Money Matters: Broad Divisia Money and the Recovery of Nominal GDP from the COVID-19 Recession

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Money Matters: Broad Divisia Money and the Recovery of Nominal GDP from the COVID-19 Recession*

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Abstract

The rise of inflation in 2021 and 2022 surprised many macroeconomists who ignored the earlier surge in money growth because past instability in the demand for simple-sum monetary aggregates had made these aggregates unreliable indicators. We find that the demand for more theoretically-based Divisia aggregates can be modeled and that their growth rates provide useful information for future nominal GDP growth.

Unlike M2 and Divisia-M2, whose velocities do not internalize shifts in liabilities across commercial and shadow banks, the velocities of broader Divisia monetary aggregates are more stable and can be reasonably empirically modeled in both the short run and the long run through the COVID-19 pandemic and to date. In the long run, these velocities depend on regulatory changes and mutual fund costs that affect the substitutability of money for other financial assets. In the short run, we control for swings in mortgage activity and use vaccination rates and an index of the stringency of government pandemic restrictions to control for the unusual effects of the pandemic.

The velocity of broad Divisia money temporarily declines during crises like the Great and COVID Recessions, but later rebounds. In each recession monetary policy lowered short-term interest rates to zero and engaged in quantitative easing of about $4 trillion. Nevertheless, broad money growth was more robust in the COVID Recession, likely reflecting that the banking system was less impaired and could promote rather than hinder multiple deposit creation. Partly as a result, our framework implies that nominal GDP growth and inflationary pressures rebounded much more quickly from the COVID Recession versus the Great Recession. We consider different scenarios for future Divisia money growth and the unwinding of the pandemic that have different implications for medium-term nominal GDP growth and inflationary pressures as monetary policy tightening seeks to restore low inflation.

Keywords: Velocity, Monetary Services Index, Divisia, Liquidity, Money, Shadow Banks, Mutual Funds

JEL Codes: E51, E41, E52, E58

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1. Introduction

Despite the surge in money growth to over 20 percent in 2020 (Figure 1) many macroeconomists were later surprised by the strength of the bounce-back in output and the surge of inflation during the recovery from the COVID Recession. Many analysts and policymakers were inclined to dismiss measures of the quantity of money as indicators owing to the long-standing instability in the demand for conventionally defined monetary aggregates. Ironically, broad measures of money grew more rapidly around the COVID Recession as compared to the Great Recession even though the fed funds rate fell less (albeit to zero) and the Fed's balance sheet increased by a similar amount in both cycles.[1,2] While the demand for conventional monetary aggregates is unstable, this study finds both that, when properly analyzed, the demand for broad Divisia measures of monetary services as tracked by their velocities (the ratio of nominal GDP to the measured quantity of money) can be effectively modeled empirically and that such measures can provide policy-relevant information about nominal GDP. At the same time, our study points out limitations of earlier studies of Divisia money that overlook some flaws in the construction of Divisia aggregates and that neglect factors affecting short- and long-run demands for these aggregates. Specifically, we model how velocity can be affected by flights to quality and pandemics, and we find that the recovery of velocity in the aftermath of such events have important implications for future nominal GDP.

After employing conventional and unconventional monetary policy tools to counter the COVID-19 Recession, the Fed was surprised by a continued acceleration of inflation that it thought

[1] This difference in broad money growth and underlying money multipliers reflects the stronger condition of banks and the greater government support to businesses and households in the recent recovery. Reflecting changes in monetary policy, year-over-year growth decelerated to slightly negative values by yearend 2022.
[2] Households accumulated about $2 trillion in personal saving above trend over 2020-21 (Briggs and Mericle, 2021), which is reflected in large holdings of money and other financial assets amid negative real interest rates in those years.

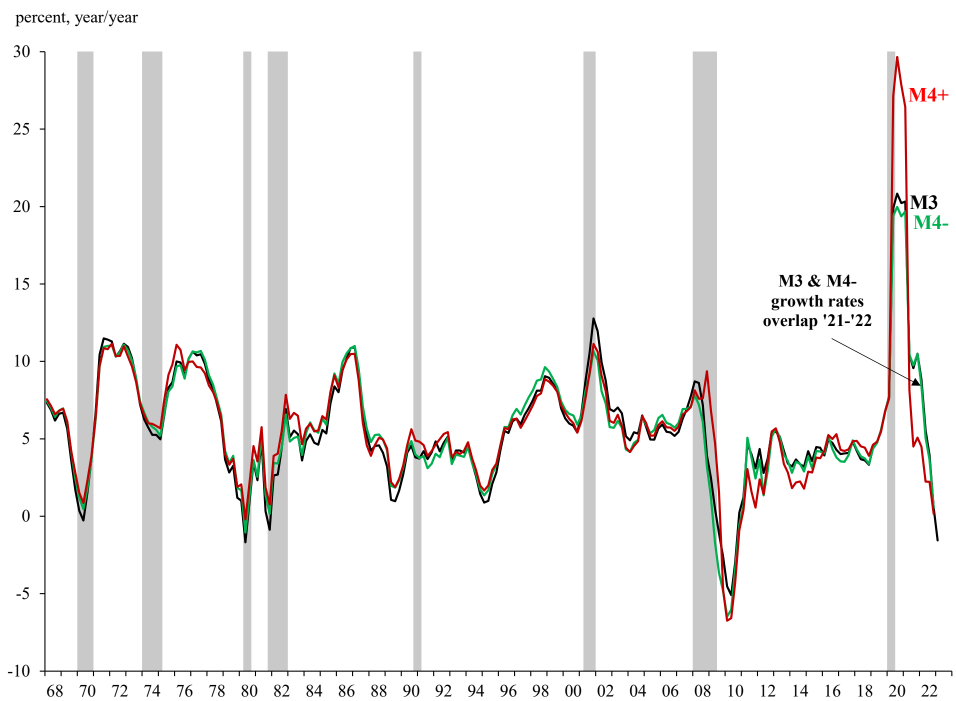

Figure 1: Broad Divisia Money Growth Surges in the COVID-19 Recession in Sharp Contrast to the Great Recession
(Sources: Center for Financial Stability, Federal Reserve, and authors' calculations.)

would dissipate based on forecasts of an unwinding of both supply disruptions and a post-pandemic rebound in spending. It then gradually began reversing earlier stimulus measures and tightening the stance of monetary policy in order to reduce inflation back toward its 2 percent target. Some analysts argue that the combination of supply constraints and past accommodative monetary and fiscal policy actions had created excessive upward pressures on long-run inflation (see Blanchard, Domach, and Summers, 2022, Bordo and Levy, 2022, Bolhuis, Cramer, and Summers, 2022, and DeSoyres et al., 2022). As illustrated in Figure 2, this view is consistent with nominal GDP being above its pre-COVID upward trend since late 2021, which was accompanied by a sustained surge in core PCE inflation above the long-run 2 percent path. This could not be solely attributed to supply shocks or to the approximately one percent decline in the size of the

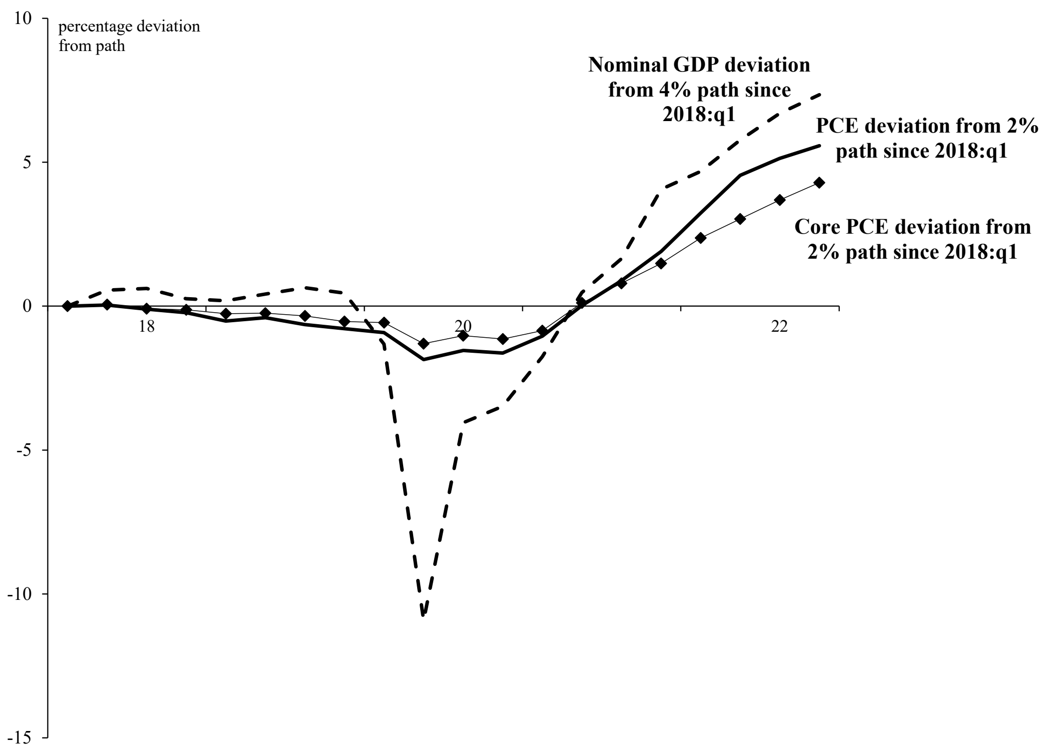

Figure 2: Above 4 % Nominal GDP Growth Linked to Above 2% Inflation
(Deviations from Hypothetical Target Paths Sources: BEA and authors' calculations)

labor force since the pandemic.[3]

One explanation for the unexpected acceleration in aggregate demand in the COVID recovery as opposed to the recovery from the Great Recession can be discussed in terms of an ISMP framework in which the zero lower bound is binding and the central bank alters the interest rate on excess reserves (IOER) to induce adjustments in policy-relevant short-term interest rates and to engage in quantitative easing or tightening to generate rightward or leftward IS shifts. Under such circumstances, quantitative easing would increase the supply of reserves and induce an increase in the money supply, with the latter effect constrained by the associated rise in the excess

[3] Figure 2 plots the divergence of nominal GDP and core PCE inflation from respective 4 and 2 percent growth paths since 2018:q1. That quarter was chosen as a base as inflation was near 2 percent and real output was near potential.

reserve ratio (see Ryan and Whelan, forthcoming). Indeed, during periods of quantitative easing in 2008-09, 2013, and 2020-21, the Fed greatly expanded its purchases of long-term Treasury, MBS, and government agency debt, which entailed a rapid expansion of reserves (Figure 3).

However, the degree to which higher money growth was induced differed during the two recoveries for three reasons. As analyzed in Ryan and Whelan (forthcoming), a tightening of bank capital requirements under the Dodd-Frank Act reduced the extent to which banks would expand loans and deposits from the rise in reserves, while the imposition of the liquidity coverage ratio raised their demand for excess reserves. The transition to these two regulatory moves plausibly restrained money and credit creation during the Great Recession and limited the extent to which quantitative easing shifted the IS curve to the right. In addition, a surge in loan losses (largely associated with busts in commercial and residential real estate) further limited banks' ability and willingness to lend. In the framework of Ryan and Whelan (forthcoming) and Reynard (2023), banks' willingness to engage in retail lending to potentially earn rates above the IOER affects the money (and credit) multiplier, and it is plausible that the dramatic surge in bank loan losses from 2008 to 2010, coupled with the impending higher capital and liquidity requirements under the 2010 Dodd-Frank Act, likely reduced the money multiplier. Consistent with these negative effects on the money multiplier amid rising reserves from the QE1 quantitative easing, Divisia M3 growth, after initially rising in late 2007 and 2008, turned negative in 2009 and 2010 and did not become positive until 2011 until loan losses began to meaningfully recede (see Figure 4).

On the surface, the pre-COVID experience suggests that QE would have some effect on aggregate demand. However, there were no increases in capital or liquidity regulation in the recovery from the COVID Recession, and loan losses were contained, likely as a consequence of larger fiscal stimulus and financial support for firms. The higher money multiplier in the COVID

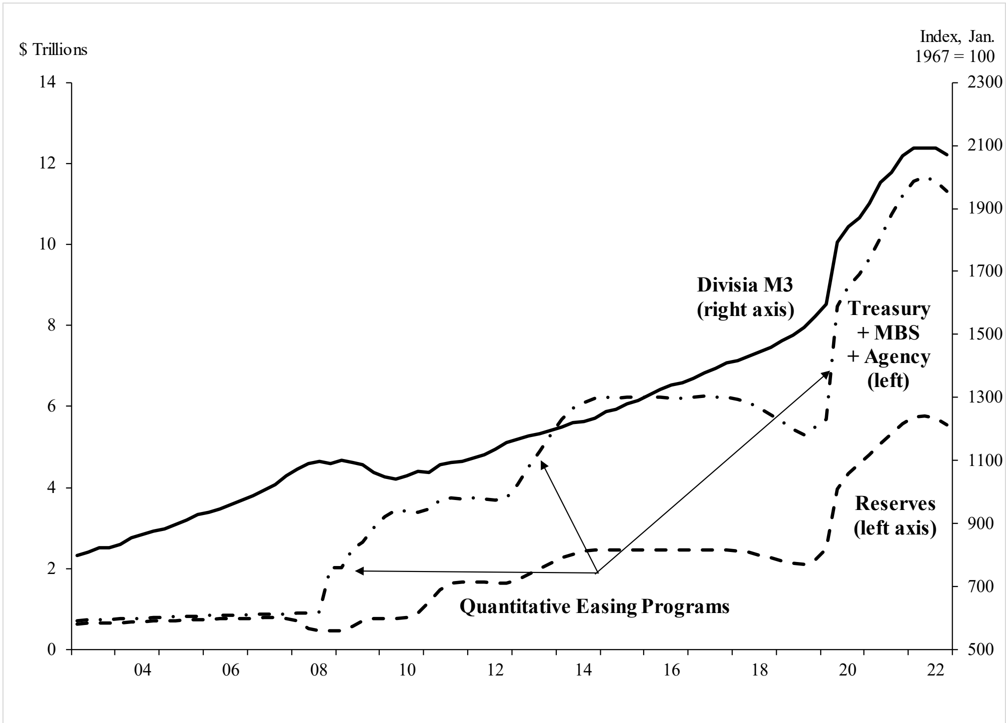

Figure 3: Broad Money Levels Bolstered by Quantitative Easing
(Sources: CFS and Federal Reserve Board)

