

Four Monetary Policy Regimes

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The Federal Reserve has become more transparent about policy as it has adopted an explicit numerical inflation objective, introduced press conferences after every other meeting, used speeches and congressional testimony to give forward guidance about upcoming policy actions, revealed the economic and policy rate forecasts of the Federal Open Market Committee (FOMC) members with the release of FOMC minutes, and even shortened the delay in the release of the minutes. Still, there is an enormous amount of uncertainty about future monetary policy. The uncertainty is not a result of secrecy or poor communication. Rather, it is simply that the Federal Reserve has not decided what it wants to do about the size of the balance sheet (all due to large excess reserves) or the procedure for implementing interest rate decisions. Also, the dynamics of the economy appear to be different. The perceived inability to forecast GDP growth or inflation during recent years is troubling to all decision-makers, in both government and private sectors.

Since ‘liftoff’ of the fed funds rate from near zero, the Federal Reserve is going through a change in policy regime in a deliberate fashion. The problem is that the market and Fed have become comfortable with some aspects of the post crisis policy, especially the large balance sheet and an operating procedure that is linked directly to the interest rate that the Fed pays on bank reserves. The Fed did not pay interest on reserves before October 2008. Paying interest on reserves was necessary in order to prevent runaway inflation that could be caused by the unprecedented amount of excess reserves. Since December 2008, the interest rate paid on reserves has been 20 to 25 basis points above the interest rate paid on 3-month Treasury bills. Returning to the old normal, before the financial crisis, would require reducing the amount of excess reserves, and possibly eliminating interest payments on excess reserves.

The deliberate fashion reflects the Fed trying to learn about how the market will respond to raising the interest rate and reducing the balance sheet. Eventually, the committee will make decisions that will reveal a new policy regime. What will it be? Will the Fed return to the interest rate procedure that was used before the financial crisis? Are recent increases in short-term interest rates only temporary until the next recession when, again, we find ourselves at the zero lower bound? Or will we move on to a new regime with a new operating procedure?

These are important issues that can be better understood by reviewing the history of U.S. monetary policy regimes. This paper describes four distinct regimes implemented by the Federal Reserve since the mid-1960s. Each monetary policy regime was associated with different policy objectives, different operating procedures, and different statistical patterns in the data.

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The first policy regime considered is the inflationary regime that followed the collapse of the system of fixed exchange rates `adopted at Bretton Woods, New Hampshire in 1944, an international monetary system anchored by a fixed-dollar price for gold. As that system deteriorated, credibility for price stability in the U.S. dollar eroded and U.S. inflation became to be perceived as an important policy problem. This first regime, the ‘Great Inflation,’ was implemented with an interest rate targeting procedure.

The crisis in dollar and worldwide inflation led our second monetary policy regime, the ‘Volcker Reform,’ initiated by Fed Chairman, Paul Volcker. This was a short-lived regime in which M1 targeting replaced interest rate targeting and interest rates soared to double digit levels with a dramatic increase in interest rate volatility. The regime was short-lived, but effective in promoting credibility for a low inflation outcome.

In October 1982, the Fed abandoned the M1 targeting procedure and adopted an indirect form of interest rate targeting. The method used to implement interest rate targeting evolved over the next decade, becoming more explicit after 1987 when Alan Greenspan replaced Paul Volcker as head of the Fed. Monetary policy during this third policy regime was praised by policymakers, business leaders and academic researchers because of the low volatility in both output and inflation. Stock and Watson (2002, page 162) coined the term ‘great moderation.’ Bernanke (2004) popularized the term and attributed the relative stability of output growth and inflation to, among other things, good monetary policy. The benefits of this Great Moderation regime were not questioned until the onset of the 2008 financial crisis.

With the onset of the crisis, the Fed abruptly switched to our fourth monetary policy regime, one with a zero interest rate policy (ZIRP). In rescuing counterparties to the bankrupt Lehman Brothers Holding Company, the Fed flooded the market with about \$600 billion in excess bank reserves and drove the fed funds rate toward zero. On December 16, 2008, the FOMC voted to set the bottom of the 25 basis point target range for the federal funds rate at zero. It also adopted unconventional policies known as Quantitative Easing (QE) and forward guidance that were intended to keep money market interest rates near zero for an extended period.² Although the Fed has a target range for the federal funds rate, the actual policy rate set by the Fed is the interest rate on reserves (IOR). As it turns out, the period with the IOR set at the top of the Fed funds target range (25 basis points) extended to exactly 7 years. I refer to this policy regime as a zero interest rate policy (ZIRP) regime.³

The FOMC has begun a transition to a new policy regime or perhaps a return to an old one. It seems possible that by using a floor system to peg the interest rate in the presence of a large balance sheet, the Fed will be able to maintain many properties of the ZIRP regime even as it raises interest rates. In my opinion, the FOMC appears to be searching for a way to operate

² See Fawley and Neely (2013) for a detailed discussion of Quantitative Easing.

