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The Fed's *Real* Reaction Function

Monetary Policy, Inflation, Unemployment, Inequality—and Presidential Politics*

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ABSTRACT

Using a VAR model of the American economy from 1984 to 2003, we find that, contrary to official claims, the Federal Reserve does not target inflation or react to "inflation signals." Rather, the Fed reacts to the very "real" signal sent by unemployment, in a way that suggests that a baseless fear of full employment is a principal force behind monetary policy. Tests of variations in the workings of a Taylor Rule, using dummy variable regressions, on data going back to 1969 suggest that after 1983 the Federal Reserve largely ceased reacting to inflation or high unemployment, but continued to react when unemployment fell "too low." Further, we find that monetary policy (measured by the yield curve) has significant causal impact on pay inequality—a domain where the Fed refuses responsibility. Finally, we test whether Federal Reserve policy has exhibited a pattern of partisan bias in presidential election years, with results that suggest the presence of such bias, after controlling for the effects of inflation and unemployment.

Keywords: Personal Income, Wage Level, Wage Differentials, Price Level, Inflation, Deflation, Term Structure of Interest Rates.

JEL Classifications: D31, E24, E31, E43, J31

I. INTRODUCTION

> *FED POLICY MAKERS ARE likely to continue to highlight risks that low unemployment could push inflation higher when they meet next week.*
>
> *The Wall Street Journal, On-line Edition Headline, June 21, 2007.*

What *does* the Federal Reserve do? What *should* the Federal Reserve do? These questions span a research field, with, as they suggest, both positive and normative elements. The Federal Reserve operates under a legal mandate that explicitly targets balanced growth and full employment, yet officials stress their higher preoccupation with price stability, a well-known central bankers' creed. Are they right to do so? And—perhaps more tellingly—do their actions reflect their beliefs?

The yield curve captures the spread between long-term and the short-term interest rates. The Federal Reserves claims direct control only over the short-term rate, while the long rate is said to reflect the prevailing *long-term* inflation expectation. The yield curve thus provides a useful and well-accepted indicator of monetary policy stance, comparable over long periods of time when inflation expectations may differ. In this respect, it is superior as an indicator to the short-term interest rate by itself, as in differing inflation contexts the same short-term rate may exercise markedly different effects on economic conditions.

The claim that the Federal Reserve targets and reacts to *changes* in inflation therefore implies a link between the yield curve and the inflation rate. Specifically, it implies that the yield curve should become flatter following increases in inflation in the short run, after taking account of possibly countervailing conditions, such as the state of overall demand and the rate of unemployment.

Is the claim correct? *Does* the Federal Reserve react to the "signal" sent by a change in the inflation rate? This is the message of the famous Taylor Rule, according to which a Federal Reserve reaction function can be specified as a weighted average of deviations of inflation and unemployment from target values.[2]

[2] The Taylor Rule is normally specified with the federal funds rate as the dependent or policy variable. However, the federal funds rate by itself is a poor indicator of monetary policy stance; its meaning depends on the state of long-term inflation expectations as reflected in the long-term interest rate. For this reason, the term structure is a preferable measure, and can be substituted into a Taylor Rule with no loss of meaning.

A failure to find a reaction to either variable can mean, in principle, one of two things. One possibility is that there really is no underlying target value, in which case there is no impetus to change policy when the state variable changes. (In this respect, a criticism of monetary policy sometimes heard among liberals holds that the Federal Reserve places too little weight on unemployment.) The other is that no deviations of the state variable from its target are observed, in which case the weight of that variable in practical decision making falls to zero, whatever its notional weight in the function.