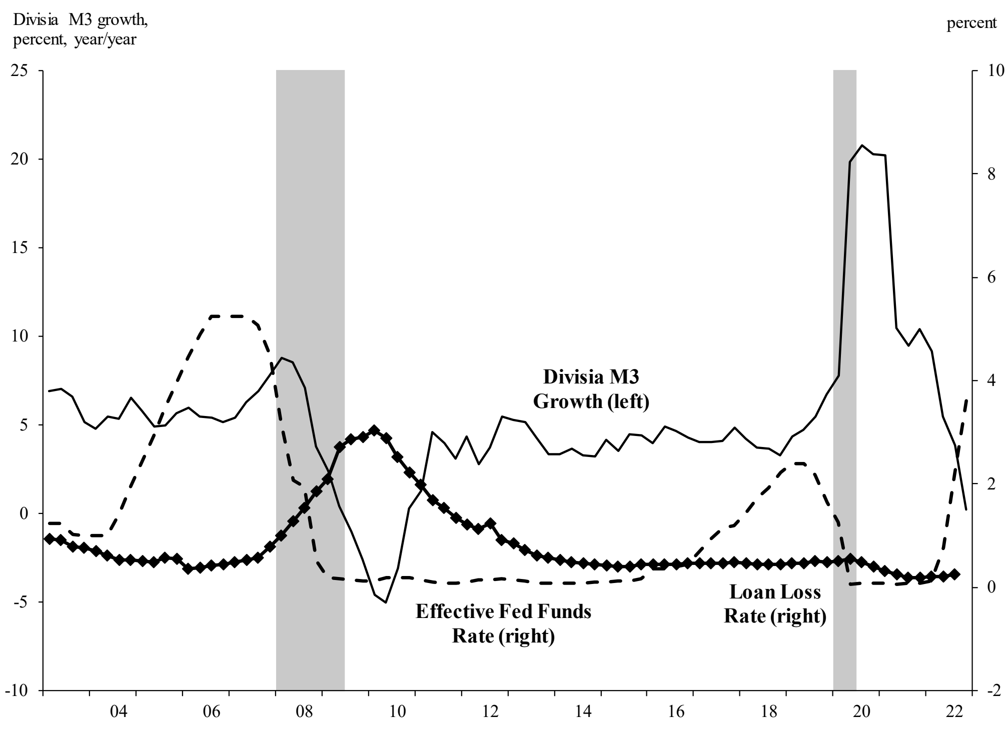

Figure 4: Divisia M3 Growth Also Affected by Loan Loss Rates
(Sources: CFS, Federal Reserve Board, and authors' calculations**)**

Recovery thereby would imply that the roughly equal-sized QE expansions of Fed assets in the two recoveries had a more pronounced (and possibly greater-than-expected) stimulative effect on aggregate demand (the IS curve shifted rightward further), partly reflected in faster Divisia M3 growth, as is evident in Figure 4. [4] In this way, differences in money growth across the two recent recoveries reflect information about IS shocks and aggregate demand (nominal GDP) that could be missed if money growth were ignored.[5] From a broader perspective, behind the surface of the now more familiar ISMP framework, the mechanics of central bank's use of quantitative easing or tightening entails movements in reserves and money growth that could be informative about nominal GDP under policy-relevant conditions.[6]

Implicit in the potential usefulness of money growth is that shocks to the demand for money can be reasonably taken into account when policies are formulated. It has long been understood that money demand shocks undermine the information content of money growth and strengthen the case for interest rate targeting, a point demonstrated by Poole (1970). Instability in the demand for conventional measures of money since the early 1990s led many central banks to rely on interest rate targets and to ignore money growth. In addition, academic and policy economists shifted away from the traditional ISLM framework in which money growth plays a more explicit role toward using the ISMP framework in which implied changes in reserve and money growth are behind the scenes and often ignored. Against this backdrop, it is understandable that most macroeconomic analysts have overlooked the information about nominal GDP trends provided by

[4] The Fed's balance sheet expanded faster in the COVID Recession, and was more drawn out (in several stages) during the recovery from the Great Recession.

[5] In a world where the overnight fed funds rate is partly determined by reserve scarcity, Poole (1970) showed that money growth can have information about aggregate demand if IS shocks are large.

[6] The framework of Ryan and Whelan (forthcoming) suggests that even though adjusting the IOER in a world of ample reserves may not change the level of reserves, a change in the funds rate could affect banks' willingness to make more loans, which, in turn, could affect the money multiplier, albeit in a more nuanced and possibly drawn out way.

money aggregates. However, it is less well recognized that broad Divisia aggregates have a more stable long-run relationship with nominal GDP than do conventional monetary aggregates (see Belongia and Ireland (2015b, 2019) and Jadidzadeh and Serletis (2019), *inter alia*). This is shown in Figure 5, which plots the velocities of conventional M2 and broad Divisia M3 (see Section 2).

Divisia aggregates better track monetary services and are more consistently linked to aggregate demand (nominal GDP) than conventional monetary aggregates, which are constructed under the assumption that different monetary components are perfect substitutes (see, Barnett (1982, 1987) and Barnett and Spindt (1979), *inter alia*). Nevertheless, the literature on Divisia monetary aggregates tends to overlook how and why the velocity of broad Divisia aggregates can shift in the long run and vary in the short run. Our study shows that addressing these issues not only can improve the information that movements in broad Divisia aggregates may provide regarding nominal GDP but can also help economists understand the underlying factors that affect the demand for liquidity. In these ways our analysis helps address the skepticism that many economists and analysts have about tracking money growth in light of past instability in the demand for conventionally measured monetary aggregates such as M2.

Indeed, interpreting the COVID-19 surge in money growth is complicated by four considerations. First, the velocity of money is susceptible to large and hard-to-model permanent shifts arising from financial innovation and changes in regulation. We find that this concern is valid for M2, but not for the broad measures of Divisia M3, M4-, and M4+ from the Center for Financial Stability (CFS). By modeling long-run technology and regulation effects, our framework can discern information about medium-term nominal GDP from Divisia monetary aggregates. This has implications for whether monetary policy actions are consistent with the Fed's long-run inflation objectives. Second, financial crises that generate surges in the demand for liquidity and

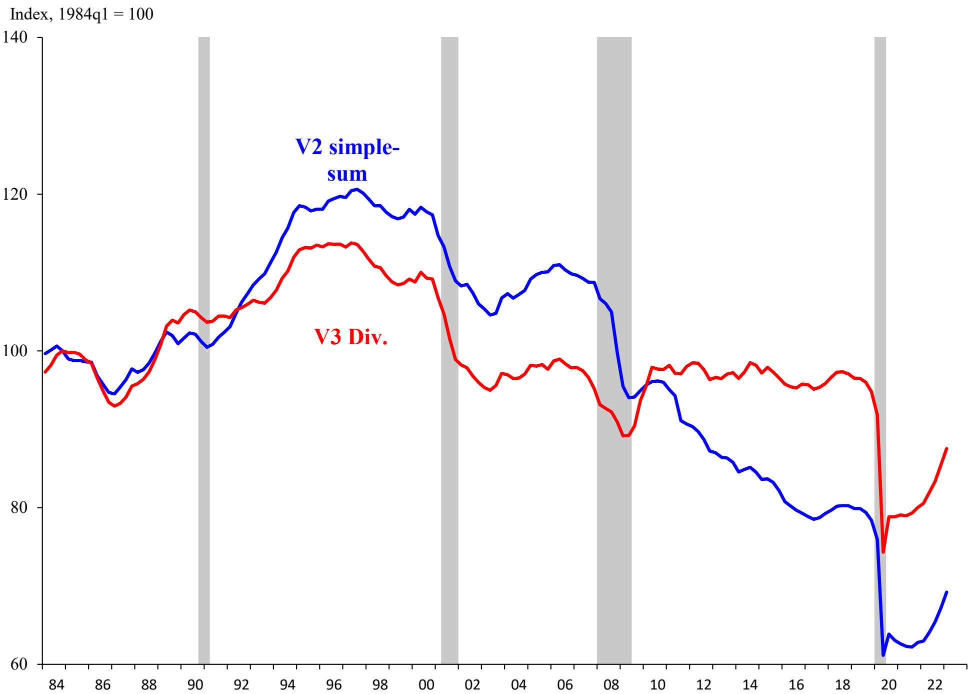

Figure 5: Since the mid-1980s, the Velocity of Broader Divisia Money (M4-) Is More Stable than that of Simple-Sum M2

(Sources: CFS, Federal Reserve, and authors' calculations. Shaded areas are NBER recessions.)

flights to safety that push up money holdings relative to GDP temporarily reduce the velocities of these aggregates. Third, the combination of a flight to quality and an associated expansionary monetary policy caused velocity to initially fall in the COVID pandemic as households held onto large monetary balances (and personal savings) as a precaution against uncertainty. More recently, Divisia velocity has started to recover, which we track using measures of vaccination rates and government COVID restrictions.

Our study addresses the major money demand issues in modeling long-run trends and short-run variation—including flights to liquidity and surges in mortgage refinancing in the last two recessions and the effects of the pandemic. In doing so, our framework improves our ability to interpret the influence of broad money growth on future nominal GDP growth in a way that accords with basic monetary theory. Using different scenarios for the unwinding of the recent mortgage refinancing boom and of social distancing, we construct medium-term forecasts for nominal GDP growth that illustrate the inflationary pressures of excess aggregate demand growth. One key finding is that both money growth and the pace of recovery in velocity can help track the deceleration of nominal GDP growth needed to return inflation to the Fed's target.

To present our findings, the paper is organized as follows. Section 2 provides background on Divisia monetary indexes and trends in their velocity. Section 3 reviews relevant studies to motivate our empirical models of Divisia velocity. Section 4 lays out the empirical specifications of money demand and section 5 presents the data and variables used. Section 6 presents results from estimating the velocity of broad Divisia measures of money. Using several scenarios, Section 7 uses our model to forecast nominal GDP growth, which has implications for long-run inflation. Section 8 concludes by discussing our findings in a broader context.

2. The Velocity of Broader Divisia Monetary Aggregates in Recent Decades

2.1 The Appeal of Divisia

Divisia indexes measure the flow of *money services* received by households and firms from their holdings of *monetary assets* that are either medium of exchange (currency, demand deposits) or are highly liquid.[7] Financial assets that are not medium of exchange and are not liquid, as defined above, provide zero monetary services and are not described as monetary assets. The Divisia approach treats monetary assets as providing a flow of nonpecuniary liquidity services to households at a user cost equal to the gap between the pecuniary return on a benchmark safe, nonliquid asset (R_t) minus the pecuniary rate of return on a monetary asset i (r_{it}). The flow of real services from each dollar in monetary asset i equals its user cost $(R_t-r_{it})/(1+R_t)$. The growth rate of an aggregate index of monetary services equals the sum across monetary assets of the share of

[7]Hahn (1980), Brunnermeier and Sannikov (2016), and others view liquid assets as providing "self-insurance" against unexpected fluctuations in income and spending.

total monetary services provided by monetary asset i multiplied by the growth rate of its quantity (Barnett, 1980, 2000). In contrast, simple-sum monetary aggregates put a weight of one on each of their monetary components, which implies that the components are perfect substitutes.

As noted by Barnett (1982, 1987) and Jones (2008), this is theoretically objectionable as the components provide different degrees of liquidity and is counter to empirical evidence indicating that simple-sum aggregates violate weak separability, meaning that "that there exists a well-defined utility function for the monetary assets (or a subset of them) that separates them from all other decision variables in the instantaneous utility function," Jones (2008, p. 9). This is an important property because if a monetary aggregate is weakly separable, then in an intertemporal utility framework, agents first decide on their current and future consumption decisions. Then given their expenditure decisions, they decide on the quantities of needed monetary assets in the current period. Empirical money demand models implicitly assume weak separability by treating expenditures as exogenous in the very short-run. Consequently, if a monetary aggregate or services index is not weakly separable, it is less likely that a stable demand function for it can be estimated.

It is well-known that empirical demand equations for conventional, simple-sum monetary aggregates experience shifts arising from financial innovation and changes in banking regulations and risk premia (e.g., Anderson et al., 2017, Duca, 2000), and Duca and VanHoose, 2004). Indeed, earlier studies found that weak separability was violated for simple-sum M1 (Barnett) but not for early measures of Divisia money, while weak separability did not hold for simple-sum M2, but did for zero-maturity measures, such as MZM and M2 excluding small time deposits (Jones, 2008). Later work argued that simple-sum measures and narrower Divisia measures are not weakly separable, but broad Divisia measures are (Jadidzadeh and Serletis, 2019).

2.2 Empirical Challenges to Divisia

Recent out-sized and persistent declines in the velocities of both simple-sum M2 and Divisia indexes of the monetary services provided by M2 components (a.k.a., monetary services indexes, or MSI) may be ascribed to such shifts and have raised doubts about their usefulness as indicators of nominal spending and inflation. Less attention has been paid to research indicating that the velocity of monetary measures that include a broader span of liquid assets have been more stable, not only in the mid-1970s (Barnett and Spindt, 1979), but also recently (see Anderson et al., 2017).[8] The empirical behavior of these broader aggregates as they respond to financial innovation and regulatory change is among the topics addressed by our analysis.