³ The ZIRP regime is a ‘floor system’ in which the IOR was 25 basis points. Note that Treasury bills and the federal funds rate traded below that rate often near zero. See Gagnon and Sack (2014) for a discussion of this operating procedure.

policy that will maintain relative certainty about the bank cost of funds in the short-run. They change the rate gradually and broadcast expected changes well in advance.

A Brief History of Four Monetary Policy Regimes

This paper characterizes the monetary regime by two properties: 1) by the weight policymakers put on price stability relative to their concern about output stabilization, and 2) by the day-to-day procedures used to implement policy. The four regimes are:

1) *Great Inflation*: January 1965 to October 1979, a period with an interest rate targeting procedure and a rising trend in both inflation and interest rates. Little concern is shown for price stability.

2) *Volcker Reform*: October 1979 to October 1982, a short period in which a money supply (M1) targeting procedure was used to stop the acceleration of inflation and earn credibility for the price objective. Little concern was shown for output stabilization policy.

3) *Great Moderation*: October 1982 to December 2008, a period in which the Federal Reserve used interest rate targeting procedures to maintain the low level of inflation that was achieved in the second regime. The concerns were about evenly divided between price stability and output stabilization as revealed in the Taylor-type interest rate rules used to describe policy during this period.

4) *ZIRP*: December 2008 to December 2015, a seven year period in which the target range for the federal funds rate was pegged at 0 to 0.25 percent. The pegging at zero was natural as the market was flooded with trillions of dollars of excess reserves. The main concern was output stabilization as output appeared to grow along a path that was considered to be well below the potential for GDP. There was little concern about inflation because the observed inflation trend stayed below the Fed's desired objective.

We study these four episodes, briefly describing the operating procedure and documenting statistics that are important for estimating cyclical and inflation dynamics. We find important and predictable differences in dynamic patterns across the four separate regimes.

The data. We study 4 monthly economic indicators over the period from January 1965 to December 2015. They include the effective federal funds rate (FF), the yield on 10 year Government Securities ($GS10$), the year-over-year inflation in the Consumer Price Index (CPI) and the growth rate of real per capita personal consumption expenditures ($Cdot$). The fundamental policy goals involve inflation and real economic activity, hence the inclusion of CPI and $Cdot$. The policy instruments are FF and $GS10$. Once FF hits the zero lower bound, then the FOMC used balance sheet policies to lower rates on long-term assets represented here by $GS10$.

We also look at some combinations of these 4 indicators: the spread between the two interest rates, $FF-GS10$ ($Spread$), the ex post real federal funds rate, $FF-CPI$ (rFF), the ex post real 10 year bond rate, $GS10-CPI$, ($rGS10$), and the gap between the real federal funds rate and the real per capita growth rate of consumption, $rFF-Cdot$ ($Rgap$). The spread between the fed funds rate and the long bond rate has often been used as an indicator of the stance of monetary

policy. Since it is the real rates that go into the theoretical models, real versions of these policy instruments are also included. The *Rgap* variable is based on consumption growth because modern models in macroeconomics and finance generally include an equilibrium condition that makes the risk-free real interest rate converge approximately to real per capita consumption growth.

The Great Inflation

The Great Inflation began with the collapse of the dollar-gold standard established at Bretton Woods.⁴ Much has been written about why the inflation became such an important policy problem. Nelson (2005) blamed the policy community for not understanding the role of money in causing inflation, instead viewing inflation as being caused by supply shocks and excess demand for labor and goods in a Phillips Curve framework. Delong (1997) argued that the Phillips Curve framework was fine, but that the Fed used error ridden measures potential output and real interest rates that caused them to keep interest rates too low, too often. Sargent (2002) argued that the problem was the Phillips Curve framework applied by policymakers that were ignoring modern advances in macroeconomic theory.⁵ Figure 1 shows that the year-over-year inflation rate rose from around 2 percent in 1965 to above 13 percent in 1980. Whatever the cause, the rapid deterioration of the value of the dollar discredited the Keynesian policy framework.

Figure 2 depicts interest rates. During the Great Inflation, the relationship between FF and GS10 displays three distinct features. First, both interest rates display rising trends and, on average, are roughly equal; the federal funds rate was just 28 basis points below the 10-year bond rate (See Table 1 for regime averages). Second, the policy rate was sometimes as much as 2 percentage points higher or lower than the bond rate. Third, periods with a relatively low policy rate were followed by higher inflation and inflation expectations, reflected in rising bond rates. Also periods with a relatively high policy rate were followed by lower inflation and recession.

The lack of credibility made setting the policy rate above the bond rate necessary in order to reduce inflation expectations. When the FOMC raised the policy rate too slowly, inflation expectations would rise to match the rise in the interest rate, and there was no dampening effect on either the economy or inflation. The lack of credibility meant that to succeed in lowering inflation, the FOMC had to raise the policy rate high enough to slow the economy. This led to a belief that raising interest rates would likely lead to recession. A corollary to this idea was that low interest rates would end the recession and stimulate both inflation and economic expansion. What has not been generally recognized is that these dynamic relationships came to be part of conventional wisdom in macroeconomics during a time when the Fed had no credibility for its inflation objective. High inflation challenged this conventional wisdom and discredited the Phillips Curve as a policy framework. This public view gave Fed Chairman Paul Volcker the

⁴ See Mayer (1980) who reviews the history of U.S. financial policy from the end of WWII to 1980. He documents the policies and actions taken by the United States that led to inflation and the collapse of international monetary system set up at Bretton Woods. There were signs that the system could not be sustained as early as 1961.

