2010. Because Basel 1 and 2 applied capital regulation to banks but not nonbanks, the accords disadvantaged banks relative to nonbanks, largely by encouraging loan securitization which replaced deposit funding with market funding of loans.

Dodd-Frank ended much of this disparity for two key reasons. First, it made systemically important nonbank financial firms subject to regulatory capital and stress test requirements at a time when systemically important (very large) banks greatly dominated the U.S. banking system. Second, Dodd-Frank imposed regulations on derivative securities and the securitization of loans, which reduced the regulatory arbitrage appeal of securitization. Reflecting these factors, the interlude between the start of Basel 1 and the advent of a more even-playing regulatory field under Dodd-Frank has been associated with prolonged shift toward nonbank sources of short-term business credit that only reversed following the passage of the Dodd-Frank Act (see Duca, 2013). We also include a Dodd-Frank initial impact dummy (*DFADum*) which equals 1 in only 2010q4 when there was an apparent and sudden shift from nonbank back to bank intermediation.

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seen as a device through which the regulated banking system seeks to increase effective corporate leverage beyond that permitted *de jure* for a regulated bank. If credible firewalls existed between the regulated and shadow systems, this effort would fail. Unfortunately, too-big-to-fail and similar regulatory/market failures frustrate efforts to create such firewalls.

### III. Mortgage Refinancing Effects

Mortgage activity affects money demand (see Duca (1990) and Anderson (1993)). Mortgage originations for home purchases and for refinancings increase liquid deposit balances. However, because of its volatility, refinancing is the more important factor for our analysis.

Mortgage refinancing activity affects M2 demand in a number of ways. First, households have a three-day period following a transaction secured by their principal residence to reverse a decision to refinance. During this period, funds from the mortgage refinancing are held in an escrow account.. Second, households can also convert equity to cash at the time of refinancing, and are likely to store all or part of the the funds in M2 until spent. Finally, and most important, are the balances that mortgage servicers hold when a mortgage is prepaid early (e.g., when households close a refinancing or a sale of a mortgaged home) and remit unscheduled principal payments to the mortgage servicer. All three federal mortgage agencies (GNMA, FNMA, FHLMC) require that mortgage servicers hold these funds in a liquid federally-insured deposit for periods from a few days to several weeks before remitting the funds to either the agency or MBS holders.<sup>11</sup> We develop an index of refinancing activity based on MBS activity. Our index complements the Mortgage Bankers' Association (MBA) index of applications to refinance mortgages. First, MBA data start in 1990 and miss two decades, while our GSE MBS-based index begins in 1970. Second, the MBA series may not capture refinancings arranged by depositories or by special government programs to address the recent housing crisis (e.g., refinancing under the HAMP or HARP programs). Third, the rejection and delays in processing

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<sup>11</sup> Three government sponsored enterprises (GSEs) securitize mortgages: the Federal National Mortgage Association (FNMA, Fannie Mae), Government National Mortgage Association (GNMA, Ginnie Mae), and Federal Home Loan Mortgage Corporation, Freddie Mac. Servicers of Freddie Mac MBS hold incoming unscheduled principal in liquid deposits for 5 days prior to remittance to Freddie Mac. Servicers of GNMA MBS hold unscheduled funds received during a month in liquid deposits until approximately the 18<sup>th</sup> calendar day of the following month. Servicers of FNMA MBS face a more complex remittance environment which depends on the program under which the servicer acquired the servicing rights.

mortgage refinance applications can vary over time, whereas the liquidations more consistently reflect mortgage closings and their timing.

Swings in mortgage refinancing activity can significantly, if temporarily, distort money growth. Mortgage refinancing, once rare, has become commonplace. Owing to more liberal fiduciary rules and greater use of deposit-sweep programs by commercial banks, their impact has expanded beyond demand deposits to MMDA deposits included in M2 but excluded from M1. Our estimates of the impact use a more refined version of Anderson's (1993) techniques for approximating unscheduled mortgage prepayments from monthly data on GSE mortgage outstanding balances and issuance.<sup>12</sup> The resulting refinancing series is not an estimated direct effect of refinancings on M2 balances that can be used to directly adjust M2: rather it enters the equation in the form of a right-hand side variable in equation (2) to help clean up short-run residuals. Depending on whether nominal GDP or total nominal total consumption (PCE) scales M2 in defining V2, we scale nominal refinancing volume by GDP or PCE, respectively, (Figure 6). Based on experimentation, the time t and t-1 lags of *REFI* are highly significant and are added to the models to help clean up model residuals. In future versions we plan to directly adjust M2 for refinancing effects and thereby adjust the level and lags of first differences of V2 in the models.

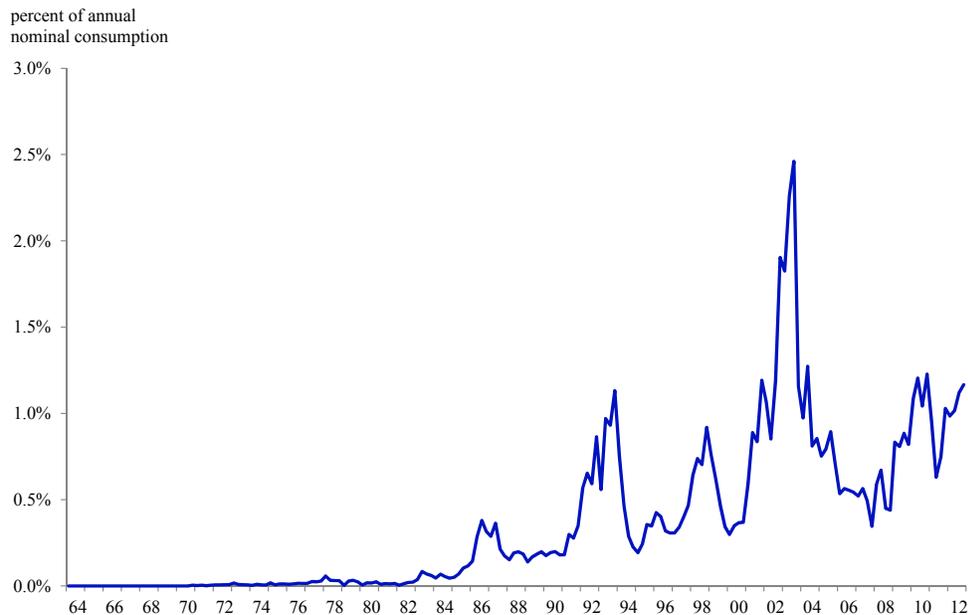
#### **IV. Empirical Specifications and Data**

The progress of our empirical work has followed a general-to-specific track. We started with a general specification that included possible long-run effects of mutual fund costs, liquidity premia, and bank regulation, as well as a number of possible special short-run factors,

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<sup>12</sup> One improvement is to use to calculate scheduled principal payments from outstanding mortgage balances using the outstanding stock of household mortgages, a 30-year fixed rate amortization schedule, an assumed 10 year average life of a mortgage, and the time-varying average interest rate on outstanding mortgages.