In principle, an economy should have only one Divisia monetary-services index defined over all monetary assets. In practice, however, due to measurement uncertainty, practitioners have constructed hierarchical sets of indexes, each including more assets than the previous (Anderson, et al., 1997). Our analysis suggests that empirical studies focused on a very wide set of assets are to be preferred to studies based on the traditional M2 set of monetary assets. These broader measures (see Barnett and Chauvet, 2011, and Barnett, et al., 2013) internalize changes in the flow of monetary services that arises from the financial intermediation services of the shadow bank system (see Gorton, et al., 2012, and Gorton and Metrick, 2010). As Anderson et al. (2017) note, the relatively steadier velocity of more broadly defined MSIs, such as Divisia M4 (excluding Treasury bills), versus that of Divisia or simple-sum M2 (Figure 6), partly reflects that broader MSIs better internalize the shrinkage of the money-like liabilities of shadow banks after the global financial crisis and the increased regulation of shadow banking that followed.

[8] Barnett (1980) proposed Divisia aggregates, extending user cost concepts from Diewert (1974), Donovan (1978) and Barnett (1978), and Diewert's (1976) work on superlative index numbers. Barnett and Spindt (1982) built Divisia monetary aggregates that Farr and Johnson (1985) revised and dubbed as "monetary services indexes".

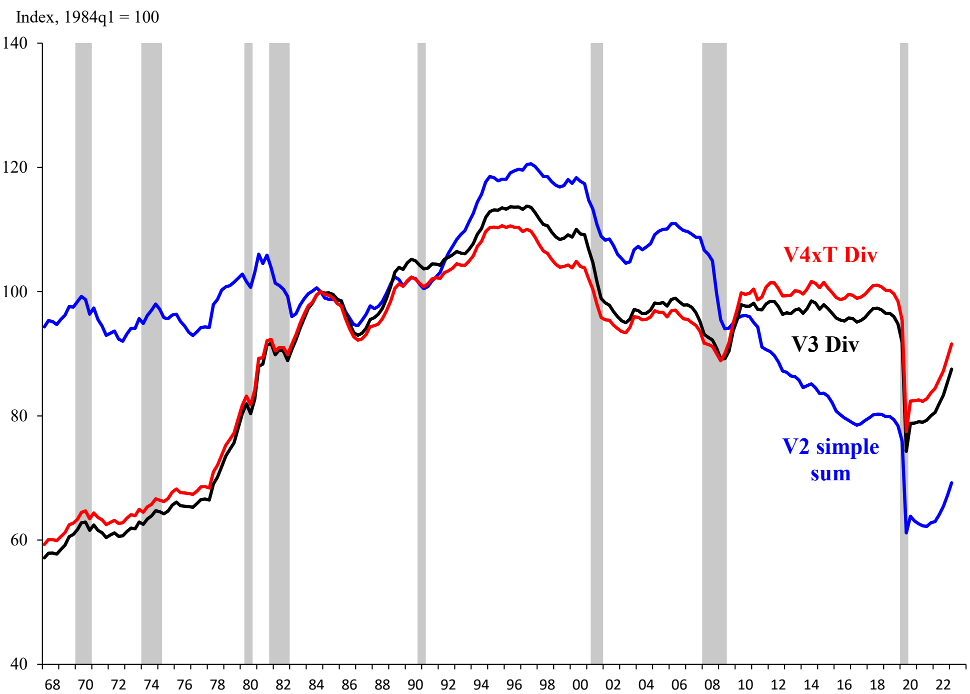

Figure 6: Since the mid-1980s, Velocity of Broader Divisia Money (V3Div and V4Div-) More Stable than that of Simple-Sum M2
(Sources: CFS, Federal Reserve, and authors' calculations. Shaded areas are NBER recessions.)

Nevertheless, the velocities of broad Divisia indexes have changed. Of particular concern is a large, upward level shift in their velocities in the late 1970s and early 1980s, a shift not well-addressed in the literature. That shift followed the stability in the early and mid-1970s, which Barnett and Spindt (1979) touted as evidence of the superiority of Divisia over simple-sum monetary aggregates. We argue that the upward level shift of broad Divisia velocity in the late 1970s and early 1980s coincided with Regulation Q ceilings on interest rates on bank deposits becoming binding, which induced households to shift from low interest-bearing bank deposits into newly offered money market mutual funds (MMMFs) and money market deposit accounts (MMDAs) at banks that regulations had just allowed.

The Divisia approach ignores regulatory distortions because it theoretically assumes that agents maximize the utility of their asset holdings in the absence of legal constraints. It appeals to duality theory to gauge the monetary services provided by an instrument as an increasing function of how much interest it pays. In doing so, Divisia indexes mistakenly treat the shift in the portfolio composition of the late 1970s and early 1980s as a decrease in monetary services. Essentially, households' shifted assets away from low interest-bearing small time and savings deposits that had a high opportunity (user) cost toward checkable and higher yielding MMMFs and MMDAs, which had a smaller opportunity or user cost and became available owing to deregulation. By measuring the liquidity services of a dollar in each asset type by its user cost, such shifts are tracked as indicating a decline in liquidity services provided by overall asset balances.[9]

And because these compositional effects were large, they distorted the velocity of Divisia aggregates. In fact, the money fund share of M2 jumped nearly 10 percentage points from 1978 to 1982 (Figure 7). Part of this rise was undone in 1982-83 when households shifted some of their money fund balances into newly offered MMDAs, whose share of M2 soared from 0 in late 1982 to 17 percent by mid-1983. As illustrated in Figure 4, these large rises in the relative importance of MMMF and MMDA holdings coincided with sizable upward shifts in the velocities of Divisia indexes. Because Divisia indexes measure implicit money services as proportional to user costs, calculations that ignore the regulatory cause of this shift will imply that these shifts reduced household liquidity. It is implausible that shifts from regulated saving and small-time deposits into checkable and higher interest paying MMMFs and MMDAs reduced household liquidity, but that is what existing Divisia indexes imply. Consequently, the time patterns of the shifts into MMMFs and MMDAs created a permanent upward shift in velocity that it is spurious in being an artifact of the construction of Divisia money indexes that do not accurately handling the transitions involving

[9] Note that the MSI are index numbers unique only up to a [level] normalization. The growth rate of the MSI equals a weighted average of the growth rates of its components, where each asset's weight is its share in the total aggregate expenditure on monetary services summed across all assets. The introduction of new assets is highly nonlinear because it affects total expenditure and the shares of included assets. Anderson, et al. (1997) discuss technical issues related to using a Fisher Ideal index to calculate the Divisia in such periods.

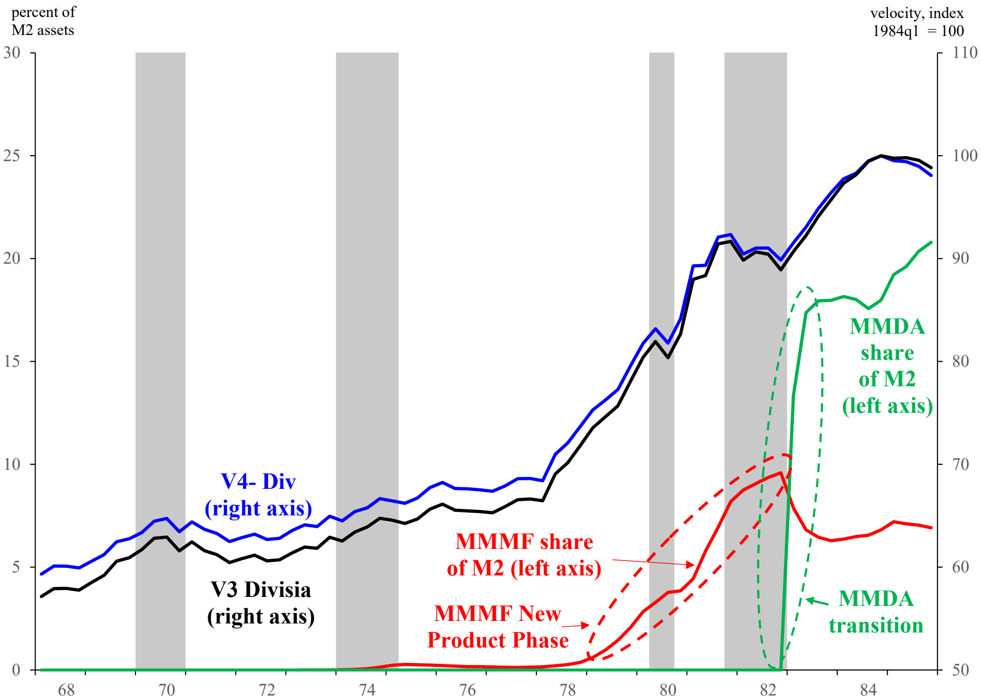

Figure 7: Spurious Upward Level Shift of Broad Divisia Velocity During the Transition from Regulated to Unregulated Deposit-Like Instruments
(Sources: CFS, Federal Reserve, and authors' calculations. Shaded areas are NBER recessions.)

the adoption of new instruments by the public. As a result, it is not valid to simply interpret the demand for and velocity of Divisia monetary aggregates over samples that span the eras of deposit regulation, the transition to market- based yields on liquid assets, and of the market-determined interest rates on monetary assets.[10] For this reason, our models of Divisia velocity are estimated over samples covering the post-1984 era which omits data affected by the spurious shift.[11]

Since 1984 the velocities of broader Divisia aggregates such as M3 and M4- have been subject to less pronounced and easier to model shifts (Figure 8). Our study attributes the bulk of

[10] We note that Richard Anderson and Barry Jones, two economists at the Federal Reserve Bank of St. Louis who created the MSI upon which the CFS Divisia, are based, agree with these points about the limits of Divisia indexes.
[11] Alternatively, we could use samples starting in 1968 but include a shift term for the adoption of MMMFs and MMDAs which equals the degree to which the velocity of each broad Divisia aggregate rose between 1974 and 1982, where the former reflects when courts ruled MMMFs were legal and the latter when shifts linked to MMDAs ended. The difficulty is that the bindingness of deposit rate ceilings varied and when MMDAs were introduced the narrowing of user costs was much less pronounced by deregulation than was the case when MMMFs spread earlier. As a result, the impact of the initial rise in the MMMF share differed, which complicates this approach and using pre-1985 data.

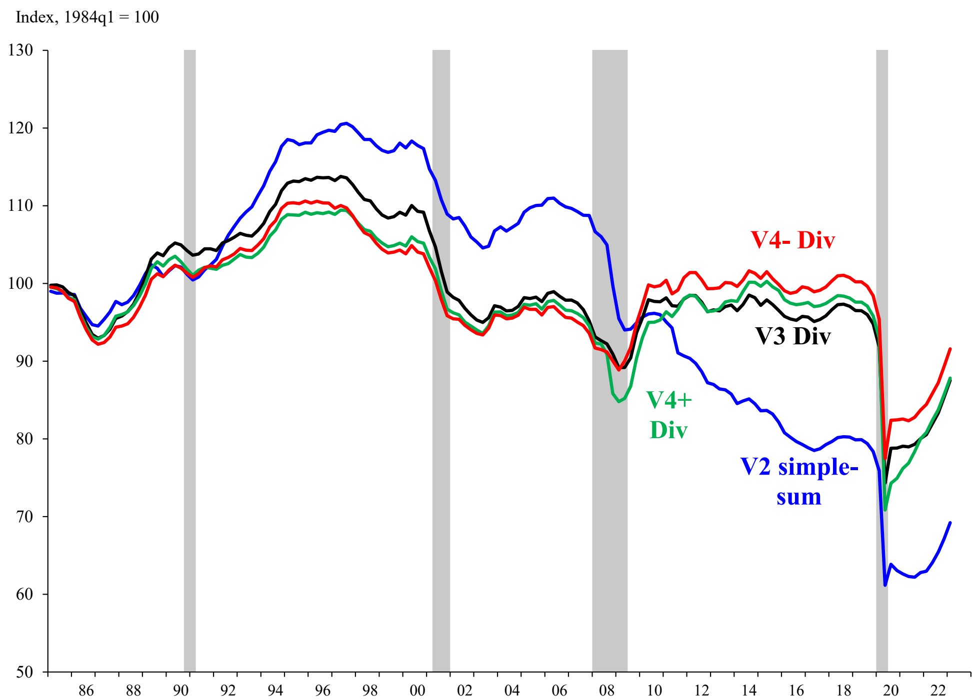

Figure 8: Since the mid-1980s, Velocity of Broader Divisia Money (V3Div) More Stable than that of Simple-Sum M2

(Sources: CFS, Federal Reserve, and authors' calculations. Shaded areas are NBER recessions.)

such swings to three types of factors. One is improvements in the liquidity of less-liquid assets not tracked by Divisia indexes. The second are regulatory shifts affecting the intermediation of less liquid assets and thereby the funding of them with shadow- bank liabilities whose services are outside broad Divisia aggregates. Third, because data limitations preclude Divisia indexes from measuring the liquidity of all assets, shifts in risk premia on less liquid assets induce portfolio substitution between highly liquid and less liquid assets and thereby affect the velocity of even broad Divisia indexes. By constructing sensible models of the demand for Divisia monetary services, this study demonstrates the importance of shadow bank short-term *and* long-term liabilities for understanding the demand for liquidity and how some monetary services indexes can help provide information about nominal aggregate demand.

3. Theoretical and Literary Motivation for the Empirical Analysis

Our specifications of the demand for monetary services from liquid assets account for two major factors that shift the demand between conventional liquid assets and assets that traditionally have been seen as less liquid. One is the declining costs of shifting between monetary assets and stocks for the marginal agent holding money. The bulk of M2 and M3 assets are held by middle-income households, for whom stock mutual funds are the main vehicle to hold a diversified portfolio of stocks. Following Anderson et al. (2017) who extend Duca's (2000) analysis of simple-sum M2 velocity, we assume the costs of transferring between monetary assets and stock mutual funds is proportional to the average load fee for buying or selling a stock mutual fund over a one-year horizon. As these costs fall, stocks become more liquid. Since Divisia indexes omit shifts in the liquidity of less liquid assets, such shifts alter the demand for liquid versus less liquid assets, thereby affecting the demand for Divisia monetary services.