⁵ For perhaps the best theatrical and empirical analysis of this issue, see two articles by Cogley and Sargent (2001, 2005).

cover to squash inflation, causing very high interest rates in a three year period that included two recessions separated by a very short expansion.

The Volcker Reform⁶

Figure 1 shows that inflation dropped rapidly from double digits in 1980 to around 3 percent by the end of 1982. Figure 2 shows that the average federal funds rate was much higher overall and relative to the long bond rate during the Volcker Reform than in any other period. Inflation came down quickly, but interest rates stay high throughout this regime and well into the next. Because this extreme policy disrupted the economy, consumption growth was much lower in this regime than in any other (See Figure 3 and Table 1).

The Fed used an indirect form of money supply targeting to implement the reform. By targeting the money supply, the Fed could rightly say that it was not setting high targets for interest rates, just implementing a growth path for money consistent with ending inflation.⁷ It was the market setting interest rates. However, the policy did not just lead to high interest rates, but it also led to a quadrupling of the standard deviation of changes in FF and GS10 (see Figure 2 and Table 2).

The Great Moderation

The beginning of the next regime begins in October 1982 when the Fed abandons the operating procedure based on target paths for the money supply. Chairman Volcker was not willing to admit that the Fed had gone back to an interest rate operating procedure because he felt that such a procedure was too susceptible to political influence and was one of the basic problems with policy during the Great Inflation. He officially adopted a target for borrowed reserves, but that was just an indirect form of interest rate targeting. Volatility in the policy rate dropped immediately but remained relatively high as the borrowed reserves operating procedure introduced volatility around the FF target which was a secret revealed only indirectly to the market.⁸ Figures 2 and 3 show that the level and volatility of the fed funds rate continued to decline throughout Volcker's tenure and dropped even further as Greenspan gave up the pretense that the Fed was not targeting the fed funds rate.

During Great Moderation, trends in interest rates were falling. When the economy went into recession, the FOMC lowered the fed funds rate in order to stimulate the economy. The FOMC expected this to lead to higher inflation, but it did not. The recoveries were not as vigorous as those during the Great Inflation. As the economy expanded, the FOMC did not have to raise the federal funds target above the 10-year bond rate. By the time that the fed funds rate was approximately level with the long rate, inflation and inflation expectations had moderated. So the policy during the Great Moderation was asymmetric, the FOMC eased aggressively when

⁶ See Lindsey, Orphanides and Rasche (2005) for a description of events leading the October 6, 1979 regime change.

⁷ See Goodfriend (1983) for a discussion of this operating procedure and the role of the discount window in this indirect form of money supply targeting.

⁸ See Thornton (1988).

the economy was weak, but did not have to raise rates so much during expansions. The result was that the average fed funds rate was 128 basis points lower than the average long bond rate.

The signature characteristic of the Great Moderation was the reduced volatility of inflation and output. Table 2 shows that the standard deviation of changes in consumption growth fell to 0.70 during the Great Moderation, down from 0.89 percent during the Great Inflation and 0.84 percent during the Volcker Reform. The biggest surprise for the Fed was that inflation did not accelerate in response to lower interest rates during two extended periods of low interest rates—first from September 1992 to February 1994 and the second from 2002 to 2004. There was no need to invert the yield curve, raising FF well above *GS10* in order to keep inflation under control. Another surprise for the Fed was the rebound of more rapid economic growth in the 1990s. Figure 3 and Table 1 show that this was the regime with the highest per capita consumption growth. Note, however, that *Cdot* during the Great Inflation was not that much lower than during the Great Moderation.

During this period the FOMC adopted a risk management approach to monetary policy.⁹ The idea was that the Fed would forecast the future taking account of all potential scenarios. To find the policy setting, they would look at the probability of each scenario occurring, such as a replay of the Great Depression or the Great Inflation. Then they would estimate the cost of each bad outcome. The weight of each scenario in setting the policy rate would be a product of the likelihood of the event occurring times the magnitude of the economic costs if that outcome occurred. The Fed viewed a lower interest rate setting as insurance against the outcome of all bad events except inflation. In the Fed's policy framework, the only important downside to low interest rates was the possibility of inflation. If there was no inflation, then interest rates were not be too low.

The financial crisis raised awareness of another downside to low interest rates. The abuses in the mortgage market were due to many factors. But the sheer volume of bad debt must have been partly due to low interest rates. Today, the Federal Reserve takes responsibility for financial stability, but it uses interest rate setting for output stabilization policy and, separately, adopts macro-prudential policies to promote financial stability.

