What Remains of Monetarism after the Great Recession?

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Although one hears very little of the monetarism of Milton Friedman since the Great Recession, its basic hypotheses and methodology for the identification of shocks remain useful. It is remains useful to review the basic tenets of monetarism and to apply them to an understanding of the Great Recession.

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There is no self-evident experimental design to the forces that cause recessions. As a result, economists will rarely if ever form a consensus over the cause of a particular recession. Various approaches toward the identification of the shocks that cause recessions exist. All offer some insight but there is no econometric technique that does not incorporate significant judgment on the part of the econometrician. Economists and policymakers are left with no choice but to consider all alternatives and then make a choice about which model of the economy is most useful for making predictions about policy.

The genesis of the debate over statistical inference in a model of the economy represented by a system of equations in which each equation contains endogenous variables occurred at the University of Chicago in the late 1940s under the auspices of the Cowles Commission (Christ 1952.) In his review (“Measurement without Theory”) of Burns and Mitchell’s book, Measuring Business Cycles, Koopmans (1947, 167) wrote:

There is no … awareness of the problems of determining the identifiability of, and measuring, structural equations as a prerequisite to the practically important types of prediction….Without resort to theory…conclusions relevant to the guidance of economic policies cannot be drawn…. [T]he mere observation of regularities in the interrelations of variables then does not permit us to recognize or to identify behavior equations among such regularities.

The Cowles Commission set the research agenda for modern macroeconomics. The holy grail of the profession is a structural model of the economy sufficiently well-grounded in microeconomic theory as to organize a professional consensus. The need for a model in order to disentangle causation from correlation forms one criterion for what it means to be an economist. However, the identification of shocks in the absence of consensus over the appropriate model has led to alternative strategies for macroeconomic research. Lawrence Klein represented the mainstream offshoot of the Cowles Commission agenda (see Pinzon-Fuchs 2014). Klein led the profession in the estimation of large-scale econometric models of the economy subject to identification restrictions such as the exclusion restrictions on the estimation of individual equations.

In his book, A Theory of the Consumption Function, Milton Friedman (1957a) contributed to the mainstream research agenda of constructing a micro-founded structural model of the economy. However, he pursued a different strategy for identification characterized here as the concatenation of semi-controlled policy experiments. The general monetarist policy prescription is that the central bank should follow a rule that provides for a stable nominal anchor in terms of the domestic price level and that allows the price system to work freely to determine real variables like output and employment. Policy “experiments” occur when the central bank contravenes these principles.

Section 1 elaborates on the monetarist approach to identification. Section 2 criticizes the adequacy of Taylor rules as summaries of monetary policy. Section 3 looks critically at estimated DSGE models as vehicles for the identification of shocks. Section 4 provides an overview of the monetarist approach to the identification of shocks. Sections 5 and 6 apply this approach to the Great Recession.

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1 Given the contemporaneous stability and interest inelasticity of money demand, the k-percent rule for money growth advanced by Friedman (1960) is one rule that would implement these principles.
1. Milton Friedman and monetarist identification

Friedman (1953a) advanced the argument that the validity of a hypothesis depends upon its ability to predict rather than the descriptive realism of its assumptions. However, as Friedman (1953a, 40) noted, “The necessity of relying on uncontrolled experience rather than on controlled experiment makes it difficult to produce dramatic and clear-cut evidence to justify the acceptance of tentative hypotheses.” Every particular event such as an individual recession possesses multiple explanations because of the inability to apply ceteris paribus conditions that eliminate the influence of the numerous variables that compete as alternative causal factors. Friedman (1953a, 25 and 22-23) wrote:

Each occurrence [particular application of a model] has some features peculiarly its own, not covered by the explicit rules. The capacity to judge that these are or are not to be disregarded, that they should or should not affect what observable phenomena are to be identified with what entities in the model … can only be learned by experience. … An even more important body of evidence for the maximization-of-returns hypothesis is experience from countless application of the hypothesis to specific problems and the repeated failure of its implications be contradicted… The evidence for a hypothesis always consists of its repeated failure to be contradicted… (Friedman 1953a, 25, 22-23).

The reality of the poor experimental design that characterizes episodes of monetary instability led to Friedman’s historical narrative approach. An early illustration was the 1956 collection of historical essays by students of Friedman in the money and banking workshop showing the relationship between money growth and inflation over numerous, diverse historical episodes. The most famous one was “The Monetary Dynamics of Hyperinflation” by Phillip Cagan (1956).

One can find another example of Friedman’s concatenation methodology in a letter that Friedman (1957b) wrote Arthur Burns criticizing Burns’ manuscript for the book Prosperity without Inflation for a confusion of monetary policy with credit policy. (Burns did not alter the manuscript.) Friedman argued that one should consider the effect of the money stock on nominal expenditure and prices independently of the operation of the credit market.

[I]t is striking that changes in the stock of money have had very similar effects under widely different institutional arrangements for bringing about changes in it, some under which the credit market was of minor importance…. the evidence persuades me that this old fashioned, fairly direct linkage between the stock of money and flows of outlays is empirically more important than the Keynesian linkage between investment and other outlay flows that underlies the “credit policy” approach you adopt—though I was almost reconciled to seeing Keynes conquer central bankers I now feel like saying “et tu, Brute!” … Where … these lectures can do a great deal of harm … is your taking its [monetary policy’s] effects to operate solely through the “credit” market. If this is right, then any other device for affecting “credit” will do as well, such as investment controls, and the like; and, indeed, will be better since they will enable you to affect what you want to directly, not indirectly.

Friedman and Schwartz (1963b) documented the empirical fact that cyclical turning points in money preceded cyclical turning points in output. They imparted causal content to that empirical association through studies such as Freidman and Schwartz (1963a) that provided numerous examples in which one can interpret the behavior of money as arising out of a semi-controlled experiment on the part of the central bank. The implicit hypothesis in the monetarist literature is that the price system works well to attenuate macroeconomic fluctuations if the central bank provides for
a stable nominal anchor in terms of the domestic price level and allows the price system unhindered (unencumbered) freedom to determine relative prices and market-clearing real quantities. Effectively, episodes in which the central bank contravenes these principles amount to price fixing through keeping the real rate of interest different from the natural rate of interest. The resulting monetary absorptions and emissions cause the price level to evolve in an unpredictable way that destabilizes the real economy.