A second major factor is that as stock loads fall, the increased substitutability of money and stocks implies that negative shocks to stock returns will induce larger flights to quality and surges in money demand. This is consistent not only with theoretical work (Davis and Norman, 1990, Liu, 2004, and Liu ad Lowenstein, 2002) showing that high asset transfer costs create either zones of portfolio inaction or sluggish portfolio adjustment that become less pronounced as transfer costs fall, but also with evidence the lower loads have induced higher U.S. stock ownership rates (see Duca and Walker, 2022) and that demand for simple-sum M2 became more sensitive to stock price shocks after load fees decline (Anderson, et al., 2017). For this reason, money demand is more susceptible to asset market shocks in eras when stock loads are lower.

The third major factor affecting MSI velocity is bank regulation that can induce changes in financial intermediation by nonbank financial intermediaries ("shadow banks") that issue higher-liquidity liabilities (often with shorter maturities) to fund lower-liquidity assets (often with longer maturities). Two changes are of particular importance: the widespread use of derivatives to buy/sell risk and second, variation in regulatory capital standards. The first was enabled by passage of the Commodity Futures Modernization Act (CFMA) in late 2000. CFMA made it feasible for credit default swaps (CDS) to be widely used[12] to ostensibly reduce the tail risk of investments (e.g., non-government issued MBS). As Duca and Ling (2020) emphasize, CDS issuance started to become notable in the early 2000s. Such enhancements allowed many nonbanks (e.g., conduits, investment banks, and special investment vehicles) to use derivatives to protect their portfolios from tail risk and to help them obtain investment grade ratings on the short-term debt that they issued used to fund risky investments. In turn, the investment grade short-term debt was purchased by banks and institutional money market mutual funds, the latter of which tripled their liabilities between the passage of CFMA and mid-2009. In periods of low financial market stress, CFMA also induced increased repo activity, as formerly ineligible paper became acceptable as collateral, thereby expanding the pool of assets useful in repurchase agreements and the monetary services they provide. In seven years, institutional money funds (large institutional investors holding many RP assets) soared from 17 percent of M3 in 2000 (OECD data) to 31 percent just before Lehman failed (see Figure 9).[13] By inducing large increases in institutional money funds and RPs, CFMA led to a rise in liquid liabilities that pushed up the volume of monetary services and lowered the velocity of Divisia indexes in the early and mid-2000s. Indeed, the velocity of Divisia M4- fell from about 14 - 1/4 to around 13-¼ during that interval.

Combining roles for transfer costs affecting the liquidity of nonM4 assets and for regulations affecting nonM4 liabilities, we find a well-defined error-correction and cointegrating relationship among broad Divisia velocity, transfer costs (mutual fund loads), and regulations.

[12] As stressed by Bolton and Oehmke (2015) and Stout (2011), CFMA made CDS contracts enforceable nationwide and gave them priority over other claims in bankruptcy.
[13] The Federal Reserve no longer releases the data needed to add RPs net of MMMF holdings to this ratio.

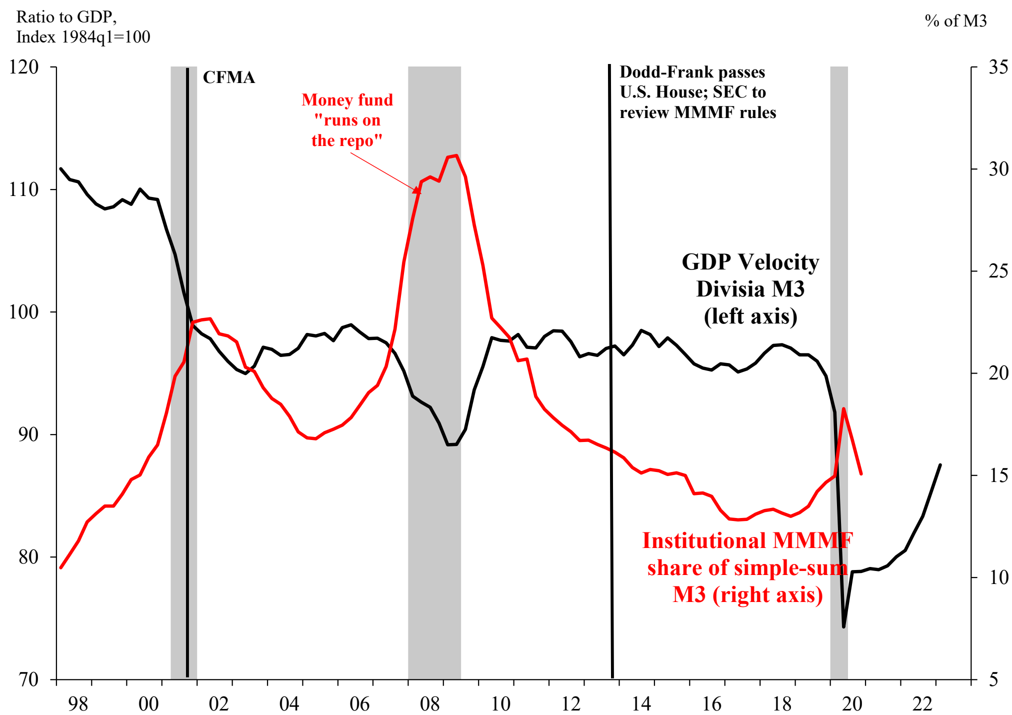

Figure 9: Velocity and Institutional Money Fund Share of M3
(Sources: Authors' calculations data from the BEA, CFS, OECD, and Federal Reserve. Institutional MMMF data end in 2020)

Weak exogeneity tests imply long-run causality from transfer costs and regulation to M4 velocity, but not the reverse.[14] Further, broad Divisia velocity is more statistically and economically related to high-risk premia when accounting for how lower asset transfer costs raised asset substitutability. Our models are estimated using data spanning nearly four decades (1986-2022) when returns on deposits and deposit-like instruments have been market determined.

4. Empirical Specification

As noted above, in principle, for any economy during a time interval, there exists but a single Divisia index that measures the aggregate flow of monetary services received by households and firms from their assets (by definition, the flows from monetary assets are nonzero and the

[14] Of course, causality tests must be interpreted with care in any forward-looking model and models of money demand, due to how money holdings insure against income and needed expenditure shocks, are necessarily forward looking.

flows from non-monetary assets are zero).[15] Financial innovation would be captured within such a measure by changing own rates, opportunity costs, and the calculated expenditure on monetary services. In practice, however, it is infeasible to historically track the liquidity of all assets, separating "monetary" from other assets, and measuring the changing liquidity imparted by financial innovation. As a result, the demand for an MSI is affected by changes in the liquidity of assets outside of the index. This limitation makes broader indexes (M3 or M4) preferable to M2.

We estimate an error-correction model for the short and long-run demand for MSI using Johansen's multivariate, reduced-rank "cointegration" framework (Johansen, 1995; Carlson, et al., 2000; Juselius, 2006).] The aforementioned asset substitution implies the following, plausible empirical specification for the long-run equilibrium log velocity of an MSI ($LVCMSI^*$):

$$LVMSI^* = \alpha_0 + \alpha_1 \ln(\text{asset transfer costs})$$
$$+ \alpha_2(\text{regulations altering the liquidity of nonmonetary assets}) + \alpha_3(\text{COVID}) \quad (1)$$

where the two types of nonstationary variables are usefully modeled as I(1); $\alpha_1 < 0$ since they raise the demand for MSI services and $\alpha_2 < 0$ in the case for regulations that induce increases in the liquidity of assets whose monetary services are not tracked by MSIs. *COVID* is medium-run shock to the demand for money that we later define in more detail at the end of Section 5. Unit root tests show that all of the long-run variables classifiable in the first two groupings are I(1), with the COVID variable being I(0). To keep the size of the cointegrating vector reasonable, we put the I(0) spread among the short controls, as described below.

Using eq. (1) to track equilibrium MSI velocity, short-run changes can be modeled as:

$$\Delta LVMSI_t = \beta_0 + \beta_1(LVMSI_{t-1} - LVMSI^*_{t-1}) + \sum \gamma_k \Delta Y_{t-k} + \beta_j X_j + \varepsilon_t \quad (2)$$

[15]In theory, a Divisia index for a durable good, for example, an index of transportation services, should not add the market values of trains, planes, and cars, but rather sum the flows of services from them. One might try to measure the total transportation capital stock or total flow of transportation services; these are very different even if one could reasonably vary weights across various vintages of the same capital item (see Anderson, Jones and Nesmith (1997).

where an error-correction term can be defined as $EC_{t-1} \equiv LVMSI_{t-1} - LVMSI^{*}_{t-1}$, $|\beta_1|$ is the quarterly speed of adjustment; ΔY are first differences of all the Y elements of the long run cointegrating vector, X is a vector of exogenous money demand shocks, and ε_t is an i.i.d. residual.

5. Data and Variables

Monetary Services and Its Velocity

We model three of the broadest CFS measures of U.S. monetary services. One, Divisia M3, adds the liquidity services of large time deposits, institutional money funds, and repurchase agreements to the liquidity services from M2. To Divisia M3, Divisia M4- adds the liquidity services of commercial paper and Divisia M4+ also adds the liquidity services of Treasury Bills. We track velocity using nominal GDP but find that our money demand framework also works well—indeed better—for velocity defined using total personal consumption expenditures.[16] Nevertheless, we focus on GDP velocity given the greater appeal of modeling nominal GDP.

Regulatory Variables Affecting the Liquidity of Traditionally Less Liquid Assets

Based on our earlier discussion, we test a long-run regulatory shift variable that plausibly induced changes in the relative liquidity of M3, M4, nonM3, and nonM4 assets and affected their velocities. The dummy, *CFMA*, equals 1 since 2001q1 and 0, otherwise, to control for how CFMA increased the issuance of liabilities within M3 and M4 and thereby their monetary services. Such induced effects lower velocity, implying a negative sign on the long-run coefficient on *CFMA*.[17]

Mutual Fund Loads

Owing to improvements in technology, stock and bond funds have greatly reduced the

[16] Friedman (1956, 1957) and Cochrane (1994) argue that money demand reflects consumption more than GDP as the former better reflects permanent income. This scaling yields a more stable and less noisy velocity than does GDP.
[17] Since Divisia M3 includes services from shadow bank liabilities, it internalizes shifts from relative changes in capital regulations on commercial versus shadow bank, that can induce shifts in the composition of M2 liabilities.

proportional fees (loads) they charge retail customers to invest in mutual fund accounts (Duca, 2005), which for many decades were the only effective, feasible, and common way for middle class households to hold a diversified portfolio of stocks or bonds. These declining costs have been linked to greater rates of stock ownership (Anderson, et al., 2017) and bond ownership (Duca, 2000), and increased substitutability of these assets for official measures of money. We track the increased liquidity of mutual funds with the average load on stock mutual funds that investors incur if they invest in a mutual fund account or withdraw such an investment after one year. As argued by Brunner and Meltzer (1967) and Duca (2000), proportional transfer costs affect velocity in contrast to the implications of the overly stylized Baumol-Tobin framework. We extend the series used by Anderson et al. (2017) to track this one-year horizon measure of front-end plus back-end loads (*SLD1*). As mutual funds loads become less expensive, the liquidity of their liabilities increases, which become more substitutable for the monetary services of assets included in MSI measures. By reducing the demand for MSI, lower loads raise velocity as found by Duca (2000) and Anderson et al. (2017) for the velocity of simple-sum M2.

Short-Term Money Demand Shock Variables

Note that we do not include a traditional measure of the opportunity cost of money. In contrast to simple-sum measures of money, broad Divisia measures essentially are defined with opportunity cost measures that they use to measure the flow of nonpecuniary money services from each monetary asset. Hence, a spread between a safe short-term rate of return (e.g., a 3-month T-bill rate) and the own pecuniary rate of return on money balances is embedded into the velocity of Divisia aggregates and adding such a term as a right-hand side variable creates simultaneity bias.

Five types of short-run money demand variables are in the *X* vector. To control for unusual money demand shocks from financial market turmoil that induce portfolio shifts, we include the t-

1 to t-4 lags of the stationary change in the log spread between yields on Baa-rated corporate and 10-year Treasury bonds ($\Delta LBaaTr$).[18] Higher spreads reflect flight-to-quality and flight-to-liquidity shifts in the bond market that raise the demand for money and thereby lower its velocity, consistent with Anderson, et al.'s (2017) model of annual M2 velocity spanning 1929-2016.[19]

Velocity dropped during the near default of Bear Stearns in 2008q1 followed by a complete reversal in 2008q2 when it was rescued and acquired. Velocity also fell in 2008q4 just after Lehman's failure in late September 2008 and then recovered much in 2009:q1. These outsized effects from the risk of a large investment bank failure are tracked by *InvBkFail* which equals 1 in first and fourth quarters of 2008, -1 in 2008:q2 and 2009:q1, and 0 otherwise. As a precaution against disruptions from the century date change ("Y2K"), the public increased its demand for liquidity in 2000q1, but then quickly reduced those holdings in 2000q2. To control for these large shifts, we include the dummy *DY2K*, which equals 1 in 2000q1, -1 in 2000q2, and 0, otherwise.

The demand for monetary services is also affected by swings in mortgage refinancing activity that are not reflected in current nominal GDP or consumption. Because the balances of mortgage principal in mortgage refinancing transactions are held in custodial liquid monetary assets until refinancings are completed, they can cause large and short-lived out-sized surges in money balances as shown by Duca (1990) and Anderson (1993) for simple-sum M1 and M2, respectively. To control for these money demand shocks, we include the time t lag of the log share of government-related securitized mortgages that are refinanced (*LMortRefi*, extending Anderson

[18] This spread is stationary in our sample. When we included the t-1 and t-2 spreads, they were significant with opposite signs and of nearly equal magnitude. To limit the number of short-run controls, we used the t-1 first difference.
[19] To control for similar shifts in the stock market, we tested the t and t-1 lags of the percent change in the S&P500 ($\Delta SP500$). These were neither jointly nor individually significant for the broad Divisia aggregates, as was the slope of the yield curve. In contrast, such variables are often significant for the velocity of M2 (Friedman (1957) and Hamburger, (1966, 1977) and Divisia M2 (Anderson, et al., 2017), reflecting that broader Divisia aggregates better internalize shifts between commercial and shadow banking that can lower M2 velocity when shadow banks fail or stock prices plunge. Accordingly, such variables were not in the full set of controls in the velocity models.

and Duca's (2017) data), which is expected to have a positive sign.