**Figure 6: Quarterly Unscheduled Liquidations of GSE MBS as a Percent of Annual Nominal Consumption**



particularly with an eye towards capturing portfolio substitution into mutual funds and fillips in money demand due to mortgage activity. After dropping all variables that were not close to being marginally significant, we settled on a preferred specification (model 4 in tables 1 and 2).

To better convey a sense of what the addition of some variables contributes and how sensitive the estimated effects of some short-run factors are to being better measured (e.g., scaling the yield curve and stock shock effects by transactions costs), we present the results in a sequential way that builds up to the preferred models. For models that use either consumption or GDP as a scale variable, we begin by presenting results from a “baseline” M2 specification (model 1) that has a limited number of special short-run control variables, but which includes mortgage refinancing effects along with the short-run stock price change and yield curve variables that are not scaled by mutual fund costs. Model 2 then adds a full set of short-run control variables, in case there are concerns about including them. Then we present results from a model (number 3 in each table) reverts back to the narrower set of short-run controls, but which

adds long-run variables to capture the time-varying effects of lower mutual fund loads along with short-run variables that test for a constant or a time-varying (due to falling transaction costs) impact of stock-price changes and the yield curve slope. Then the findings from a richer, preferred model that includes a full set of controls are shown in the fourth specification in each table. To see how including the financial crisis period affects the estimates, the fifth model shown in each table is the preferred model estimated over a pre-crisis sample period ending in 2006. To illustrate the importance of controlling for shifts in transactions costs, the last model shown in each table reverts to the full sample, but omits mutual fund loads in the vector of long-run determinants and does not scale stock price and yield curve effects by mutual fund loads.

The models presented and the strategy adopted reflects the challenges to estimating money demand models that are posed by interactions among the variables. Technological change has reduced transaction costs making portfolio shifts between M2 and equity funds and of refinancing home mortgages. As these activities have become more sensitive to interest rate differentials, their correlation with other RHS variables (e.g., M2 opportunity costs) likely has changed. To the extent that the correlation has diminished through time, the degree of specification error from omitting mortgage activity likely is higher than in earlier periods when movements in the M2 opportunity cost variable would have better captured swings in mortgage activity. To address this issue, we also plan to re-estimate each of the above models using two M2 series that are directly adjusted for mortgage refinancing effects based on Anderson (1993).

For two reasons, it is preferable to measure mortgage refinancing effects via MBS liquidations rather than rely on standard money demand opportunity cost terms to control for the effects. First, mortgage refinancing activity had become more sensitive to interest rates when fixed costs had fallen (e.g., Bennett, Peach, and Peristiani, 2001). Refinancing applications and

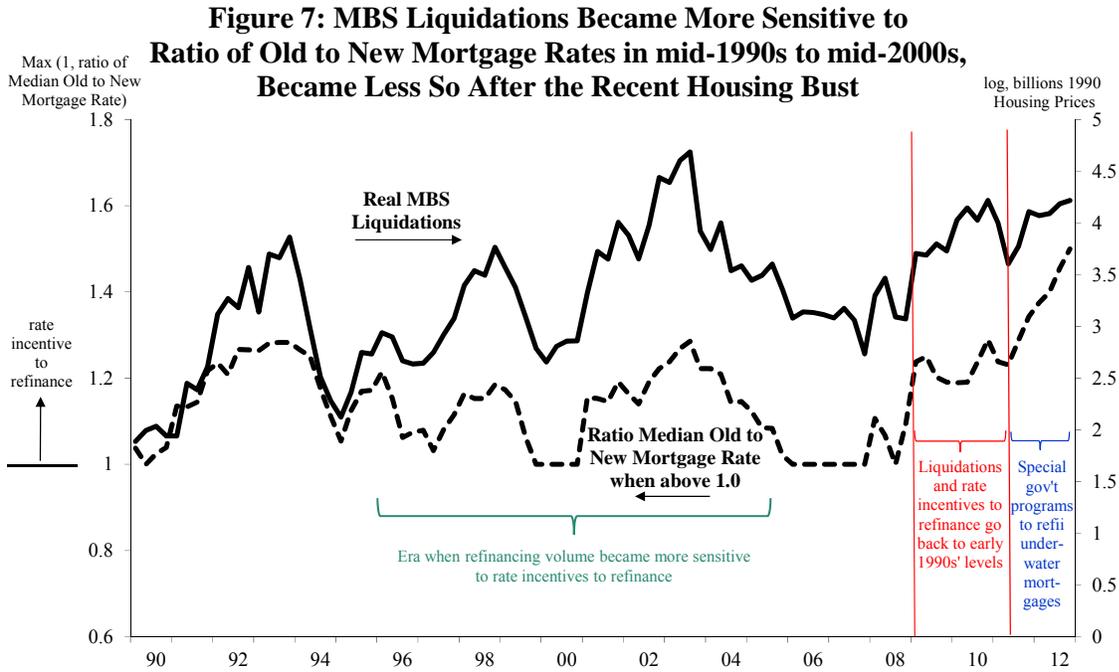
MBS prepayments became more sensitive to the ratio of the new and old mortgage rates from the mid-1990s to mid-2000s, but less so after the housing bust hurt collateral values (Figure 7). Second, the triggers for surges and halts in mortgage refinancing activity involve the time-varying, nonlinear relationship between interest rates on existing mortgages and those on new ones, and the option value of the refinancing feature of most American mortgages. It is unlikely that such nonlinear relationships involving mortgage rate spreads will be tracked by short-lived, symmetric effects of differences between yields on Treasury and M2 deposit interest rates.