The Zero Interest Rate Policy (ZIRP)

Both the level and the volatility of the fed funds rate went to zero in September 2008 as the Fed came to the rescue of big financial institutions (see Tables 1 and 2). Initially, the Fed supplied about \$600 billion reserves mainly by making loans of 180 days or less. The Fed justified this action as insurance against the worldwide collapse of financial markets and a replay of the Great Depression. A review of Greenspan (2004) shows that this was an application of the 'risk management' approach to monetary policy. However, whenever the Fed has 'taken out insurance' against a bad outcome by lowering the fed funds rate, it has been reluctant to raise interest rates back up to the pre-event level. Generally, the Fed has shown an aversion to reversing interest rate movements within a short-time span.

⁹ See Greenspan (2004)

In the case of the financial crisis, the excess reserves would have naturally run off and the balance sheet would have returned to normal by mid-2009 if the Fed had not adopted the first instance of Quantitative Easing (QE) in December. The ZIRP regime was characterized by attempts to lower long term rates through QE, a one-time rebalancing of the portfolio substituting long-term assets for short-term ones, and through forward guidance provided in FOMC statements. Although the policy was initially thought to be temporary, it became apparent by 2010 that rates were likely to be at zero for a long time.

There is a good example of a ZIRP regime in use in Japan since 1995. Cooke and Gavin (2015) show that the Japanese data can be used to estimate time-series models for the United States. Such use of Japanese data is unconventional, but we found much better forecasts for U.S. GDP growth and long-term bond rates using Japanese data as if it were generated in the United States rather than using U.S. data from the Great Moderation. Of course, the fed funds rate forecasts were better using Japanese data, but that is expected because both countries were pegging their policy rates near zero. The inflation forecasts were about equally bad. The Japanese data predicted that inflation would be lower than it was, and the Great Moderation data predicted that inflation would be higher than the actual outcome.

Table 1 shows that the averages for all the four indicators were much lower during the ZIRP regime than in any other. Table 2 shows that is also true for volatility of interest rates and consumption growth, but not inflation. The standard deviation of changes in the inflation rate is higher than in all but the Volcker Reform in which inflation fell by 10 percentage points in 3 years.

An important feature of the ZIRP regime, which began with a big 2-quarter decline in consumption, is the failure of the economy to return to the trend in potential GDP that had been estimated both by the Fed staff and the Congressional Budget Office. The Fed and private forecasters forecasted a return to trend and were frustrated repeatedly over the next seven years. One response was to lower estimates of the level and growth rate of potential GDP. In the policy response, the Fed turned to QE twice more, taking the balance sheet to \$4.6 trillion by 2014. We decided to date the end of the ZIRP regime when the FOMC voted to raise the fed funds rate target range by 25 basis points in December 2015. This ending date may have been chosen prematurely. Given the current policy of holding the rate well below normal and using a floor system to implement interest rate policy in the presence of a large balance sheet, it may be that characteristics of this regime will continue into the indefinite future.

Dynamic interactions among, consumption, interest rates and inflation

Policymakers place a large value on models that ‘fit the data.’ Econometric methods extract information from the dynamic variance-covariance structure of data. Gavin and Kydland (1999, 2000) show that the Volcker reform that made the inflation objective credible introduced statistically significant changes in the variance-covariance structure of data sets that include nominal indicators. It was also generally true that there did not appear to be significant changes in variance-covariance structure of data sets that included only real quantities such as consumption, investment, or labor.

Figure 5 reports the cross-correlations between real per capita consumption growth and three nominal variables, CPI inflation, the fed funds rate and the 10-year bond rate. We calculate the monthly correlations from a six month lead to a six month lag. We also report the autocorrelation function for real per capita consumption growth. We report results for the Volcker Reform for completeness, but the sample is short and we think the one important fact about this regime is that it is an extreme regime in which the Fed tried to keep the fed funds rate well above the normal rate. The intention was to keep the rate high until people became convinced that the Fed was serious about ending inflation. We don't expect to go back to that regime. We also do not expect to go back to the Great Inflation regime. The results clearly suggest that the monetary policy regime has important effects on the variance-covariance structure of the data that are important for estimating the relationships between interest rates and the economy.

The fed funds rate and the long-term bond rate were both procyclical during the period of the great moderation and have become countercyclical during the ZIRP regime. Inflation has been procyclical during the ZIRP regime, but it was countercyclical during the Great Moderation. Models relating interest rates to consumption growth and inflation that were estimated using data from the great moderation would be expected to perform poorly in forecasting during the ZIRP regime. Only the persistence in consumption growth seems to be independent of the policy regime (again, leaving out the 3-year Volcker Reform).

The cross-correlations of interest rates with inflation are shown in Figure 6. Of course, there is only very small variation in the fed funds rate in the ZIRP regime, so we put more emphasis on the long bond rate. The long rate was procyclical with consumption during the Great Moderation, but that positive correlation turns negative during the ZIRP regime. We also show that the cross-correlations between the spread between the fed funds rate and the 10 year rate. This correlation was strongly positive during the Great Inflation, but fell during the Great Moderation. The long-term bond rate enters the Spread variable with a negative sign, so the ZIRP cross-correlation is just a mirror image of the GS10 cross-correlation because variation in the fed funds rate is so small.