The fourth type of short-run variable controls for the effects of an outsized temporary swing in current but not permanent income. Extreme cold weather from an unusual and long-lasting polar vortex in the first quarter of 2014 that unwound in the second and third quarters caused nominal GDP growth to slow from about 4 percent per annum to 0, followed by surges in nominal GDP in the following quarters that unwound 60 and then 40 percent of the unusual first quarter fall (see Bloesch and Gourio, 2015, for analysis of temporary effects on real activity). As Friedman (1956) emphasized, money demand is barely affected by temporary changes in income, which can create short-run serial correlation in velocity as implied by a temporary drop in income that is subsequently and quickly unwound. Outsized shocks of this type can give rise to significant correlation absent control variables. A deep freeze that impacted half of the U.S. implying similar signed shocks to velocity which fell sharply in 2014q1 and then recovered 60 and 40 percent of that outsized drop in the following quarters, respectively. To control for the impact of the 2014 polar vortex on velocity, we include the variable *2014Freeze* which equals 1 in 2014q1, -0.6 and -0.4 in the following two quarters, respectively, and 0 otherwise. *2014Freeze* is expected to have a negative sign and has zero medium and long-run effects by construction.

The fifth type of short-run variable controls for the temporary effects of a regulatory change. In 2011:q2, the FDIC switched from levying deposit insurance premiums on domestic deposits to domestic assets because some deposits were booked abroad to avoid the insurance premium. This change was made with no advance warning and caused foreign deposits to be domestically booked, which boosted money balances and lowered velocity in 2011:q2. In the fourth quarter of 2011, banks found ways to replace these rebooked funds to avoid the insurance premium, causing velocity to rebound to its late 2010 level. To control for these outsized but short-run effects, we include a dummy *FDICIns* equal to 1 in 2011q2 and -1 in 2011q4 (see Kreicher, et al., 2013). The inclusion of the short-run controls does not qualitatively affect the long-run cointegrating relationships but does eliminate serial correlation that arises in their absence.

Unusual COVID-19 Effects on Velocity

The COVID-19 pandemic has arguably affected the demand for money in two major ways that are not tracked by movements in GDP, in interest rate spreads used to construct measures of monetary services, interest rate spreads used to track flights to quality, and other money demand variables. First, higher uncertainty about the economic and financial outlooks can induce flights to quality, a long, recognized effect (see Friedman and Schwartz, 1963). By late 2020, much of the flight to quality had eased partly owing to Federal Reserve actions (see Bordo and Duca, 2022). These included flooding the financial system with liquidity via open market purchases of short and long-term government securities, the expansion of discount lending, and efforts to ease credit constraints in other markets, such as those for commercial paper (Clarida, et al. 2021), corporate bonds (Gilchrist, et al. (2020) and Bordo and Duca (2022), and municipal bonds (Bordo and Duca (2021, 2023) and O'Hara, et al (2021)). As a result, measures of risk (e.g., spreads between yields on corporate and Treasury bonds) were distorted by policy actions and may not fully reflect the risk facing households. By the fall of 2020, upward pressures on spreads had largely abated, inducing the Treasury to end these programs by yearend 2020.

Nevertheless, COVID-19 has likely depressed velocity in a second major way. Spurred by government restrictions and self-preservation, households initially slashed spending on services that entailed much social interaction. There are signs that the pandemic has created a pent-up demand for such services (see Walmsley, et al., 2020) and could have plausibly induced households to build up monetary balances in anticipation of future spending on services when conditions eased. This is salient for the velocity of broad Divisia money as these aggregates largely reflect household demand for liquidity.

Major COVID effects on velocity appear related to two inter-related factors. One is the stringency of government pandemic restrictions[20] (*String*, Oxford Blavatnik Index, Figure 10) which not only directly reduces spending, but also has indirect effects by inducing the public to be more risk averse to social physical interactions. While some relaxation of restrictions occurred in summer 2020, they have only recently fallen from about 40% above pre-COVID levels to roughly 28% above them by 2022Q3. The other major factor is the rising share of fully vaccinated people (*Vaxfull*, two pre-booster shots), which appears to have attenuated risk aversion to physical interactions. Including separate terms for each would pose challenges to identifying the lagged adjustment effects in a cointegrating framework given the short sample affected by COVID. To parsimoniously control for both effects the cointegrating vector for samples covering the pandemic include *StringVax*, which equals the stringency index multiplied by the <u>un</u>vaccinated share (1-*Vaxfull*). *StringVax* is preferable to the Google mobility index, whose movements—relative to *String* and *Vaxfull*, are more endogenous and pick up the effects of other variables on money demand. Owing to the exogenous nature of *StringVax*, we include the time t lag in the cointegrating vector and the time t lag of its first difference when modeling changes in velocity.

Nevertheless, including lags of Δ*StringVax* arguably do not fully control for the dynamic effects of COVID. One reason is that the imposition of shutdowns in 2020Q2 imparted a sudden halt to much spending (and hence velocity), whereas the public's response to the lifting of restrictions was more drawn-out. To control for this "sudden start" effect, we include a dummy equal to 1 only in 2020q2 (*D2020q2*). Another apparent asymmetry in the short-run response is

[20]Note, for comparison, velocity has moved less tightly with the Google mobility index than with the Blavatnik index.

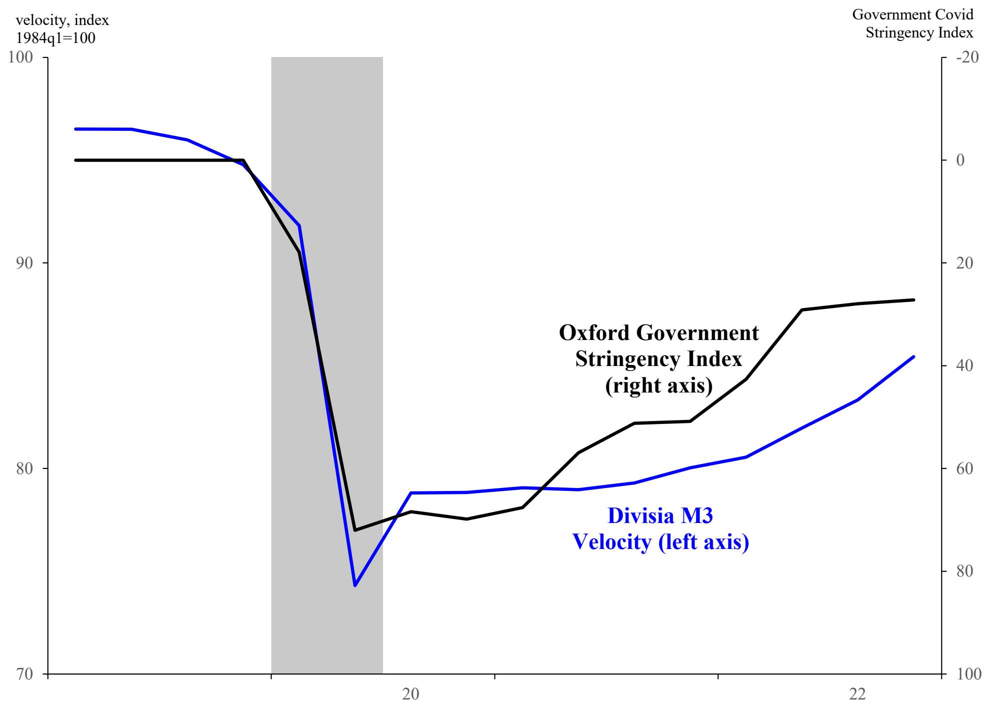

Figure 10: Velocity Affected by Government Restrictions in the COVID-19 Pandemic
(Sources: BEA, Federal Reserve, CFS, Oxford's Blavatnik Center, and authors' calculations).

to the rise in vaccinations, for which we also included to the model of changes in velocity the time t to t-2 changes in the vaccination rate ($\Delta Vaxfull$).

6. Estimation Results

6.1 Specification and Models Estimated

Using the variable definitions above, our full model specification is:

$$LVMSI^*_t = \alpha_0 + \alpha_1 LSLD1_t + \alpha_2 CFMA_t + \alpha_3 StringVax_{t+1} \tag{3}$$

$$\Delta LVMSI_t = \beta_0 + \beta_1 EC_{t-1} + \sum \delta_k \Delta VMSI_{t-k} + \sum \gamma_k \Delta LSLD1_{t-k} + \sum \Omega_k \Delta CFMA_{t-k} + \sum \mu_k \Delta StringVax_{t-k+1}$$

$$+ \underbrace{\sum^4_{i=1} \beta_3 BaaTr_{t-i} + InvBkFail_t}_{\text{flight-to-quality}} + \underbrace{\beta_7 LMortRefi_t}_{\text{mortgage refi.}} + \underbrace{\beta_9 FDICIns_t}_{\text{FDIC premium}} + \underbrace{\beta_{10} 2014Freeze_t}_{\text{climate shock}}$$

$$+ \underbrace{\beta_{10} D2020q2 + \sum^2_{i=0} \beta_{12+i} \Delta Vax_{t-i}}_{\text{extra COVID effects}} + \varepsilon_t \tag{4}$$

Note that the timing of the COVID control variables is moved up one quarter relative to the other variables to allow them to have a contemporaneous effect owing to the timing of COVID effects stemming from quickly imposed government shutdowns and other stringency measures. We jointly estimate two versions of eqs. (3) and (4) for the velocities of Divisia M3 (Models 1 and 2), M4- (Models 3 and 4), and M4+ (Models 5 and 6). For each measure, the first model covers a pre-COVID sample of 1986q1 to 2020q1—and hence omits COVID controls (*D2020q2*, Δ*Vax, LStringVax* and its lags)—while the second model covers the full sample and includes COVID controls. The specification used implicitly assumes that monetary services' velocity mainly reflects a transactions demand for money, with only short-run effects from the shock terms whose effects wear off depending on the speed of error correction. Since the models use four lags of first difference terms in estimating most of the cointegrating vectors, the sample periods begin in 1985q1 to avoid including samples covering the introduction of MMDAs in the first half of 1983. These models are estimated using velocity defined in terms of nominal GDP and total personal consumption expenditures, with the latter in an appendix to conserve space. Qualitative results are similar for corresponding models of consumption velocity, which have smaller standard errors.

6.2 Estimation Results

Table 2 reports estimation results for the GDP velocity of Divisia M3, M4-, and M4+, respectively. The lag length in the models minimized the lags needed to find a unique significant cointegrating variable and, if possible, yield clean residuals based on VECLM statistics on lags *t-1* to *t-4*. This criterion also was consistent with lags based on minimizing the Akaike Information Criterion. Estimation allowed for possible time trends in long-run variables without an independent time effect in the vector not linked to measured factors. As noted in Table 2, significant and unique long-run relationships (cointegrating vectors) are found in all six cases.

Several long-run patterns can be seen in Table 2. Consistent with priors, the long-run coefficients on *SLD1*, *CFMA,* and *String* are significant and negative. Reflecting the importance of the long-run variables, the error-correction term is significant and negative in every model. Inverting the sign of the error-correction coefficients implies that velocity tends to adjust to reduce the prior quarter's gap between actual and equilibrium velocity by 6 to 15 percent per quarter. Also encouraging is that the long-run and error-correction coefficients are similar across the pre-COVID and full samples, reflecting that the COVID variable is tracking unusual pandemic effects that are not reflected in other variables. Among the noteworthy short-run patterns are that most of the short-run Baa-Treasury spread lags are significant (they are jointly significant), reflecting negative flight-to-quality effects on velocity. Mortgage refinancing lowers velocity on impact (by boosting money balances). The dummy for bankruptcy-threats to large investment banks is negative as expected, while attempts to levy deposit insurance premiums on foreign deposits temporarily led to a fall in velocity as foreign-booked deposits were initially counted as U.S. deposits until investors found less regulated alternatives, which unwound the effect on velocity in two quarters. Together, the above patterns plus the good fit of the models and the lack of serial correlation in residuals reflect that the models are well specified and credible.

