Interest Rates, Leverage, and Money*

Apostolos Serletis† and Khandokar Istiak
Department of Economics
University of Calgary
Calgary, Alberta T2N 1N4
Canada

and

Periklis Gogas
Department of International Economic Relations and Development
Democritus University of Thrace
Komotini, Greece

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†Corresponding author. Phone: (403) 220-4092; Fax: (403) 282-5262; E-mail: Serletis@ucalgary.ca; Web: http://econ.ucalgary.ca/serletis.htm.

Abstract:

The current mainstream approach to monetary policy is based on the New Keynesian model and is expressed in terms of a short-term nominal interest, such as the federal funds rate in the United States. It ignores the role of leverage and also downplays the role of money in basic monetary theory and monetary policy analysis. But as the federal funds rate has reached the zero lower bound and the Federal Reserve is in a liquidity trap, the issue is whether there is a useful role of leverage and monetary aggregates in monetary policy and business cycle analysis. We address these issues and argue that there is a need for financial stability policies to manage the leverage cycle and reduce the procyclicality of the financial system. We also argue that in the aftermath of the global financial crisis and Great Contraction there is a need to get away from the New Keynesian thinking and back toward a quantity theory approach to monetary policy, based on properly measured monetary aggregates, such as the new Center for Financial Stability Divisia monetary aggregates.

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1 Introduction

The mainstream approach to monetary policy is based on the new Keynesian model and is expressed in terms of the interest rate on overnight loans between banks, such as the federal funds rate in the United States. However, in the aftermath of the global financial crisis and Great Contraction, short-term nominal interest rates have hardly moved at all, while central bank policies have been the most volatile and extreme in their entire histories. This has discredited the short-term interest rate as an indicator of policy and led central banks to look elsewhere. For example, the Federal Reserve and many central banks around the world have departed from the traditional interest-rate targeting approach to monetary policy and are now focusing on their balance sheet instead, using quantitative measures of monetary policy, such as credit easing and quantitative easing.

The current approach to monetary policy ignores the role of leverage or collateral rates. However, recently leverage attracted a great deal of attention and it has been argued that leverage on Wall Street increased to 35 to 1 prior to the global financial crisis, but never previously in the history of the United States leverage had exceeded 30 to 1 — see Barnett (2012) for an excellent discussion. For example, in early 2007, Bear Stearns had a record-high leverage ratio of 35 to 1. Around the same time, (then) major Wall Street investment banks (Goldman Sachs, Morgan Stanley, Merrill Lynch, and Lehman Brothers) together averaged leverage ratios of 30 to 1, up from 20 to 1 in 2003. It has also been argued that leverage is procyclical. As Adrian and Shin (2010) put it, "the evidence points to financial intermediaries adjusting their balance sheets actively, and doing so in such a way that leverage is high during booms and low during busts."

The current approach to monetary policy also ignores the role of money. Monetary aggregates were used as intermediate targets in the 1970s, but then monetary policy was procyclical because the Fed was actually using the federal funds rate as its operating instrument. In the period from October 1979 to October 1982, the Fed de-emphasized the federal funds rate as an operating instrument and nonborrowed reserves became the primary operating instrument. Between October 1982 and the early 1990s, the Fed targeted on borrowed reserves but abandoned monetary aggregates as a guide for monetary policy. In fact, since the early 1990s the Fed has been using the federal funds rate as the primary operating instrument and recently switched to public announcement of the specific target. Moreover, the Fed has recently moved towards a flexible-inflation-targeting approach to monetary policy, involving a strong credible commitment to stabilize the inflation rate in the long run and pursue policies to stabilize output around its natural rate level in the short run.

The question then that arises is whether there is a useful role of monetary aggregates in today's approach to monetary policy. In answering this question, as McCallum and Nelson (2011, p. 138) put it, "one should note that the shift toward analyses that ignore or downplay money largely reflects a change in empirical judgments. In the era in which monetary aggregates were used as guides to policy, policymakers expressed the view that —

although monetary policy actions did work on spending via interest rates, and the authorities did typically employ a short-term nominal interest rate as their policy instrument — it was a more straightforward matter to establish money/inflation relations than it was to establish connections between policy-rate actions and subsequent inflation movements."

It is the purpose of this article to address these issues. We begin with the current conduct of monetary policy and discuss related issues regarding the institutional framework within which monetary policy is conducted and the recent use of nonconventional monetary policies. In the next section we discuss the effectiveness of conventional and nonconventional monetary policies in the aftermath of the global financial crisis and Great Recession. Next, we discuss the relationship between leverage and the level of economic activity and consider the macroeconomic implications of ignoring the role of leverage and the banking sector. Finally, we consider the role of money in the conduct of monetary policy, discuss monetary aggregation issues, and argue that properly measured monetary aggregates, such as the new Center for Financial Stability Divisia monetary aggregates, can and should play an important role in the conduct of monetary policy.

2 The New Keynesian Model

Since the early 1980s, many central banks around the world abandoned monetary aggregates as a guide for monetary policy in favor of using targets for overnight interest rates. In fact, the current mainstream approach to monetary policy is the New Keynesian model. The following simple system (ignoring fiscal policy variables), from McCallum and Nelson (2011), is representative of the basic New Keynesian model

$$y_t = b_0 + E_t y_{t+1} + b_1 \left(i_t - E_t \Delta p_{t+1}\right) + v_t, \quad b_1 < 0 \tag{1}$$

$$\Delta p_t = \beta E_t \Delta p_{t+1} + \kappa \left(y_t - \bar{y}_t\right) + u_t, \quad 0 < \beta < 1, \kappa > 0 \tag{2}$$

$$i_t = \mu_0 + \mu_1 \Delta p_t + \mu_2 \left(y_t - \bar{y}_t\right) + e_t, \quad \mu_1 > 1, \mu_2 \geq 0 \tag{3}$$

where E_t is the expectations operator conditional on information available at time t, $y_t =$ log of output, $p_t =$ log of price level (so that Δp_t represents inflation and $E_t \Delta p_{t+1}$ expected inflation), $i_t =$ short-term nominal interest rate, $i_t - E_t \Delta p_{t+1}$ is the real interest rate, and $y_t - \bar{y}_t$ the output gap.

Equation (1) is a forward-looking expectational IS function according to which output is negatively related to the real interest rate, $i_t - E_t \Delta p_{t+1}$. The disturbance v_t represents the effects of taste shocks and is assumed to be exogenous. Equation (2) is a Phillips curve relationship, with u_t being a cost push shock. Both equations (1) and (2) can be derived from optimizing behavior on the part of private economic agents, as shown by McCallum and Nelson (1999) and Woodford (2003).

Equation (3) is a monetary policy rule of the Taylor (1993) type, showing how the central bank is managing monetary policy by the short-term nominal interest rate, i_t. The policy shock is represented by e_t. Equation (3) also shows how the central bank sets the policy rate according to the Taylor principle, raising it by more than any increase in the inflation rate, so that the real interest rate increases when there is an increase in the inflation rate. If the central bank did not follow the Taylor principle, monetary policy would be destabilizing, with the inflation rate continually rising out of control.

One of the features of the New Keynesian modeling approach is that the system of equations (1), (2), and (3) includes no money measures (known as monetary aggregates). In this approach, monetary policy is made with regard to the short-term nominal interest rate, i_t. It is to be noted, however, that although monetary policy is not expressed in terms of monetary aggregates, the central bank's adjustments of the nominal interest rate, i_t, translate into changes in the monetary aggregates. For example, when the central bank conducts open market operations to achieve the desired target for the overnight interest rate, it exchanges the monetary base (the monetary aggregate directly affected by the central bank's open-market operations) for government securities.

In recent years, the New Keynesian model has also been extended to allow for interest rate channels (or corridors) as well as nonconventional monetary policies — see, for example, Cúrdia and Woodford (2011). In this regard, over the last ten years or so, many central banks have changed the institutional structure within which monetary policy is conducted and now use a corridor system of monetary policy implementation. For example, such systems are used by the Reserve Bank of Australia, the Bank of Canada, the Bank of England, the European Central Bank, the Bank of Japan, the Reserve Bank of New Zealand, Norges Bank, and the Riksbank. See Whitesell (2006) and Bowman *et al.* (2010) for a detailed discussion and evaluation of interest rate corridors which have become the main framework for monetary policy implementation.

The channel systems used by the various central banks differ in a variety of important details. In particular, the central banks of Australia, Canada, England, Sweden, and (until spring 2006) New Zealand use what is known as a 'symmetric' channel system. In particular, they operate a standing lending facility, making (collateralized) overnight loans to banks at the lending rate, i_d. They also operate a standing deposit facility that allows banks to earn overnight interest on their excess reserve holdings at the deposit rate, i_{er} ($< i_d$). The interest rates at the two standing liquidity facilities form a channel (or corridor) and the central bank targets the overnight interest rate at the midpoint of that channel. That is, the lending rate, i_d, is a fixed number of basis points above the target overnight interest rate, i^*_{or}, and the deposit rate, i_{er}, is the same number of basis points below the target overnight interest rate, i^*_{or}; in other words, the system has symmetric opportunity costs on short and long positions on accounts at the central bank.

In this symmetric channel system, the central bank's reserve supply is horizontal at the interest rate paid by the lending facility, i_d, and the banks' reserve demand is horizontal at the interest rate paid by the deposit facility, the excess reserves rate i_{er}, as shown in Figure 1. Equilibrium occurs at the intersection of the reserve supply curve R^s and the downward-sloping reserve demand curve R^d at point 1 and an overnight interest rate of i^*_{or}. In this system, the central bank can arbitrarily increase the supply of reserves, to undertake expanded asset purchases, shifting its reserve supply schedule to the right. But if it goes beyond a certain point (in Figure 1, the point at which the reserve demand schedule becomes horizontal at the excess reserves rate, i_{er}), then the overnight interest rate will not equal the central bank's target, i^*_{or}, but rather the interest rate paid on excess reserves, i_{er}. Thus, the central bank cannot independently choose both the interest rate and the quantity of reserves.

In July 2006, the central bank of New Zealand switched from the symmetric channel system described in Figure 1 to what is known as a 'floor' system of monetary policy implementation. The floor system is effectively an asymmetric channel system in which the central bank sets the deposit rate, i_{er}, equal to the target overnight interest rate, i^*_{or}, instead of below it, thereby targeting the floor of the channel. Also, for years, the Federal Reserve did not pay interest on reserves. However, during the subprime financial crisis, legislation was passed and changed the institutional structure within which the Fed carries out monetary policy by authorizing the Fed to remunerate excess reserve holdings at the target federal funds rate. Thus, since October 2008, the Federal Reserve operates a floor system for setting the federal funds rate, similar to that used by the Reserve Bank of New Zealand (since July 2006).

Figure 2 depicts the floor system of monetary policy implementation, as applied to the case of the Federal Reserve. The Fed's reserve supply is horizontal at the interest rate paid by the Fed's lending facility, the discount rate i_d, and the banks' reserve demand is horizontal at the interest rate paid by the Fed's deposit facility, the excess reserves rate i_{er}, which is equal to the target federal funds rate itself, i^*_{ff}. Equilibrium occurs at the intersection of the reserve supply curve R^s and the flat part of the demand curve R^d at a federal funds rate of i^*_{ff}. The key feature of the floor system is that the central bank can independently choose both the interest rate and the quantity of reserves, since the central bank can supply any amount of reserves without any consequence for the policy rate. As Keister *et al.* (2008, p. 51) put it, "in this way, a floor system 'divorces' the quantity of money from the interest rate target and, hence, from monetary policy. This divorce gives the central bank two separate policy instruments: the interest rate target can be set according to the usual monetary policy concerns, while the quantity of reserves can be set independently."

This then raises the important question of how the quantity of reserves should be set in a floor system of monetary policy implementation, such as that currently used by the Federal Reserve, the European Central Bank, the Bank of Japan, the Norges Bank, and the Reserve Bank of New Zealand (since 2006). By creating more reserves, which banks hold as excess reserves, the central bank necessarily takes on more assets, thereby effectively also using its balance sheet as an instrument of monetary policy — see, for example, Cúrdia and Woodford (2011). The use of such nonconventional monetary policies, often refereed to as 'quantitative easing,' has sparked considerable debate with respect to the exit from such policies, the effectiveness of conventional interest-rate policy, and the potential conflict with the central bank's financial stability responsibilities.

3 The Effectiveness of Monetary Policy

What fueled the global financial crisis was the housing policy and expansionary monetary policy in the United States in the early 2000s that produced the price bubble in the U.S. housing market. The Federal Reserve did attempt to lean against the housing bubble by raising interest rates to stop the bubble from getting out of hand. It was, however, unsuccessful, because of the collapse of stable relationships in financial markets that caused the term structure of interest rates relationships, upon which the New Keynesian transmission mechanism depends, to loosen even before the financial crisis. For example, the Federal Open Market Committee raised the target federal funds rate in 17 consecutive meetings between June 2004 and July 2006, from 1% to 5.25%, but long-term interest rates in the United States declined for most of this period, as can be seen in Figure 3. In fact, long-term interest rates throughout the world had exhibited similar declines over that period despite steady increases in short-term interest rates.

Similarly, in the aftermath of the global economic crisis, the decline in the federal funds rate to (its current range of) between 0 and 0.25%, from 5.25 % in August of 2007, has not led to desirable declines in long-term interest rates. With the policy rate at the zero lower bound, the Federal Reserve adopted expansionary, nonconventional monetary policies to raise the expected inflation rate, reduce the real interest rate, and stimulate the level of economic activity. This mechanism is a key element in many monetarist discussions of why an expansionary monetary policy could have prevented the sharp decline in output in the United States during the Great Depression of the 1930s and why it would have helped the Japanese economy, when nominal interest rates fell to near zero in the late 1990s.

In particular, in response to the global economic crisis, the Federal Reserve (and many other central banks around the world) adopted nonconventional monetary policies, lending directly to financial and nonfinancial firms and purchasing certain types of assets to promote the flow of credit to the economy. In fact, the Fed's response was highly effective, as the Great Recession in the United States lasted for only about 19 months (from December 2007 to June 2009), with a decline in real GDP of about 5% and an increase in the unemployment rate (from 5%) to 10% during this period. By comparison, during the Great Depression, real GDP declined by more than 25%, the unemployment rate increased (from close to zero) to 25%. Moreover, the price level declined by 25%, leading to a real interest rate of over 10%.

However, a by-product of the Fed's intervention has been the creation of a large quantity of excess reserves, as can be seen in Figure 4. In fact, the level of bank reserves in the United States had been around $10 billion prior to the global financial crisis, but has increased to close to \$2 trillion in the aftermath of the Great Recession. During normal times, the opportunity cost of holding excess reserves is positive (either because bank reserves earn no interest or if they do, the interest rate is less than market interest rates). With a positive opportunity cost of holding excess reserves, banks increase lending and expand deposits until excess reserves are converted into required reserves. The money supply increases (as the money multiplier is fully operational), the level of economic activity rises, and this may lead to inflation.

The Federal Reserve dealt with the problem of excess reserves by paying interest on bank reserves to reduce the opportunity cost of holding excess reserves to zero, so that multiple deposit creation does not come into play. In fact, for the first time in its history, in October 2008 the Fed began paying interest on bank reserves and set that interest rate equal to its target for the federal funds, i^*_{ff}. Other central banks also adopted similar strategies. For example, from April 1, 2009 to June 1, 2010, the Bank of Canada lowered the band for the overnight interest rate from 50 basis points to 25 basis points (from $\frac{1}{4}$% to $\frac{1}{2}$%) and instead of targeting the overnight rate at the midpoint of the band (as it does during normal times), it started targeting it at the bottom of the operating band; on June 1, 2010, the Bank of Canada re-established the normal operating band of 50 basis points for the overnight interest rate, currently being from $\frac{3}{4}$% to $1\frac{1}{4}$%.

Clearly, with the Federal Reserve and many central banks around the world implementing unconventional monetary policies in a zero lower bound environment and the level of excess reserves in the trillions of dollars, no one is sure how things will unfold. The Fed may be contributing to a build up in systemic risk, producing a feedback loop that increases the economic agents' appetite for risk. In fact, as Hamilton and Wu (2012, p. 3) recently put it, "trying to lower the short-term interest rate or increase the volume of reserves any further offers little promise of boosting aggregate demand. With the Fed's traditional tools incapable of providing further stimulus to the economy, it is of considerable interest to ask what other options might be available to the central bank."

4 The Ignored Role of Leverage

The mainstream approach to monetary policy ignores the role of leverage (or collateral rates) in basic monetary theory and monetary policy analysis. However, as Geanakoplos (2012, p. 389) puts it, "leverage can be more important to economic activity and prices than interest rates, and more important to manage." In fact, leverage cycles (fluctuations in collateral rates) can have important effects on the level of economic activity. For example, when leverage is high, economic agents can buy many assets with very little money down, and asset prices increase; when leverage is low, they must have all (or nearly all) of the money in hand to purchase the same assets, and asset prices decline.

Leverage, l, is defined as

$$l = \frac{A}{A - L} \tag{4}$$

where A denotes total assets and L liabilities other than net worth (equivalently, capital). Thus, leverage is the ratio of assets to capital and is a measure of how much debt an investor assumes in making an investment; the reciprocal of leverage, $1/l$, is known as the leverage ratio. Figures 5 to 9 plot the levels and growth rates of leverage for five different sectors of the U.S. economy — households, nonfinancial (nonfarm) corporations, commercial banks, brokers and dealers, and shadow banks — using quarterly data from the Board of Governors of the Federal Reserve System, over the period from 1951:4 to 2011:2. Shaded areas represent NBER recessions. Note that shadow bank data are available only since 1983:3 and that by shadow banks we mean finance companies, funding corporations, and asset-backed securities issuers. These are unregulated nonbank financial intermediaries without access to central bank liquidity, and whose balance sheets are almost fully marked to market and potentially hold more information regarding underlying financial conditions than traditional bank balance sheets. They have been at the center of the financial crisis of 2007-2008 and there is almost universal agreement that the financial crisis originated in this unregulated shadow banking system. See, for example, Fostel and Geanakoplos (2008), Geanakoplos (2010, 2012), and Adrian and Shin (2010, 2011, 2012).