There are also good reasons to prefer using MBS liquidations to track MBS effects on M2. Because the MBA index begins in the early 1990s, its sample is too short to capture this time-varying effect. MBS data, in contrast, start in 1970 and imply no refinancing before, allowing samples to start in 1964. The underlying estimates of MBS prepayment volume closely track the MBA index of refinancing applications during their common sample (Figure 8), which allows us to reasonably splice the series until we can obtain up-to-date GSE data. A comparison of the estimated models allows us to assess how much of the recent swings in M2 growth are attributable to swings in risk premia, stock market effects, and mortgage refinancing activity.

### ***A. Empirical Framework***

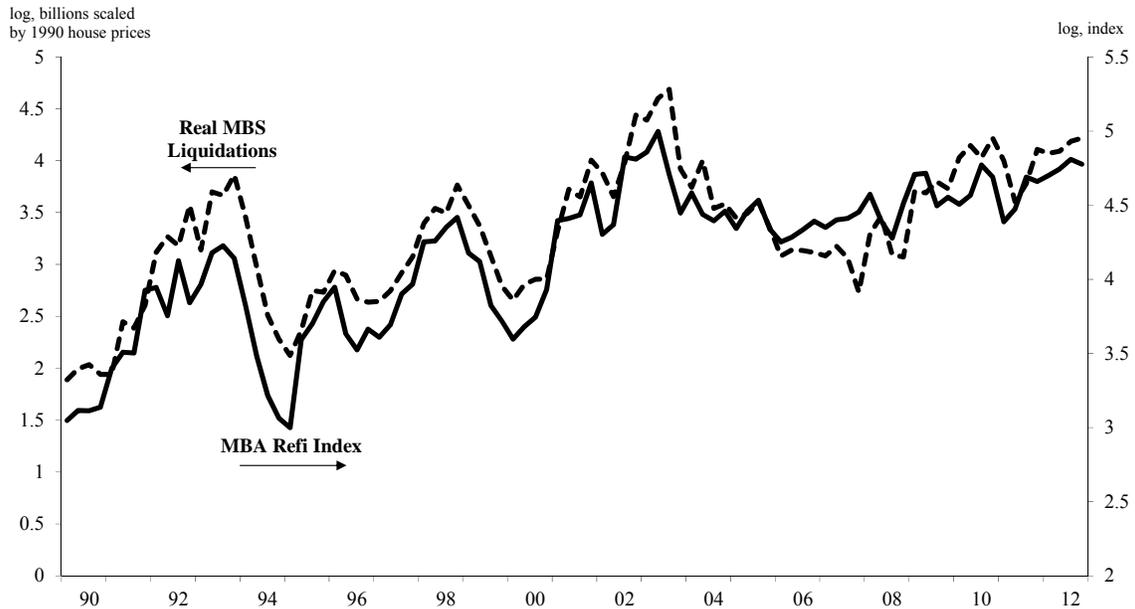
Building off the discussion of regulatory burden effects and equation (2), which models long-run velocity as a function of bond fund loads and the ratio of the Baa-Treasury yield spread to bond fund loads, we estimate a series of VEC models using the basic framework of:

$$\begin{aligned} \Delta \ln V2_t &= \beta_0 + \beta_1(V2_{t-1} - V2^*_{t-1}) + \beta_2 \Delta OC_t + \beta_3 OC_{t-1} + \beta_6(REFI_t) + \beta_7(REFI_{t-1}) + \\ &\beta_4(YC_t/bload_t) + \beta_5(Sshock_t/sload_t) + \text{other short-run money demand controls} \\ \ln V2^*_t &\equiv \alpha_0 + \alpha_1 bload_t + \alpha_2 (Baa10TR_t/bload_t) + \alpha_3 Basel12DFA_t \end{aligned} \quad (3)$$



Sources: FNMA, GNMA, FHMLC, Office of Federal Housing Enterprise Oversight, and authors' calculations.

**Figure 8: MBS Liquidations Move With Mortgage Refinancing Applications**



Sources: Mortgage Bankers Association, FNMA, GNMA, FHMLC, FHFA, and authors' calculations.

where  $\alpha_1 < 0$ ,  $\alpha_2 < 0$ , and  $\alpha_3 > 0$  are expected since velocity is inversely related to money demand and other short-run money demand controls are described later. Lag lengths were chosen to find a

unique cointegrating vector with the fastest speed of adjustment and if possible, clean residuals. In all but one case, a lag length of 10 was chosen. The models were estimated allowing for no time trend in the cointegrating vector, but allowing for possible time trends in the variables. The specification directly models long-run velocity rather than using an algorithm to passively track time-variation in equilibrium velocity as in Orphanides and Porter (2000). As in Duca (2000), the non-interactive bond fund load variable (*bload*) accounts for the large upward shift of velocity in the early 1990s. Our specification improves upon that approach in two ways. First, it also accounts for how the declines in bond fund loads have also increased the sensitivity of velocity (and money demand) to corporate bond and stock risk premia and the yield curve. This is equivalent to finding that the liquidity of nonmoney assets has become more sensitive to risk premia because the cost of transferring between nonmoney and money assets has fallen. The second improvement is accounting for how shifts in financial regulation have affected the relative importance of bank versus nonbank sources of financial intermediation.

One set of models defines velocity using personal consumption expenditures (PCE) for two important reasons. First, M2 is largely a measure of household money balances as it excludes large time deposits and many of the non-money means (money management) by which businesses conduct transactions. Accordingly, PCE is a more natural “scale” variable or measure of transactions conducted using M2 as a final means of payment. Second, velocity would be subject to much noise if GDP were used to define it. This reflects that GDP does not necessarily track permanent income and transactions, as stressed by Friedman (1956). In contrast, because the consumption reflects permanent income (Cochrane, 1994), using PCE to define M2 velocity largely addresses Friedman’s concerns. Another benefit of the PCE is that some GDP components (e.g., inventories) make GDP more volatile and less reflective of final sales.

Another set of regressions uses GDP to scale velocity, which may be preferable on two grounds. First, this focuses on the link with broader economic activity, which is usually more important for macroeconomic and policy purposes. Second, not all M2 deposits are owned by households and using a more narrow scale variable may inadvertently discard information.