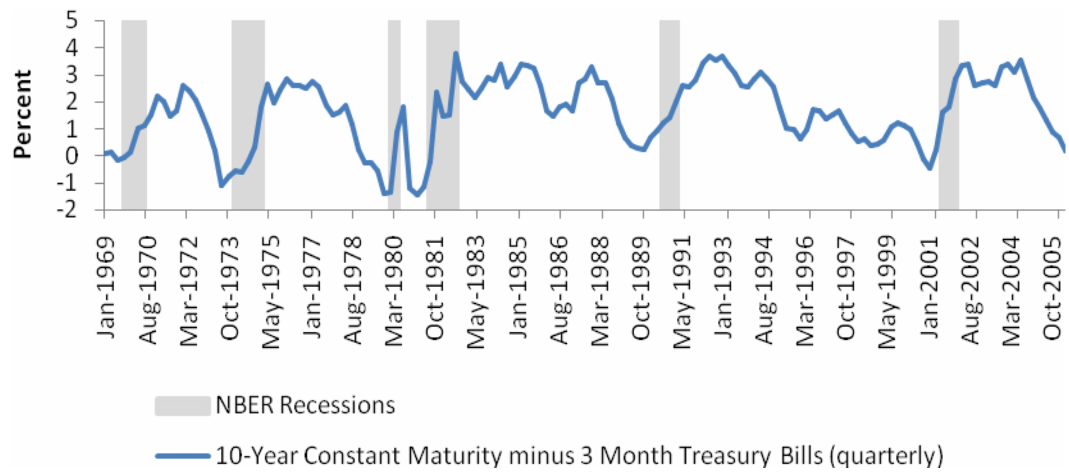
This paper is concerned mainly with what the Federal Reserve does. From the above discussion stem three interrelated variables: the term structure, unemployment, and inflation. Following Galbraith (1998), we enlarge this framework by adding another macroeconomic dimension: *inequality*—a topic that Federal Reserve officials maintain to be "outside the scope… of the issues with which we deal" (Greenspan 1997). But since measures of pay inequality are closely linked to unemployment, it is reasonable to ask whether one should take the obviously self-interested word of central bankers at face value on this point. Adding a measure of changes in pay inequality to our analysis permits a low-cost test of this interesting question.

Obviously other variables could be considered, but the literature in this area—both theoretical and econometric—favors parsimony, and so will we. Initially we restrict ourselves to the study of a small but synthetic model of four variables, with emphasis on the relationship between the yield curve on one hand, and inflation, inequality, and unemployment on the other. After a brief exploration of the properties of the yield curve, we begin with a straightforward VAR model and its causal implications. We then proceed to structural explanations, permitting us to test several permutations of the Taylor Rule for the one that best captures actual Federal Reserve behavior. We add simple political variables at this stage. In an appendix we offer a third method, based on ARIMA techniques, aimed at clarifying possible lag structures and issues of autocorrelation.

II. SIMPLE PROPERTIES OF THE YIELD CURVE

Figure 1 presents our measure of the yield curve or term structure (TS) of interest rates, measured as the difference between a 30-day Treasury bill rate and a ten-year bond rate, from 1969 to 2006.

Figure 1. The Term Structure of Interest Rates, 1969–2006.



Source: U.S. Department of Commerce: Bureau of Economic Analysis, National Accounts Data. Authors' calculation

The yield curve captures the tightness or ease of monetary policy in any given climate of price change, an important virtue for the purpose of comparisons over a long period of time. The association of this measure with monetary policy is not controversial. For example, Wu (2001) finds a strong correlation between monetary policy and the movement in the slope of the yield curve, and we show in an appendix that movements in the term structure coincide exactly with movements in the discount rate.[3] The yield curve also bears a strong relationship to the state of the economy, with periods of inversion historically associated with the onset of recessions, as the figure shows.

From a statistical point of view, the term structure behaves strangely. After accounting for a series of breaks between 1980 and 1983, we find that it is normally distributed but weakly stationary, and—most importantly—very persistent. Since the term structure behaves as the Federal Reserve wants it to, the persistence must be due to repetitive anomalies in central bank behavior. Using a simple rule to locate outliers, we

[3] Assuming that discount rate changes (which are purely administrative) may be taken as exogenous, this counts as reasonable evidence that the term structure is directly influenced by monetary policy.

find that they are not randomly distributed, as should be expected if the term structure were a random variable, but, to the contrary, span entire periods: five of them, of two to three years each, to be precise. In Section V we turn to a close analysis of these periods.

III. A VECTOR AUTOREGRESSION MODEL OF THE YIELD CURVE

The vector autoregression (VAR) model has been advanced by Sims (1980) on the ground that structural macroeconomic models, which rely on *a priori* theoretical hypotheses, "could not be taken seriously." The VAR model presents a flexible framework for analyzing time series without restricting any coefficient or promoting any causal relation. The few parameters the researcher has to decide upon can be chosen on statistical grounds.