These semi-controlled experiments constitute three classes of central bank behavior. First, there are episodes from the gold standard in which an increase in the real price of gold or capital flight forced deflation. Second, there are episodes from the system of pegged exchange rates like the Bretton Woods system in which an appreciation of the real terms of trade or capital flight forced deflation. Third, there are episodes in which the central bank attempted to lower inflation through the creation of a negative output gap. These last episodes are the chief semi-controlled policy experiments in the post-Treasury-Fed Accord period in the United States and they occurred without clear announcement and an explicit target for inflation. The price level required to give the public its desired real money balances evolved in a persistently unpredictable and destabilizing way.

Of course, there remains a need for an explicit model. By temperament, however, Friedman was an applied statistician not a theoretician. The version of the New Keynesian (NK) model labelled as “divine coincidence” by Blanchard and Gali (2007) captures basic monetarist hypotheses in that price stability is consistent with a zero output gap (see Goodfriend and King 1997). That is, the central bank should follow a rule that provides a stable nominal anchor in terms of the domestic price level and allow market forces to determine real variables.

2. Assessing monetary policy “experiments:” how useful are Taylor rules?

Because recessions are infrequent events, it follows that the price system must work well most of the time in order to stabilize growth in output. An additional implication is that the FOMC must possess a baseline monetary policy, which allows the price system to work in order to maintain output growing around potential. Economists differ over whether recessions originate in the destabilizing behavior of the central bank or of markets. The issue then becomes whether departures from the baseline policy regularly precede recessions and destabilize the economy or whether they instead occur with the onset of recession in a way that stabilizes the economy. However, because monetary policymakers use the language of discretion rather than rules, it is left to the systematic investigation by economists of the nature of FOMC decision-making to characterize monetary policy.

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2 Disruption to the real economy arises from changes in individual dollar prices uncoordinated by a common set of expectation. Friedman and Schwartz (1963a, 41) contrast the sustained deflation in the Greenback period after the Civil War, which was not associated with economic stagnation, with the deflation that accompanied the return of Britain to the gold standard in the 1920s and was associated with economic stagnation. Friedman (1963 [1968], 46-7 and 1968 [1969]) associated the real effects of inflation with the transition period during which expectations adjusted to a change in inflation.

3 Friedman (1953b, 165) wrote, “If internal prices were as flexible as exchange rates, it would make little economic difference whether adjustments [to the terms of trade] were brought about by changes in exchange rates or by equivalent changes in internal prices. But this condition is clearly not fulfilled.
For example, economists must evaluate the standard assertion by policymakers that monetary policy is countercyclical rather than procyclical in recession because interest rates are cyclically low.

It is convenient for economists to use regression analysis in order to characterize the systematic behavior of monetary policy as a reaction function, that is, a systematic relationship between the funds rate and macroeconomic variables. Especially for purposes of model estimation and simulation, economists need an arithmetical rule that prescribes individual changes in the funds rate. Since the original paper by John Taylor (1993), the norm has been to use some variant of a Taylor rule in models as the monetary policy rule (see also Taylor 1999 and 2015). According to Taylor rules, the FOMC possesses a known benchmark interest rate and then adjusts the funds rate relative to that benchmark based on deviations of lagged inflation plus deviations of inflation from a target of 2 percent and on the output gap. As shown in Figure 1, over the interval 1987 through 2008, a form of the Taylor-rule does predict the level of the funds rate.

Unfortunately, because estimated Taylor rules are reduced forms, they are of limited use for normative evaluations of monetary policy and for the identification of shocks. With respect to the first point, note that estimated Taylor rules typically start the estimation with 1987. However, the Greenspan Fed initiated a contractionary monetary policy starting in 1988 in order to return to price stability (Hetzel 2008, Ch. 15). Taylor rules that fit over this period incorporate that contractionary policy. In the Great Recession, when instability in financial markets likely caused a sharp decline in the natural rate of interest, inertial Taylor rules capture the behavior of the FOMC but they seem especially problematic as normative guides to policy. A reduction in labor force and productivity growth in the second half of the first decade of the 2000’s probably lowered the benchmark interest rate below the 2 percent assumed in the estimation of Taylor rules. More generally, Laubach and Williams (2016) present evidence for a secular decline in the natural rate of interest.

Also, because Taylor rules are reduced forms rather than structural equations, they provide misleading implications about how the FOMC controls inflation. Because the measure of slack either in the form of an output or an unemployment gap captures the cyclical state of the economy, Taylor rules capture the relationship of the funds rate to the cycle average. The coefficient on the output gap then measures the cyclical relationship in short-term interest rates. However, the coefficient on the inflation term captures the low frequency (trend) movements between inflation and interest rates. As a result, the relationship between inflation and the funds rate disappears when the series are first-differenced (Granger and Newbold 1974).

Equation (1) displays the Taylor-rule formula that generates the predictions shown in Figure 1. In a level-form regression, the estimated coefficients come close to the “a” (inflation miss) and “b” (unemployment gap) coefficients of equation (1). In such a regression from 1987 through 2008 using the series of Figure 1, the estimated value of the coefficient “a” is .8 (13.3), which is close to the coefficient of .5 assumed in Figure 1. The estimated value of the coefficient “b,” which is -1.9 (-25.7), is also close to the coefficient of -2 assumed in the simulations of Figure 1. (The t-statistics are in parentheses). In contrast, when the regression is estimated in first differences, the estimated value of “b” is -.7 (-6.2), which is at least of the appropriate sign. However, the estimated value of the inflation coefficient “a” is -.8 (-9.2), which is of the opposite sign from the coefficient of .5 used in Figure 1.

\[ FFR = r^* + \pi + a(\pi - 2) + b(u - u^*) \]

(1)
Because Taylor rules are not structural, they may predict without explaining how the FOMC controls inflation. Does it control inflation through the regular manipulation of a Phillips curve trade-off in which the central bank can manage an output gap as part of the control of inflation? Alternatively, in the spirit of the “divine coincidence” version of the NK model, does it control trend inflation through a credible rule that shapes the way in which the firms that set prices for multiple periods (firms in the sticky-price sector) set their dollar prices? That is, in the spirit of the divine coincidence version of the NK, a credible rule provides for price stability (stable trend inflation) while allowing the price system to work unhindered to determine real variables.