## **B. Additional Short-Run Money Demand Variables**

In the short-run, money demand can be affected by regulations (Small and Porter, 1989), financial crises, and price shocks. Some of our regressions include a dummy variable for the introduction of money market deposit accounts (MMDAs;  $DMMDA = 1$  in 1983q1), a flexible interest-paying account that attracted funds into banks from Treasury bills. The  $t$  and  $t-1$  lags of  $DMMDA$  were included to control for the drop and then partial recovery of velocity in 1983:H1.<sup>13</sup>

In 2011Q2 the FDIC switched its base for the calculation of deposit insurance premiums from a bank's domestic deposits to its domestic assets, thereby countering the attempt by some banks to minimize premiums by booking deposits abroad. This change induced foreign deposits to be domestically booked, which boosted M2 balances and lowered velocity in mid- 2011, for which we include a dummy  $FDICIns$  equal to 1 in 2011q2 and 2011q3 (see Kreicher, et al., 2013). Some models also include a dummy for the height of the financial crisis triggered by the collapse of Lehman ( $LEHMAN = 1$  in 2008q4).

Following other M2 models, some specifications included a dummy ( $DCON$ ) equaling 1 for the imposition and -1 for the lifting of credit controls in 1980:q2 and 1980:q3, respectively, which depressed and then boosted consumption, having oppositely signed effects on velocity. To control for other sharp and temporary changes in consumption relative to money holdings, we

include *RENERGY* equal to the percent real change in the relative consumer price of energy (PCE energy prices/nonenergy PCE prices). Since the retail demand for energy is inelastic in the short run, a jump in energy prices is usually accompanied by a rise in nominal spending relative to more sluggish money balances, implying a short-lived positive spike in velocity.

As in Dow and Elmendorf (1998) and Carlson and Schwartz (1999), asymmetric effects of stock market shocks were tested by separating stock price changes into positive ( $DSPPos = S\&P$  if  $>0$ ; 0 otherwise) and negative ( $DSPNeg = S\&P$  if  $<0$ ; 0 otherwise) changes. Both of these studies found that positive and negative changes boosted M2 growth, where the former result is consistent with a positive wealth effect, while the latter is consistent with a positive flight to quality effect outweighing a negative wealth effect. However, the positive impact of rising stock prices may be an artifact of the end of an upward shift in M2 velocity (which brought the return of moderate M2 growth rates) and the strong bull market of the late-1990s. Of the stock price variables, only  $DSPNeg$  was found to be significant, and only in some models.

## V. Empirical Results

Our estimated demand functions for M2 are shown in Tables 1 and 2. In all regressions, we impose a unitary income elasticity on the demand for money. In Table 1, income is taken to be personal consumption expenditures; in Table 2, income is nominal GDP. In each table, the first set of four regressions is estimated for 1964Q1 to 2012Q. The four regressions differ with respect to whether yield curve and stock price variables are scaled by mutual fund loads, and the inclusion of some short-run money demand variables. From these four, we select a “preferred” model and re-estimate that model for 1964 to 2006, that is, the period that predated the recent

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<sup>13</sup> The t-1 lag was insignificant in models of M2’s GDP velocity and that lag was omitted from the final runs.

financial crisis (column 5). Finally, (column 6), we display a model, estimated 1964-2012, that omits mutual fund loads but includes controls for bank regulation.

Table 1 presents six regressions (columns 1 to 6). Five of the models are estimated over 1964Q1-2012Q4, each of which include the same set of long-run consumption V2 determinants along with the time  $t$  change and the  $t-1$  level of M2 opportunity costs (columns 1-4, 6). Mortgage refinancing volume is significant in the models, each of which includes a variable to capture the impact of the Dodd-Frank Act (DFA). Two models (columns 1 and 3) include additional explanatory variables commonly included in money demand studies, including a variable for the introduction of MMDAs ( $t$  and  $t-1$  lags of *MMDA*), and one to capture the effect of the Carter credit controls in 1980q2 and 1980q3 (*DCON*) on the economy. Four models (columns 2, 4, 5, and 6) include an extended set of explanatory variables, including the sudden impact of Lehman's failure on velocity in 2008:q4 (*Lehman*), the changes in velocity from the change in FDIC insurance premium levies (*FDICIns*), and the near-term impact of changes in relative energy prices on nominal consumer spending relative to nominal money balances (*RENERGY*). Three models (columns 3, 4 5) also include the  $t-2$  lag of the yield curve and the time  $t$  negative stock market shock variable, scaled by bond or equity fund loads, respectively.

Finally, the first two models (columns 1 and 2) include the negative stock price shock (*DSP*) and yield curve without scaling by bond or equity mutual fund loads. The second two models (columns 3 and 4) include the stock price shock and yield curve variables scaled by bond and stock mutual fund transfer costs, respectively. The fifth model (column 5) re-estimates model 4 over a pre-crisis (1964-2006) sample period, dropping some of the dummy variables for post-2006 events. The last model (column 6) estimates a version of model 4 over the full sample that omits information from mutual fund costs in the long- and short-run variable components.

Our results suggest several important conclusions.

- First, a significant, and unique cointegrating vector is estimated in each case.
- Second, in each model, long-run velocity is positively affected by increased regulatory burdens on banks (*Basell2DFA*).
- Third, velocity is significantly and negatively affected by bond fund loads and the corporate bond spread scaled by bond fund loads, as expected.
- Fourth, the magnitudes of the long-run coefficient estimates are stable across the different sets of short-run variables.
- Fifth, the speed of adjustment in models containing mutual fund loads is in the 9 to 10 percent per quarter range, implying that 9 to 10 percent of any money disequilibrium is error-corrected away on average each quarter. The speed is much lower and the fit worse in model 6 that omits load information.
- Sixth, only when the full set of other money demand variables is included (in the even number models) are the residuals clean. While this inclusion is important for model validity, the long-run coefficients are unaffected.
- Seventh, the separate stock market shock variable is only significant in models 1 and 3 which both omit the Lehman shock dummy. This likely reflects collinearity since the Lehman shock coincides with a huge decline in stock prices in 2008:q4. Nevertheless, omitting that dummy yield models plagued by serious serial correlation. In other models, the negative stock shock is insignificant. This may partly reflect that the inclusion of the interactive term,  $Baa10TR_t/bload_t$ , in the

long-run equilibrium relationship and the ten lags of its first difference likely diminish the statistical significance of any direct stock price effect.<sup>14</sup>

- Another important pattern is that the coefficients on the time  $t$  and  $t-1$  refinancing variables are significantly negative and positive, respectively. Since velocity is inversely related to money, this pattern sensibly reflects that refinancing balances first boost money balances, which run off quickly by the next quarter.