In the present case, our VAR model consists of the term structure (TS, measured as the difference between the 30-day bill rate and the 10-year Treasury bond rate), consumer price inflation and unemployment (CPI and UN, measured conventionally), and pay or earnings inequality (SIC), which is measured with the between-groups component of a Theil index across 31 manufacturing sectors. The model was first estimated on data beginning in 1969, but the pre-1984 years contained many breaks in the estimated relationships, to the extent that the interpretation of such relationships is risky (see below). Therefore, we will concentrate on the "current" monetary policy of the Federal Reserve, starting in 1984. No serious indication of a structural break has been found since that date. Due to the restricted availability of continuous and homogenous inequality measures, our estimation sample covers 1984–2003.

The VAR model is written:

$$\boldsymbol{X}_t = \boldsymbol{A}_1 \boldsymbol{X}_{t-1} + \ldots \boldsymbol{A}_k \boldsymbol{X}_{t-k} + \boldsymbol{A}_0 + \boldsymbol{D}_t + \boldsymbol{u}_t \tag{1}$$

where $\boldsymbol{X}_t$ represents the column-vector of the variables of interest (term structure, CPI, unemployment, and inequality), and the terms $\boldsymbol{A}_i$ are matrices of freely estimated coefficients. Equation (1) presents a model where each variable is treated *equally*, and explained by its own past values, as well as the past values of the other variables. The VAR framework is particularly useful when the primary interest is on the significant predictors. By looking at the significance of the coefficients in the $\boldsymbol{A}_i$s, one can distinguish between causal variables and noncausal variables, which is the idea behind Granger causality.

The requirement for unbiased future inference is that the residuals $\boldsymbol{u}_t$ be non-autocorrelated and at least approximately normally distributed (especially not skewed). In addition, we want to avoid potential breaks in relationships and to account for special events separately; these are captured in the deterministic term $\boldsymbol{D}_t$ containing dummies. Therefore, two parameters have to be chosen: the number of relevant past values to include (k) and the number and location of the dummy variables.

The choice of k and $\boldsymbol{D}_t$ can be made on statistical grounds. Further, we can choose those parameters to fulfill the requirement of well-behaved residuals. That is, we choose k so as to provide non-autocorrelated errors, and we choose $\boldsymbol{D}_t$ so as to account for well-localized events which, if left unaccounted for, would provide non-normal residuals.

Choice of Parameters

Since the term structure is stationary (i.e., it has a constant mean), all variables have been transformed so as to be stationary, too. Thus, each equation is balanced and consistent. Over our sample 1984I–2002III (N=75 quarterly observations), the CPI and inequality measures have been taken in log-changes and the unemployment rate in first differences. We therefore have:

$$\boldsymbol{X}_t = \left[TS_t, \Delta \log CPI_t, \Delta UN_t, \Delta \log SIC_t\right]'.$$

All transformed variables have been found to be stationary around the 5% level by a battery of unit root tests, partly reported in an appendix. The case of the CPI is interesting, for it is customary to take this variable in double differences. However the second difference is only required when the sample covers the inflation spike of the late seventies. Inflation turns out stable (i.e., stationary) on our post-1984 sample. This is evidence of the stabilization of inflation since that time, characterized by virtually no sign of accelerating inflation.

The model was then estimated using those stationary variables; the lag length, k, was increased incrementally starting from k=1 until non-autocorrelated residuals were reached.[4] That procedure resulted in the parsimonious choice of k=2, i.e., the dynamics of our four variables are well described by relating each variable to the past two observations of the other variables. Further, the residuals were individually inspected to locate “exceptional events,” spikes, or plateaus. Six such events have been found:

– One in the term structure equation, in 1987II. This date captures the transition from Volcker to Greenspan at the Federal Reserve, and prefigures the stock market crash of the following October.

– Three in the CPI equation: 1986II and 1989II, as well as a step dummy for the whole year 1990. The first date may be capturing the effect of the Plaza Accord. The other dummies capture an inflationary period related to oil prices in the run-up to the first Gulf War.

– Two for the unemployment rate, in 1995II and 2001IV. These may be associated with a moment of restrictive Federal Reserve policy (beginning in early 1994), and with the effect of the 9/11 attacks, respectively.

– None for the inequality equation.