From equation (4) we can see that if economic agents are passive and do not adjust their balance sheets to changes in capital, then there would be a negative relationship between changes in leverage and changes in total assets, since leverage would fall when total assets rise and it would rise when total assets fall, as shown in Figures 10, 11, and 13 for households, nonfinancial firms, and securities brokers and dealers, respectively. Adrian and Shin (2010), using data over a shorter period from 1963 to 2006, also provide evidence of a negative relationship between changes in leverage and changes in total assets for households, of a less negative relationship for nonfinancial firms, but of a positive relationship for securities brokers and dealers. If, however, economic agents manage their balance sheets actively and target a fixed leverage ratio, then there could be a positive relationship between changes in leverage and changes in total assets, as shown in Figures 12 and 14 for commercial banks and shadow banks, respectively. This is also consistent with the evidence provided by Adrian and Shin (2010) using their shorter sample, suggesting that financial intermediaries react to changes in assets prices by changing their stance on leverage.

More recently, Istiak and Serletis (2012) investigate the macroeconomic effects of leverage by testing whether the relation between real GDP and leverage is nonlinear and asymmetric, using the Kilian and Vigfusson (2011) methodology based on impulse response functions. They show that in the case of commercial banks, there is no evidence against the null hypothesis of symmetry, for both one and two standard deviation leverage growth rate shocks. In the case, however, of households, nonfinancial firms, brokers and dealers, and shadow banks, in general they reject (at conventional significance levels) the null hypothesis of symmetric impulse responses of the real GDP growth rate to both one and two standard deviation shocks to the leverage growth rate, suggesting that the relation between real GDP and each of household leverage, nonfinancial firms leverage, brokers and dealers leverage, and shadow banks leverage is nonlinear and asymmetric. They also show that negative leverage growth rate shocks have stronger effects on the real GDP growth rate than positive ones, arguing that the deleveraging process that began in the United States at the end of 2008 will be long and painful.

Clearly, there is a need for financial stability policies to manage the leverage cycle and reduce the procyclicality of the financial system. For example, if countercyclical capital requirements were initiated, this would require more capital held at financial institutions during booms, which would reduce lending and help to mitigate credit bubbles that can be damaging later on. Likewise, when the economy goes into a downturn, capital requirements could be lowered, which would encourage more lending and facilitate faster economic growth.

5 The Increasing Role for Money

The current approach to monetary policy also ignores the role of money. In the framework presented in Section 2, the interest rate is the sole monetary variable and there is no reference to any monetary aggregate even though the economy in question does utilize a medium of exchange. Regarding this issue, as McCallum and Nelson (2011, p. 147) put it, "too much in the reaction to problems in measuring money has taken the form of abandoning the analysis of monetary aggregates, and too little has taken the form of more careful efforts at improved measurement." In fact, although modern macroeconomics has largely solved a number of problems, including those associated with the Lucas critique, it has so far failed to address the problems of measurement associated with monetary aggregates, the "Barnett critique," to use the phrase coined by Chrystal and MacDonald (1994) and Belongia and Ireland (2012).

In this regard, Barnett and Chauvet (2011, p. 21) argue that "most of the puzzles and paradoxes that have evolved in the monetary economics literature were produced by the simple-sum monetary aggregates, provided officially by most central banks, and are resolved by use of aggregation theoretic monetary aggregates. We argue that official central-bank data throughout the world have not significantly improved, despite the existence of better data internal to some of those central banks for their own use. We document the fact that the profession, financial firms, borrowers, lenders, and central banks have repeatedly been misled by defective central-bank monetary data over the past half century." Moreover, Barnett, Diewert, and Zellner (2011, p. 1) go on to say that "all of applied econometrics depends on economic data and if they are poorly constructed, no amount of clever econometric technique can overcome the fact that generally, garbage in will imply garbage out."

The monetary aggregates currently in use by the Federal Reserve and most central banks around the world are simple-sum indices in which all financial assets are assigned a constant and equal (unitary) weight. This index is M_t in

$$M_t = \sum_{j=1}^{n} x_{jt}, \tag{5}$$

where x_{jt} is one of the n components of the monetary aggregate M_t, and implies that all financial assets contribute equally to the money total and views all assets as dollar for dollar perfect substitutes. This summation index made sense a long time ago, when assets had the same zero yield. It is, however, indefensible today, as it completely ignores the complex products and structures of modern financial markets. It is unfortunately the official (accounting) measure of central banks.

Over the years, there has been a steady stream of attempts at properly weighting monetary components within a simple-sum aggregate. With no theory, however, any weighting scheme is questionable. It is Barnett (1980) that applied economic aggregation and index number theory to construct monetary aggregates consistent with the properties of Diewert's (1976) class of superlative quantity index numbers. Barnett's monetary aggregates are Divisia quantity indices, named after Francois Divisia, who first proposed the index in 1925 for aggregating over goods; Barnett (1980) proved how the formula could be extended to include monetary assets.

The Divisia index (in discrete time) is defined as

$$\log M_t^D - \log M_{t-1}^D = \sum_{j=1}^{n} w_{jt}^* (\log x_{jt} - \log x_{j,t-1}). \tag{6}$$

According to equation (6) the growth rate of the aggregate is the weighted average of the growth rates of the component quantities, with the Divisia weights being defined as the expenditure shares averaged over the two periods of the change, $w_{jt}^* = (1/2)(w_{jt} + w_{j,t-1})$ for $j = 1, ..., n$, where $w_{jt} = \pi_{jt} x_{jt} / \sum_{k=1}^{n} \pi_{kt} x_{kt}$ is the expenditure share of asset j during period t, and π_{jt} is the user cost of asset j, derived in Barnett (1978),

$$\pi_{jt} = \frac{(R_t - r_{jt})}{(1 + R_t)} \tag{7}$$

which is just the opportunity cost of holding a dollar's worth of the jth asset. In equation (7), r_{jt} is the market yield on the jth asset and R_t is the yield available on a 'benchmark' asset that is held only to carry wealth between multiperiods — see Barnett, Fisher, and Serletis (1992), Barnett and Serletis (2000), or Barnett (2012) for more details regarding the Divisia approach to monetary aggregation.

For the last thirty years, Barnett has been insisting on measurement methods that are consistent with economic aggregation and index number theory. Yet, thirty years later, the Federal Reserve and many other central banks around the world continue to ignore the complex structures of modern financial markets and officially produce and supply low quality monetary statistics, using the severely flawed simple-sum method of aggregation, inconsistent with the relevant aggregation and index number theory. In fact, as Barnett and Chauvet (2011, p. 6) put it, "most recessions in the past 50 years were preceded by more contractionary monetary policy than indicated by simple-sum monetary data. Divisia monetary aggregate growth rates were generally lower than simple-sum aggregate growth rates in the period preceding the Great Moderation, and higher since the mid 1980s. Monetary policy was more contractionary than likely intended before the 2001 recession and more expansionary than likely intended during the subsequent recovery."

To provide some perspective on the behavior of simple sum and Divisia monetary aggregates, in Figures 15 to 19 we provide graphical representations of simple-sum and Divisia monetary aggregates at each of the five levels of monetary aggregation, M1, M2M, M2, MZM, and ALL. In doing so, we use the Federal Reserve's simple-sum monetary aggregates, the new vintage of the St. Louis Fed's Divisia monetary aggregates, called MSI (monetary services indices) and documented in Anderson and Jones (2011), and the new Divisia monetary aggregates, maintained within the Center of Financial Stability (CFS) program Advances in Monetary and Financial Measurement (AMFM), called CFS Divisia aggregates and documented in detail in Barnett *et al.* (2012). Our sample extends from 1967:1 to 2011:3 that includes the increased volatility in money supply in the aftermath of the subprime financial crisis and the Great Contraction. Again, shaded areas represent NBER recessions. In Figures 20 to 24 we also provide graphical representations of quarter-to-quarter growth rates at each level of aggregation and under the different aggregation methods.

Clearly, in Figures 15 to 19 and also 20 to 24 the MSI Divisia and CFS Divisia monetary aggregates aren't very far apart, but are not the same. They are, however, very different from the simple-sum monetary aggregates. These differences are of economic importance when we investigate the relationship between money and the level of economic activity. For example, Figures 25 to 29 show the Hodrick-Prescott [see Prescott (1986)] cyclical component of real GDP and that of each of the simple-sum, MSI Divisia, and CFS Divisia monetary aggregates at each of the five levels of monetary aggregation, M1, M2M, M2, MZM, and ALL, respectively. Table 1 also reports the contemporaneous correlations as well as the cross correlations (at lags and leads of 3, 6, 9, and 12 quarters, given the traditional view that there are 'long and variable lags' in the relationship between real and monetary variables) between the cyclical component of money and the cyclical component of real GDP. We see that the CFS Divisia M2 monetary aggregate is the most procyclical monetary aggregate (with a contemporaneous correlation coefficient of 0.277) and that it also leads the cycle.

The differences between the simple-sum and Divisia monetary aggregates are also important in investigations of theoretical propositions regarding the relationship between money and the level of economic activity. For example, Serletis and Rahman (2012), building on earlier work by Serletis and Shahmoradi (2006) and Serletis and Rahman (2009), investigate the relationship between money growth uncertainty and the level of economic activity in the

United States using the new vintage of the MSI Divisia monetary aggregates and the simple-sum aggregates, over the period from 1967:1 to 2011:3; the CFS Divisia monetary aggregates were not available at that time. In the context of a bivariate VARMA, GARCH-in-Mean, asymmetric BEKK model, they show that increased Divisia money growth volatility (irrespective of the level of aggregation) is associated with a lower average growth rate of real economic activity. However, there are no effects of simple-sum money growth volatility on real economic activity, except with the Sum M1 and perhaps Sum M2M aggregates. They conclude that monetary policies that focus on the Divisia monetary aggregates and target their growth rates will contribute to higher overall economic growth.

Also, Serletis and Gogas (2012) test the implications of neoclassical stochastic growth theory and traditional money demand theory in the context of a multivariate stochastic process, consisting of the logarithms of real per capita consumption, investment, money balances, output, and the opportunity cost of holding money. In doing so, they make comparisons among the simple-sum monetary aggregates and the MSI and CFS Divisia monetary aggregates, using data over the 1967:1 to 2011:3 period. Replicating parts of King *et al.* (1991), they provide evidence which supports the predictions of a standard real business cycle model with respect to the long-run consumption-output ratio and the money demand function only when the MSI and CFS Divisia monetary aggregates are used. In fact, with the CFS Divisia monetary aggregates at the M2M, M2, and MZM levels of monetary aggregation they identify and cannot reject both the consumption-output great ratio and the money demand function with properties consistent with neoclassical stochastic growth theory and traditional money demand theory.

6 Conclusion

As the federal funds rate has reached the zero lower bound (and cannot become negative), the Federal Reserve has lost its ability to lower long-term interest rates by lowering the federal funds rate. Moreover, the Fed has lost its usual ability to signal policy changes via changes in the federal funds rate. For these reasons, the Fed and many central banks throughout the world have departed from the traditional interest-rate targeting approach to monetary policy and are now focusing on their balance sheet instead, using quantitative measures of monetary policy, such as credit easing (the purchase of private sector assets in critical markets) and quantitative easing (the purchase of long-term government securities). Both credit easing and quantitative easing represent expansionary monetary policies designed to reduce long-term nominal interest rates, in the same way that traditional monetary easing reduces short-term nominal interest rates.

However, in the aftermath of the global financial crisis and Great Recession, short-term interest rates have hardly moved at all, while central bank policies have been the most volatile and extreme in their entire histories. We argue that there is a need for macroprudential policy to manage the leverage cycle and reduce the procyclicality of the financial system. We also argue that properly measured monetary aggregates, such as the new Center for Financial Stability Divisia monetary aggregates, can and should play an important role for the conduct of monetary policy, in addition to that of the short-term nominal interest rate, especially in the current (unprecedented) situation characterized by (almost) zero interest rates and an explosion of the balance sheets of central banks in many countries.

References

[1] Adrian, T. and H.S. Shin. "Liquidity and Leverage." *Journal of Financial Intermediation* 19 (2010), 418–437.

[2] Adrian, T. and H.S. Shin. "Financial Intermediaries and Monetary Economics." In B.M. Friedman and M. Woodford (Eds.), *Monetary Economics* Vol. 3A (2011), 601-650. Amsterdam: North Holland.

[3] Adrian, T. and H.S. Shin. "Procyclical Leverage and Value-at-Risk." Federal Reserve Bank of New York *Staff Report* 338 (2012).

[4] Anderson, R.G. and B.E. Jones. "A Comprehensive Revision of the U.S. Monetary Services (Divisia) Indexes for the United States." Federal Reserve Bank of St. Louis *Review* September/October (2011), 325-359.

[5] Barnett, W.A. "The User Cost of Money." *Economics Letters* 1 (1978), 145-14.

[6] Barnett, W.A. "Economic Monetary Aggregates: An Application of Aggregation and Index Number Theory." *Journal of Econometrics* 14 (1980), 11-48.

[7] Barnett, W.A. *Getting it Wrong: How Faulty Monetary Statistics Undermine the Fed, the Financial System, and the Economy.* The Cambridge, MA: The MIT Press (2012).

[8] Barnett, W.A. and M. Chauvet. "How Better Monetary Statistics Could Have Signaled the Financial Crisis." *Journal of Econometrics* 161 (2011), 6-23.

[9] Barnett, W.A. and A. Serletis. *The Theory of Monetary Aggregation.* Contributions to Economic Analysis 245. Amsterdam: North-Holland (2000).

[10] Barnett, W.A., E.W. Diewert, and A. Zellner. "Introduction to 'Measurement with Theory'." *Journal of Econometrics* 161 (2011), 1-5.

[11] Barnett, W.A., D. Fisher, and A. Serletis. "Consumer Theory and the Demand for Money." *Journal of Economic Literature* 30 (1992), 2086-2119.

[12] Barnett, W.A., J. Liu, R.S. Mattson, and J. van den Noort. "The New CFS Divisia Monetary Aggregates: Design, Construction, and Data Sources." Center for Financial Stability, Working Paper (2012).

[13] Belongia, M.T. and P.N. Ireland. "The Barnett Critique After Three Decades: A New Keynesian Analysis." *Journal of Econometrics* (forthcoming, 2012).

[14] Bowman, D., E. Gagnon, and M. Leahy. "Interest on Excess Reserves as a Monetary Policy Instrument." Board of Governors of the Federal Reserve System, International Finance Discussion Papers, Number 996 (2010).

[15] Chrystal, K.A. and R. MacDonald. "Empirical Evidence on the Recent Behavior and Usefulness of Simple-Sum and Weighted Measures of the Money Stock." Federal Reserve Bank of St. Louis *Review* 76 (1994), 73-109.

[16] Cúrdia, V. and M. Woodford. "The Central-Bank Balance Sheet as an Intsrument of Monetary Policy." *Journal of Monetary Economics* 58 (2011), 54-79.

[17] Diewert, W.E. "Exact and Superlative Index Numbers." *Journal of Econometrics* 4 (1976) 115-145.

[18] Fostel, A. and J. Geanakoplos. "Leverage Cycles and the Anxious Economy." *American Economic Review* 98 (2008), 1211-1244.

[19] Geanakoplos, J. "The Leverage Cycle." In D. Acemoglu, K. Rogoff, and M. Woodford (Eds.), *NBER Macreoconomics Annual* 24 (2010), 1-65. Chicago: University of Chicago Press.

[20] Geanakoplos, J. "Leverage and Bubbles: The Need to Manage the Leverage Cycle." In D.D. Evanoff, G.G. Kaufman, and A.G. Malliaris (Eds.), *New Perspectives on Asset Price Bubbles: Theory, Evidence, and Policy.* Oxford: Oxford University Press (2012).

[21] Hamilton, J.D. and J.C. Wu. "The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment." *Journal of Money, Credit and Banking* 44 (2012), 3-46.

[22] Istiak, K. and A. Serletis. "Leverage and the Macroeconomy." Mimeo, University of Calgary (2012).

[23] Keister, T., A. Martin, and J. McAndrews. "Divorcing Money from Monetary Policy." Federal Reserve Bank of New York *Economic Policy Review* (September, 2008), 41-56.

[24] Kilian, L. and R.J. Vigfusson. "Are the Responses of the U.S. Economy Asymmetric in Energy Price Increases and Decreases?" *Quantitative Economics* 2 (2011), 419-453.

[25] King, R.G., C.I. Plosser, J.H. Stock, and M.W. Watson. "Stochastic Trends and Economic Fluctuations." *American Economic Review* 81 (1991), 819-840.

[26] McCallum, B.T. and E. Nelson. "An Optimizing IS-LM Specification for Monetary Policy and Business Cycle Analysis." *Journal of Money, Credit and Banking* 31 (1999), 296-316.

[27] McCallum, B.T. and E. Nelson. "Money and Inflation: Some Critical Issues." In B.M. Friedman and M. Woodford (Eds.), *Handbook of Monetary Economics*, Vol. 3A. Amsterdam: Elsevier (2011), pp. 97-153.

[28] Prescott E.C. "Theory Ahead of Business Cycle Measurement." Federal Reserve Bank of Minneapolis *Quarterly Review* Fall (1986), 9-22.

[29] Serletis, A. and P. Gogas. "Divisia Monetary Aggregates for Monetary Policy and Business Cycle Analysis." Mimeo, University of Calgary (2012).

[30] Serletis, A. and S. Rahman. "The Output Effects of Money Growth Uncertainty: Evidence from a Multivariate GARCH-in-Mean VAR." *Open Economies Review* 20 (2009), 607-630.

[31] Serletis, A. and S. Rahman. "The Case for Divisia Money Targeting." *Macroeconomic Dynamics* (forthcoming, 2012).

[32] Serletis, A. and A. Shahmoradi. "Velocity and the Variability of Money Growth: Evidence from a VARMA, GARCH-M Model." *Macroeconomic Dynamics* 10 (2006), 652-666.

[33] Taylor, J.B. "Discretion Versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy* 39 (1993), 195-214.

[34] Whitesell, W. "Interest Rate Corridors and Reserves." *Journal of Monetary Economics* 53 (2006), 1177-1195.

[35] Woodford, M. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton: Princeton University Press (2003).