More concretely, during baseline periods when the FOMC tracks the natural rate of interest while stabilizing expected inflation, the FOMC does not respond directly to measured inflation. However, at the end of a tightening cycle when the economy starts to weaken, if the FOMC has become concerned that inflation is too high, it responds directly to observed inflation. As a result, it imparts inertia to downward movements in short-term interest rates in an effort to create a negative output gap and as a byproduct to lower inflation. The monetarist critique is that this interference with the price system produces the contractionary monetary policy that causes recessions.

3. Identification of shocks using estimated DSGE models

The divine coincidence version of the NK model captured the prevailing narrative during the period known as the Great Moderation. The monetary experiment run in the prior stop-go era was evident (Hetzel 2008). In the Keynesian spirit, policymakers believed that the price system worked poorly in order to maintain the aggregate demand required for full employment. Keynesians assumed that inflation had to be of the cost-push rather than the aggregate-demand variety because of the coexistence of inflation and excess unemployment held to occur when the unemployment rate exceeded the assumed full-employment level of 4 percent. In this environment, optimal policy required monetary stimulus combined with incomes polices (wage and price controls in the extreme) in order move the unemployment rate down along a Samuelson-Solow (1960) Phillips curve to a level of full employment with moderate inflation. The high and rising inflation of the 1970s combined with the experience in the Volcker-Greenspan era in which the control of inflation did not require periodic recourse to engineered increases in the unemployment rate created a general acceptance of the applicability of the divine-coincidence version of the NK model. With the financial crisis of the Great Recession any such consensus has disappeared.

Nevertheless, within the framework of the NK model, given the simultaneous decline in inflation and output in 2009, monetary policy had to have been contractionary. In addition, given the subsequent persistent decline in inflation, monetary policy had to have been contractionary. No doubt after the Lehman bankruptcy, there was some disruption to financial intermediation. However, central banks should then have missed their output and inflation targets on the positive side. Within the context of the NK model, adding an additional friction in the form of a financial friction creates an additional objective in the objective function of the central bank. The central bank should go beyond tracking the natural rate of interest and trade off among objectives (Carlstrom et al 2010). Optimal policy in a financial crisis would require missing the inflation and output objectives on the upside not on the downside as occurred in the Great Recession.

Of course, the holy grail of macroeconomics remains a structural model of the economy that can both identify and provide numerical substance to the shocks that produced the Great Recession. By this standard, the monetarist statement that the Great Recession is just one more observation consistent with the hypothesis that contractionary monetary policy accompanies recession seems
unsatisfactory. While recognizing the contribution of estimated DSGE models, it is also important to recognize how little evidence they provide for the nonmonetary causes of the Great Recession.

Faust and Gupta (2011, 27 and 35-6) highlight the weakness of estimated DSGE models as mechanisms for identifying shocks.

Recessions in the post-War sample, according to the model, were a collective freak occurrence of abnormally large and abnormally correlated shocks occurring systematically with a periodicity corresponding roughly to that of business cycles…. Perhaps the most dominant aspect of the story the SW [Smets-Wouters] model tells of post-War business cycles is the following: business cycles of the variety observed were a collective black swan. Taken literally, the main message to policymakers should be to prepare for something else because the existing sample tells us little about the fluctuations we will see in the future.

In order to understand the difficulty of using estimated DSGE models in order to distinguish monetary from financial-friction shocks, consider an NK model without financial frictions. Demand shocks enter into the consumer Euler equation and generate a time-varying wedge between the risk-free real rate of interest and the intertemporal rate of substitution in consumption of the household. For example, the natural rate of interest declines in response to an intertemporal preference shock that causes households to value current consumption less highly than future consumption.

It is natural to interpret demand shocks as savings shocks. For example, at the existing interest rate, a positive savings shock causes households to want to transfer additional consumption from the present to the future. Correspondingly, it increases the demand for the risk-free asset. In order to neutralize the impact on the economy, the central bank should lower the policy rate in line with the natural rate. Keeping the real rate equal to the natural rate maintains the output gap equal to zero. It then satisfies the increased demand for the risk-free asset through additional supply. In particular, with an interest-rate target, an increased demand by households for the risk-free asset is met automatically by an increased supply of insured deposits.

Plausibly, the Lehman bankruptcy on September 15, 2008 produced a significant decline in the natural rate of interest. However, if the central bank imparts inertia to declines in the policy rate, monetary policy becomes contractionary. Despite the problems referred to above, inertial Taylor rules do capture this aspect of FOMC behavior. The existence of nominal rigidities then requires that real income decline in order to offset an increased demand for the risk-free asset. Ideally, an estimated model would track a divergence of the natural rate from the real rate of interest associated with a change in the expected output gap. In the NK model, the real rate equals the natural rate plus the expected change in the output gap (times the reciprocal of the intertemporal rate of substitution in consumption). Unfortunately, economists possess minimal ability to forecast productivity growth and thus minimal ability to model and forecast output gaps and their changes. It is probably best to

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4 Modelling risk in a linear model is problematic because risk concerns tail outcomes captured by higher order moments of the correlation between expected rates of return and consumption (see Guvenen et al 2014).

5 For the United States, over the period 2008Q1 through 2009Q1, Gali et al (2012) estimated a decline of about 6 percentage points for the output gap and 12.5 percentage points for the natural rate of interest. Numbers kindly supplied by Rafael Wouters.
view the expected change in the output gap in NK models as a proxy for changes in households’ and investors’ optimism (pessimism) about the future.

The financial crisis has generated interest in DSGE models with financial frictions such as Christiano, Motto, and Rostagno (2010 and 2013), CMR. A financial-accelerator mechanism amplifies the effect of macroeconomic shocks through an external finance premium that varies negatively with firms’ net worth. The belief that the productivity of firms has become more dispersed exacerbates default risk, which is captured by a shock to firms’ external finance premia. Such models express the idea of a financial crisis.

Estimation of the NK model reveals how hard it is to distinguish between shocks that reflect disruption to financial intermediation and shocks that reflect monetary disorder, that is, central bank interference with the operation of the price system. Neither shock is directly observable while both manifest themselves through increased uncertainty in financial markets. In a model with financial frictions, a credit-risk shock that depresses investment increases consumption (see for example, Kollmann et al 2016, Fig. 3e). In order to achieve the positive correlation between consumption and investment that characterizes recessions, models that include financial frictions also include demand shocks. As noted above, however, with demand shocks, the central bank can neutralize the impact on the real economy by following the change in the natural rate with the policy rate. In assessing monetary policy during the Great Recession, it is not informative to look at shocks to the policy function (Taylor rule). One needs to perform the counterfactual simulation in which the central bank follows the natural rate of interest.