The treatment of dummy variables is important but difficult because several events, not necessarily exceptional in themselves, can explain abnormal spikes in the residuals. On the other hand, it is interesting to note that each and every spike has a plausible interpretation as capturing a special event. The following analysis rest upon the six dummies:

$$\boldsymbol{D_t} = \left[d_{86q2}, d_{87q2}, d_{89q2}, d_{1990}, d_{95q2}, d_{01q4} \right]$$

[4] This procedure avoids relying on the Akaike Information Criterion (AIC) to choose the lag length. Information criteria are valid only under the assumption that the model is well specified—that it is stable with outliers accounted for. Yet we do not know if the model is well specified unless the model is first estimated and tests run; therefore the lag length has to be chosen first. Our procedure resulted in the same value of k as given by the AIC, FPE, and LR criteria in the final stable model, incorporating dummies. Our model is thus found to be the most parsimonious and to the best precision of fit, as indicated by a minimized FPE.

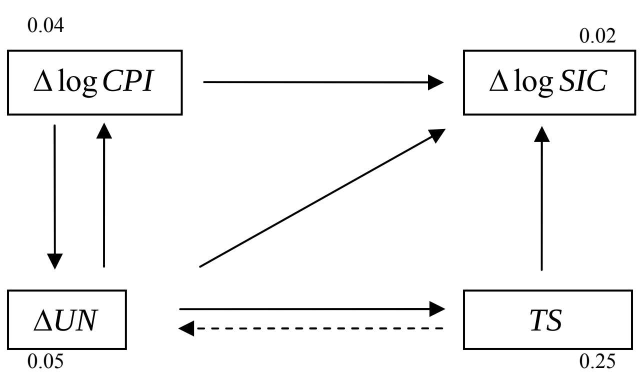
Based on those six dummies and *k*=2, the residuals of the model appeared well behaved (see appendix): no residual autocorrelation or heteroskedasticity was detected, and the residuals were individually as well as jointly normally distributed.

Finally, the overall stability of the model was assessed by means of system-wide Chow tests. None of the three tests—forecast, breakpoint, and sample-split—could reject stability. The stability probabilities were low on the interval 1989–94 for Chow's breakpoint test, but are acceptable in the sample-split test, which is only concerned about the stability of the estimated coefficients, as we are here. The Chow forecast test does not report any serious indication of break either. The overall model is therefore parsimonious, well specified and stable on the 1984–2002 sample.

Granger Causality

The model has been found to be sufficiently well-specified to permit inference as to the parameters. Granger causality is a popular tool for this purpose. Using the significance of coefficients in the VAR, Granger causality allows discriminating between significant predictors and otherwise. We are primarily concerned with the predictors or "causal" variables of the term structure, but an overall picture of causality model-wide may be interesting. Using a threshold 5% significance level, the following causal chart arises:

Figure 1. Granger Causality Results on 1984–2003



Note: Arrows represent Granger causality from past values to current values: temporal causality at the 5% level (dotted lines) or 1% level (thick lines). The numbers are the probabilities of *not* being jointly caused by the other variables.

The results of Granger causality have been checked to be robust to different lag length and dummy specifications. The results are interesting in at least four respects:

– There is only one properly causal variable, the term structure. This indicates both the importance of monetary policy and the nature of the term structure as a leading indicator of economic conditions.

– The term structure *is* influenced by changes in unemployment.

– The term structure *does affect* inequality.

– The term structure is *not* affected by inflation.

IV. TESTING THE TAYLOR RULE ON THE TERM STRUCTURE

Following the encouraging results of the VAR model, we decided to inquire directly into the empirical determinants of Federal Reserve decisions, this time using simple but powerful dummy regressions. These examine the functioning of the Taylor Rule in a model where the stance of monetary policy is represented by the yield curve.

This version of a Taylor Rule may be written as follows:

$$TS = f[(\Delta logCPI - \Delta logCPI^*), (UN^* - UN)]$$

where TS represents the stance of monetary policy as measured by the term structure or yield curve; ΔlogCPI and UN are inflation and unemployment, and the asterisks represent their target values. Inflation is measured, as before, by the rate of change of the Consumer Price Index. The function (f) incorporates direction-of-effect, as well as the weights placed on the two variables. Thus, the rule predicts that the Fed will tighten when inflation is above its target or unemployment below its target, and conversely.