The importance of scaling yield curve effects is more evident and stronger in models 3-5 which scale the yield curve effect with bond mutual fund loads. Without scaling, the yield curve slope effect is smaller as in models 1 and 2 compared with models 3 and 4, and comparing model 5 with its full sample counterpart, model 4. The combination of carefully controlling for mortgage refinancing and other short-run money demand controls, and for scaling yield curve and direct, near-term stock price terms using mutual fund loads is reflected in both the superior fit and faster speed of equilibrium adjustment in model 4. If that model is estimated over a pre-crisis sample period ending in 2006—as in model 5—the long-run coefficients, speed of adjustment and standard error are similar. So the findings are not an artifact nor are they primarily driven by the inclusion of the recent financial crisis period in the samples used. This robustness suggests that the basic long-run specification is reasonable and fairly stable.

Table 2 displays estimations using nominal GDP. The models, by column, correspond to similarly numbered models in Table 1, except that they omit a lagged control for MMDAs ( $t-1$ ). The qualitative findings are largely identical to those in Table 1, with model 4 being the preferred model. There are three noteworthy differences when switching to GDP velocity. The first is that the speed of adjustment is about 50 percent faster in the GDP velocity models, with

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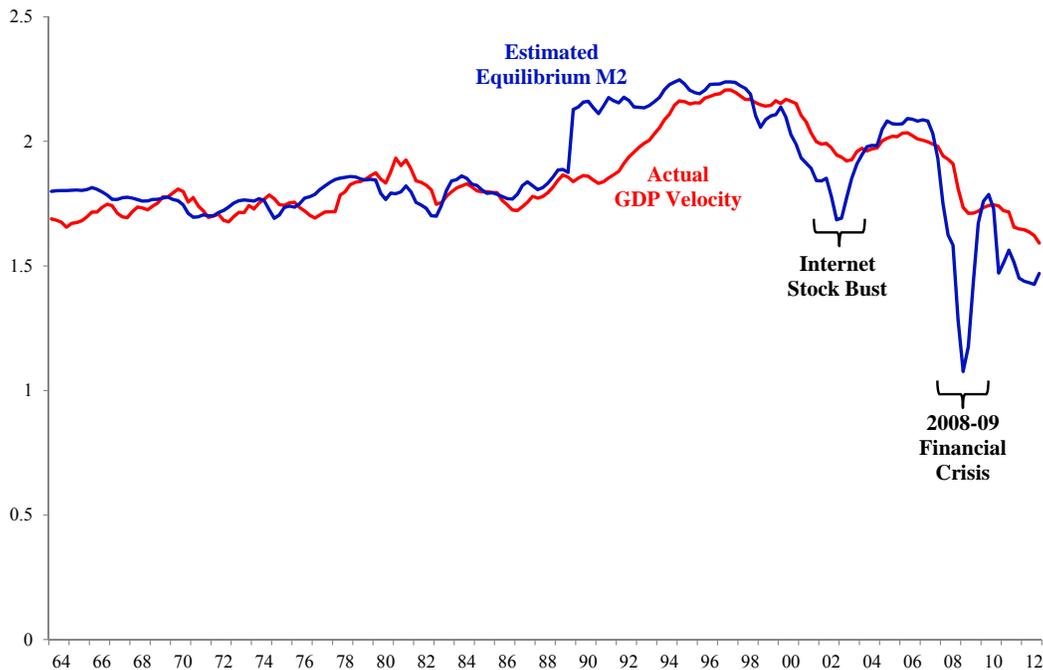
<sup>14</sup> In the Federal Reserve Board's quarterly model, the target rate of return off which stock prices are modeled is based on adding a time-varying equity risk premium to a spread between corporate and Treasury bond yields.

estimated speeds of error correction of 13-17 percent per quarter and 15 percent per quarter in the preferred model. A second difference is that the model fit is better using consumption when comparing corresponding models. And a third difference is that the model omitting bond fund loads (model 6) has even weaker evidence (now mixed) about whether a unique and statistically significant cointegrating vector can be found.

The long-run equilibrium level of V2 implied by model 4 tracks GDP velocity (Figure 9). The sharp drops in equilibrium velocity in the Internet stock bust of the early 2000s and the financial crisis of 2008-2009 reflect jumps in corporate risk premiums. The less rapid fall in velocity in the asset busts reflects sluggish household adjustment of M2 balances. The risk premia spikes were short-lived, and gaps between equilibrium and actual velocity closed quickly.

Also encouraging are weak exogeneity tests. In a vector error-correction model, the long-run cointegrating vector implies error-correction terms for corresponding models of the

**Figure 9: Regulatory and Load-Adjusted Equilibrium Estimates Line Up Well with Actual GDP Velocity**



changes in bond fund loads and the corporate-Treasury bond spread scaled by bond fund loads. were statistically insignificant. Along with the significance of the EC term in velocity model 6, these results indicate that while velocity is not weakly exogenous to loads and the load-scaled spread, the two load variables are weakly exogenous. In the words of Granger and Lin (1995), loads and corporate spreads scaled by loads “causes” velocity in a long-run, temporal sense.

### ***Further Research***

The results above suggest several future extensions of our analysis. One is to directly adjust M2 for estimated refinancing effects, which will make the lags of first difference velocity terms more accurate and could improve the estimated speed of adjustment. This will entail updating our earlier refinancing series, which is underway. Second, we plan to forecast velocity and nominal spending building off the models developed here. Third, we plan to report results from estimating models of M2-minus (which is M2 excluding small time deposits) and MZM. Fourth, based on the new MZM model, we plan to estimate disaggregated M2 models in an equation system with inter-linked MZM and small time deposit equations in an approach similar to that of Moore, Porter, and Small (1990). Fifth, we plan to assess whether the sensitivity of money demand to bond return volatility (stressed by Baba, Hendry, and Starr, 1992) is affected by mutual fund costs.