4. Organizing the data: the monetarist view

As discussed in Section 1, the identification strategy followed by Friedman falls into the category of chained event students. Romer and Romer (1989) continued that tradition and, more recently for the United Kingdom, so have Cloyne and Hürtgen (2016). Price fixing furnishes the appropriate analogy. Central bank interference with the market determination of the real rate of interest for one of the reasons detailed in section 1 produces an excess demand in the bond market. Maintaining the real rate above the natural rate produces an excess demand for bonds, which requires that the central bank sell bonds and as a consequence destroy money. Similarly, maintaining the real rate below the natural rate produces an excess supply of bonds, which requires that the central bank buy bonds and as a consequence create money.

As long as a stable, interest-inelastic demand for money existed, monetary decelerations and accelerations flagged this interference. Most famously, Friedman and Schwartz (1963b) showed that monetary contractions predicted cyclical peaks. Figures 2 and 3 show annualized M1 growth rates. Following Friedman and Schwartz (1963b), as a visual aid to seeing the alternating intervals of “low” and “high” growth rates, the figures fit step functions to the monthly observations. Starting in 1981, however, money growth ceased to offer a straightforward measure of the stance of monetary policy.6

6 In 1981, the phasing out of Reg Q, which fixed the rates on bank time deposits below market rates, caused real M1 demand to become interest sensitive. As a result, it gives off misleading signals about the stance of monetary policy by strengthening when the economy weakens and vice versa. Also, in periods of financial stress, M1 grows rapidly as market participants seek liquidity. More generally, by endowing debt instruments with liquidity, innovation in financial markets has obscured the moneyness represented by various monetary aggregates. Finally, there are pure measurement issues.
During the stop-go era, monetarist narrative emphasized the cyclical inertia in the adjustment of the funds rate as the source of procyclical money growth (see Poole 1978, 105). Friedman (1984, 27) wrote:

Rising concern about inflation, and growing recognition of the role played by monetary growth in producing inflation, led Congress in 1975 to require the Federal Reserve to specify targets for monetary growth.... In practice, it continued to target interest rates, specifically the federal funds rate, rather than monetary aggregates, and continued to adjust its interest rate targets only slowly and belatedly to changing market pressure. The result was that the monetary aggregates tended on average to rise excessively, contributing to inflation. However, from time to time, the Fed was too slow in lowering rather than raising the federal funds rate. The results were a sharp deceleration in the monetary aggregates and an economic recession.” (italics added)

This combination of a weakening of the economy prior to cyclical peaks along with high cyclically real rates of interest going into the recession characterized monetary policy in both the pre-1981 and post-1981 periods. Prior to cyclical peaks, the FOMC departs from its baseline “lean-against-the-wind” procedures by not lowering the funds rate as the economy weakens. It does so out of concern for inflation (the value of the dollar in 1960). Figures 4 to 7 document the weakening of the economy prior to cyclical peaks. Figures 4 and 5 show that weakness in real GDP growth precedes cyclical peaks. Figures 6 and 7 fit a trend line to real personal consumption expenditures from peak to peak for a given cycle. (A single trend line is fitted to the short 1980 recession and the 1981-1982 recession.) They then show how consumption weakens relative to trend prior to cyclical peaks. Figures 8 to 10 document the cyclical lag at peaks in the decline in the real rate of interest.

Although the real rate of interest falls in recession, once past the cycle peak, the magnitude of the output gap increases rapidly in response to the inventory cycle. Standard Fed rhetoric is that because interest rates are at cyclical lows during recessions, monetary policy is easy. However, the relevant characteristic of policy is the inertia the FOMC imparts to the funds rate prior to the cycle peak while the economy weakens. Although the FOMC never talks in terms of trade-offs, effectively at these times it was trying to create a negative output gap in order to lower inflation.

After the mid-1990s, the Fed did not record the amount of deposits removed from bank balance sheets by swap arrangements and did not record the deposits moved offshore in order to avoid FDIC premia. In 2011, the combination of low interest rates and a change in how the FDIC calculated its insurance premia caused banks to put these “missing” deposits back on their balance sheets.

Fève et al (2009, 13) repeat for Europe the monetarist critique contained in the above references to Friedman (1984) and Poole (1978): “[T]he form of monetary policy, namely monetary policy inertia, has played an important role in the large and persistent increase of the real interest rate and the sizeable output losses that have followed from disinflation policies of the eighties.”

Figure 8 uses inflation forecasts from the Livingston survey, which are biannual and become available in 1946. Figure 9 uses inflation forecasts contained in the Board of Governors staff document called the Greenbook prepared before FOMC meetings. They first became available in November 1965 and correspond to FOMC meetings.

In the pre-World War II period, the analogue was the Fed’s use of discount rate increases followed by downward cyclical inertia as the economy weakened in order to lower prices (commodity prices
Figures 11 and 12 give purposeful content to FOMC behavior. Going into recessions, inflation (the sold line) is at a cyclical high. Examination of FOMC transcripts shows that the priority of the FOMC at these times was to reduce inflation (Hetzel 2008, 2012; Romer and Romer 1989). As a consequence, the FOMC raised the funds rate until the economy weakened as illustrated by the way in which consumption fell below trend (dashed line). It then maintained a cyclically high rate while the economy weakened in order to create a negative output gap. Over the course of the recession, the real rate (diamonds) declined. With the exception of the recovery from the July 1981 to November 1982 cyclical contraction, during the economic recovery short-term real interest rates fell to zero. However, by then it was too late to undue the effects of contractionary monetary policy.

The criteria used above in order to associate contractionary monetary policy with the onset of recession provide causal substance to the common practice of using the yield curve as a predictor of recession. As illustrated by Estrella and Trubin (2006), forecasters associate a flattening of the yield curve with an increased probability of recession. Figure 13, which displays the difference between the 10-year bond rate and the 3-month bill rate along with NBER recession shading, illustrates the association. However, as shown in Wright (2006), what predicts recession is the combination of a flattening of the yield curve and a cyclically-high short-term interest rate, as evident in Figures 4-7. Of course, in themselves, these leading indicators say nothing of causation.