Issues Surrounding Monetary Regimes

In this section we address issues that have arisen during the ZIRP regime using cross-regime comparisons. Issues include the volatility of the market's 2013 'temper tantrum,' the controversy surrounding the use of the Fisher equation to explain low inflation, and issues involving real interest rates. We introduce the idea of using per capita real consumption growth as an independent measure of the equilibrium real interest rate.¹⁰ We also ask whether it is reasonable to think that it is monetary policy itself that is the cause of the low natural rate estimated by Federal Reserve economists.

¹⁰ Another measure of the real interest rate that is relatively independent of monetary policy is the ex post return to capital (See Gomme, Ravikumar and Rupert, 2011 and 2015). Bullard (2017) uses their data when explaining that it is the real interest rate on safe assets, not real returns to capital that are abnormally low.

Volatility across regimes and the temper tantrum. As the FOMC begins its transition away from the ZIRP regime, members have expressed concern that these changes should not upset the market. They ask whether the market can absorb the extra securities as they are shed from the Fed's balance sheet. They even worry that tapering the reinvestment of maturing securities—a very gradual shrinking of the balance sheet—will lead to another temper tantrum. Just what is a market's temper tantrum? It has been reported as if the Fed's announcement of an imminent tapering of the QE3 in May 2013 caused volatile asset returns between the time Fed Chairman Bernanke first mentioned the idea and the subsequent implementation of it. Figure 3 measures time-varying volatility in the bond market by computing the standard deviation of a 7-month centered moving average of changes in GS10. As the figure shows, there was no increase in volatility above the average for the regime if volatility is measured in this way. It seems more likely that the perception of the market's temper tantrum was not actually in asset price volatility, but more likely associated with Fed communications and the likelihood that that Fed would stop making the short term interest rate so predictable. A return to the Great Moderation Regime would imply a future increase in volatility for interest rates.

The Fisher Equation. The Fisher equation is an equilibrium condition which says that, no matter what policy regime is in effect, the market interest rate will be the sum of two components, a real return and a premium for expected inflation. If the Fed pegs the interest rate at any level, including zero, then an increase in real returns will lead to a decline in inflation. If the policy rate is pegged at a higher level the inflation rate will be higher. The equilibrium condition says nothing about what will happen in the short run if the Fed changes its policy rule. The opposition to raising interest rates by business and policy economists is based on beliefs about economic dynamics that were learned during the Great Inflation. These beliefs are imposed as maintained assumptions in large econometric models, but they are not obvious in post-1983 data. Such models do not impose the equilibrium condition known as the Fisher equation and produce forecasting errors when low rates do not produce higher inflation.¹¹

Real interest rates. In theory, real interest rates that matter for real economic activity because they influence consumption and savings decisions. Higher real interest rates reflect high returns to investment, and high returns to working now for consumption in the future. They also reflect the opportunity cost of building capital. Periods with low expectations for the future are periods of low interest rates.¹²

Ex post real interest rates were quite low during the Great Inflation, the real fed funds rate averaged 0.88 percent while the 10 year bond rate averaged 1.16 percent. This was a period of slowing productivity growth. It was also a period when people were devoting many resources to protecting themselves from the damage done by inflation. Nevertheless, the average per capita real consumption growth was relatively high, just slightly above 2 percent. The three years of the Volcker Reform were three years of high real interest rates. The real fed funds rate was 4.2

¹¹ Williamson (2012) presents a macroeconomic model that captures many features of the post crisis economy and emphasizes the role of the Fisher equation. See also Williamson (2016) for a less formal treatment of the issue.

¹² Many have argued that exogenous factors have kept the economy operating below trend, inflation low, and real interest rates low. For a sample of these arguments, see Summers (2016) and Williams (2017).

percent, well above the 10-year rate of 2.62 percent. Note, however, during the Great Moderation, the real fed funds rate fell by about half, to 2.27 percent while the average real return to holding a 10-year treasury bond rose to 3.69 percent. During the ZIRP regime, following the crisis, the real fed funds rate fell to -1.25 percent while the return to holding a 10-year treasury bond fell to 1.21 percent.

How should we measure the counterfactual equilibrium real interest rate? What would the real interest rate on fed funds and 10-year treasury securities be if the Fed were not following the ZIRP regime? The Federal Reserve uses its monopoly on bank interest rates to lower interest rates when it wants to lower the cost of capital. This presents a real problem for the analyst. Are real rates low because future growth is expected to be low, or because the Fed is holding short-term rates on bank reserves low? In other words, are low interest rates in the United States and around the world caused by Fed policy? To answer this question we need a measure of the equilibrium real interest rate that is not taken from observed market interest rates. The measure used in this section, $Cdot$, is based on the consumption-based asset pricing model (CCAPM) with logarithmic utility as in chapter 1 of Cochrane (2001). Note however, that any of the commonly used utility functions in macroeconomics or finance would lead to a similar equilibrium condition involving rFF and $Cdot$. It is real consumption in a representative agent model, so the appropriate empirical measure is the per capita real consumption growth.