The long-term relationships not only provide information about short-run movements in velocity, but also track actual velocity well until the pandemic. For example, the implied equilibrium velocity of Divisia M3 from the full sample Model 2 nicely tracks actual velocity through 2019 with about a one-quarter lead (Figure 11). That lead, also reflected in the sign of the error-correction term, reflects the partial adjustment of household use of monetary services from holding different types of balances. Of the full sample models, we prefer that of Divisia M3 (Model 2), which had the smallest standard error. Its 12 percent quarterly speed of adjustment implies that

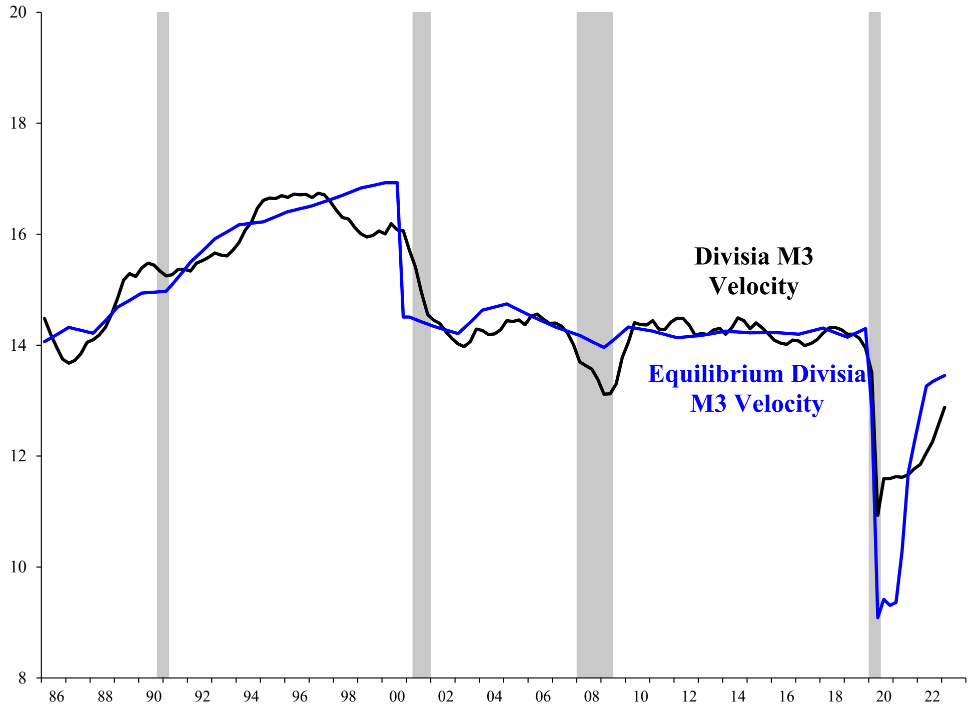

Figure 11: Covid-Adjusted Equilibrium Tracks Trends in Actual M3 Divisia Velocity
(Sources: BEA, CFS, and Authors' calculations. Shaded areas denote NBER recessions.)

two-thirds of the adjustment occurs in about 2 years, similar to that of Anderson, et al. (2017) for simple- sum M2 velocity. The close tracking of the model estimates reflects the importance of both short-run money demand shocks and partial adjustment for tracking velocity in the short-run.

7. Forecasting Nominal GDP using Divisia M3 and M4

7.1 Forecasting Approach

Monetary policy was accommodative during the COVID pandemic and prevented a deeper downturn and shortened the recovery from it. At the same time, the revival in aggregate demand created much upward pressure on nominal GDP growth amid supply shortages, sparking an unanticipated surge in inflation. The upward pressure on nominal aggregate demand reflected how a rapid acceleration in money growth outweighed a rise in money demand (the fall in velocity) as households demanded more liquidity as a cushion against uncertainties arising from the pandemic. Looking ahead, the path for nominal GDP depends on not only the pace of broad money growth, but also how much velocity recovers to its pre-Covid level. Using our models of the demand for Divisia money, we forecast nominal GDP growth first by forecasting velocity and then multiplying those forecasted paths with different paths for Divisia money growth.

7.2 Forecasting Velocity

To forecast velocity, we use a modification of our preferred money demand specification (Model 2) under several scenarios for the future path of the stringency of government COVID regulations. Essentially, we convert Model 2 into an autoregressive distributed lag (ARDL) model that mimics equations (3) and (4) by replacing the error-correction term in equation (4) with the levels of variables in the long-run relationship in eq. (3):

$$\begin{aligned}\Delta LVMSI_t = {} & \theta_0 + \theta_1 LVMSI_{t-1} + \theta_2 LSLD1_{t-1} + \theta_3 CFMA_{t-1} + \theta_4 StringVax_t + \textstyle\sum \gamma_k \Delta LSLD1_{t-k} \\ & + \textstyle\sum \Omega_k \Delta CFMA_{t-k} + \beta_2 \sum \mu_k \Delta StringVax_{t-k+1} + \sum^4_{i=1} \beta_3\, BaaTr_{t-i} + \beta_7\, LMortRefi_t \\ & + \beta_9\, FDICIns + \beta_{10}\, D2020q2 + \beta_{11} \Delta Vax_t + \beta_{12} \Delta Vax_{t-1} + \beta_{12} \Delta Vax_{t-2} + \varepsilon_t \qquad (5)\end{aligned}$$

where the long-run equilibrium coefficients in eq. (3) can be derived as $\alpha_0 = (\theta_0/-\theta_1)$, $\alpha_1 = (\theta_2/-\theta_1)$, $\alpha_2 = (\theta_3/-\theta_1)$, and $\alpha_3 = (\theta_4/-\theta_1)$. Eq. (5) applies Pesaran et al.'s (2001) insight that many cointegration models—particularly linear ones like the Divisia money models in eqs. (3) and (4)—have simpler, auto-regressive distributed lag (ARDL) model analogues, which are for practical reasons easier to simulate in forecasting exercises.

In early 2023:q1, the government stringency index fell to about 27 percent of its pre-pandemic level, down from roughly 42 percent above its pre-pandemic level in 2022:q2 and down from a peak of 72 percent above its pre-pandemic level in 2020q2. We assess the impact of three possible paths: low, medium, and high. Under the pessimistic (low) scenario, the stringency index recedes by 5 points from 2023:q1 to 2023:q2, and then levels out at 22 points above its pre-pandemic level. This scenario presumes some long-lasting effect of restrictions or of COVID effects for which it may be proxying. Under the medium path, the stringency index recedes by 5 points per quarter from 2023:q2 to 2023:q3, and then levels out at 17 points above its pre-pandemic level. Under the optimistic scenario, the stringency index recedes by 5 points per quarter from 2023:q2 to 2024:q2, and then reaches and stays at its pre-pandemic level in 2024:q3. This scenario assumes that the long-run effect of the pandemic on the demand for liquidity completely fades away. While one can quibble with the particulars of the scenarios, they are intended to provide a rough guide to how developments may unfold.

Figures 12-14 plot the forecasted velocity paths for Divisia M3, M4-, and M4+, respectively, under the three different COVID-recovery scenarios. For each Divisia measure, velocity rebounds to slightly above its 2020:q1 level under the fast Covid recovery scenario and nearly reaches its pre-Covid benchmark. Under the slow scenario, velocity would not fully recover to its 2020:q1 level, reflecting that restrictions (and risk aversion among the public) prevent a full unwinding of the COVID-induced rise in the precautionary demand for liquidity.

The forecasted paths of velocity have economically meaningful implications. For example, while money growth downshifted sharply to about zero in the spring of 2022, nominal GDP growth was supported by the partial recovery in velocity in the first half of 2022. Indeed, the forecasted recovery in velocity implies it may take several quarters of flat to slow growth in Divisia money to slow nominal GDP growth to a pace consistent with the restoration of low inflation rates in the long run. This is consistent with the famous point of Friedman and Schwartz that changes in monetary policy affect aggregate demand and inflation with long and variable lags. In particular, they argued not that the velocity of money was stable in the very short-run, but that it was stable in the long run. Consequently, rises in uncertainty associated with financial crises and other unusual events can raise the demand for money and lower velocity, but eventually these effects

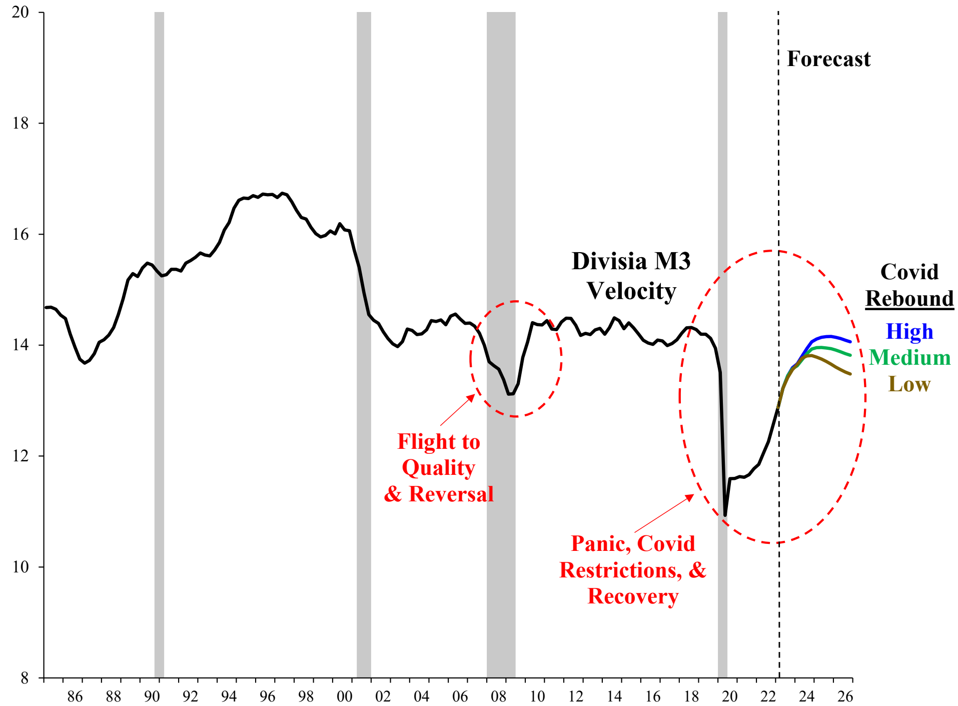

Figure 12: The Recovery of Divisia M3 Velocity Under Three COVID Scenarios
(Sources: CFS, BEA, Federal Reserve, and authors' calculations)

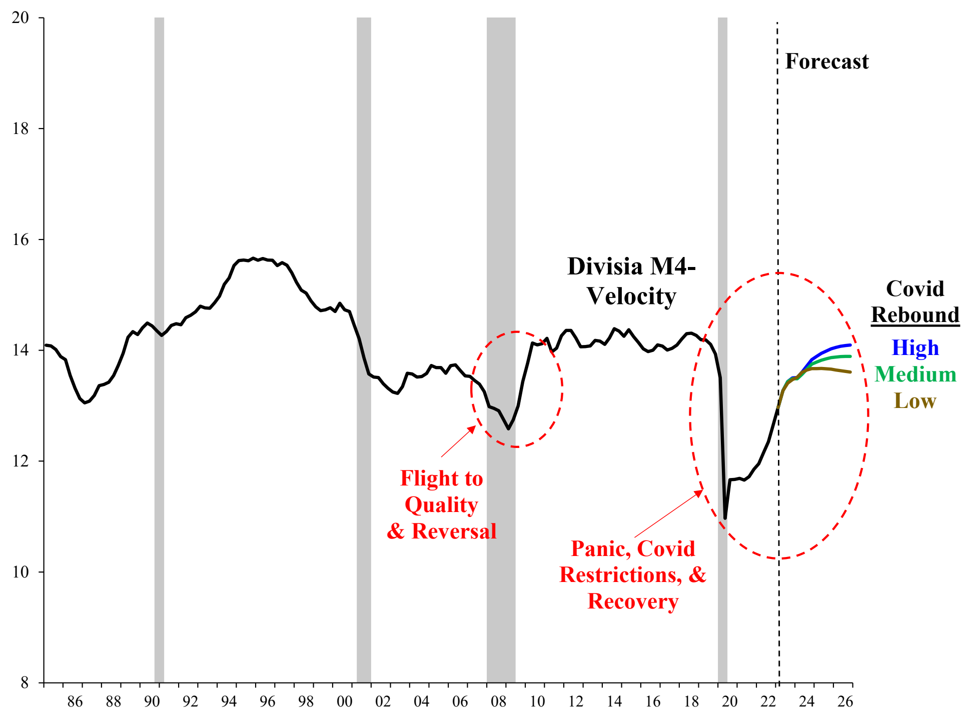

Figure 13: The Recovery of Divisia M4- Velocity Under Three COVID Scenarios
(Sources: CFS, BEA, Federal Reserve, and authors' calculations)

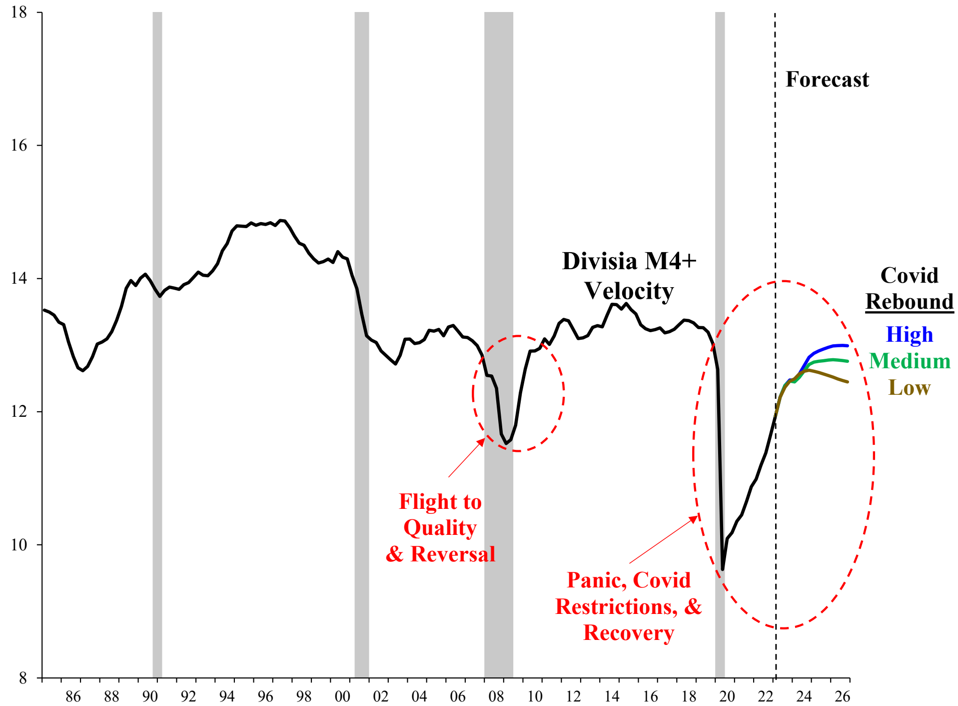

Figure 14: The Recovery of Divisia M4+ Velocity Under Three COVID Scenarios
(Sources: CFS, BEA, Federal Reserve, and authors' calculations)

will unwind. Hence, central bank induced near-term increases in the money supply relative to nominal GDP that are intended to accommodate flights to quality will eventually need to be unwound to avoid later fueling inflation. This did happen following the large increases in money to counter the COVID Recession. Partly as a consequence, aggregate demand growth accelerated and inflation rose sharply in 2021 and 2022.[21]

7.3 Nominal GDP Paths and Implications for Long-Run Inflation Under the Scenarios

In forecasting the path of nominal GDP, we assess nine cases for each Divisia aggregate reflecting three scenarios for velocity—which were developed in the prior section—and three paths for the growth rate of broad money treating the path of velocity as independent of the growth rate of Divisia money. While technically risk premia and refinancing activity can plausibly differ

[21] While supply disruptions contributed to inflation, by 2021:q4 and 2022:q3, the acceleration in aggregate demand pushed up nominal GDP to levels that were 3.7 and 6.4 percent, respectively, above what a 4 percent growth path since 2019:q4 would imply. Consequently, pandemic-related temporary and long-run declines in aggregate supply cannot fully account for the acceleration of inflation, especially that of core PCE inflation to 5 percent in mid-2023.

and can be hard to predict in the short run across these three money growth scenarios, our focus is on the central path of nominal GDP growth that will unfold in the medium run. To that end recall each of the velocity scenarios zeroes out future shocks to the Baa-Treasury spread by assuming that the spread persists at its 2023:q1 level, which is near its 2018 pace that preceded the 2020-21 boom in mortgage refinancing boom.