A monetarist attribution of causation emerges by assuming that the pragmatically-developed procedures during the first part of the tenure of William Mc Chesney Martin as FOMC chair, which Hetzel (2008, 2012) terms “lean-against-the-wind (LAW) with credibility,” can track the natural rate of interest. In a measured, persistent way, the FOMC raises the funds rate above its prevailing value when output grows at a sustained rate in excess of potential (rates of resource utilization are increasing and the unemployment rate is falling), and conversely in the case of sustained economic weakness. In periods of economic recovery, output grows in a sustained way above trend. The FOMC then assesses whether the upward slope in the yield curve and implied rise in forward rates is an adequate guide to maintaining growth at a gradually declining rate consistent with a return to steady growth that no longer reduces rates of resource utilization (Hetzel 2016).

Although the FOMC does not use the language of trade-offs, the FOMC departs from its standard LAW procedures prior to cycle peaks. At the end of a tightening cycle, the economy weakens. If the FOMC is concerned about inflation, it imparts inertia to downward movements in the funds rate in order to create a negative output gap.

5. The Great Recession

During the Great Recession, monetary policy followed the pattern of earlier recessions. The difference was that the unacceptably high inflation in 2007 and 2008 emerged not from prior monetary expansion but rather from a prolonged inflation shock. Illustrative of the increase in commodity prices, Figure 14 shows the sustained rise in the real price of oil that began in summer 2004 and peaked in summer 2008. Figure 15 shows how the inflation shock pushed headline inflation above core inflation in this period.

or equity prices) considered as elevated through speculative excess (Friedman and Schwartz 1963a; Hetzel 2008 and 2012).
One characteristic of the Great Recession was the almost simultaneous occurrence of business cycle peaks in the developed countries. An explanation for this common behavior is the similar response of central banks to the prolonged inflation shock. Concerned about losing credibility and comparably to the stop phases of past recessions, the central banks of the developed countries kept interest rates at cyclical highs while their economies weakened in order to create a negative output gap that would restrain headline high inflation. As shown in Figures 16 and 17, both the Eurozone and the United Kingdom kept real interest rates at cyclically high levels going into the recession (Hetzel 2013).

Because the NK model exposited in Aoki (2001) contains both a flexible-price sector and a sticky-price sector, it facilitates discussion of how monetary policy became contractionary in the Great Recession in response to the huge inflation shock that lasted from mid-2004 to mid-2008. In order to allow the price system full freedom to determine relative prices, central banks should have allowed headline inflation to rise above core inflation. That is, they should have confined policy to stabilizing policy in the sticky-price sector. Aoki (2001, 75) summarized:

[S]uppose there is an increase in the price of food and energy … putting an upward pressure on aggregate inflation…. The central bank could respond with a sharp contractionary policy and reduce aggregate demand by a large amount so as to decrease prices in the sticky-price sector…. However, our model shows that such a policy is not optimal. The optimal policy is to stabilize core inflation.

Starting with the June 2004 meeting, the FOMC raised the funds rate from a cyclical low of 1 percent to a cyclical high at the June 2006 meeting of 5.25 percent. Typically, at the end of a tightening cycle, the funds rate has reached a point at which the economy weakens. Two phenomena combined to make monetary policy unusually restrictive. On the one hand, several forces came together to create pessimism among households and plausibly to lower the natural rate of interest. On the other hand, the commodity-price shock that lasted through summer 2008 pushed headline inflation well above core inflation. Out of fear of destabilizing expected inflation, the FOMC became unwilling to lower the funds rate aggressively.

By summer 2007, the high rate of inflation due to the extended commodity price shock had depressed real disposable income and growth in consumption weakened correspondingly (Figure 18). Temporary factors made it appear that the economy was stabilizing in 2008Q2. A decline in net exports boosted GDP. The enormous boost to disposable income provided by the Bush tax cuts temporarily halted the decline in real personal consumption expenditures that had begun in December.

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10 Bacchetta and Wincoop (2016) argue that the world-wide practically simultaneous occurrence of the Great Recession originated in a universal self-fulfilling panic. They do not consider the common behavior of central banks.

11 Clarida, Gali, and Gertler (1999) add a markup shock to the Phillips curve in order to present the central bank with a trade-off and move away move away from divine coincidence. Markup shocks arise out of changes in the extent of monopoly power of firms in the sticky-price sector and affect the monopoly power of firms without affecting real marginal cost (Blanchard and Gali 2007, 39; Woodford 2003, 451-2). They do not reflect inflation shocks coming from the flexible-price sector.
2007 (Hetzel 2012, 213). However, as shown in Figure 19, the pessimism of households continued unabated.

In addition to the shock to real disposable income produced by the commodity price shock, a decline in house prices depressed household wealth. Mian and Sufi (2010, 2011) document how this decline affected the consumption of credit-constrained households (households with low FICO scores). Figure 21 shows an index of real house prices and the growth rate of real personal consumption expenditures. Between 1997Q1 and 2006Q1, real house prices rose by 58 percent. From 2006Q1 until the start of the recession in 2007Q4, they fell by 12.1 percent. Again, it is plausible that an increase in households’ pessimism about the future lowered the natural rate of interest.

The peak of the business cycle occurred in December 2007. The FOMC had started lowering the funds rate from its cyclical peak of 5.25 percent at its September 2007 meeting out of concern that a disruption to the flow of credit to mortgage markets would weaken growth. Following its lean-against-the-wind procedures, it lowered the funds rate to 2 percent at its April 2008 meeting. However, at that meeting, the FOMC signaled an end to the easing cycle. The FOMC became concerned about the persistent overshoot in its inflation target and also about depreciation of the dollar. Its communication delivered the message that the easing cycle was over so that the next move in the funds rate was likely to be upward.

12 The following figures are for annualized growth rates of monthly real PCE:

<table>
<thead>
<tr>
<th>Period</th>
<th>Growth Rate</th>
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<tbody>
<tr>
<td>12/2007 – 2/2008</td>
<td>-1.9%</td>
</tr>
<tr>
<td>3/2008 – 5/2008</td>
<td>1.7%</td>
</tr>
<tr>
<td>6/2008 – 9/2008</td>
<td>-3.8%</td>
</tr>
<tr>
<td>10/2008 – 12/2008</td>
<td>-4.5%</td>
</tr>
</tbody>
</table>

The pause in these negative growth rates in the months of March, April, and May came from the boost to income from the tax cut, which President Bush signed into law on February 12, 2008. The actual rebates arrived in the month of May, but households anticipated their arrival. Real personal disposable income increased at an average monthly rate of $12.1 billion over the months January 2007 through September 2007; at the average rate of $6.6 billion over the months October 2007 through April 2008; and then jumped by $562.1 billion in May 2008.