We use $Cdot$ rather than an econometric estimate of the equilibrium real rate. Such estimates are derived from observed inflation and interest rates and do not adequately control for the effect of extreme policy positions on *ex post* measures of real interest rates.¹³ As we show below, the Volcker Reform and the ZIRP regimes are both extreme policy settings given the Fed's inflation objective.

According to the CCAPM, the real interest rate will converge to per capita real consumption growth. Note that periods of disinflation in the United States and elsewhere are associated with high *ex post* real returns and positive values for $Rgap$. Table 1 shows that $Rgap$ has been negative in both periods of easy monetary policy. It was -1.17 percent during the great inflation and -1.87 during the ZIRP regime. It was very high during the Volcker Reform. The Volcker reform was associated with a 5 percent $Rgap$. This reflects Volcker's and the FOMC's determination to end inflation.

Figure 4 plots rFF and $Cdot$ separately throughout the four regimes. During the Great Moderation the average rates were equal. The real funds rate was higher than consumption growth in the 1980s following the disinflation policy and it was unusually low in the period from September 1992 to February 1994 when Greenspan pegged the fed funds rate at 3 percent to stimulate employment growth (this was the first of two 'jobless' recoveries). The real fed funds rate is also unusually low in the period from 2002 to 2004 (the second 'jobless' recovery) when the FOMC was trying to 'get ahead of the curve' and prevent the inflation from becoming so low that interest rates would hit the zero lower bound.

¹³ See, for example, Bullard (2017) and Holstrom, Laubach, and Williams (2015) and other articles referenced there.

Conclusion

In theory, we expect the monetary policy regime to have important effects on inflation and the variance-covariance structure of a nominal data sets. This has been shown in earlier work and is extended to include the ZIRP regime. The most important conclusion is that the Lucas Critique is important when deciding how to make forecasts in a period with a new policy regime. Time series models estimated with Japanese data from their extended ZIRP regime do a better job of forecasting output and interest rates than do models estimated using data from the Great Moderation.

In planning future work, the most important question is whether we can safely assume long-run monetary neutrality in periods of extreme policy positions. During the Volcker reform real interest rates were dramatically higher than the real *per capita* consumption growth. In two episodes during the Great Moderation, and throughout the ZIRP regime, short-term, real risk-free interest rates have been zero or negative. Real long-term returns on safe assets also remain significantly below real *per capita* consumption growth. The ZIRP regime has shown that the Fed can control real interest rates on long-term safe assets. What we don't know is the sign of the effect that extremely low policy rates and Fed-induced changes in returns on safe assets have on economic activity.

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	Great Inflation	Volcker Reform	Great Moderation	ZIRP
Federal Funds Rate (FF)	6.43	14.36	5.36	0.13
Yield on 10-year bonds (GS10)	6.71	12.77	6.79	2.58
Inflation (CPI)	5.55	10.15	3.10	1.38
Real per capita consumption growth (Cdot)	2.06	-0.85	2.27	0.57
FF - GS10 (Spread)	-0.28	1.58	-1.42	-2.45
FF-CPI (rFF)	0.88	4.20	2.27	-1.25
GS10-CPI (rGS10)	1.16	2.62	3.69	1.21
rFF-Cdot (Rgap)	-1.17	5.06	0.01	-1.87

Table 1. Average Value in Each Regime

	Great Inflation	Volcker Reform	Great Moderation	ZIRP
Fed funds rate	0.44	1.92	0.25	0.02
GS10	0.20	0.72	0.28	0.20
CPI inflation	0.33	0.46	0.37	0.42
Per capita real PCE growth	0.89	0.84	0.70	0.40

Table 2. Volatility (Standard deviation of monthly changes in each regime)