## **VI. Conclusion**

Interpreting broad money has been difficult because of financial innovations that have directly shifted velocity and altered its sensitivity to risk premia and the yield curve. This study addresses both effects and finds that falling bond and stock transfer costs are responsible, along

with shifts in the relative capital regulatory burden on banks, for the bulk of unconventional movements in M2 velocity, and that controlling for large swings in refinancing-related money balances notably improves our ability to model short-run movements in money. Using mortgage refinancing and mutual fund load data, we successfully model short- and long-run movements in M2 velocity in a specification that is robust to excluding the recent financial crisis.

There are two broad implications of our findings. First, declines in bond and stock fund loads have increased the impact of risk premia on money demand. Insofar as financial innovation has altered asset substitutability, this finding accords with the implications of Tobin's (1958) extension of Keynes' (1935) speculative demand for money into a general portfolio framework and Liu's (2004) model examining the fixed and proportional asset transfer costs in a multi-asset portfolio. Nevertheless, because mutual fund loads were high before the 1980s, our findings imply that the speculative demand for money had been less important in the earlier period examined by Friedman (1956). Our study thus addresses a long-standing debate about the speculative demand for money, and finds that in recent decades the portfolio demand for liquidity has become a more important element of the overall demand for money. And consistent with New Monetarist and I (intermediation) theories of money, we find that money demand is very susceptible to shifts and shocks altering the liquidity of traditional "nonmonetary" assets.

A second key implication is that when properly modeled, M2 can provide signals about nominal demand growth during the recovery from the Great Recession, which will likely be marked by large changes in mortgage refinancing and corporate risk premia. In this way, money can help inform policy at a time when both conventional money- and real interest rate-oriented models have been plagued by instability stemming from shifts in financial frictions and financial architecture. As risk premiums recede to normal, they will raise aggregate demand not only by

directly lowering private real interest rates and raising asset prices, but also indirectly through enhancing the liquidity of asset substitutes for broad money as velocity recovers. For monetary policy to support a path of moderate nominal GDP growth, broad money growth will need to slow in line with money demand as mortgage refinancing and flight to quality effects unwind.

Our study also suggests the possibility of a liquidity accelerator mechanism in the macroeconomy. More specifically, by reducing assets' transaction costs, financial engineering has reduced the penalty in lost output that arises in liquidity models due to the imperfect pledgeability of future income that prevents agents from holding larger quantities of liquid assets.

For example, in the recent financial crisis, lower asset transfer costs amplified the effects of shifts in risk premia, giving rise to liquidity accelerator effects reflected in more pronounced risk-related swings in the quantity of money demanded. As a result, increased risk premia simultaneously contributed to the macroeconomic slowdown and induced an upward shift in money demand. Such a confluence of events risks misleading policymakers into inferring incorrectly that there has been a permanent increase in money demand when, in fact, the increase is transitory. If the liquidity of nonmonetary assets later rises when risk premia fall, earlier increases in conventional money may threaten long-run price stability unless reversed.

**Table 1: Vector Error Correction Models of Log M2's Consumption Velocity**

Maximum likelihood estimates of the long-run cointegrating relationship and speed of adjustment in the VEC velocity model assuming, at most, one cointegrating vector, lag length 10.

	Sample 1964-2012 including <i>REFI</i> , <i>YC</i> , and <i>DSPNeg</i>		Sample 1964-2012 include <i>REFI</i> load- scaled <i>YC</i> , <i>DSPNeg</i>		1964-2006 <i>REFI</i> load-adj	1964-2012 No load-adj
	Limited	Full	Limited	Full	<i>YC</i> , <i>DSPNeg</i> Full	<i>YC</i> , <i>DSPNeg</i> Full
<b>Long Run</b>	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha_0$ , constant	0.481	0.508	0.598	0.602	0.612	0.0440
$\alpha_1$ , $bload_{t-1}$	-0.058** (6.03)	-0.062** (6.53)	-0.072** (7.11)	-0.072** (7.61)	-0.075** (8.03)	
$\alpha_2$ , $BaaTR_{t-1}/$ $bload_{t-1}$	-0.179** (7.21)	-0.187** (7.04)	-0.244** (7.75)	-0.244** (7.91)	-0.257** (6.77)	
$\alpha_3$ , $Basel12-$ $DFA_{t-1}$	0.149** (5.29)	0.139** (5.02)	0.125** (4.40)	0.116** (4.37)	0.107** (4.12)	0.277** (7.02)
<b>Short Run</b>						
$\beta_0$ , constant	-0.0089** (3.29)	-0.0083** (3.60)	-0.0060* (2.55)	-0.0079** (3.84)	-0.0080** (3.81)	0.0049* (2.25)
$\beta_1$ , 'adjustment speed'	-0.097** (4.72)	-0.085** (4.76)	-0.091** (4.65)	-0.096** (5.69)	-0.108** (5.90)	-0.031* (2.48)
$\beta_2$ , ' $\Delta$ opportun- ity cost $_t$ ' $\Delta OC_t$ '	0.0037** (4.476)	0.0031** (4.38)	0.0032** (4.01)	0.0029** (4.27)	0.0027** (3.64)	0.0030** (4.02)
$\beta_3$ , 'opportunity cost $_{t-1}$ ' $OC_{t-1}$ '	0.0032** (3.64)	0.0028** (3.79)	0.0020* (2.65)	0.0024** (3.67)	0.0029** (4.07)	-0.0020* (2.64)
<b>Cointegration</b>						
Trace, 1 Vector	64.47**	68.36**	63.52**	73.785**	80.32**	17.32*
Trace, 2 Vectors	16.93	20.63	14.49	18.88	24.18	2.01
$\lambda$ Max, 1 Vector	47.54**	47.73**	49.03**	54.90**	56.14**	15.31*
$\lambda$ Max, 2 Vectors	9.15	12.42	9.22	9.24	18.08	2.01
Adjusted R <sup>2</sup>	0.503	0.646	0.518	0.659	0.511	0.575
SE $\times$ 100	0.747	0.630	0.735	0.618	0.631	0.691
LM(1)	40.39**	17.16	64.69**	19.85	25.40	7.68
LM(2)	8.77	5.55	7.18	6.60	13.18	2.23
LM(10)	22.14	18.35	17.67	16.05	18.25	8.580 <sup>+</sup>

Absolute t-statistics are in parentheses. \*\* (\*, +) denotes significance at the 99% (95%, 90%) confidence level. First difference terms of elements in the long-run cointegrating vector are omitted to conserve space. L-run coefficients shown in terms of their equilibrium relationship:  $\ln V2_t^* \equiv \alpha_0 + \alpha_1 bload_t + \alpha_2 (Baa10TR_t/bload_t) + \alpha_3 Basel12DFA_t$ . All estimated with a lag length of 10 consistently yielding a unique, significant vector and clean residuals.