13 For the United States, the interest sensitivity of money demand eliminates the leading indicator property of money for the Great Recession. Figure 20 displays M2 growth and the opportunity cost of holding M2. Given the sharp drop in the opportunity cost of holding M2 starting in 2007, the stability of M2 growth in 2007-2008 indicates contractionary monetary policy. M2 growth should have increased rapidly. From January 2007 through September 2008, the opportunity cost of holding M2 fell by 2.8 percentage points. Hetzel (2008, Table 14.1) estimated an (semi-log) interest elasticity of demand for real M2 of 1.6. Real M2 demand then increased by 4.5% while M2 increased by 10.6% over this 19 month interval. Assuming the long-run historical value of M2 velocity of one, these figures are consistent with annualized growth in nominal GDP of only 3.1% [(10.6 – 4.5) = 6.1% with 6.1 taken to the 12/19 power]. For a sophisticated study of M2 demand, see Anderson et al (2015).
That communication appears in Figure 22. For observations the day following an FOMC meeting, it plots the difference between the 3-month (6-month) Treasury bill rate and the funds rate target. The difference is positive when markets expect the FOMC to raise the funds rate. In this situation, markets believe that the FOMC wants to restrain growth. Conversely, a negative difference indicates a market belief that the FOMC wants to boost growth through funds rate reductions. The series declined after the May 9, 2007 FOMC meeting and declined significantly after the September 18, 2007 FOMC meeting. At the April 30, 2008 meeting, the FOMC lowered the funds rate from 2.25 percent to 2 percent. However, in line with the messages sent by the FOMC about the likely direction of the next move in the funds rate, as shown in Figure 22, the yield curve jumped after April 2008 FOMC meeting. (See appendix: Communicating an end to the easing cycle.)

6. A graphical overview of monetary policy in 2008

Figures 23 and 24 offer a summary view of monetary policy leading into the Great Recession. Figure 23 is a construct for the path of “potential nominal GDP” assuming an inflation target of 2 percent. The underlying path for potential real GDP uses real GDP in 2005Q4 as a base. That base value is updated each quarter using Board of Governors staff Greenbook estimates of potential real GDP growth (for first FOMC meeting of a quarter). The path for potential nominal GDP adds 2 percentage points—the assumed inflation target. Figure 24 is the nominally-unadjusted path for potential real GDP.

Figures 23 and 24 also show “actual” contemporaneously-available values taken from the Philadelphia Fed real-time data set and measured with a one-quarter lag. Nominal GDP follows the benchmark path until 2008Q4, which reflects the decline shown for 2009Q1. In contrast, real GDP began to drop below its path in a persistent way in 2008Q1, which corresponds to the fall off shown for 2008Q2. The interpretation is that the FOMC attempted to maintain steady GDP growth by trading off slack in the economy against a reduction in high headline inflation.

7. Learning about the nature of the monetary standard

Hetzel (2016) wrote:

The creation of the Federal Reserve System corresponded closely in time to the abandonment of commodity standards in favor of paper money standards. Since 1914, the Fed has engaged in a process of trial and error over how to manage a paper standard. That process created the semi-controlled experiments that allow learning about the optimal monetary standard. However, learning is exceedingly difficult. A major reason is the difficulty in characterizing the systematic character of the policy process and its evolution. The language of discretion allows the Fed to communicate in a way that deflects political attack. Each individual policy action is defensible in terms of the economy’s contemporaneously most pressing problem. However, that language obscures the systematic nature of monetary policy and renders learning difficult. For learning to occur systematically rather than haphazardly, it is important that policy makers be explicit about their understanding of the monetary standard.
Figure 1
Taylor Rule: Actual and Estimated Funds Rate

Notes: The Taylor Rule is \( FFR = r^* + \pi + a(\pi - 2) + b(u - u^*) \). Observations correspond to FOMC meetings. FFR is the funds rate. The "neutral" interest rate \( r^* \) is 2. \( \pi \) is the 12-month percentage change in the core personal consumption expenditures price index (PCEPI) in the month prior to each FOMC meeting. Starting August 2000, core PCEPI is measured from the real-time data release archived in Alfred maintained by the St. Louis Fed. Before August 2000, when the real time figures are no longer archived, core PCEPI is measured from the currently-available data series. The inflation target is 2. \( u \) is the real-time unemployment rate as reported in the month prior to each FOMC meeting taken from Alfred. Before 1987, \( u^* \) is the current CBO estimate of the natural rate of unemployment. From 1987 to 2010, \( u^* \) is the natural rate of unemployment (NAIRU) estimated by the staff of the Board of Governors taken from the Philadelphia Fed Real Time Data Research Center. Thereafter, \( u^* \) is the midpoint of the range of the FOMC Survey of Economic Projections (SEP) for the longer run unemployment rate. FFR is from Haver Analytics. The inflation gap coefficient "a" is 0.5 and the unemployment gap coefficient "b" is -2 and is taken from Yellen (4/11/2012), fn. 15. The form of the modified Taylor rule is from Taylor (1999).

Figure 2
M1 Step Function and Recessions: 1906-1945

Notes: Series are a three-month moving average of the annualized monthly money growth rates and a step function fitted to monthly annualized growth rates of money. Step function before May 1907 uses annual growth rates based on June observations of M2 from 1900-1907. Observations for money from June 1900 to May 1914 are for M2; observations from June 1914 to December 1945 are for M1. Data are from Friedman and Schwartz (1970). Shaded areas indicate NBER recessions. Heavy tick marks indicate December.

Notes: The M1 steps are an average of the annualized quarterly M1 growth rates. In 1981, M1 is "shift adjusted" (Bennett 1982). Real output growth is 4-quarter percentage changes in real GDP. Quarterly annualized real GDP is annualized quarterly growth rates. Shaded areas indicate NBER recessions. Heavy tick marks indicate fourth quarter.
Figure 5
Real Output Growth

Notes: Real output growth is 4-quarter percentage changes in real GDP. Quarterly annualized real GDP is quarterly annualized growth rates. Shaded areas indicate NBER recessions. Heavy tick marks indicate fourth quarter. Source: Haver Analytics.