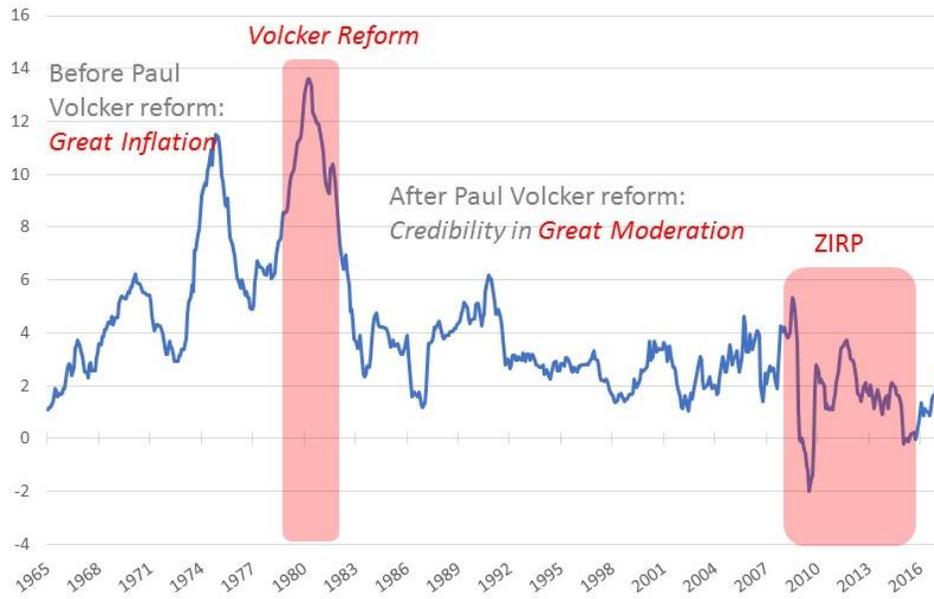


Figure 1. Inflation in the United States



Figure 2. Federal Funds Rate and Yield on 10-Year U.S Bonds

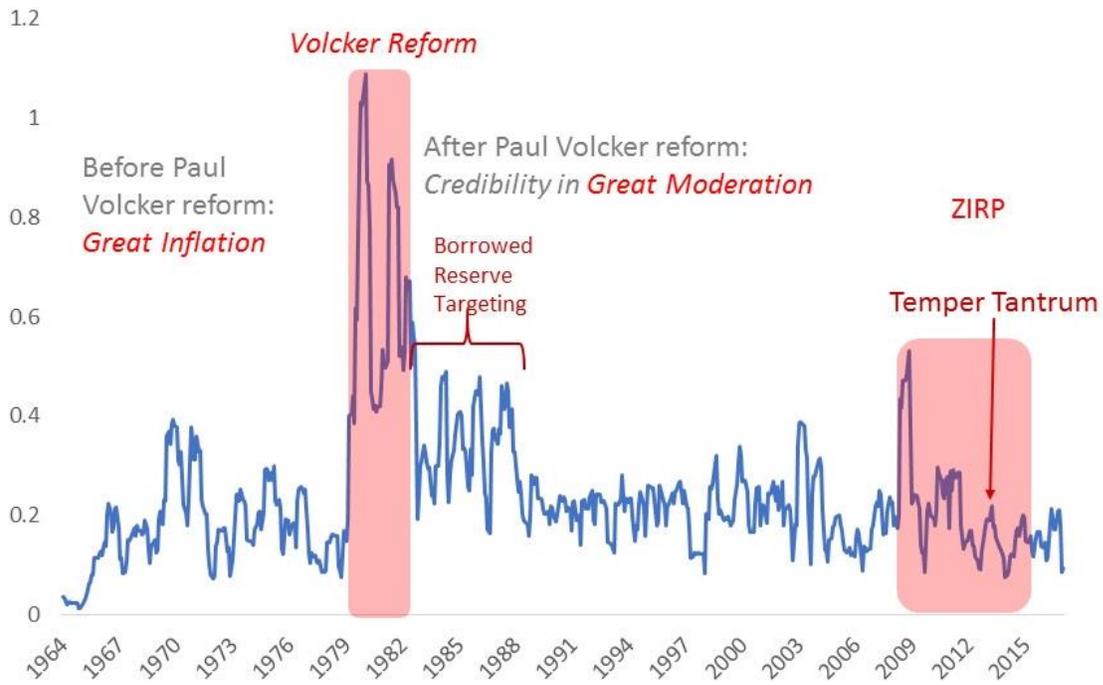


Figure 3. Volatility in GS10 (Standard Deviation of 7-month centered moving average)