Since the Federal Reserve began hiking the federal funds rate and started unwinding its holdings of long-run securities, broad Dvisia money growth downshifted further in late 2022 and early 2023, with broad measures declining. For example, Divisia M3 declined at annualized rates of -3 ½ and – 4 ½ percent in 2022:q4 and 2023:q1, respectively. Looking forward, our first "slow growth" scenario assumes that money declines at a -4 percent annual pace in 2023:q2 and 2023:q3, is unchanged in 2023:q4, and then grows at a 2 percent annual pace in 2024 and a 4 annual percent pace thereafter. In the "moderate growth" scenario money follows the same path in 2023 but then grows at a 4 percent annual pace through yearend 2026. In the partial retrenchment scenario, Divisia money declines at a 4 percent annualized pace through 2023:4, then is flat in 2024 and then grows at 4 percent annualized pace thereafter.

For each definition of Divisia money, we obtain a similar set of nine paths for nominal GDP under the three COVID scenarios for the recovery of velocity (slow, medium, and high). Out of space considerations, the main text discusses the forecasts using Divisia M3, the aggregate for which our full sample model of velocity has the lowest standard error.

As illustrated in Figure 15, the pace of nominal GDP growth under the slow money growth scenarios holds up through 2023:q2 and slows in the second half of 2023, under all three velocity paths before eventually rising to 4 percent pace sometime in 2024 or 2025. The temporary resilience in nominal GDP growth in late 2022 and early 2023 reflects the recovery in velocity

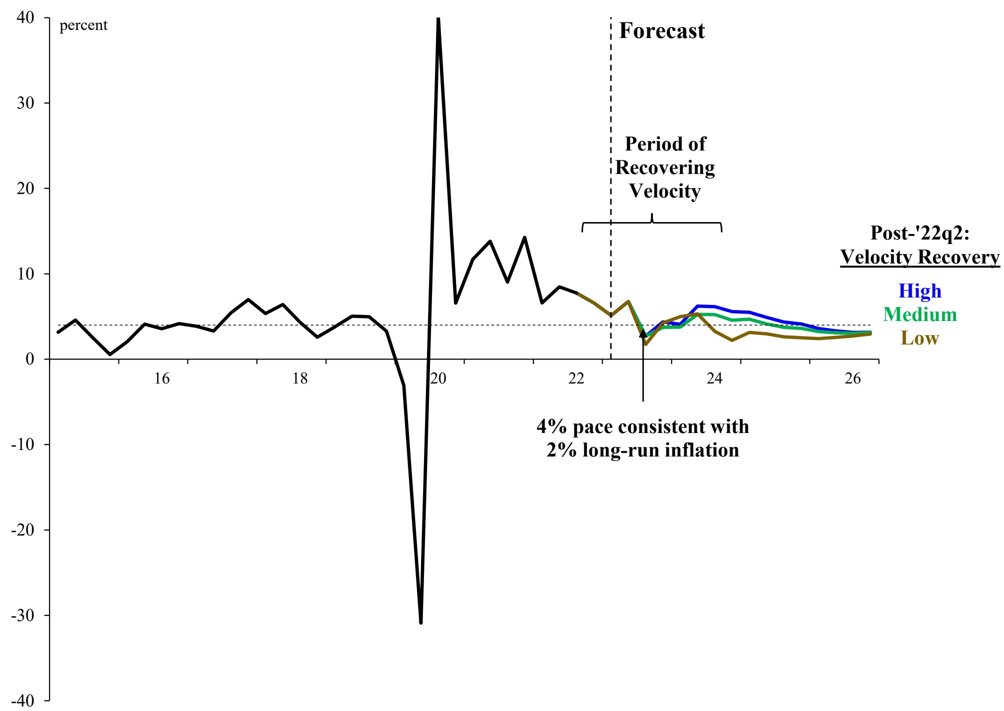

Figure 15: Nominal GDP Growth: Slow Divisia M3 Growth and Three Velocity Scenarios
(Sources: CFS, BEA, Federal Reserve, and authors' calculations)

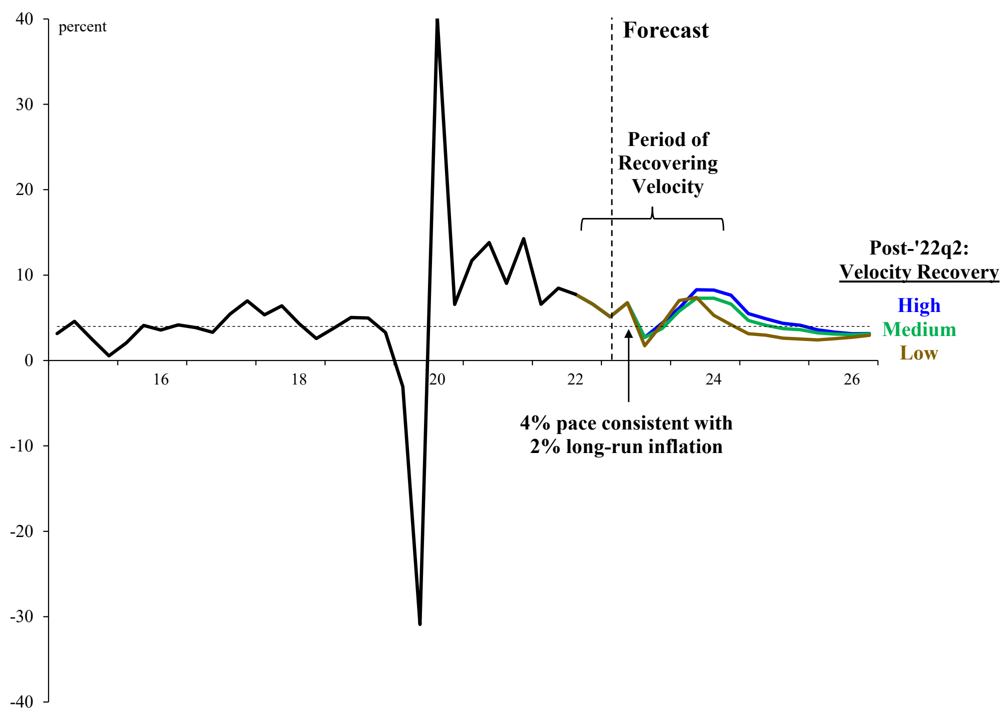

Figure 16: Nominal GDP Growth: Modest Divisia M3 Growth & Three Velocity Scenarios
(Sources: CFS, BEA, Federal Reserve, and authors' calculations)

which can maintain nominal GDP growth at rates faster than money growth until velocity returns to equilibrium. In all three scenarios, nominal GDP growth slows in mid-2023 reflecting near-term declines in money. Under the slow and moderate money growth paths, nominal GDP growth returns to a 4 percent pace in early 2024—a pace roughly consistent with 2 percent annual inflation in the long-run. This accords with the median core PCE inflation projections of FOMC members in December 2022 which implied that it may take a while to return to a low inflation rate. Of course, the return to a sustained 4 percent pace of nominal GDP growth can be slower (faster) if Divisia money growth is faster (slower) than in the scenarios. or if the effects of the COVID pandemic on velocity wear off more slowly (quickly) than is assumed in the velocity scenarios.

A quick return in 2024:q1 to four percent steady Divisia M3 growth is assessed under the three velocity scenarios in Figure 16. Reflecting slightly stronger money growth than in the scenarios depicted in Figure 15, rebound in nominal GDP growth is somewhat stronger in 2024-25. Under the partial retrenchment scenario, the recovery in nominal GDP growth to 4 percent is less robust depending on the velocity scenario, with a particularly slow recovery under the low velocity scenario (Figure 17).

8. Conclusion

Following the Great Inflation of the 1970s, some money-macro models developed in the 1980s and 1990s rediscovered the potential informational value of monetary aggregates. That renewed interest waned as later shifts in the demand for simple-sum monetary aggregates weakened the link between money and nominal GDP (Duca, 2000). Indeed, in the past two decades, many macroeconomists have utterly removed “money” from their analyses of the macroeconomics of inflation. And yet, after the new recent inflationary burst, this study brings up a once-more-overlooked role that measures of money could have provided if they had not been

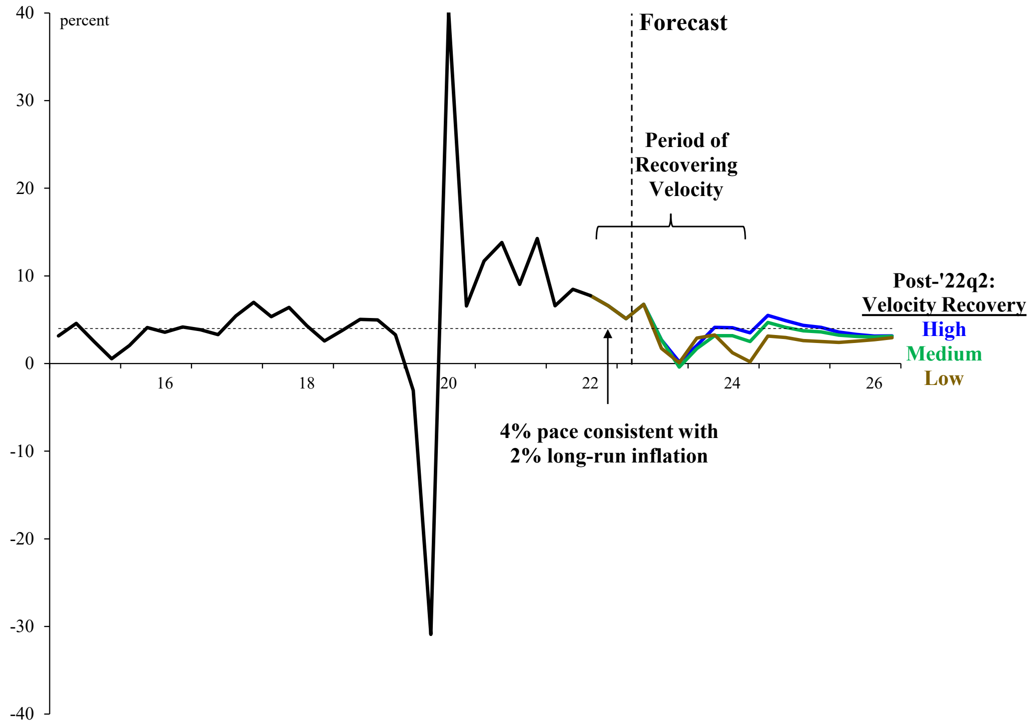

Figure 17: Nominal GDP Growth: Weak Divisia M3 and Three Velocity Scenarios
(Sources: CFS, BEA, Federal Reserve, and authors' calculations)

ignored. To be clear, we are not advocating the targeting of Divisia aggregates, but rather that their informational content not be overlooked in accounting for velocity. The latter qualification has parallels to paying attention to the information content of short-term interest rates while making allowances for variation in the latent neutral real rate of interest and quantifying the effects of quantitative easing and forward guidance in gauging the shadow federal funds rate.

In addressing a financial crisis and a deep economic downturn, it is important for a central bank to protect the health of the financial system by acting as a lender of last resort and by preventing a flight to quality from pushing up interest rates and amplifying economic weakness (see, *inter alia*, Bernanke, 2013, and Friedman and Schwartz, 1963). That said, it is also important that unusual monetary stimulus be unwound as the crisis ebbs, especially before nominal aggregate demand becomes overstimulated. In the short-run, large monetary stimulus during a crisis can result in money growing faster than nominal GDP, pushing velocity lower. Friedman (1971) cautioned that velocity adjusts with a lag after money growth changes its trajectory and that velocity will eventually recover to pre-crisis levels. This gives rise to Friedman's point that monetary policy works with long and variable lags, which implies that if not reversed, it will take a while for monetary stimulus to result in higher inflation and nominal GDP growth. Because the velocity of traditional monetary aggregates has been unstable and prone to large, permanent shifts, macroeconomists have understandably downplayed monitoring their growth in the years preceding the Great Recession and the COVID Recession. However, Friedman's concerns are valid for the more theoretically grounded measures of broad Divisia money, which have tended to be overlooked and whose velocity, as our study shows, is much more stable and mean-reverting in the long-run.

Our new models of broad Divisia velocity could be viewed as providing information useful for targeting nominal GDP, a strategy that Tobin (1983, p. 516) suggested could be described by a central bank as targeting a velocity-adjusted monetary aggregate. Indeed, by including information on the user cost of money components, Divisia indexes implicitly control for much of the short-run swings in velocity associated with opportunity cost measures in contrast to traditionally defined M2. And by internalizing shifts between commercial and shadow banking, broad Divisia aggregates like Divisia M3 are less prone to velocity shifts emanating from swings in shadow banking than is traditionally defined M2. Nevertheless, our models of the demand for Divisia money show that it is important to account for the effects of risk premia and technological changes in the liquidity of other assets (e.g., changes in transfer costs) when interpreting broad Divisia aggregates. By doing so, we find that growth in Divisia M3 pointed to a pickup in nominal aggregate demand that has contributed much to the 2021-22 rise in inflation (obviously oil, food, and supply chain shocks also bolstered that inflationary surge). Viewed in this context, analysts should not summarily ignore information from broad Divisia money indexes.