Figure 6
Real Personal Consumption Expenditures and Cycle Trend

Notes: Observations are the natural logarithm of monthly observations of real personal consumption expenditures normalized using the value at the prior business cycle peak. Trend lines are fitted to these observations between peaks in the business cycle. The trend lines are extended through the subsequent recession. Shaded areas indicate NBER recessions. Heavy tick marks indicate December. Source: Haver Analytics.
Figure 7
Real Personal Consumption Expenditures and Cycle Trend

Notes: Observations are the natural logarithm of monthly observations of real personal consumption expenditures normalized using the value at the prior business cycle peak. Trend lines are fitted to these observations between peaks in the business cycle. The trend lines are extended through the subsequent recession. Shaded areas indicate NBER recessions. Heavy tick marks indicate December. Source: Haver Analytics.

Figure 8
The One-Year Market Interest Rate on Government Securities and the Corresponding Real Rate of Interest

Notes: The market rate of interest is monthly observations of the yield on U.S. government securities from "Short-Term Open Market Rates in New York City" in Board of Governors (1976), Banking and Monetary Statistics, 1941-1970. Through July 1959 the series uses "9- to 12- month issues." Thereafter, it uses "one year Treasury bills." The series for the real rate of interest is the market rate minus predicted CPI inflation from the Livingston Survey. See notes to Figure 4.4 (Hetzel 2008). Shaded areas demarcate recessions. Heavy tick marks indicate the November observation of the market interest rate.
Figure 9
Short-term Real Treasury Bill and Commercial Paper Rate

Notes: The real interest rate series is the commercial paper rate minus inflation forecasts made by the staff of the Board of Governors before FOMC meetings. Before January 1980, the inflation forecasts are for headline inflation. Thereafter, they are for core inflation. For a description of the series, see “Appendix: Real Rate of Interest.” Shaded areas indicate NBER recessions. Heavy tick marks indicate December FOMC meeting.
Figure 10
Output Gap and Real Rates of Interest

Notes: The output gap is the logarithm of real final sales to domestic purchasers minus the logarithm of potential output measured by the Congressional Budget Office. The real interest rate series are the commercial paper rate or the Treasury bill rate minus core inflation forecasts made by the staff of the Board of Governors before FOMC meetings. For a description of the series, see "Appendix: Real Rate of Interest." Shaded areas indicate NBER recessions. Heavy tick marks indicate fourth quarter.

Figure 11
Deviation of Real PCE from Cycle Trend, Real Interest Rate, and Inflation: 1966-1982

Notes: Deviation of Real PCE from Cycle Trend is the difference between the actual values and trend lines shown in Figure 5. Inflation is twelve-month percentage changes in the personal consumption expenditures deflator. The Real Interest Rate is the commercial paper rate minus inflation forecasts made by the staff of the Board of Governors shown in Figure 8. Shaded areas indicate NBER recessions. Heavy tick marks indicate December. Source: Inflation data from Haver Analytics.
Figure 12
Deviation of Real PCE from Cycle Trend, Real Interest Rate, and Inflation: 1983-2009

Notes: Deviation of Real PCE from Cycle Trend is the difference between the actual values and trend lines shown in Figure 6. Inflation is twelve-month percentage changes in the personal consumption expenditures deflator. The Real Interest Rate is the commercial paper rate minus the inflation forecasts made by the staff of the Board of Governors shown in Figure 8. Shaded areas indicate NBER recessions. Heavy tick marks indicate December. Source: Inflation data from Haver Analytics.
Figure 13
Treasury Yield Spread: 10-year bond rate minus 3-month bill rate

Notes: Monthly observations of the difference between the 10-year bond rate and the 3-month bill rate. Shaded area indicate NBER recessions. Heavy tick marks indicate December. Data from U.S. Treasury via Haver Analytics and Board of Governors of the Federal Reserve System.

Figure 14
Real Price of Oil

Notes: Monthly observations of the West Texas intermediate crude oil spot price per barrel deflated by the personal consumption expenditures price index. Data from the Wall Street Journal and Commerce Department via Haver Analytics. Shaded areas indicate NBER recessions. Heavy tick marks indicate December.
Figure 15
Headline and Core PCE Inflation

Notes: Monthly observations of 12-month percentage changes in the personal consumption expenditures deflator. Heavy tick marks indicate December. Source: Haver Analytics.

Figure 16
Real ECB MRO Interest Rate and Real Euribor Interest Rate

Notes: Quarterly observations of real ECB MRO (main refinancing operations) and real one-year Euribor interest rates are constructed by subtracting one-year ahead inflation forecasts from ECB Survey of Professional Forecasters mean point estimates. Shaded areas mark recessions with cycle peaks 2008Q1 and 2011Q1. Heavy tick marks indicate fourth quarter. Source: ECB and Haver Analytics.
Notes: Quarterly observations of the real rate of interest using as the nominal interest rate the official bank rate set by the Bank of England and the 1-year London Interbank Offered Rate. The real rate is the nominal rate minus forecasted inflation. The latter is from the Bank of England Survey of Professional Forecasters. It is corrected for a discontinuity in 2004 due to the change from the RPIX to the CPI. Source: Bank of England and Haver Analytics.

Figure 19
Income Expectation vs. Real Personal Disposable Income

Notes: Income expectation is the difference between the percentage of respondents who expect their income to increase and the percentage of respondents who expect their income to decrease for six months hence. Real personal disposable income are expressed as 12-month percentage changes. Data are monthly. Source: Consumer attitudes & buying plans from the Conference Board and real personal disposable income via Haver Analytics. Heavy tick marks indicate December.

Figure 20
M2 Growth and the Opportunity Cost of Holding M2

Notes: Monthly observations of 12-month percentage changes in M2. The opportunity cost of holding M2 is the 3-month Treasury bill rate minus the own rate of interest on M2. Heavy tick marks indicate December. Source: FRED and Haver Analytics.
Notes: Quarterly observations of FHFA (Federal Housing Finance Agency) House Price Index divided by the personal consumption expenditures (PCE) deflator and normalized using 1997Q1 as the base. Real personal consumption expenditures (PCE) are 4-quarter percentage changes. Shaded areas indicate NBER recessions. Heavy tick marks indicate fourth quarter of year. Source: Haver Analytics.

Note: The series are the difference between three-month and six-month Treasury yields and the funds rate target. Treasury yields are from Board of Governors statistical release H.15 starting January 7, 2002 and from G.13 before. Starting October 2, 2001, yields are constant maturity. Before, they are the three-month and six-month yields. Observations are for the day after an FOMC meeting. Heavy tick marks indicate December.
Figure 23
Estimates of Potential Real GDP and Actual Real GDP

Notes: The graph is constructed similarly to the one for nominal GDP without the addition of two percentage points to the potential path.