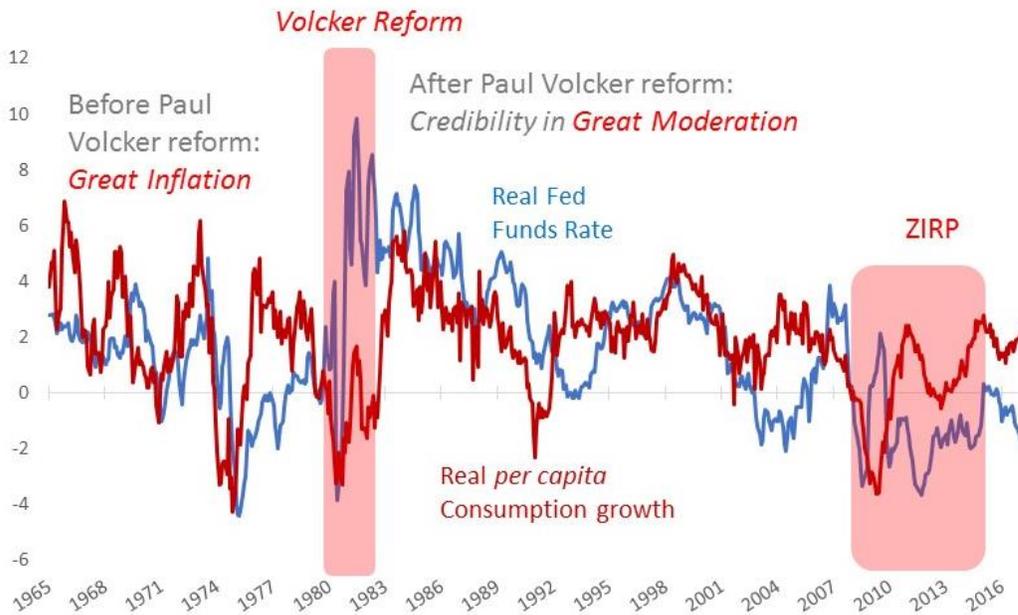


Figure 4. Real Fed Funds Rate and Real per capita Consumption Growth Rate

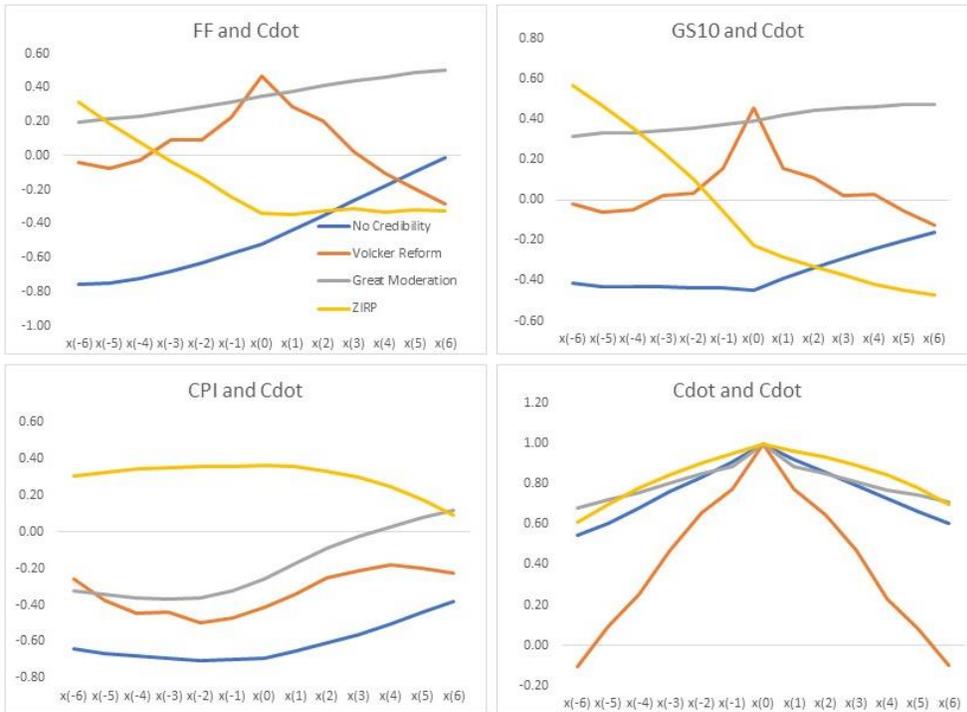


Figure 5. Cross Correlations with Consumption Growth

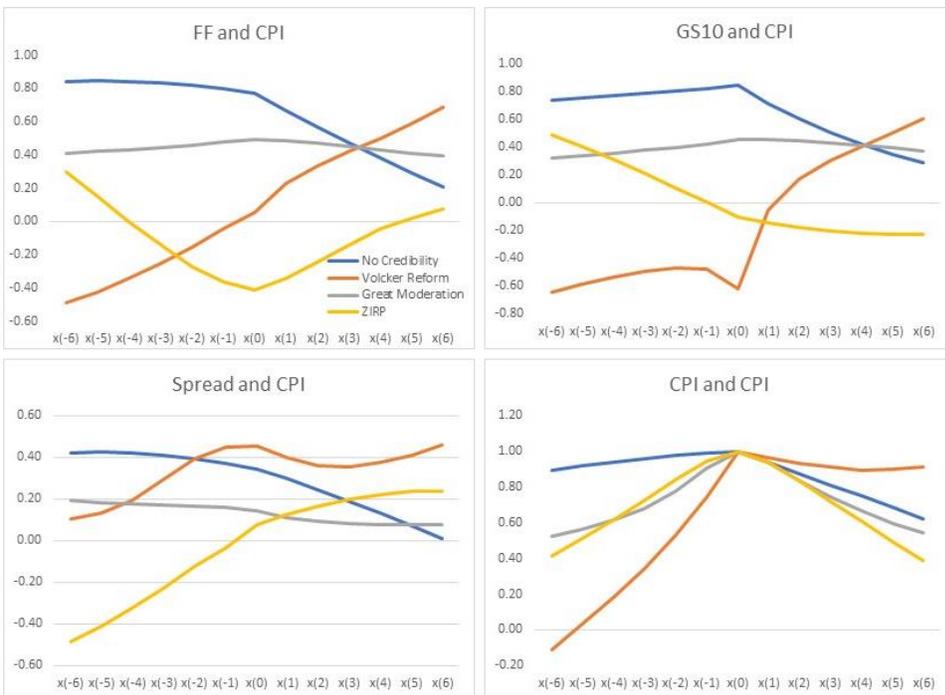


Figure 6. Cross Correlations with CPI