Figure 1. Equilibrium in the Market for Reserves in a Symmetric Channel System of Monetary Policy Implementation

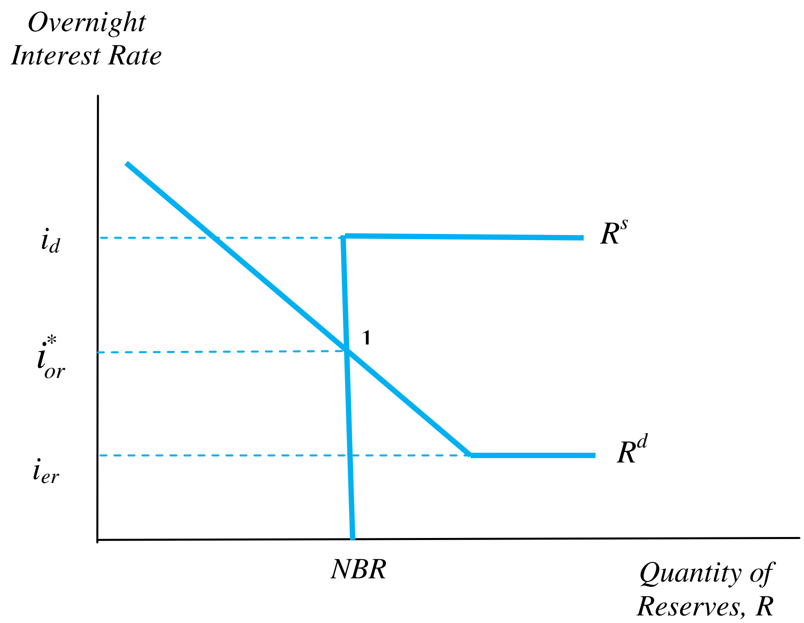


Figure 2. Equilibrium in the Market for Reserves in a Floor System of Monetary Policy Implementation