Interestingly, other recent research, notably Blanchard, Domach, and Summers, 2022, Bordo and Levy, 2022, Bolhuis, Cramer, and Summers, 2022, and DeSoyres et al., 2022, attribute much of the recent run-up of inflation to a pickup in aggregate demand, which they attribute to fiscal stimulus. We note that because the stimulus was effectively money financed in the short run via QE purchases of Treasury debt, that these effects arguably are reflected in faster money growth.

This study makes several contributions to the money-macro literature. First, it extends earlier findings that established that Divisia monetary aggregates have a more stable demand than conventional M2 (Barnett, et al., 1984, Belongia and Ireland (2015a, 2015b, 2019) and Jadidzadeh and Serletis (2019), *inter alia*) by providing a more structural model of the short- and long-run demand for Divisia money. Our approach is similar to those used in the financial economics literature, which equates the "liquidity" of an asset to its transaction cost (e.g., Acharya and Pedersen, 2005) in that we treat equity mutual funds as the relevant alternative assets. By incorporating mutual fund costs, a time-varying liquidity accelerator arise in our model insofar as it tracks how innovations have altered the sensitivity of Divisia velocity to shocks affecting the liquidity of alternative assets. Second, by improving models of the demand for Divisia money, we can better assess emerging trends in nominal GDP growth.[22]

Nevertheless, even if they provide information about aggregate demand, Divisia and broad monetary aggregates should not be interpreted as being tightly controlled by the central bank. The main reason is that both types of aggregates incorporate the endogenous liquidity provided by commercial and nonbank (shadow bank) financial system, consistent with recent advances in

[22] 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).

analyzing liquidity creation, such as Brunnermeier and Sannikov's (2016) I-Theory of money. This especially includes financial innovation effects arising from technological advances as well as from regulatory arbitrage. Furthermore, even if swings in the velocities of such aggregates are well tracked by money demand models, these movements reflect endogenous manifestations of risk and the portfolio reactions to them that also reflect substitution with less "money" like instruments. Hence, the demand for money or liquidity services provided by a set of assets also depends on the riskiness of alternative assets as stressed by Tobin (1958) and Baba, Hendry, and Starr (1992), rediscovered in the "New Monetarist" literature (e.g., Williamson and Wright, 2010), and implied by intermediation (I) theories of money demand (Brunnermeier and Sannikov, 2016) and broad views of the demand for safe assets (Gorton, et al. 2012). With these qualifications in mind, our results indicate that Divisia money could be used as an indicator of nominal GDP that could inform the setting of the central bank's target interest rate and other balance sheet policies that are based on the paths of GDP and inflation.

A third contribution is that our study shows the importance of considering not only broad Divisia money, but also predictable movements in its velocity that can give rise to temporary divergences between money and nominal GDP growth rates. Essentially, we have illustrated Friedman and Schwartz's (1963, 1982) point that there are long and variable lags in the transmission of monetary policy that take the form of temporary changes in velocity—only we do so in the context of Divisia money indexes rather than simple-sum measures of money.[23]

This is very relevant for understanding the last two recessions. In this regard, note that the large drop in the velocity of broad Divisia aggregates during the Great Recession later unwound. But also note that the path of Divisia money growth was much less robust during that recession

[23] There are parallels to Tobin's views that there are lags in the transmission of policy (Buiter, 2003, p. 39) and that it takes time for household portfolios to adjust to changes in the financial environment (Tobin, 1982).

and the recovery from it than was the case in the COVID-19 recession and the early recovery from it. As a result, the recovery of nominal GDP was much less robust following the Great Recession and inflation remained in check.

In the COVID crisis, higher risk premia, public reactions, and government COVID restrictions initially contributed to the macroeconomic slowdown and induced an upward shift in money demand and a downshift in velocity. These effects were countered by aggressive monetary stimulus that induced very rapid money growth that offset lower velocity. Along with the lifting of many pandemic-restrictions and two large money-financed fiscal stimulus packages, this helped nominal GDP and the economy recover in the second half of 2020, but later overstimulated nominal GDP contributing to higher inflation in 2021, that was made more salient by a partial bounceback in velocity. Indeed, what might have been incorrectly interpreted as a permanent fall in velocity (increase in money demand) was a medium-term occurrence reflecting both an increase in the precautionary demand for money and monetary stimulus during the early pandemic in 2020 that started the process of unwinding in late 2021. Our framework implies that reductions in risk premia and the easing of COVID restrictions have induced households to spend out of unusually large money balances built up in 2020 and early 2021, which spurred increases in velocity that have helped return it toward its pre-COVID levels, boosting aggregate demand and inflation.

This is important for understanding the behavior of nominal GDP since early 2022, when monetary policy shifted to counter higher inflation and contributed to a sharp deceleration in broad Divisia money monthly growth rates to near zero since spring 2022. In line with an easing of Covid restrictions and a waning of pandemic effects on spending, velocity rose in the middle quarters of 2022 helping to keep nominal GDP growing despite zero money growth. Looking ahead, further rises in velocity are likely, depending on how quickly pandemic effects abate. An implication of rising velocity is that earlier increases in liquidity could have lagging positive effects on nominal GDP growth that will work oppositely from recent moves to slow growth in aggregate demand. This recovery of velocity echoes the points made long ago by Friedman and Schwartz (1963) about monetary stimulus not only having long and variable effects on the economy, but also inducing waves in both money creation and velocity (see Friedman, 1971).

There are some parallels with more Keynesian-oriented concerns that the unusually high buildup of precautionary savings during the pandemic stemming from fiscal stimulus has started to be drawn down and will help sustain consumer spending for a while after fiscal and monetary policy have changed course (see Blanchard, 2022, and Furman, 2022, *inter alia*). Hence, both approaches imply that it will likely take time for the more recent changes in the stance of monetary policy to lower core inflationary pressures by slowing growth in aggregate demand (nominal GDP). In the more monetary framework, this is manifested in the recovery of velocity while in the more traditional Keynesian framework this is manifested in the drawdown of excess precautionary saving. Both perspectives imply that there is information in quantities and lagged adjustments that we should be wary of ignoring.

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Table 1: Unit Root Tests

Variable	Augmented Dicky-Fuller (lag)	Reject Unit Root?	Phillips -Perron (bandwidth)	Reject Unit Root?	KPSS stationarity (bandwidth)	Accept Station-arity?
LV3div	-2.124 (0)	No	-2.214 (1.86)	No	0.181864^{*} (47.2)	No
ΔLV3div	-11.309^{**} (0)	Yes	-11.308^{**} (0.64)	Yes	0.052180 (1.62)	Yes
LV4-div	-2.132 (0)	No	-2.204 (1.71)	No	0.199026^{*} (44.7)	No
ΔLV4-div	-11.528^{**} (0)	Yes	-11.528^{**} (0.55)	Yes	0.052022 (1.37)	Yes
LV4+div	-2.417 (0)	No	-2.607 (2.14)	No	0.119041^{+} (36.7)	weakly No
ΔLV4+div	-11.135^{**} (0)	Yes	-11.135^{**} (0.597)	Yes	0.036719 (1.82)	Yes
LSLD1	-1.608 (9)	No	-1.562 (12.5)	No	1.600044^{**} (153)	No
ΔLSLD1	-3.343^{**} (8)	Yes	-4.993^{**} (2.18)	Yes	0.095192 (12.6)	Yes

Notes: Lag lengths for the ADF tests were selected using the Schwartz Information Criterion. We used the quadratic spectral kernel for the spectral estimation method for the Phillips-Perron and KPSS tests with an Andrews Bandwidth. All tests included an intercept and time trend. The sample period is 1984:q1-2023:q1.

Table 2: Quarterly Models of the GDP Velocity of Broad Divisia Money 1986q1-2023:q1

Long-Run Relationship: $LVDiv_t = \alpha_0 + \alpha_1 LSLD1_t + \alpha_2 CFMA_t + \alpha_3 StringVax_t$

	V3Div	V3Div	V4-Div	V4-Div	V4+Div	V4+Div
Sample:	86:1-19:4	86:1-23:1	86:1-19:4	86:1-23:1	86:1-19:4	86:1-23:1
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Constant	3.044	3.049	2.945	2.986	2.872	2.911
$LSLD1_t$	-0.261**	-0.263**	-0.249**	-0.276**	-0.210**	-0.236**
	(12.77)	(14.48)	(7.38)	(6.89)	(9.23)	(7.27)
$CFMA_t$	-0.158**	-0.154**	-0.085*	-0.091**	-0.110**	-0.116**
	(16.40)	(17.45)	(4.31)	(4.55)	(8.51)	(7.27)
$StringVax_t$x100		0.636**		0.744^{+}		0.794*
		(3.40)		(1.83)		(2.29)
TraceCorr (1v.)	51.89**	67.76**	34.85*	50.42**	43.12**	52.44*
TraceCorr (2v)	13.12	21.13	7.18	21.81	7.76	23.37
Unique Coint-	Yes**	Yes**	Yes*	Yes*	Yes**	Yes*
Lag Length	5	5	9	6	9	6

Short-Run: $\Delta VDiv_t = \alpha_0 + \alpha_1(EC)_{t-1} + \beta_i\Delta(LVDiv)_{t-i} + \theta_i\Delta(LSLD1)_{t-i} + \varphi_i\Delta(CFMA)_{t-i} + \sigma_i\Delta(StringVax)_{t-i} + \delta S\text{-}runVar_t + \varepsilon_t$

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Constant	-0.012*	-0.014**	-0.019**	-0.016*	-0.017**	-0.011
	(2.42)	(2.79)	(3.06)	(2.57)	(2.90)	(1.62)
EC_{t-1}	-0.117**	-0.122**	-0.083**	-0.058**	-0.146**	-0.104**
	(4.60)	(4.47)	(3.69)	(3.05)	(5.04)	(3.68)
$\Delta LV3/4Div_{t-1}$	0.304**	0.265**	0.278**	0.323**	0.237**	0.252*
	(3.85)	(3.56)	(3.24)	(3.89)	(2.69)	(2.35)
$\Delta LSLD1_{t-1}$	-0.075	-0.074	-0.208*	-0.164*	-0.241**	0.161^{+}
	(1.17)	(1.11)	(2.53)	(2.06)	(3.08)	(1.67)
$\Delta CFMA_t$	-0.002	-0.001	-0.008	-0.009	0.002	-0.002
	(0.35)	(0.23)	(1.16)	(1.30)	(0.33)	(0.20)
COVID Controls						
$\Delta StringVax_t$ x100		-0.084*		-0.110**		-1.192*
(COVID-19)		(2.43)		(2.78)		(2.48)
$D2020q2_{t-1}$		-0.143**		0.151*		0.168**
		(7.43)		(6.72)		(5.05)

$\Delta LVaxfull_t$ x100		0.260**		0.164		0.137
		(2.72)		(1.42)		(0.88)
$\Delta LVaxfull_{t-1}$ x100		-0.012		0.129		0.119
		(0.10)		(0.88)		(0.61)
$\Delta LVaxfull_{t-2}$ x100		0.133*		0.092		0.094
		(2.11)		(1.27)		(0.94)
NonCOVID Controls						
$\Delta BaaTr_{t-1}$	-0.013**	-0.012**	-0.013**	-0.011**	-0.016**	-0.008*
	(7.23)	(6.89)	(6.34)	(5.17)	(6.40)	(2.61)
$\Delta BaaTr_{t-2}$	-0.018	-0.002	-0.000	0.005	-0.006*	-0.006+
	(0.94)	(0.99)	(0.11)	(0.21)	(2.51)	(1.95)
$\Delta BaaTr_{t-3}$	-0.004	-0.003	-0.002	-0.004	-0.007**	-0.011**
	(1.967)	(1.76)	(1.04)	(1.82)	(2.84)	(3.55)
$\Delta BaaTr_{t-4}$	0.001	-0.001	0.001	-0.001	0.000	-0.001
	(0.45)	(0.47)	(0.67)	(0.65)	(0.11)	(0.17)
$LMortRefi_t$ x100	-0.266*	-0.293*	-0.409**	-0.334*	-0.370**	-0.221
	(2.41)	(2.62)	(2.98)	(2.47)	(2.77)	(1.40)
$InvBkFail_t$	-0.012**	-0.012**	-0.015**	-0.013**	-0.028**	-0.013**
	(4.03)	(3.94)	(4.41)	(3.62)	(8.43)	(2.64)
$2014Freeze_t$	-0.012**	-0.012**	-0.009+	-0.009+	-0.009+	-0.008
	(2.76)	(2.77)	(1.82)	(1.72)	(1.78)	(1.28)
$DFDICIns_t$	-0.018**	-0.018**	-0.025**	-0.013*	-0.018**	-0.008
	(4.39)	(4.40)	(4.94)	(2.60)	(3.66)	(1.41)
$DY2K_t$	-0.014*	-0.014*	-0.014*	-0.013*	-0.013*	-0.014+
	(2.60)	(2.52)	(2.28)	(2.00)	(2.21)	(1.71)
Adjusted R^2	.714	.934	.627	.904	.715	.911
S.E.	0.053	0.053	0.059	0.063	0.058	0.076
VECLM(1)	5.56	14.50	4.61	14.19	4.39	18.69
VECLM(4)	13.55	25.14	16.42	25.01	6.18	17.40

Notes: Data for estimation cover 1984q1-2022q4. "v." denotes vector. ** and *** denote 95% and 99% significance. Absolute t-statistics are in parentheses. Estimates allow for a linear trend in the VAR and a constant and no trend in cointegrating vector. Significance of VECLM statistics accounts for size of the vector.