We note that this is a different specification from that implied by the VAR model, which emphasizes reaction to movements in inflation or unemployment. The Taylor Rule adds the extra element of a target. We do not know what that target is, but from our reading of the literature, for the purposes of this paper, we assume that the inflation target is between two and three percent, while the unemployment target is governed by a stationary NAIRU at 5.5 percentage points.[5] The model is not very sensitive to minor changes in these assumptions.

A difficulty of the Taylor Rule is that in its general format it is ambiguous in many cases. Both inflation and unemployment may be above, or both below, their targets; in which cases the two variables tug policy in opposite directions and the predicted reaction must depend on the precise specification of the rule. Further, we have no *a priori* reason to know that the Federal Reserve is governed by the level of a variable as opposed to its rate of change; if inflation is above its target value but falling toward it, is monetary policy still likely to be restrictive? Such questions are essentially empirical; they are a matter of estimating actual central bank behavior. This is what we now propose to do.

Our statistical analysis of the yield curve leads to special requirements for further inference. First, breaks should be accounted for. This has been done by splitting the sample between 1969III to 1983I and 1984I to 2006IV.[6] Second, the persistence of TS (heteroscedasticity) would lead to incorrect standard errors in regressions involving TS as a dependent variable. Third, dummy regressions involving TS may feature autocorrelated residuals, again invalidating the conclusions. Newey and West (1987) have developed a procedure to jointly solve the last two problems. The regressions to follow use the HAC modification of the covariance matrix they describe, which corrects for both heteroscedasticity and autocorrelation of unknown form. We also followed Newey and West concerning the choice of the truncation lag in their method (always resulting here in a lag of 3).

We identify four variations on the possible functioning of a Taylor Rule, each of them testable with a different set or package of dummy variables. The packages are as follows:

MODEL 1. Levels and Changes Separately for Each Variable

This first set of dummies simply divides the cases according to the individual behavior of the two underlying variables; the underlying hypothesis is that the Federal Reserve looks separately at each variable and assigns some weight to the position and movement of each.

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[5] Estimating the NAIRU is a game of largely historical interest at this point, but we note that Akerlof, Dickens, and Perry (1996) gave a value of 5 percent, while Gordon (1997) maintained a range centered on 6 percent. Our target splits the difference between these sources.

[6] Those dates have been chosen partly on economic ground and for the sake of coherence with the previous analysis. The breaks discovered in 1980–1982 and in 2001II change the results slightly but do not change their interpretation.

In each case, therefore, the model looks separately at the level and the rate of change of the variable in question; thus, there are four dummy variables in the model: INFLABOVE, INFLRISING, UNBELOW, and UNFALLING.

As the mnemonics indicate, INFLABOVE is set to 1 when inflation is above the target, and zero otherwise. INFLRISING is set to 1 when inflation is higher in the present period than in the immediately previous one, and zero otherwise. UNBELOW is set to 1 when unemployment is below its target, and UNFALLING is set to 1 when unemployment is lower than in the previous period, and zero otherwise.

In this model, recommendations can conflict and the direction taken by monetary policy will then be determined by the relative strength of the coefficients together with the deviation of the variable from its target or the strength of its movement in a favorable or unfavorable direction. This is, in short, the most comprehensive specification, but it could prove difficult to interpret if different variables signal differing actions, as may often be the case *a priori*.

MODEL 2. Strong Signals from Inflation or Unemployment

In a second specification, we focus attention on the cases sending the strongest, most unambiguous signals from each variable. The idea in this model is of a more cautious Federal Reserve that does not adjust interest rates smoothly in response to changing conditions, but rather responds only to clear signs of trouble. These are hypothesized to be seen when inflation is *both* above its target and rising, or when unemployment is *both* below its target and falling. (Conversely, inflation or unemployment may send unambiguous signals that an easing policy is required.) Where signals are ambiguous, on the other hand, this model assumes that the Federal Reserve will not act.

Again we have four dummy variables: INFLTIGHTEN, INFLEASE, UNTIGHTEN, and UNEASE. INFLTIGHTEN is set to 1 for those quarters where inflation is above target *and* rising (and zero otherwise), while INFLEASE set to 1 for those quarters where inflation is both below target *and* falling (and zero otherwise). UNTIGHTEN is set to 1 for cases where unemployment is below target *and* falling (and zero otherwise) and UNEASE is set to 1 for those cases where unemployment is above target *and* rising (and zero otherwise).