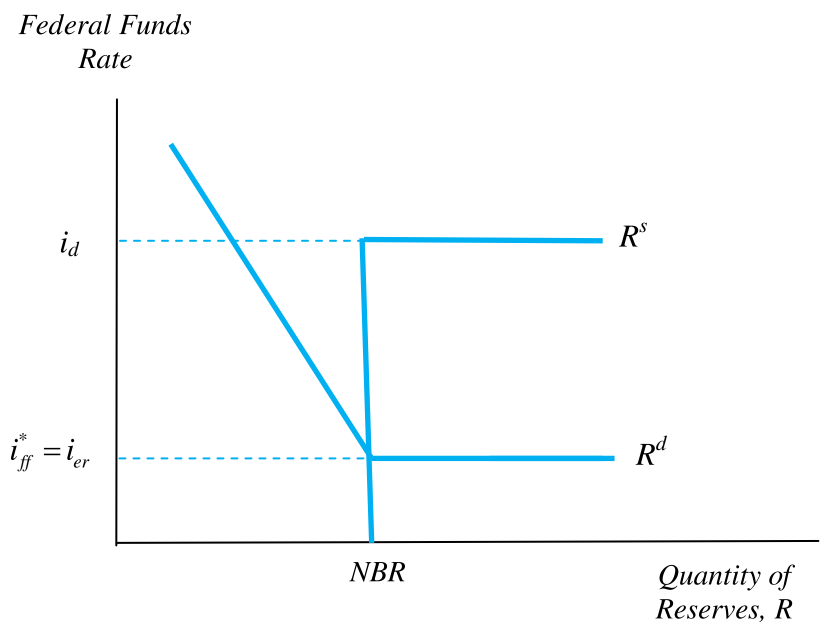


Figure 3. Interest Rates in the United States

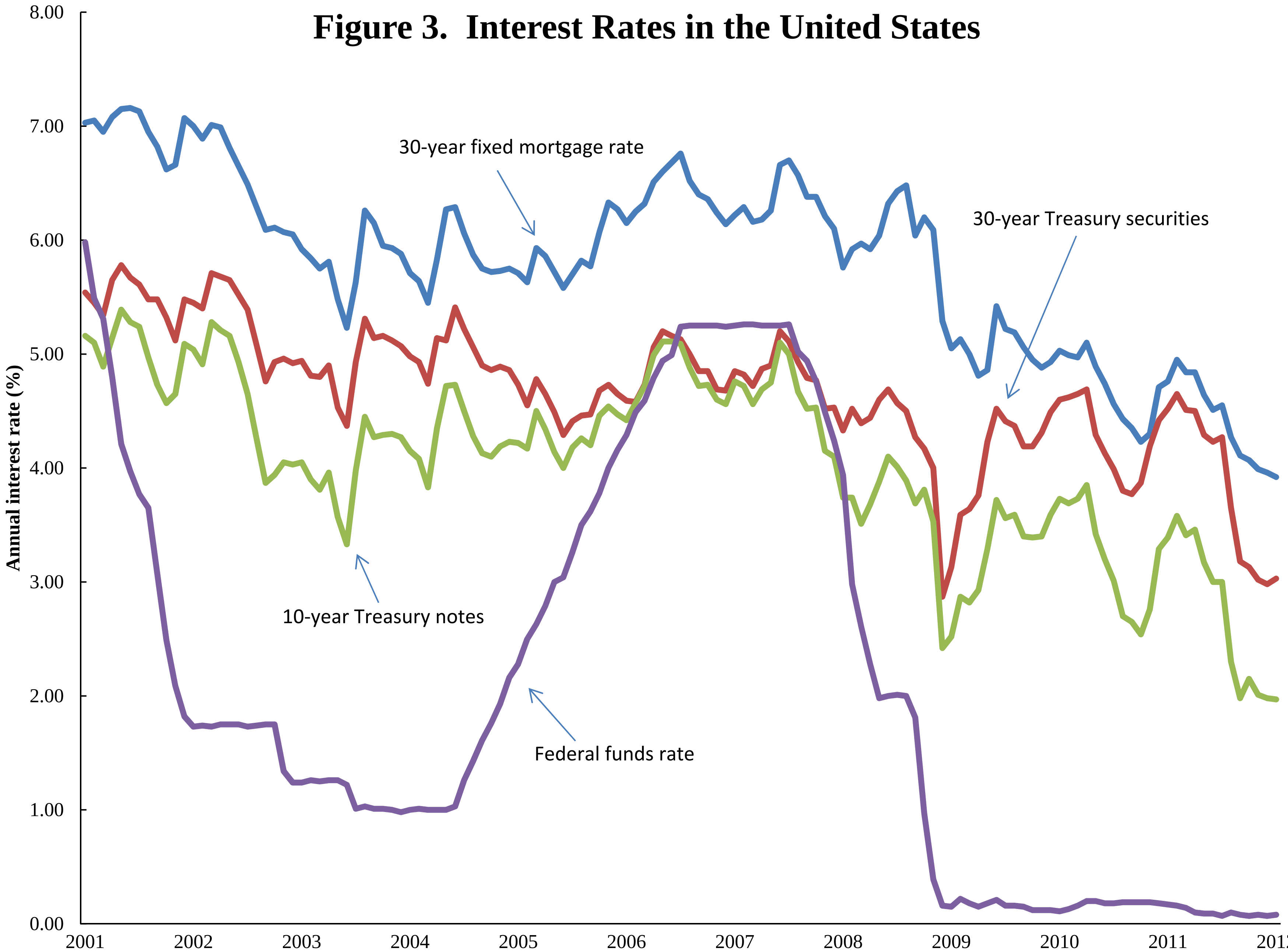


Figure 4. Total Bank Reserves in the United States

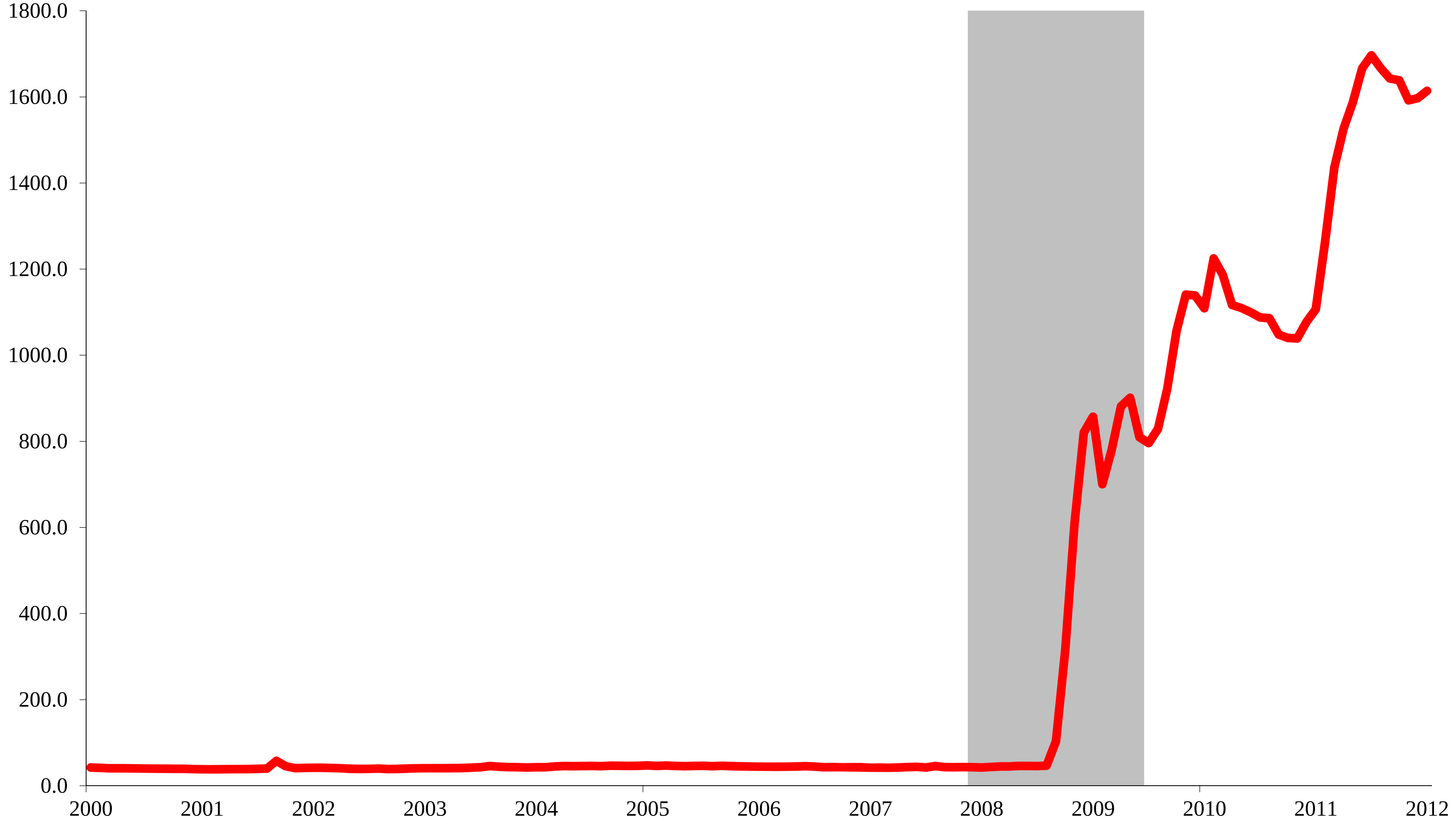


Figure 5. Household Leverage and Its Growth Rate

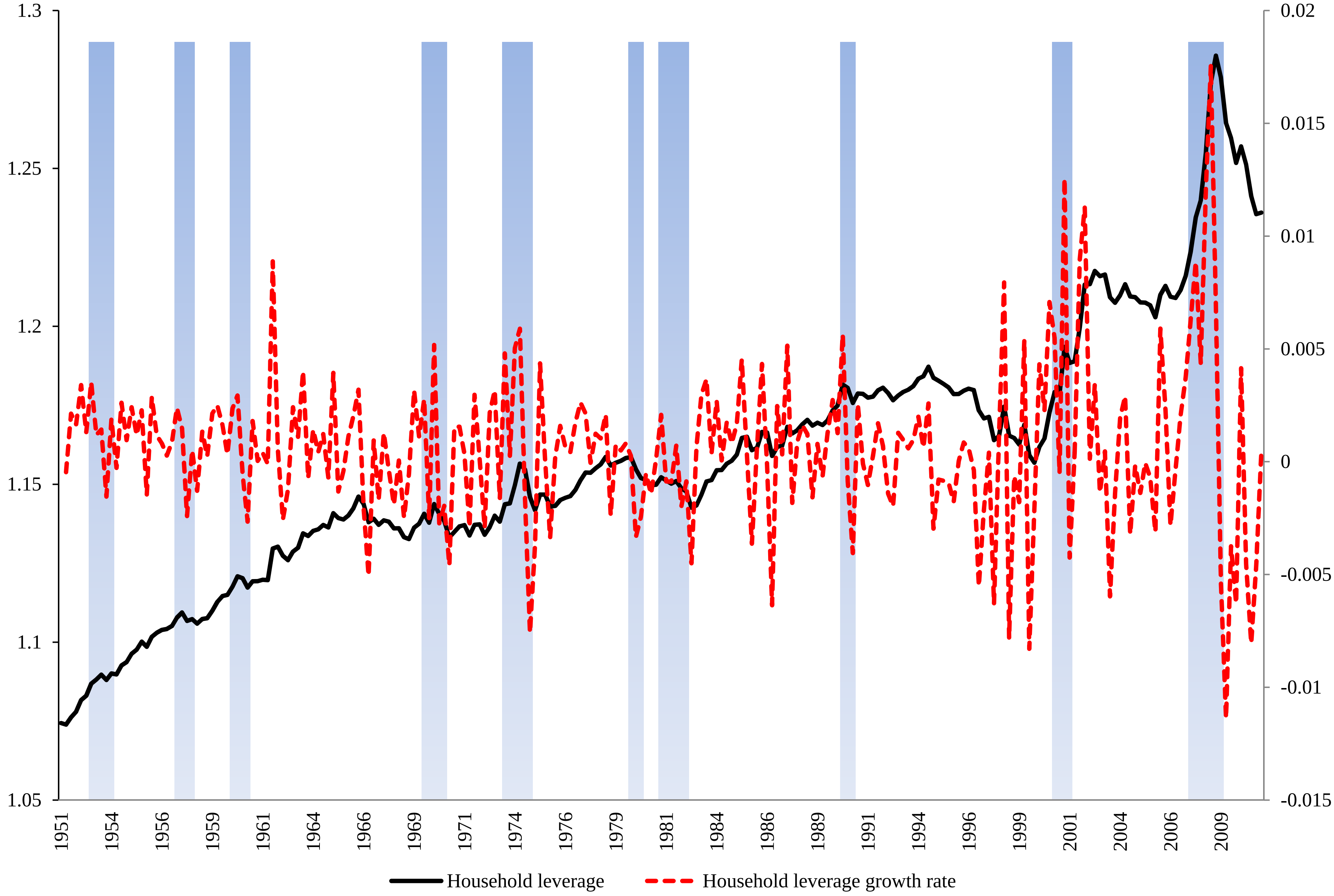


Figure 6. Nonfarm Nonfinancial Corporate Leverage and Its Growth Rate

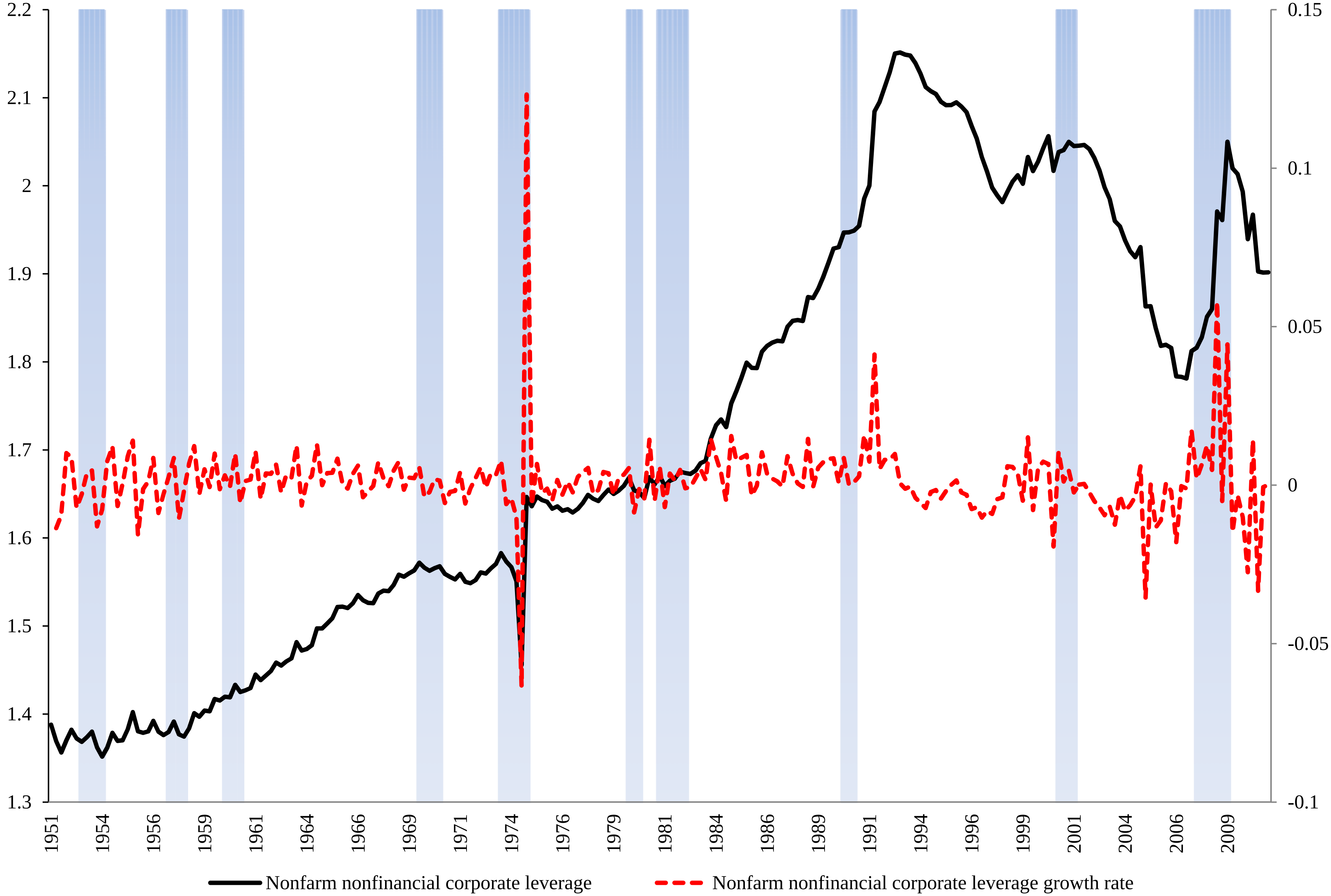


Figure 7. Commercial Bank Leverage and Its Growth Rate

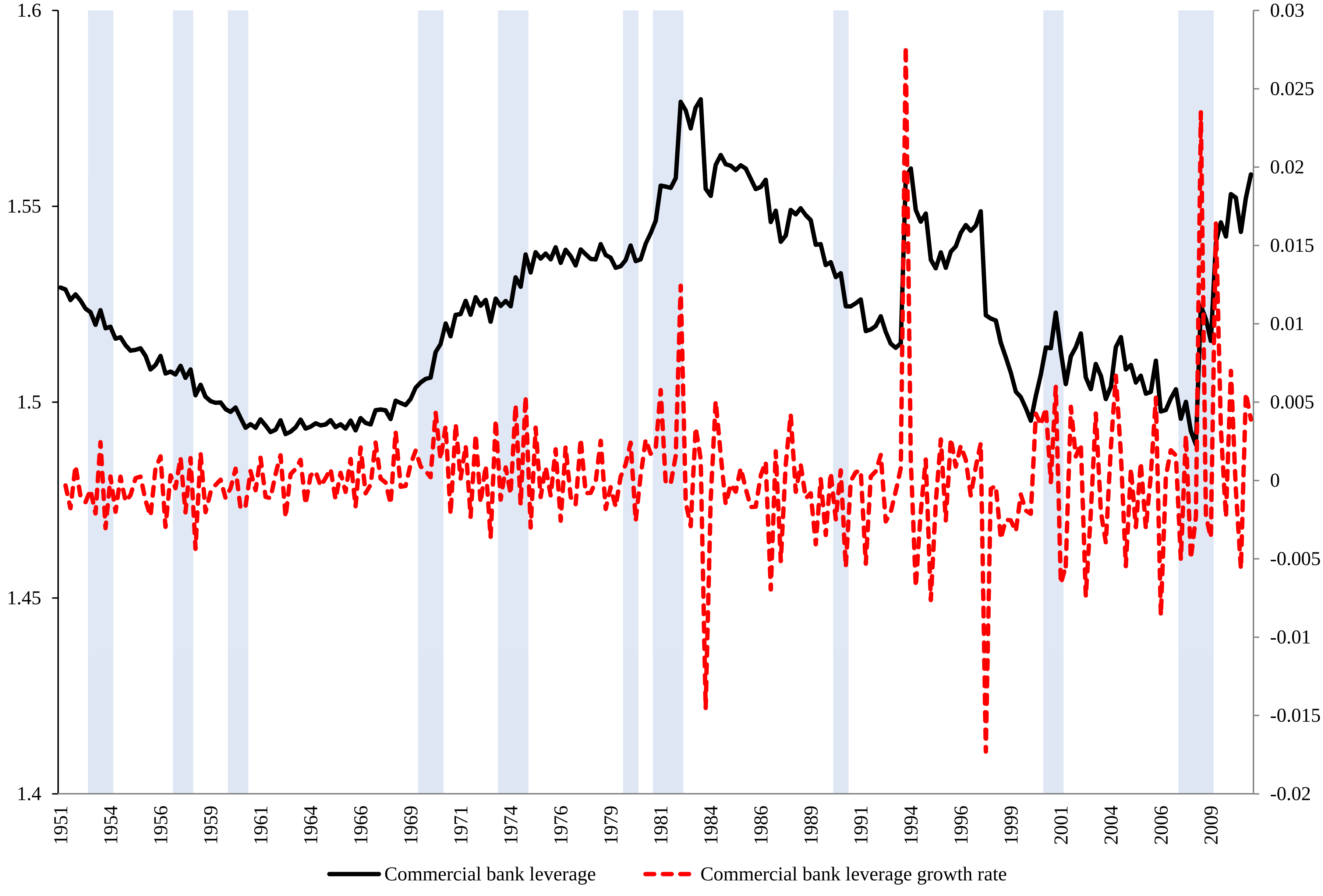


Figure 8. Broker & Dealer Leverage and Its Growth Rate

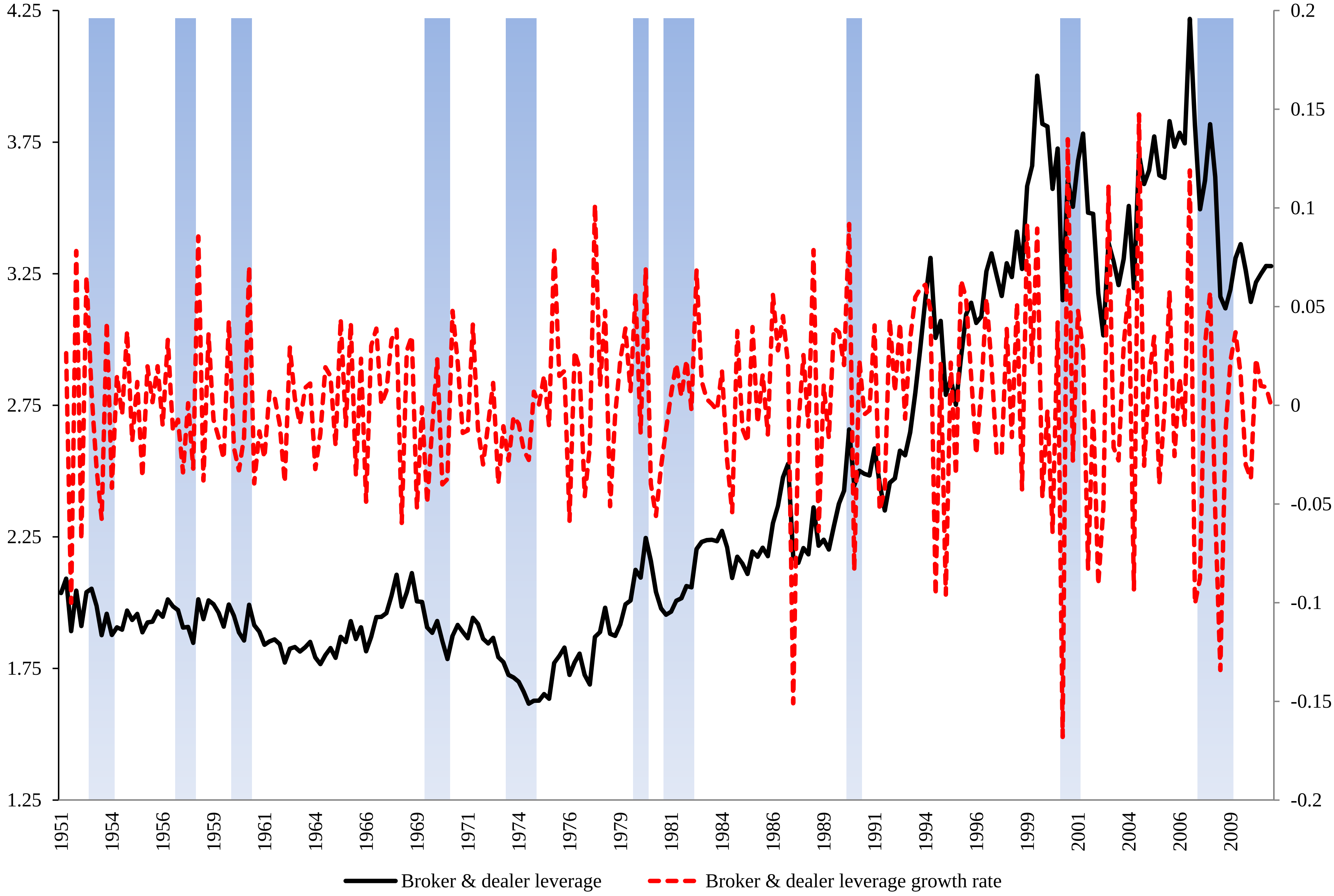


Figure 9. Shadow Bank Leverage and Its Growth Rate

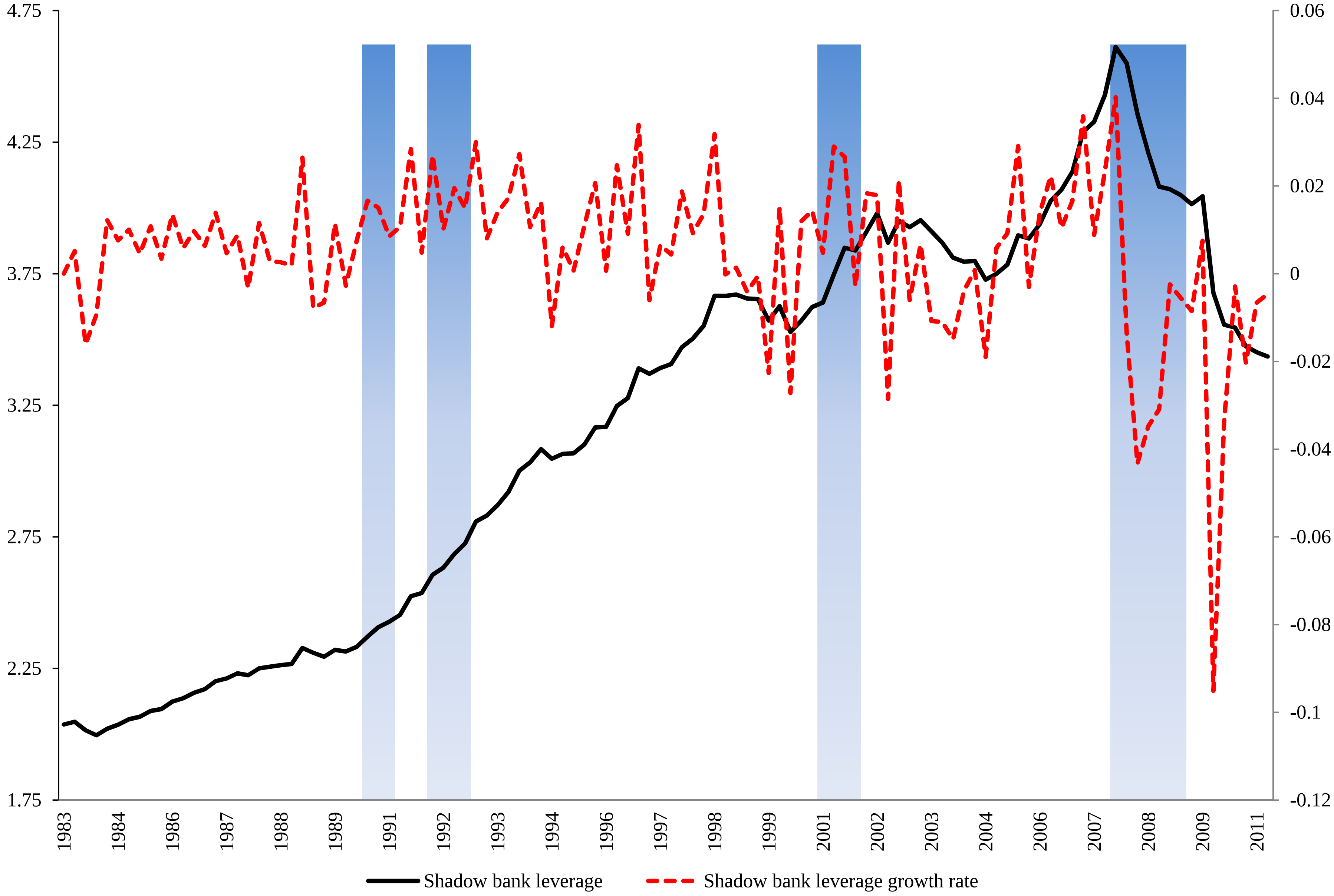