Figure 24
Estimates of Potential Nominal GDP and Actual Nominal GDP

Notes: The contemporaneously available values for nominal GDP are for the quarters prior to the dates shown and are from the Philadelphia Fed real-time data set. The path of potential nominal GDP uses as its base the contemporaneously available value of nominal GDP for 2005Q4. Initially, this value is subject to quarterly revisions. For each quarter, the Tealbook from the first FOMC meeting of the quarter is used and the estimate of potential real GDP growth for the year recorded (from the table “Decomposition of Structural Labor productivity” initially and then the table “Decomposition of Potential GDP”). Through successive quarters starting in 2006Q1, the quarterly values of these potential annual growth rates are used to update the path for potential real GDP. The potential nominal path is the potential real path plus two percentage points. No allowance is made for drift in the level. Because values are normalized using the base quarter 2005Q4 and expressed as natural logarithms, the vertical scale measures the percentage increase from the base quarter.
Appendix: Communicating an end to the easing cycle in April 2008

The message communicated to markets shifted between the March 18, 2008 FOMC meeting and the April 29-30, 2008 meeting. In the March 13, 2008 Greenbook, estimated growth in real final sales to private domestic purchasers for the entire year 2008 turned negative (-1.6 percent). The Greenbook “Current Economic and Financial Conditions. Part 1: Summary and Outlook, I-7, March 13, 2008” wrote:

We are anticipating a further retrenchment in consumer spending in the next few months: Consumer confidence has plummeted; soaring energy prices are biting into household purchasing power; the labor market is weakening; and real estate values are dropping. As a result, we expect that real PCE will be little changed in the first quarter.

At the March meeting, the Minutes (Board 3/18/2008, 7) recorded a primary concern for recession:

[M]ost members judged that a substantial easing in the stance of monetary policy was warranted at this meeting. The outlook for economic activity had weakened considerably since the January meeting, and members viewed the downside risks to economic growth as having increased. Indeed, some believed that a prolonged and severe economic downturn could not be ruled out…. [T]hey noted that, through a range of channels, lower short-term real interest rates should help buoy economic activity…. Even with a substantial easing at this meeting, most members saw overall inflation as likely to moderate in coming months….

The end-of-meeting statement for the March FOMC meeting (Board 3/18/2008, 7) read:

Inflation has been elevated, and some indicators of inflation expectations have risen. The Committee expects inflation to moderate in coming quarters, reflecting a projected leveling-out of energy and other commodity prices and an easing of pressures on resource utilization.

Going forward through the summer, contrary to the expectation for “inflation to moderate” due to a “levelling-out of energy and other commodity prices,” inflation rose. Year-over-year headline PCE inflation rose from 2.4 percent in July 2007 to 4.4 percent in July 2008 while the comparable figures for core PCE inflation were 2.2 percent and 2.5 percent, respectively.


Real personal consumption expenditures have been moving essentially sideways since late last year. With mounting job losses and outsized increases in energy prices holding down real income, falling home values cutting into household net worth, and consumer sentiment deteriorating further, we would, all else equal, expect a noticeable decline in PCE in the second quarter. However, the tax rebates are anticipated to boost the change in spending by 1½ percentage points in the second quarter, leading us to project PCE to increase at an annual rate of ¼ percent…. Abstracting from the effects of the tax rebates, real PCE is expected to remain weak throughout the year.
Nevertheless, the Minutes (Board 4/29-30/2008, 9) for the April 29-30 FOMC meetings sent a message to markets that the easing cycle was likely at an end:

[A]lthough downside risks to growth remained, members were also concerned about the upside risks to the inflation outlook, given the continued increases in oil and commodity prices and the fact that some indicators suggested that inflation expectations had risen in recent months…. [R]isks to growth were now thought to be more closely balanced by the risks to inflation. Accordingly, the Committee felt that it was no longer appropriate for the statement to emphasize the downside risks to growth…. In that regard, several members noted that it was unlikely to be appropriate to ease policy in response to information suggesting that the economy was slowing further or even contracting slightly in the near term, unless economic and financial developments indicated a significant weakening of the economic outlook.

The end-of-meeting statement repeated the language from the prior statement about the expectation for “inflation to moderate” but added the qualification: “[U]ncertainty about the inflation outlook remains high. It will be necessary to continue to monitor inflation developments carefully.”

Chairman Bernanke (2008) stated:

Another significant upside risk to inflation is that high headline inflation, if sustained, might lead the public to expect higher long-term inflation rates, an expectation that could ultimately become self-confirming….We are attentive to the implications of changes in the value of the dollar for inflation and inflation expectations and will continue to formulate policy to guard against risks to both parts of our dual mandate, including the risk of an erosion in longer-term inflation expectations.

By the time of the August 2008 meeting, the Greenbook contained the following commentary, “Considering the totality of the evidence, we continue to think that a significant weakening of activity is in train” (p. I-1). Nevertheless, the Board staff assumed that the next change in the funds rate would be an increase. “As before, we assume that the federal funds rate will remain at 2 percent over the rest of 2008 and be raised to 2 ¾% over the first half of 2009” (p. I-2). As part of the long-term outlook, the staff forecast that “the federal funds rate continues to climb to just above 4 percent by the end of 2012” (p. I-15).

Appendix: Real Rate of Interest

The short-term real interest rate is the difference between the commercial paper rate and Greenbook inflation forecasts made by the staff of the Board of Governors before FOMC meetings. The commercial paper rate is for prime nonfinancial paper placed through dealers (A1/P1). The dates for the interest rates match the publication dates of the Greenbooks. Because observations correspond to FOMC meetings, they occur irregularly within the year and starting in 1979 the frequency is less than twelve times per year. The Board staff forecasts for “core” inflation become available only in January 1980. From 1966 through 1970, the inflation forecasts are for the implicit GNP deflator. From 1971 through March 1976, they are for the GNP fixed-weight index. Thereafter, until January 1980, the forecast series used is the gross business product fixed-weight index. From January 1980 until February 1986, the gross domestic business product fixed-weight index excluding food and energy is used. Thereafter, until January 2000, the CPI excluding food and energy is used. From January 2000 onward, the personal consumption expenditures chain-weighted
index excluding food and energy is used. For additional details, see Hetzel (2008b, Ch. 4, Appendix: Series on the Real Interest Rate, Real Rate of Interest, Greenbook Forecasts).
References


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