In this model, it is again possible for the world to send conflicting signals. However, given known relationships between inflation and unemployment, cases where (say) inflation is sending an unambiguous signal to tighten while unemployment is sending an unambiguous signal to ease are probably quite rare. More common will be cases where one variable (say, unemployment) is sending an unambiguous easing or tightening signal, while the other is sending no signal at all. In this case, we have no *a priori* expectation; rather the model will tell us by how much the Federal Reserve tends to react to a message sent by one variable alone.

MODEL 3. The Unambiguous Taylor Cases

The spirit of the Taylor Rule holds that the Federal Reserve should tighten when inflation is above or unemployment below their respective targets, and ease otherwise. This creates two unambiguous cases: when inflation is above *and* unemployment is below their respective targets, or when inflation is below *and* unemployment is above. In other situations the signals from the two variables conflict, and the direction of policy shift recommended by the Taylor Rule depends on the precise specification of the rule and the precise underlying conditions.

To capture the cases that are unambiguous under a Taylor Rule, we ignore the direction of change of variables and concentrate solely on whether they are above or below their targets. Policy is hypothesized to react when both variables send the same signal, and not otherwise. Thus, TAYLORTIGHTEN is set equal to 1 when inflation is above its target while unemployment is below its target, and zero otherwise. Conversely, TAYLOREASE is set equal to 1 when unemployment is above its target while inflation is below its target; and zero otherwise.

In this specification, monetary policy acts only when signals are completely in harmony; it is immobile otherwise. Calls to action never conflict, but there are many situations where inflation and unemployment fail to speak with one voice, and the situation calls for no action.

MODEL 4: An Ultracautious Fed

For completeness, we include an "ultracautious" specification, according to which the Federal Reserve reacts only when all variables point unambiguously in the same direction. Thus, ALLTIGHTEN is set to one for those cases where inflation is above target and rising while unemployment is also below target and falling, and conversely for ALLEASE.

For each variable we run regressions on two subperiods, 1969–1983 and 1984–2006.[7] In all regressions all data are included; there is no "dummying" out of extreme values as in the VAR model.

Table 1 reports results for 1969–1983, with TS as the dependent variable.

Table 1. Taylor Rule Variations: 1969III–1983I

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
INFLABOVE	-1.10**			
INFLRISING	-0.25			
UNBELOW	-1.11**			
UNFALLING	0.18			
INFLTIGHTEN		-0.11		
INFLEASE		1.36***		
UNTIGHTEN		-0.94*		
UNEASE		-0.07		
TAYLORTIGHTEN			-1.12***	
TAYLOREASE			1.27***	
ALLTIGHTEN				-0.76*
ALLEASE				1.63***
INTERCEPT	2.41***	1.15***	1.26***	1.12***
R2	.12	.05	.15	.02
N=55	***significant .01 or better	**significant .05 or better	*significant .10 or better	

In this period, we find evidence broadly consistent with the Taylor Rule, and with the Phillips Curve view of the economy widely accepted at that time. In Model 1, the Federal Reserve is seen to tighten when inflation is above target and when unemployment is below. In Model 2, we find evidence that the Fed eased when inflation was low and falling, and tightened when unemployment was low and falling; however it did not tighten when inflation was high and rising, nor ease when unemployment was high and rising.

[7] We are able to extend the data set for this analysis because we have no need in this section of the inequality variable.

Models 3 and 4 give significant results with the expected signs in all cases; however, the explanatory power of the regressions is very low.

Table 2 reports on the same variable for the 1984–2006 subperiod.

Table 2. Taylor Rule Variations: 1984I–2006IV

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
INFLABOVE	0.09			
INFLRISING	-0.04			
UNBELOW	-1.65***			
UNFALLING	0.17			
INFLTIGHTEN		-0.01		
INFLEASE		0.09		
UNTIGHTEN		-1.13***		
UNEASE		0.40		
TAYLORTIGHTEN			-1.26***	
TAYLOREASE			0.28	
ALLTIGHTEN				-0.59**
ALLEASE				0.54
INTERCEPT	2.45***	2.15***	2.17***	1.92***
R2 adjusted	.51	.26	.28	.02
N=92	***significant .01 or better	**significant .05 or better	*significant .10 or better	

The results are consistent across all regressions. And they differ strikingly from the more-or-less balanced approach to inflation and unemployment of the 1969 to 1983 years.