Figure 10. Total Assets and Leverage of Households

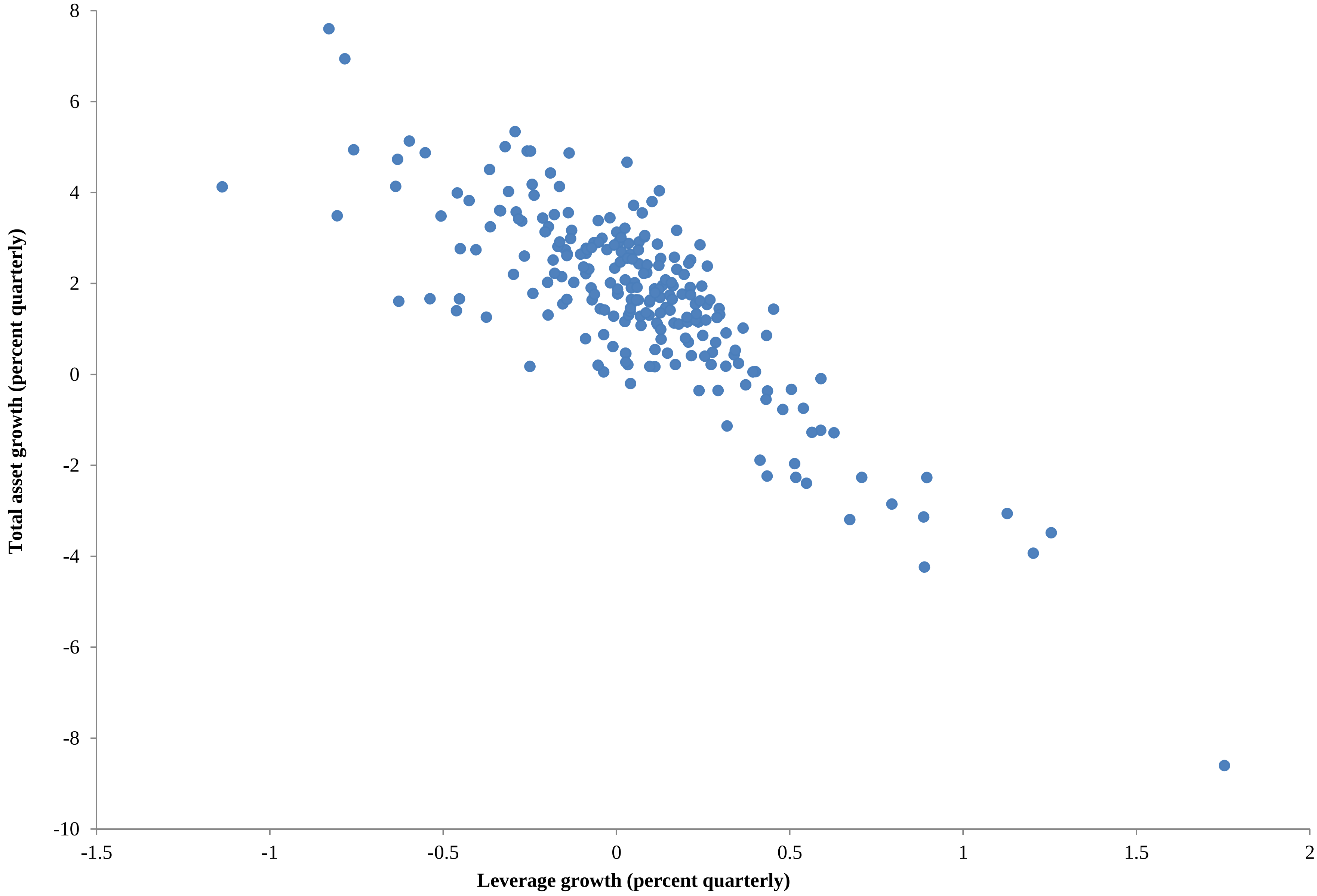


Figure 11. Total Assets and Leverage of Nonfinancial Firms

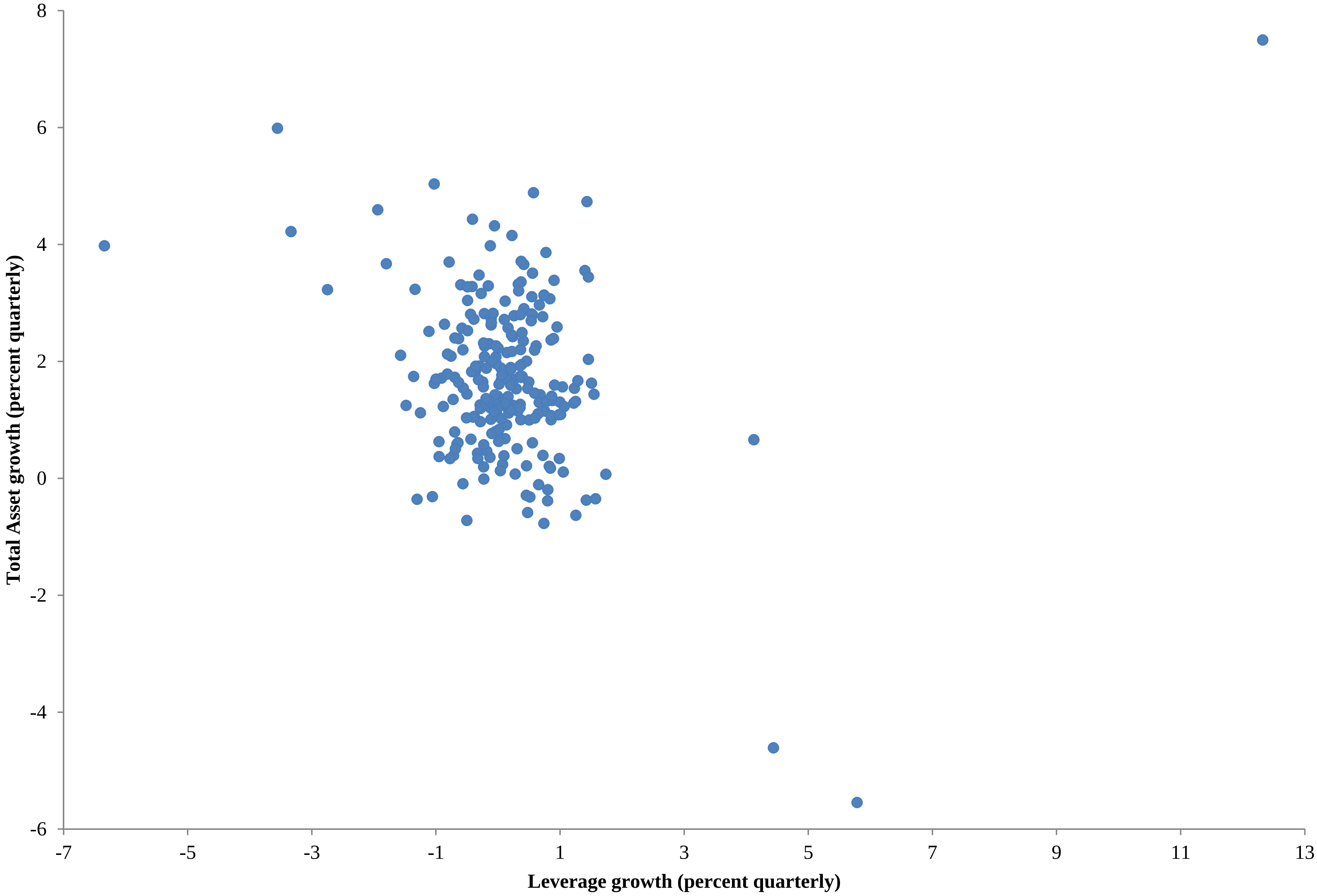


Figure 12. Total Assets and Leverage of Commercial Banks

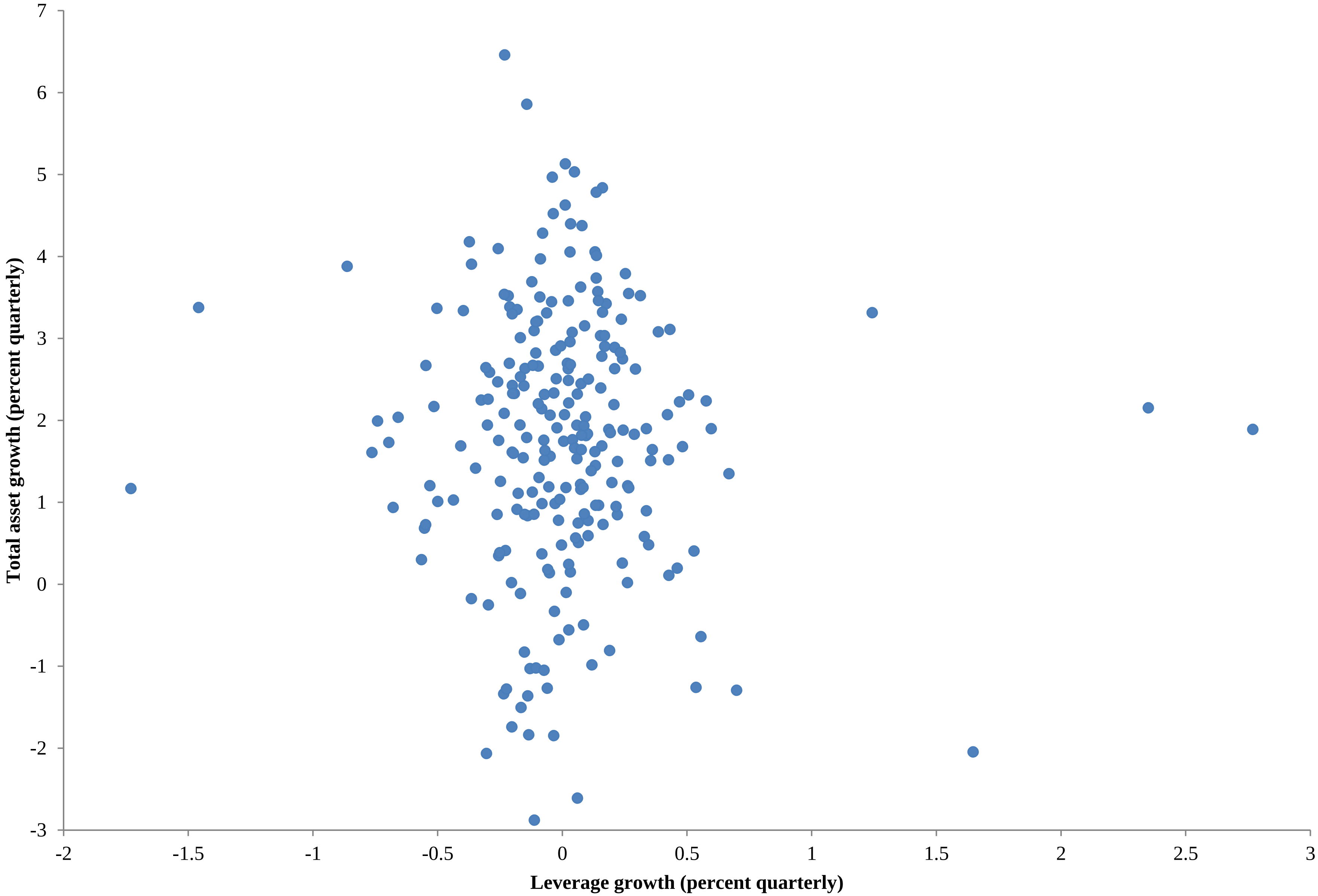


Figure 13. Total Assets and Leverage of Brokers and Dealers

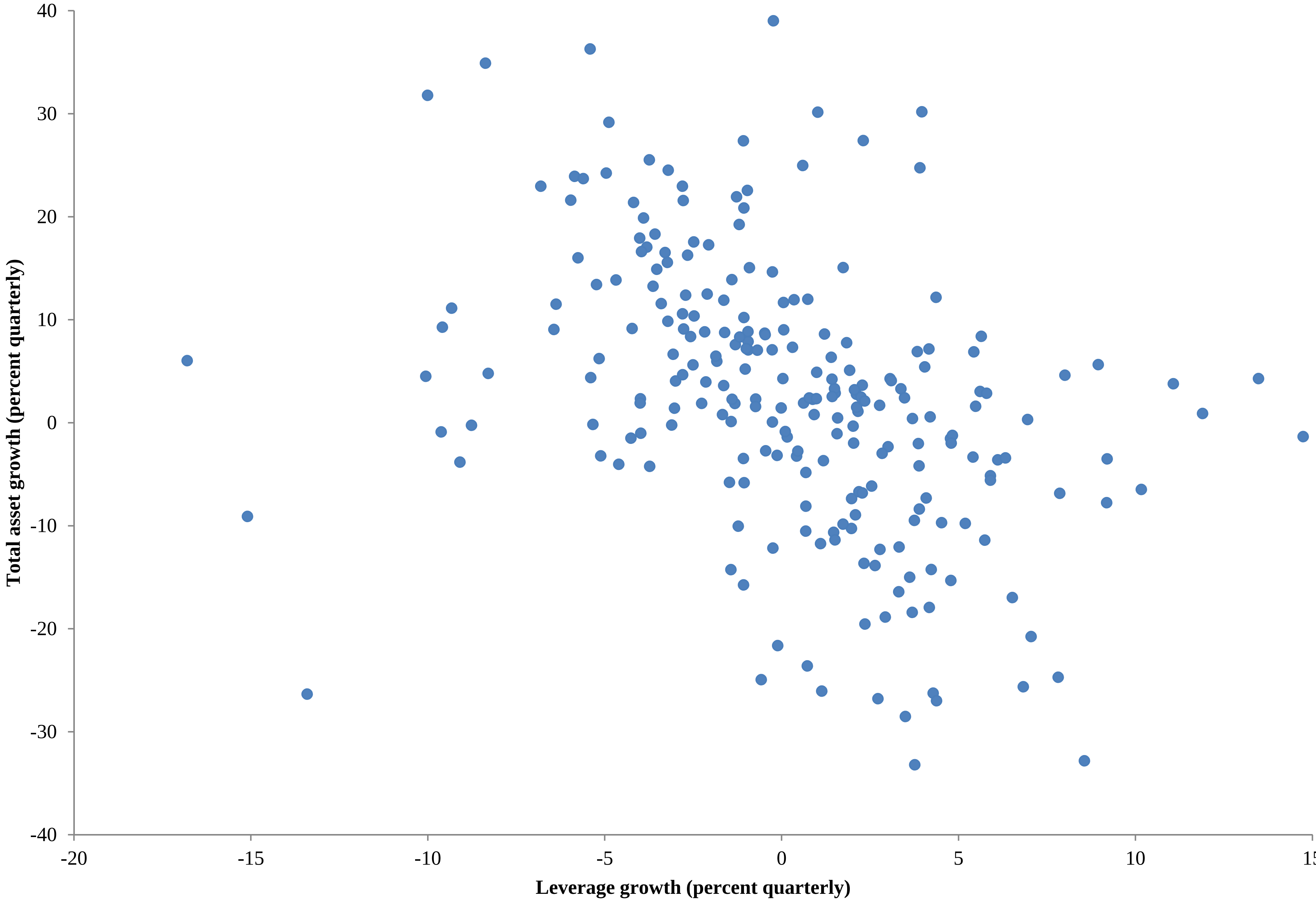


Figure 14. Total Assets and Leverage of Shadow Banks

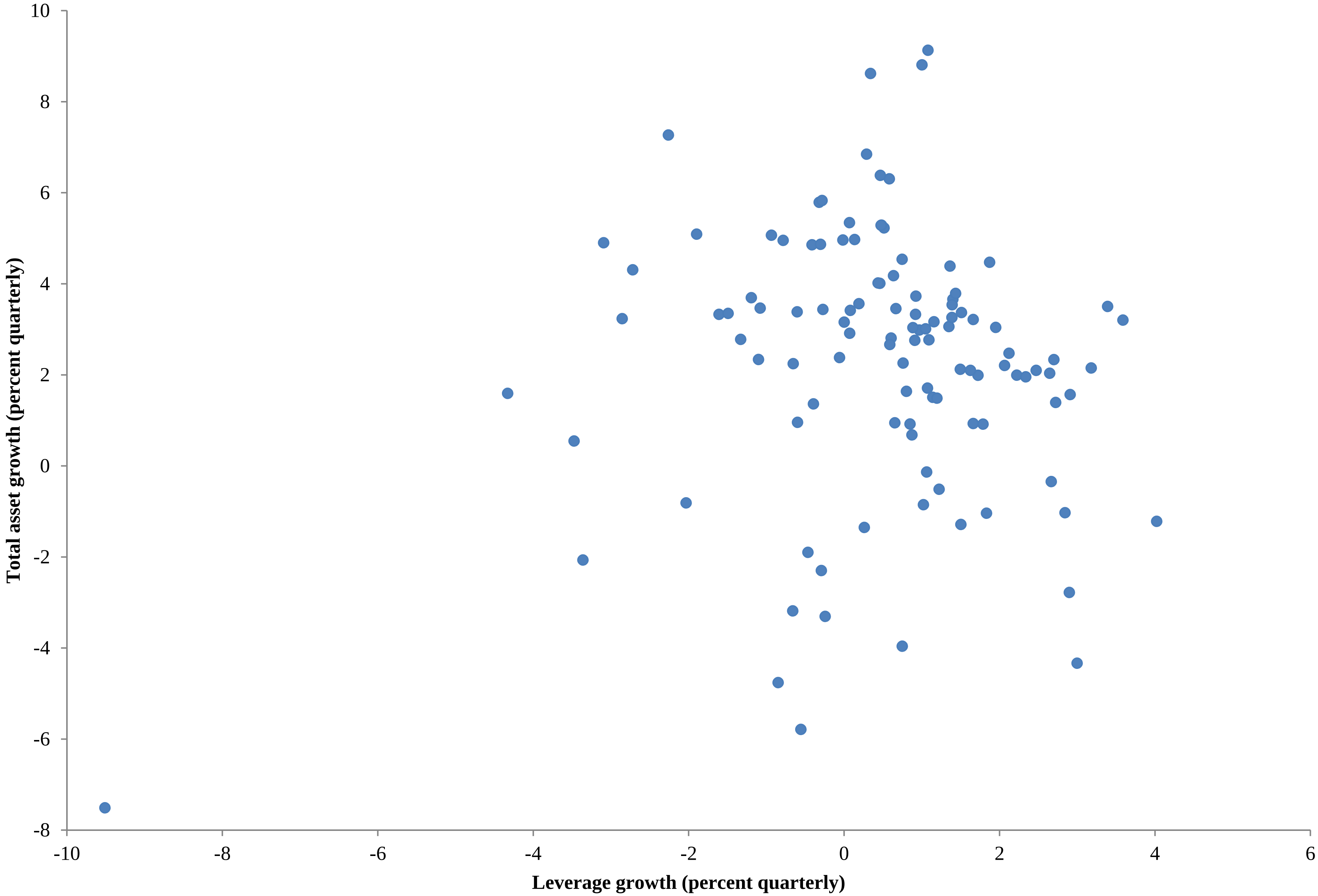


Figure 15. M1 Monetary Aggregates (normalized)

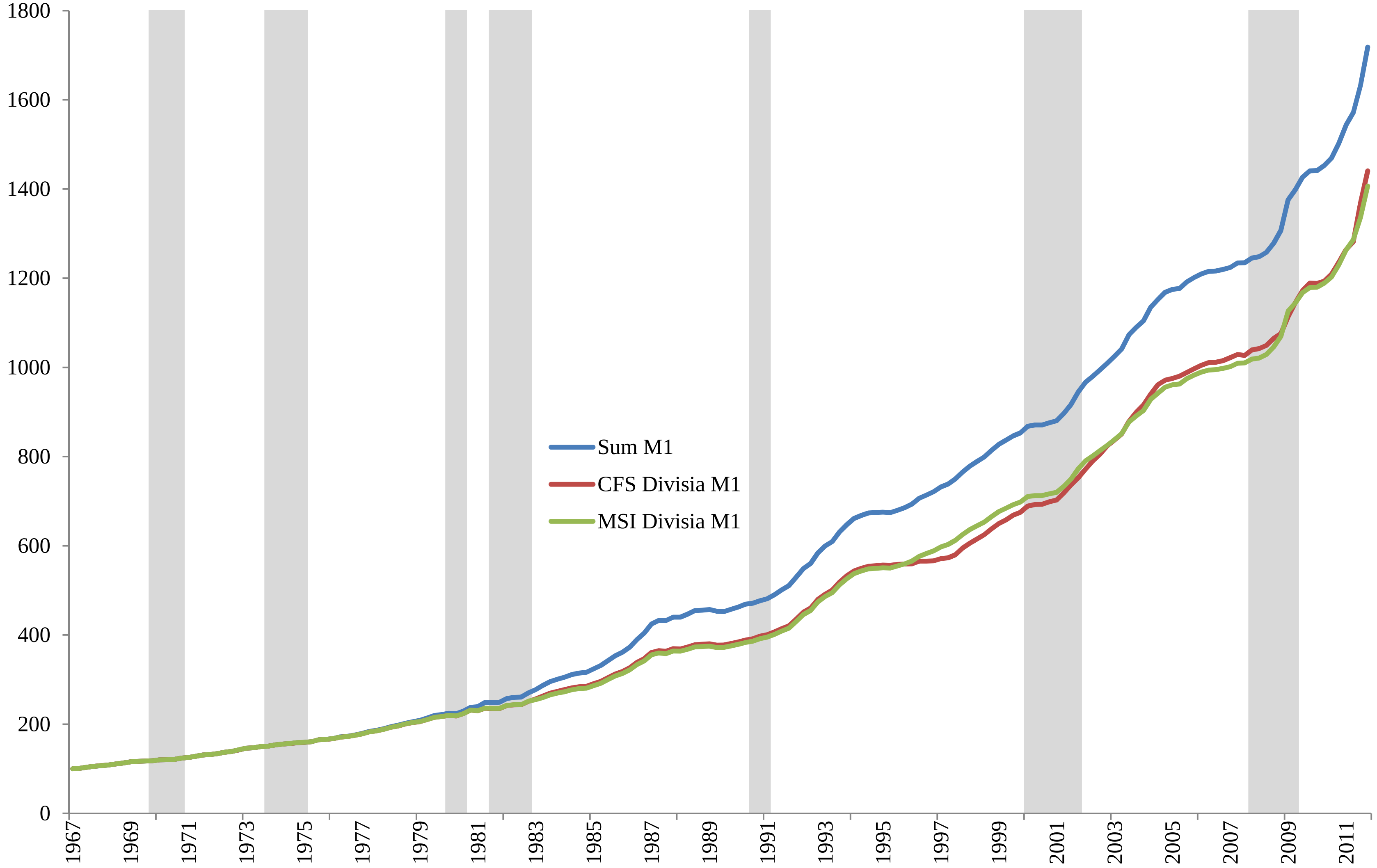


Figure 16. M2M Monetary Aggregates (normalized)

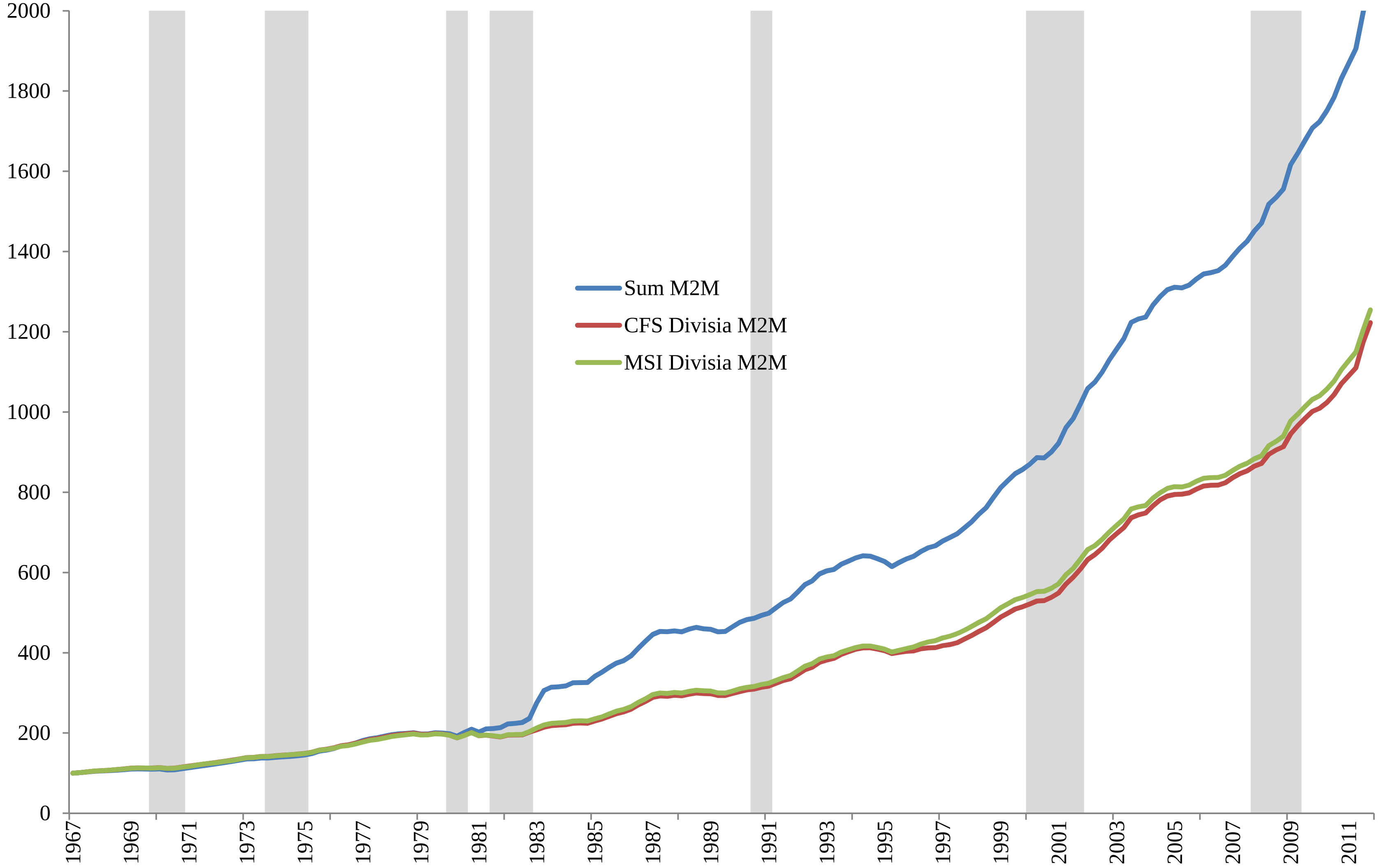


Figure 17. M2 Monetary Aggregates (normalized)