**Table 1: Vector Error Correction Models of Log M2's Consumption Velocity (continued)**

Maximum likelihood estimates of the long-run cointegrating relationship and speed of adjustment in the VEC velocity model assuming, at most, one cointegrating vector.

	Sample 1964-2012 including <i>REFI</i> , <i>YC</i> , and <i>DSPNeg</i>		Sample 1964-2012 include <i>REFI</i> load- scaled <i>YC</i> , <i>DSPNeg</i>		1964-2006 <i>REFI</i> load-adj	1964-2012 No load-adj
	Limited	Full	Limited	Full	<i>YC</i> , <i>DSPNeg</i> Full	<i>YC</i> , <i>DSPNeg</i> Full
<b>Short Run</b>	(1)	(2)	(3)	(4)	(5)	(6)
$\beta_4$ , 'refinance vol.' $REFI_t$	-0.972* (2.47)	-1.092** (3.26)	-1.194** (3.01)	-1.268** (3.75)	-1.393** (3.18)	-1.210** (3.536)
$\beta_5$ , 'refinance vol.' $REFI_{t-1}$	1.020** (2.61)	1.042** (3.13)	1.095** (2.85)	1.009** (3.08)	1.0418* (2.57)	0.983** (2.86)
$\beta_6$ , 'yield curve' load scaled 2,4,6 unscaled 3,5 $YC_{t-2}$	0.0019* (2.53)	0.0026** (3.95)	0.0044* (2.14)	0.0082** (4.44)	0.0109** (4.02)	0.0019** (3.18)
$\beta_7$ , 'stock price' load scaled 2,4,6 not, 3,5 $DSPNeg_t$	0.00045** (3.86)	0.00012 (1.05)	0.00215** (5.56)	0.00064 (1.56)	0.00048 (0.96)	0.00001 (0.09)
$\beta_8$ , $DMMDA_t$ initial impact	-0.032** (3.75)	-0.032** (4.37)	-0.029** (3.49)	-0.028** (4.03)	-0.032** (4.18)	-0.038** (5.11)
$\beta_9$ , $DMMDA_{t-1}$ payback effect	0.015+ (1.71)	0.082 (1.08)	0.015+ (1.79)	0.011 (1.47)	0.090 (1.15)	0.017* (2.17)
$\beta_{10}$ , 'credit control,' $DCON$		-0.017** (3.58)		-0.017** (3.58)	-0.018** (3.74)	-0.016** (3.06)
$\beta_{11}$ , 'Fin. Crisis' $LEHMAN_t$		-0.0366** (4.06)		-0.0380** (3.82)		-0.0421** (4.62)
$\beta_{12}$ , 'Dodd- Frank,' $DDFA_t$	0.0085 (0.54)	0.0276* (2.00)	0.0017 (0.11)	0.0024+ (1.79)		-0.0027 (0.33)
$\beta_{13}$ , 'FDIC Insur' $FDICIns_t$		-0.0226* (2.00)		-0.0282** (2.44)		-0.0240** (3.04)
$\beta_{14}$ , 'Energy Price' $Renergy_t$		0.0522** (3.41)		0.0449** (2.99)	0.0472** (2.76)	0.0464** (2.94)

**Table 2: Vector Error Correction Models of Log M2's GDP Velocity**

Maximum likelihood estimates of the long-run cointegrating relationship and speed of adjustment in the VEC velocity model assuming, at most, one cointegrating vector.

	Sample 1964-2012 including <i>REFI</i> , <i>YC</i> , and <i>DSPNeg</i>		Sample 1964-2012 include <i>REFI</i> load- scaled <i>YC</i> , <i>DSPNeg</i>		1964-2006 <i>REFI</i> load-adj	1964-2012 No load-adj
	Limited	Full	Limited	Full	<i>YC</i> , <i>DSPNeg</i> Full	<i>YC</i> , <i>DSPNeg</i> Full
<b>Long Run</b>	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha_0$ , constant	0.828	0.855	0.932	0.929	0.921	0.539
$\alpha_1$ , <i>bload</i> <sub>t-1</sub>	-0.033** (3.82)	-0.038** (4.59)	-0.046** (5.45)	-0.045** (5.79)	-0.046** (5.78)	
$\alpha_2$ , <i>Baa10TR</i> <sub>t-1</sub> / <i>bload</i> <sub>t-1</sub>	-0.184** (8.11)	-0.190** (8.196)	-0.245** (9.45)	-0.235** (9.25)	-0.239** (7.12)	
$\alpha_2$ , <i>Basel12- DFA</i> <sub>t-1</sub>	0.159** (6.08)	0.150** (6.15)	0.139** (5.75)	0.132** (5.90)	0.123** (5.49)	0.186** (6.16)
<b>Short Run</b>						
$\beta_0$ , constant	-0.0143** (4.72)	-0.0137** (4.81)	-0.0129** (4.66)	-0.0139** (5.22)	-0.0135** (4.97)	-0.0081** (3.10)
$\beta_1$ , 'adjustment speed'	-0.138** (5.69)	-0.127** (5.47)	-0.144** (6.50)	-0.151** (6.75)	-0.165** (6.66)	-0.055** (3.34)
$\beta_2$ , ' $\Delta$ opportu- nity cost <sub>t</sub> ' $\Delta OC_t$ '	0.0057** (5.78)	0.0050** (5.48)	0.0051** (5.42)	0.0049** (5.55)	0.0047** (4.93)	0.0048** (5.32)
$\beta_3$ , 'opportunity cost <sub>t-1</sub> ' $OC_{t-1}$ '	0.0048** (4.83)	0.0046** (4.82)	0.0041** (4.49)	0.0044** (4.97)	0.0049** (5.13)	-0.0031** (3.45)
<b>Cointegration</b>						
Trace, 1 Vector	67.65**	75.93**	75.75**	82.83**	82.54**	15.52
Trace, 2 Vectors	16.79	22.16	14.07	18.69	21.80	0.83
$\lambda$ Max, 1 Vector	50.87**	53.77**	61.69**	64.13**	60.74**	14.69*
$\lambda$ Max, 2 Vectors	9.78	13.90	10.14	10.03	17.05	0.83
Adjusted R <sup>2</sup>	0.482	0.570	0.534	0.588	0.466	0.485
SE $\times$ 100	0.838	0.763	0.794	0.747	0.766	0.835
LM(1)	40.24**	12.51	72.11**	21.98	15.95	3.99
LM(2)	12.31	9.23	10.39	9.99	10.06	5.28
LM(10)	7.32	9.01	4.48	5.001	13.35	3.82