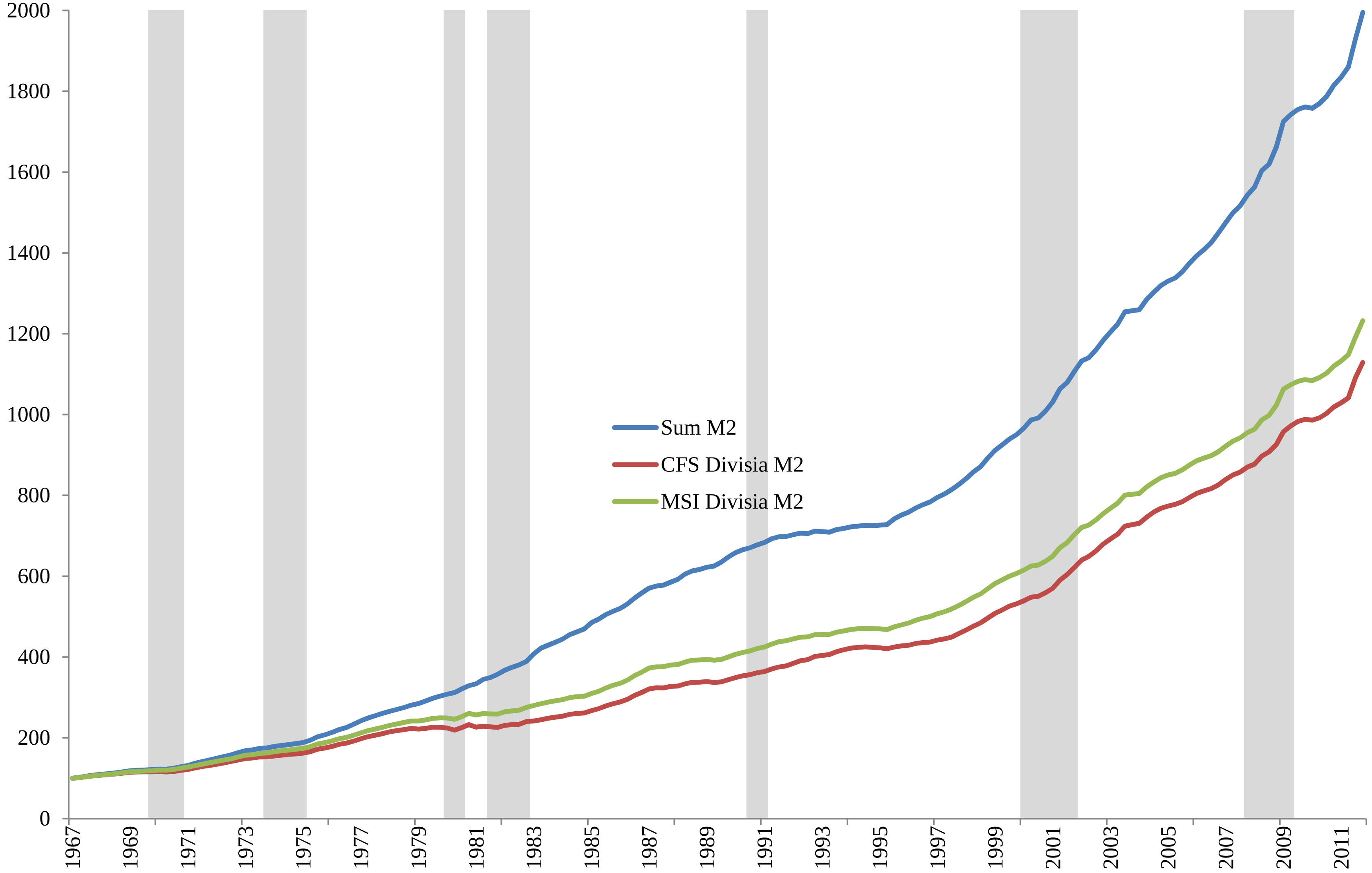


Figure 18. MZM Monetary Aggregates (normalized)

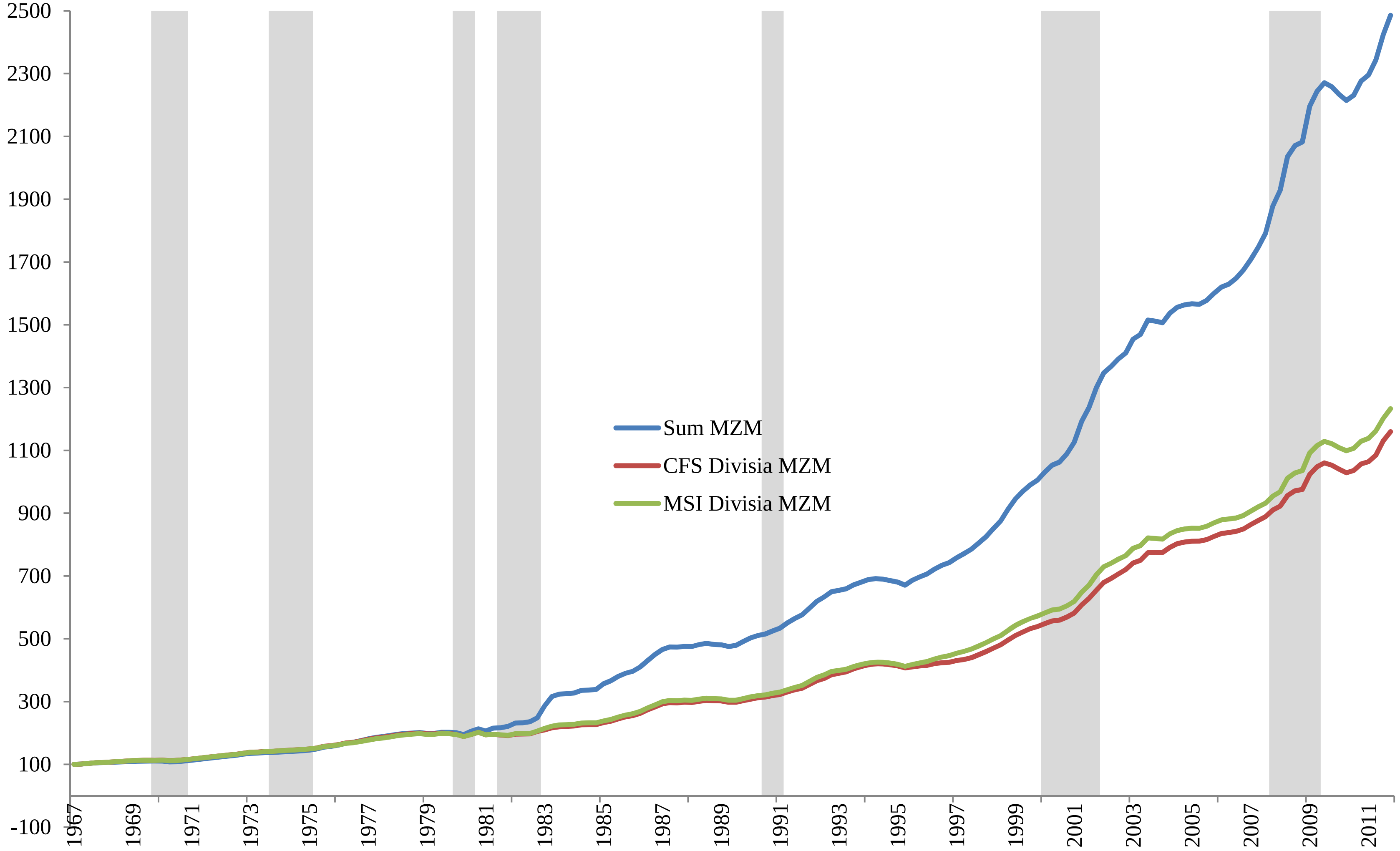


Figure 19. ALL Monetary Aggregates (normalized)

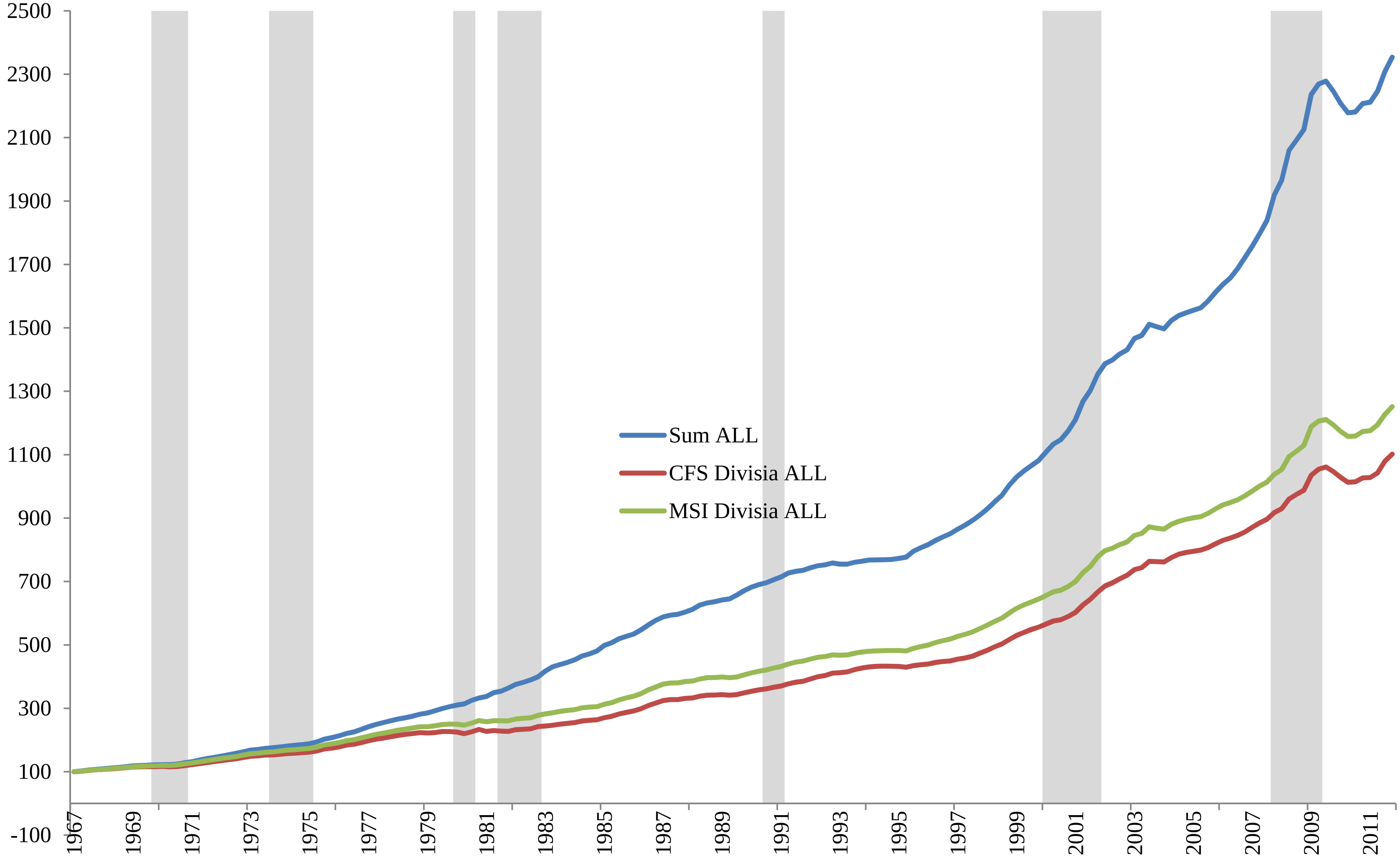


Figure 20. Monetary Aggregate Growth Rates M1

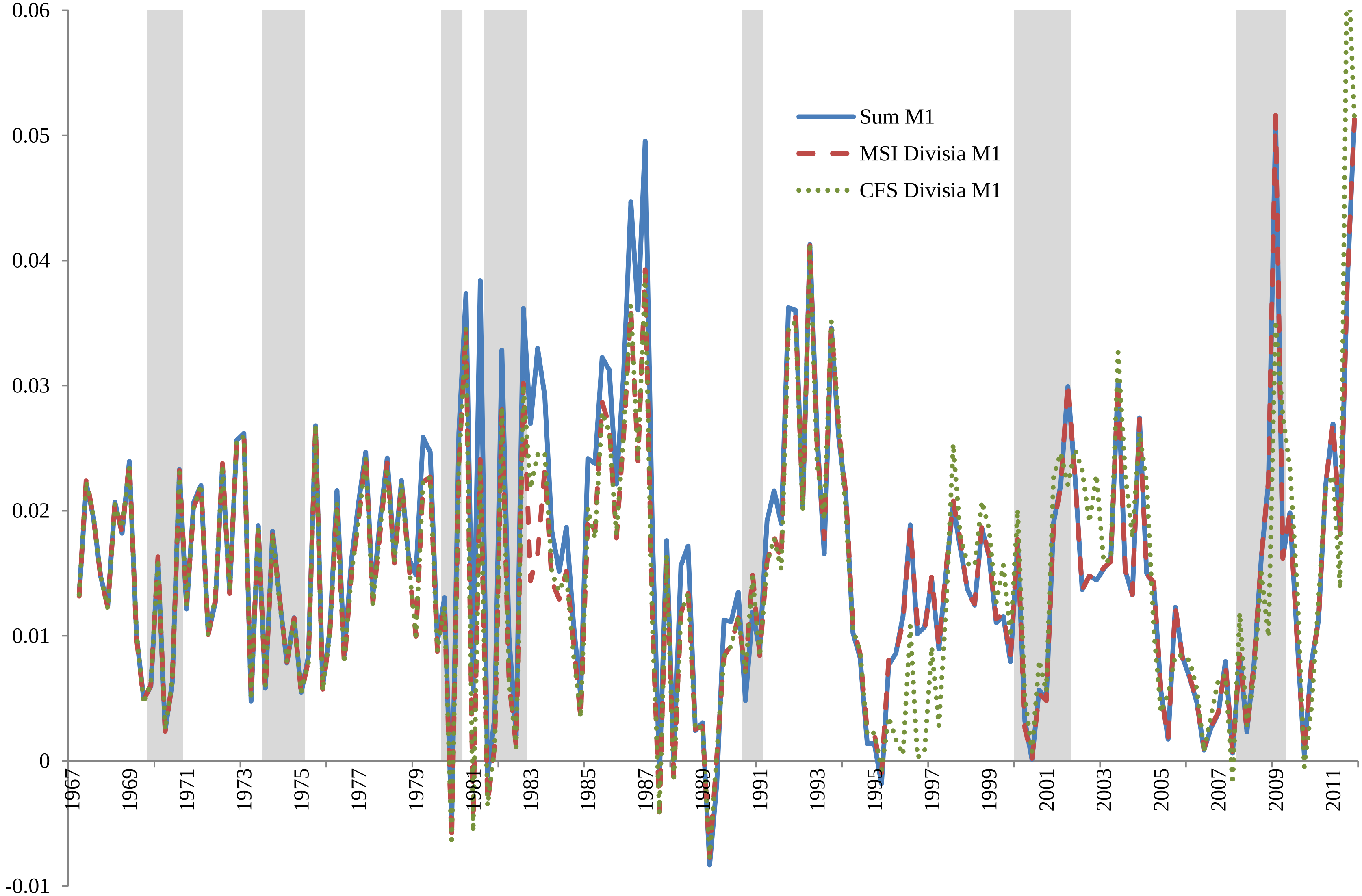


Figure 21. Monetary Aggregate Growth Rates M2M

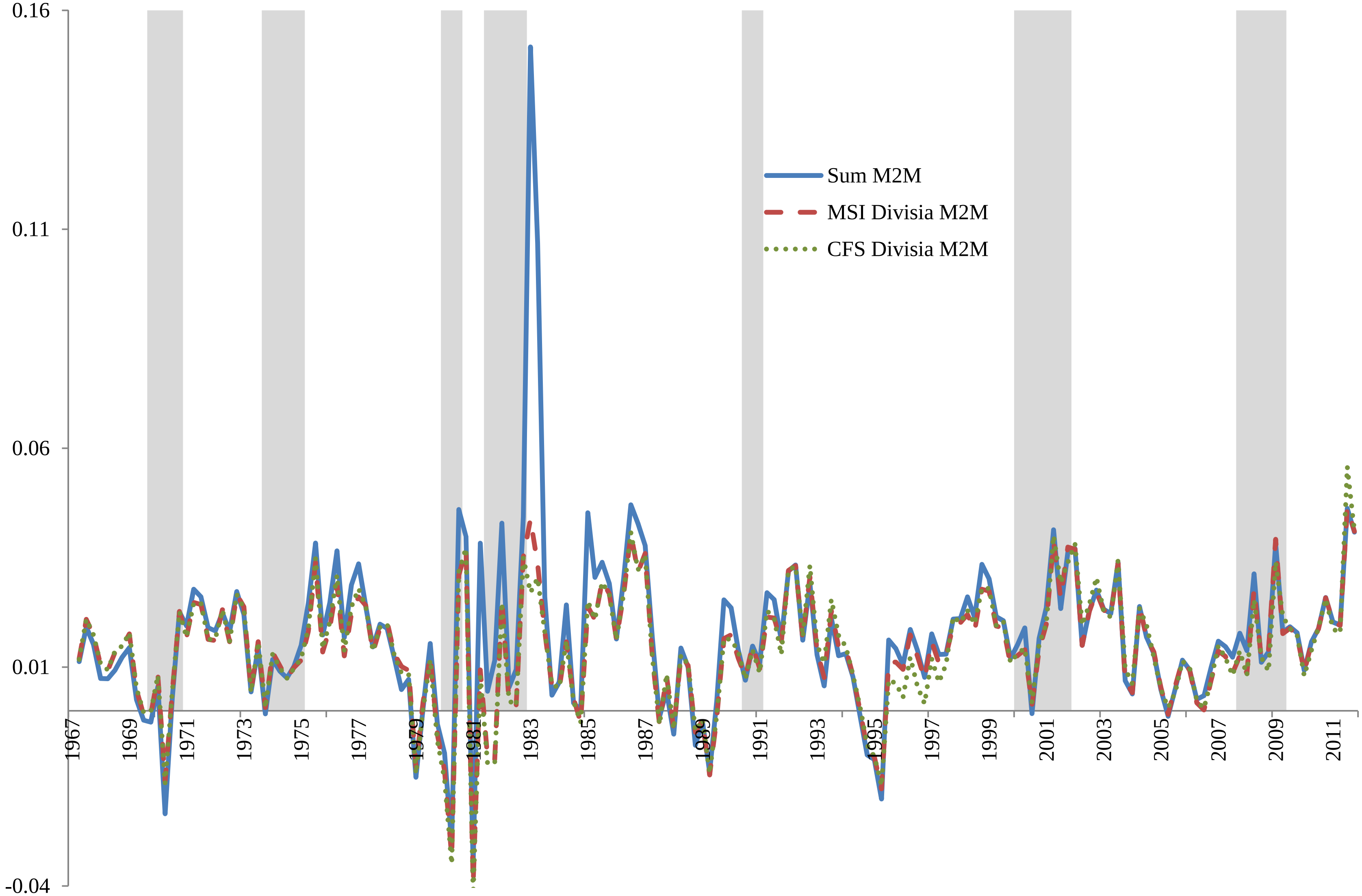


Figure 22. Monetary Aggregate Growth Rates M2

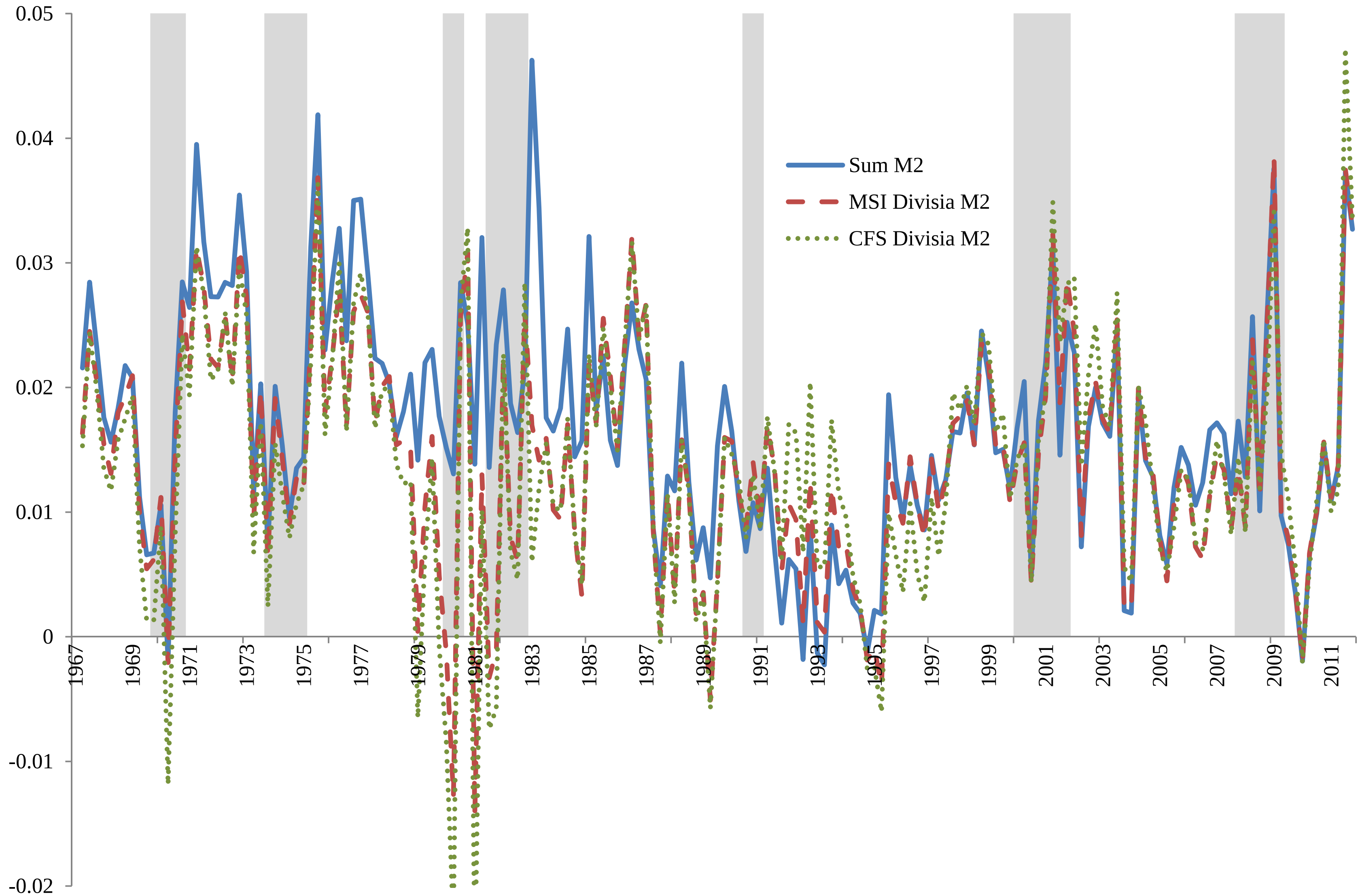


Figure 23. Monetary Aggregate Growth Rates MZM

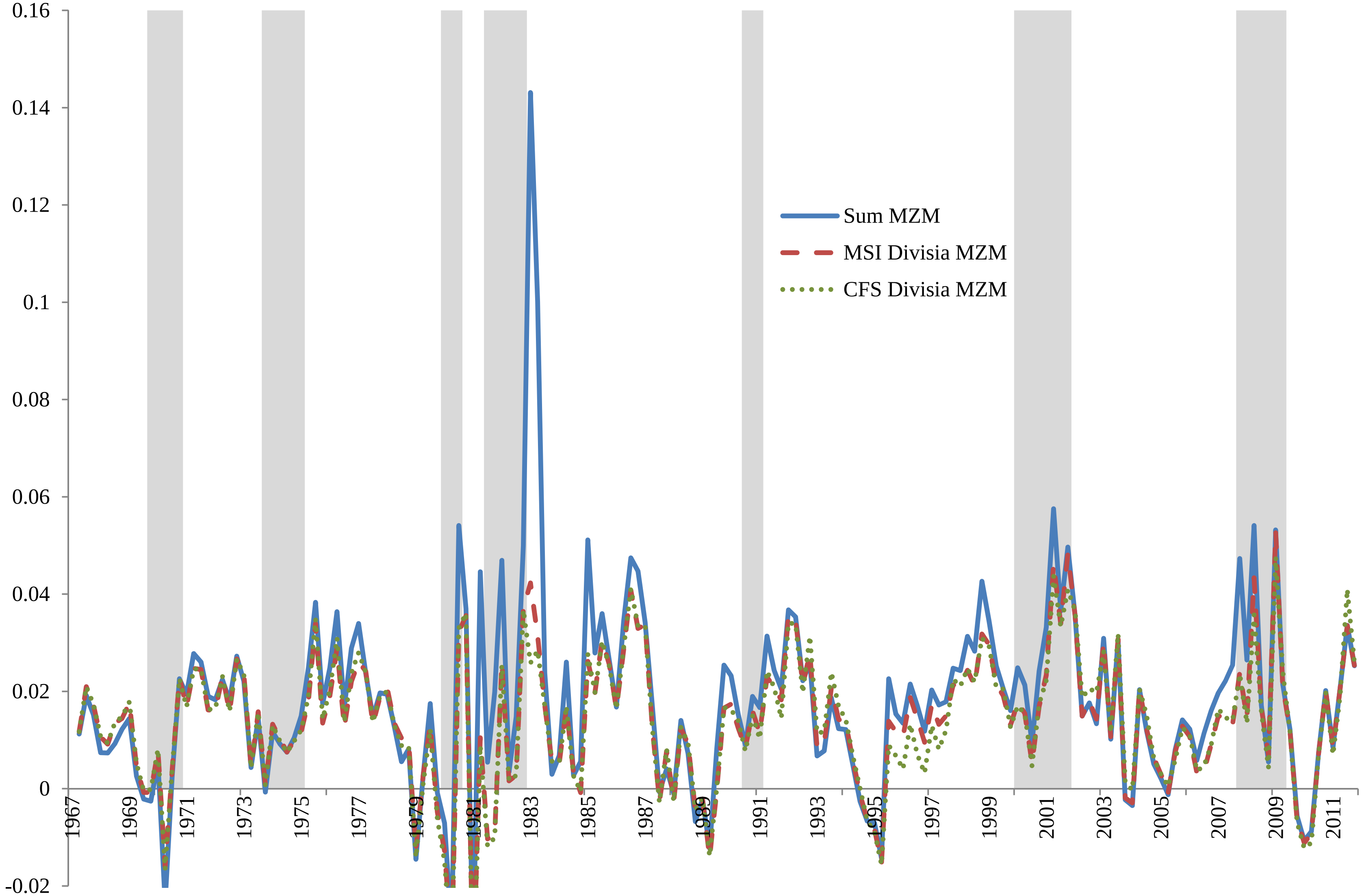
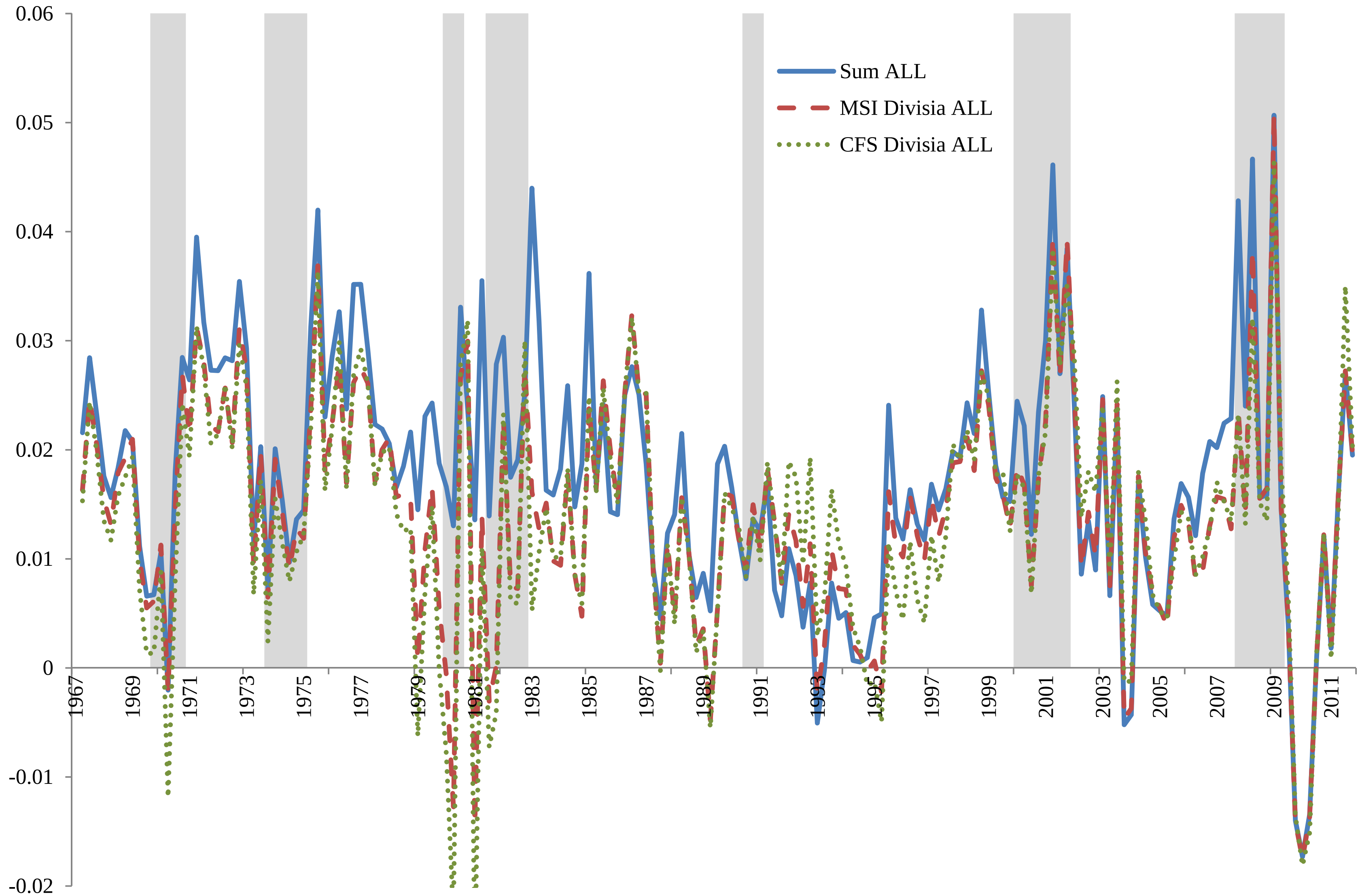


Figure 24. Monetary Aggregate Growth Rates ALL



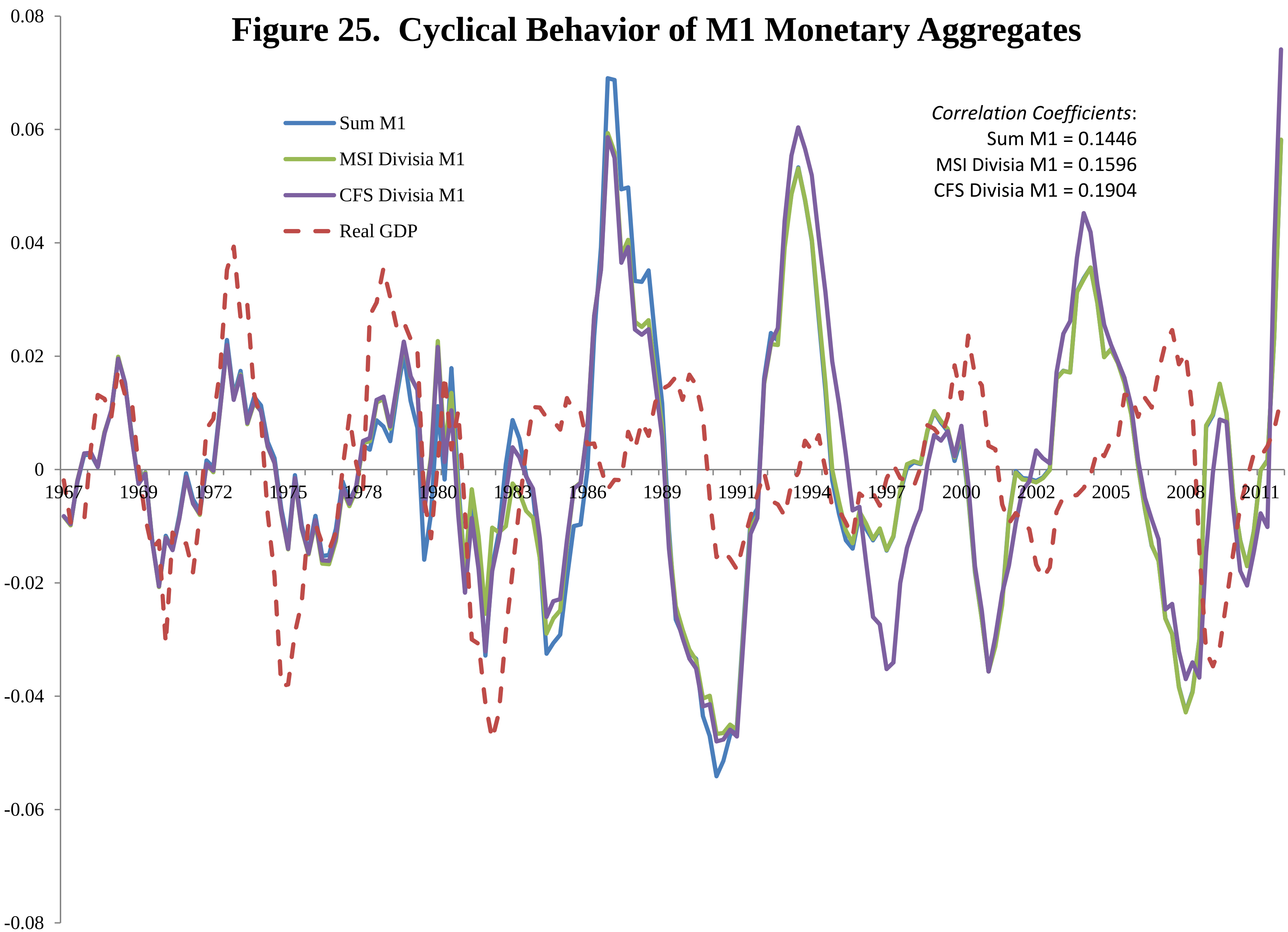


Figure 25. Cyclical Behavior of M1 Monetary Aggregates
Sum M1
MSI Divisia M1
CFS Divisia M1
Real GDP
Correlation Coefficients:
Sum M1 = 0.1446
MSI Divisia M1 = 0.1596
CFS Divisia M1 = 0.1904
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1967
1969
1972
1975
1978
1980
1983
1986
1989
1991
1994
1997
2000
2002
2005
2008
2011