Absolute t-statistics are in parentheses. \*\* (\*, +) denotes significance at the 99% (95%, 90%) confidence level. First difference terms of elements in the long-run cointegrating vector are omitted to conserve space. L-run coefficients shown in terms of their equilibrium relationship:  $\ln V2_t^* \equiv \alpha_0 + \alpha_1 \text{bload}_t + \alpha_2 (\text{Baa10TR}_t / \text{bload}_t) + \alpha_3 \text{Basel12DFA}_t$ . All estimated with a lag length of 10 except model 6 where only a lag length of 5 yielded a unique significant vector.

**Table 2: Vector Error Correction Models of Log M2's GDP Velocity (continued)**

Maximum likelihood estimates of the long-run cointegrating relationship and speed of adjustment in the VEC velocity model assuming, at most, one cointegrating vector.

	Sample 1964-2012 including <i>REFI</i> , <i>YC</i> , and <i>DSPNeg</i>		Sample 1964-2012 include <i>REFI</i> load- scaled <i>YC</i> , <i>DSPNeg</i>		1964-2006 <i>REFI</i> load-adj	1964-2012 No load-adj
	Limited	Full	Limited	Full	<i>YC</i> , <i>DSPNeg</i> Full	<i>YC</i> , <i>DSPNeg</i> Full
<b>Short Run</b>	(1)	(2)	(3)	(4)	(5)	(6)
$\beta_4$ , 'refinance vol.' $REFI_t$	-2.067** (3.18)	-2.271** (3.81)	-2.459** (3.90)	-2.653** (4.43)	-2.094* (2.63)	-2.424** (3.99)
$\beta_5$ , 'refinance vol.' $REFI_{t-1}$	2.333** (3.61)	2.374** (4.01)	2.391** (3.90)	2.330** (4.02)	2.013** (2.76)	2.000** (3.29)
$\beta_6$ , 'yield curve' load scaled 2,4,6 unscaled 3,5 $YC_{t-2}$	0.0029* (3.47)	0.0035** (4.53)	0.0083** (3.90)	0.0112** (5.02)	0.0125** (3.92)	0.0026** (3.71)
$\beta_7$ , 'stock price' load scaled 2,4,6 not, 3,5 $DSPNeg_t$	0.00033* (2.523)	0.00003 (0.22)	0.0013** (5.07)	0.00045 (1.24)	-0.00005 (0.10)	0.0002 (1.17)
$\beta_8$ , $DMMDA_t$ initial impact	-0.025* (2.54)	-0.027** (2.92)	-0.021** (2.28)	-0.024** (2.65)	-0.026** (2.72)	-0.031** (3.48)
$\beta_9$ , 'credit control,' $DCON$		-0.011+ (1.82)		-0.010+ (1.77)	-0.012* (2.00)	-0.009 (1.51)
$\beta_{11}$ , 'Fin. Crisis' $LEHMAN_t$		-0.0341** (3.15)		-0.0321* (2.39)		-0.0498** (4.56)
$\beta_{12}$ , 'Dodd- Frank,' $DDFA_t$	0.0035+ (1.99)	0.0522** (3.187)	0.0273+ (1.64)	0.0462** (2.82)		-0.0071 (0.81)
$\beta_{13}$ , 'FDIC Insur' $FDICIns_t$		-0.0286* (2.09)		-0.0370** (2.82)		-0.0211* (2.41)
$\beta_{14}$ , 'Energy Price' $Renergy_t$		0.0364+ (1.98)		0.0276 (1.53)	0.0331+ (1.60)	0.0161 (0.85)

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## Appendix A: Mutual Fund Data

Because data before the mid-1980s are sketchy and incomplete, mutual fund costs were based on a sample of large mutual funds. Funds were selected if their assets were at least \$1 billion at year-end 1991 if the fund existed before the mid-1980s; were at least \$2 billion at year-end 1994 if the fund's inception date occurred after 1983; were at least \$5 billion at year-end 2003; or were at least \$250 million at year-end 1975. The first criterion reflects whether a fund was sizable during early missing M2 period of the early 1990s. The second criterion reflects whether a growing but new fund was large near the end of the missing M2 period. The third criterion reflects whether a fund remained large following the stock market bust of the early 2000s. Given the stock and bond appreciation of the early 1990s, the hurdles for newer funds were higher for the 1994 and 2003 cutoff dates to keep data gathering costs from exploding. The fourth criterion avoids excluding funds that were relatively large in 1975 from distorting averages when fewer funds existed. Also excluded were funds that were closed-end, only open to employees of a specific firm, or institutional. One member, the Windsor Fund, became closed-end but was included because its open-end cousin (Windsor II) was started when it became closed-end, and both funds are large. Also omitted are funds with high minimum balances (100,000 or more) because such high hurdles make such funds poor substitutes for M2, which is predominantly held by middle income households. 46 non-municipal bond and 133 equity mutual funds are in the sample (a list is available from the author) using data from the funds and various issues of Morningstar, IBC/Donoghue, and CDA/Wiesenberger (a, b).

Because only year-end asset data for many equity funds are available, quarterly asset weights are interpolated from a year-end data and quarterly inception dates of the funds. Using annual data for benchmark weights is common and is used in at least one of the conventional

money variables (*OC*). Given the lack of large year-to-year changes in asset weights and the more important impact of load cuts in year-end to year-end changes in weighted-average loads, the series track quarterly load changes well. As discussed in Duca (2005, 2006), if expense ratios are added to *Sload* or *Bload* and if they were redefined using a 5-year horizon, the resulting overall mutual fund cost variables would behave very similarly with the annual, industry-side, overall equity fund cost estimates of Rea and Reid (1998, 1999).