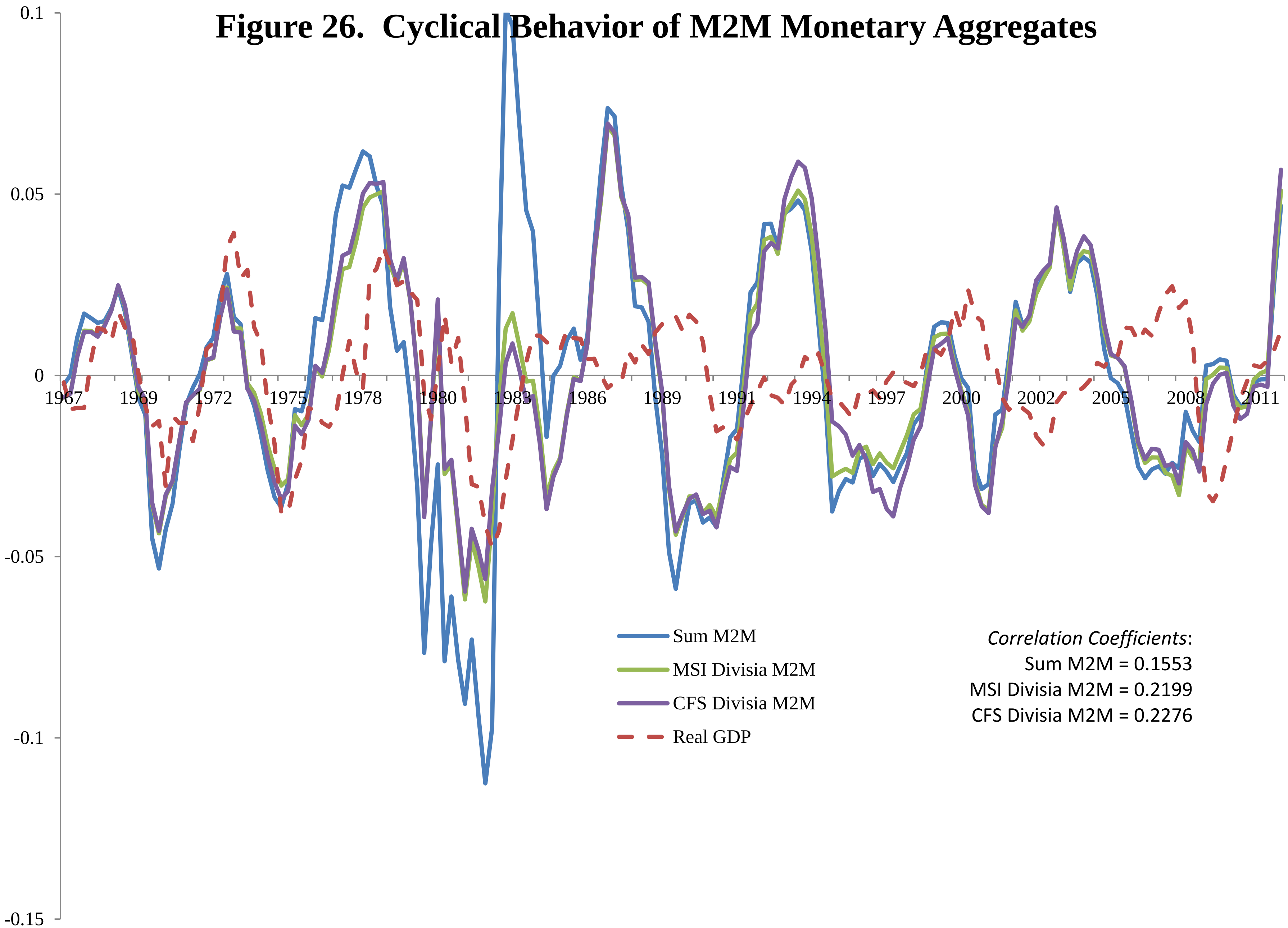


Figure 26. Cyclical Behavior of M2M Monetary Aggregates
0.1
0.05
0
-0.05
-0.1
-0.15
1967
1969
1972
1975
1978
1980
1983
1986
1989
1991
1994
1997
2000
2002
2005
2008
2011
Sum M2M
MSI Divisia M2M
CFS Divisia M2M
Real GDP
Correlation Coefficients:
Sum M2M = 0.1553
MSI Divisia M2M = 0.2199
CFS Divisia M2M = 0.2276

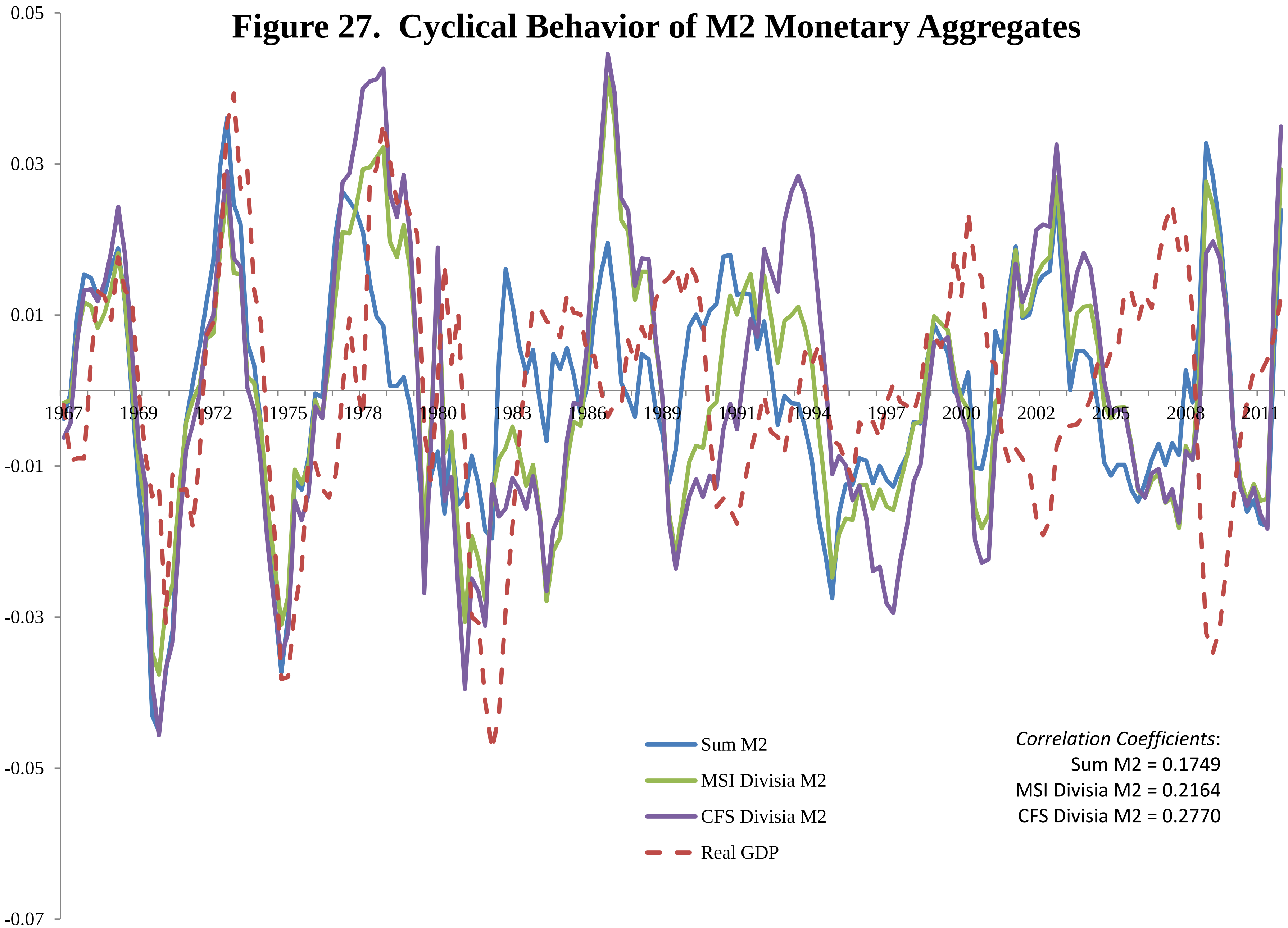
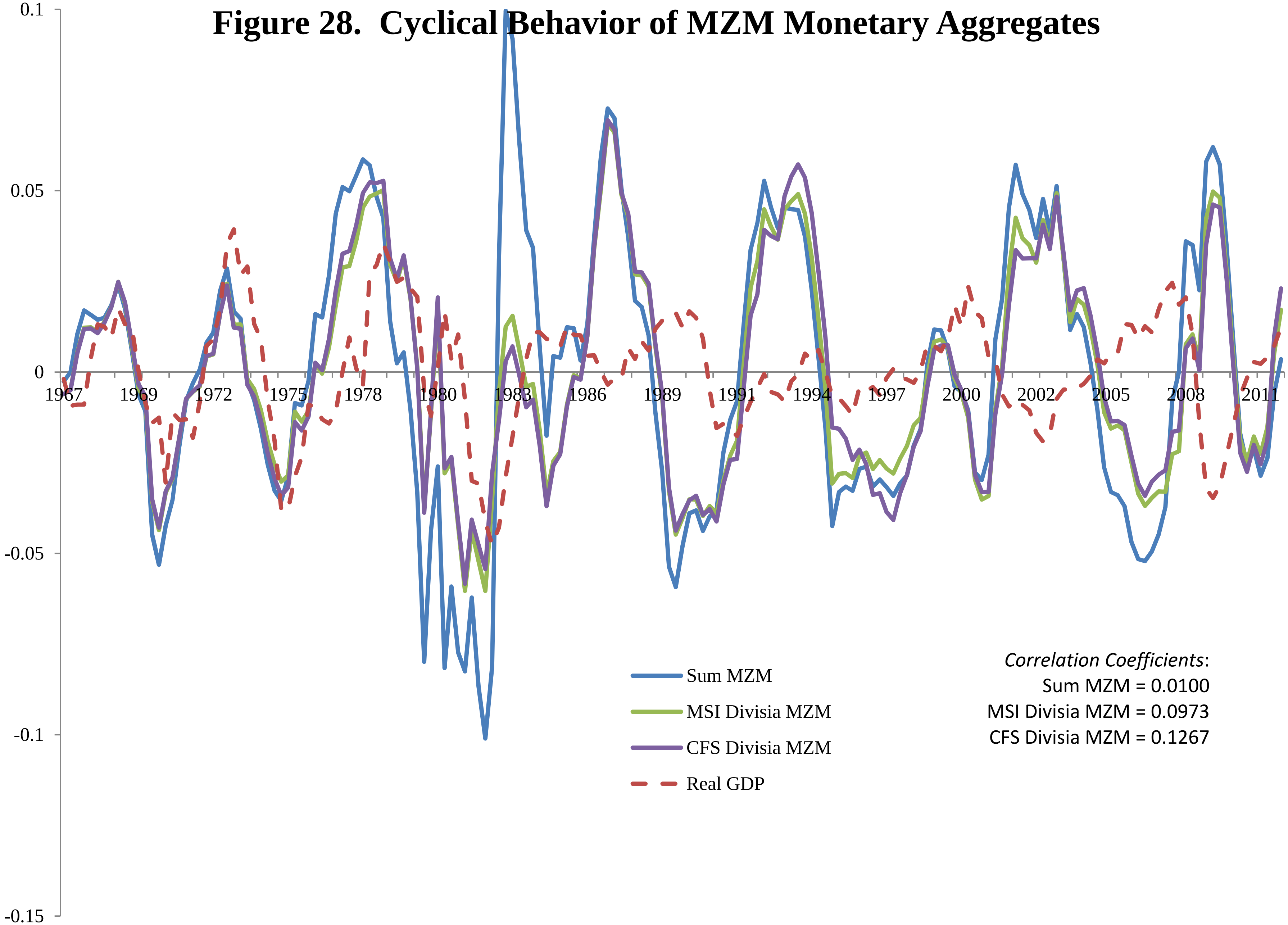


Figure 27. Cyclical Behavior of M2 Monetary Aggregates
0.05
0.03
0.01
-0.01
-0.03
-0.05
-0.07
1967
1969
1972
1975
1978
1980
1983
1986
1989
1991
1994
1997
2000
2002
2005
2008
2011
Sum M2
MSI Divisia M2
CFS Divisia M2
Real GDP
Correlation Coefficients:
Sum M2 = 0.1749
MSI Divisia M2 = 0.2164
CFS Divisia M2 = 0.2770

Figure 28. Cyclical Behavior of MZM Monetary Aggregates



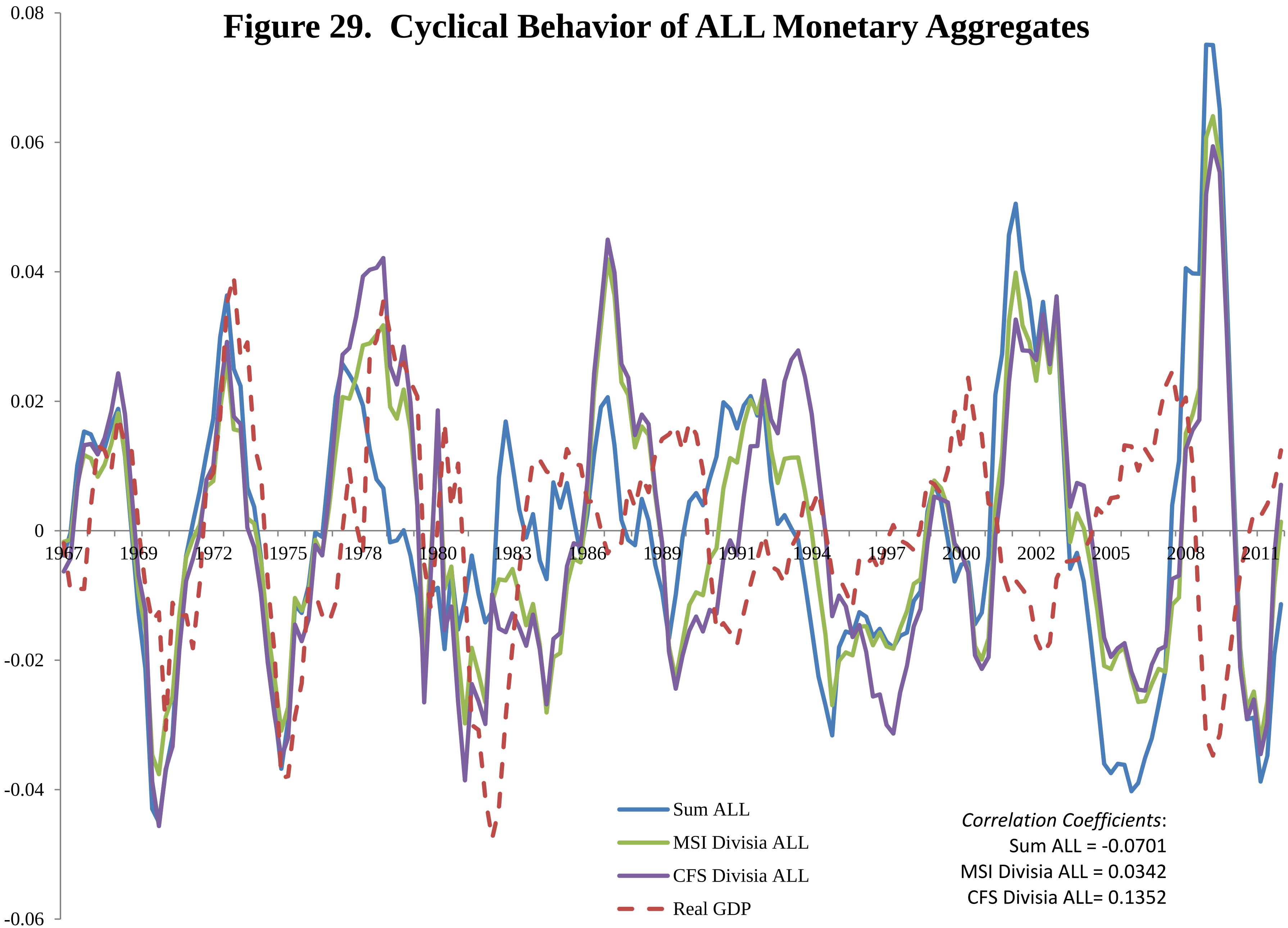


Figure 29. Cyclical Behavior of ALL Monetary Aggregates
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
1967
1969
1972
1975
1978
1980
1983
1986
1989
1991
1994
1997
2000
2002
2005
2008
2011
Sum ALL
MSI Divisia ALL
CFS Divisia ALL
Real GDP
Correlation Coefficients:
Sum ALL = -0.0701
MSI Divisia ALL = 0.0342
CFS Divisia ALL= 0.1352

Table 1. Cyclical Correlations of Sum, MSI Divisia, and CFS Divisia Money with Real GDP

	$\rho(x_t, y_{t+j})$, $j = -12, -9, -6, -3, 0, 3, 6, 9, 12$								
Series	$j = -12$	$j = -9$	$j = -6$	$j = -3$	$j = 0$	$j = 3$	$j = 6$	$j = 9$	$j = 12$
Sum M1	−.116	−.161	−.156	−.073	.144	.243	.208	.061	−.104
MSI Divisia M1	−.163	−.186	−.120	−.021	.159	.241	.185	.019	−.121
CFS Divisia M1	−.205	−.226	−.149	−.024	.190	.246	.158	−.010	−.129
Sum M2M	−.187	−.308	−.461	−.316	.155	.440	.404	.212	−.020
MSI Divisia M2M	−.160	−.250	−.309	−.160	.219	.412	.337	.107	−.110
CFS Divisia M2M	−.170	−.265	−.294	−.130	.227	.395	.313	.090	−.112
Sum M2	−.011	−.193	−.207	−.064	.174	.287	.176	−.070	−.204
MSI Divisia M2	−.077	−.107	−.090	−.005	.216	.341	.253	−.007	−.220
CFS Divisia M2	−.158	−.226	−.165	.008	.277	.381	.249	−.036	−.221
Sum MZM	−.081	−.136	−.287	−.272	.010	.236	.277	.192	.022
MSI Divisia MZM	−.084	−.101	−.154	−.124	.097	.257	.246	.092	−.089
CFS Divisia MZM	−.112	−.137	−.152	−.091	.126	.268	.237	.073	−.099
Sum ALL	.120	.079	.049	−.027	−.070	−.045	−.014	−.044	−.071
MSI Divisia ALL	.023	.071	.079	.012	.034	.112	.120	−.009	−.149
CFS Divisia ALL	−.076	−.067	−.004	.037	.135	.206	.146	−.043	−.179

Note: Sample period, quarterly data: 1967:1 – 2011:12. x_t = Money, y_t = Real GDP.