– In all cases, we find that the Federal Reserve reacts to low unemployment. In all cases, the sign is in the expected direction and the magnitude of the reaction is similar. Roughly, if unemployment is below the assumed value of the NAIRU, the term structure will flatten by an average value of at least one full percentage point, *ceteris paribus*.

– The Federal Reserve's reaction to unemployment is *asymmetric*. Habitually, the Federal Reserve flattens the term structure (inviting recession) when the unemployment rate is below target and falling. But it does not necessarily cut rates to increase the slope of the yield curve when the unemployment rate is above target and rising. In fact, in no model for the post-1984 period is any easing variable significant.[8] Since monetary policy does ease from time to time, the impetus to ease monetary policy must clearly come from elsewhere. In the next section, we shall explore one possible source of such impetus.

– Contrary to the Taylor specification, in the postmonetarist (post-1983) period, *the Federal Reserve does not react to high or rising inflation*. In no model do we find the Federal Reserve adjusting the term structure in response to changes in inflation or to deviations in inflation above the assumed target. TAYLORTIGHTEN is significant, indicating that the Federal Reserve does tighten when *both* inflation and unemployment suggest it should. But after 1983 inflation alone has no systematic effect on Federal Reserve policy.

– Nor does the Federal Reserve ease when inflation is below the assumed target. In no model is any variable measuring low or falling inflation alone significant. In other words, after 1983 one of two things happened. Either the Federal Reserve ceased to target the inflation rate, or inflation itself disappeared and ceased, giving meaningful signals to Federal Reserve policy.

For the post-1983 subperiod the models do a respectable job of explaining variation in the term structure, with Model 1, in particular, capturing over half of the variance. It is obvious that reaction to low unemployment does the lion's share of the work in all of these equations.

We estimated a number of lag structures, but because the unemployment variable is strongly autoregressive, adding lags simply reduced the significance of the estimated coefficient. We therefore see no reason at this stage to complicate the model with lags. The simplest specification is that the yield curve depends on conditions in the current quarter.

[8] TAYLOREASE does become significant, for the post-1983 period, after political effects are accounted for.

The fact that the Open Market Committee meets twice a quarter is quite sufficient to allow for current conditions in making decisions to change monetary policy.[9]

In the third appendix, we will present the results of a treatment that explicitly removes the autoregressive components from each variable before testing for causal relations.

V. FEDERAL RESERVE POLICY AND PRESIDENTIAL ELECTIONS

Historians and journalists have long noted certain episodes—such as Richard Nixon's reelection campaign—when the Chairman of the Federal Reserve Board (Arthur F. Burns on that occasion) acted vigorously to help an incumbent president win reelection (Greider 1988, page 343). Moreover, the idea of an "electoral business cycle" has an honorable academic history, implicating the use of Keynesian tools, especially fiscal policy, to stimulate the economy in advance of an election (Nordhaus 1974; Tufte 1978; Alesina and Sachs 1988). The idea that the Federal Reserve might engage in such behavior *systematically*[10] is more controversial; although it has found support in one recent paper with an approach similar to ours (Abrams and Iossifov 2006),[11] the consensus view remains adverse. Drazen (2000) provides a survey, finding no evidence of electoral cycles in real activity, inflation, money growth, or the federal funds rate.

We have previously noted that periods of a steep term structure, reflecting low short-term interest rates relative to inflation expectations and therefore a stimulative monetary policy stance, are not randomly distributed but instead strongly persistent over long periods in our sample. There are five such periods:

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[9] Most monetary policy moves consist of changing the interest rate by a quarter-point, which is also consistent with the possibility that the Federal Reserve, in effect, calibrates changes in rates to its entirely arbitrary calendar of meetings. This may be an unconscious habit, for there is no reason in the Taylor Rule why larger changes might not be called for more frequently than they actually occur.

[10] We acknowledge the provocative work of Mike Kimel on this topic.

[11] Abrams and Iossifov estimate dummy variables on the Federal Funds rate for seven quarters before presidential elections, after controlling for the predictions of a Taylor Rule. Their hypothesis is that the party affiliation of Federal Reserve chairmen matters; hence Democrats support Democratic presidents and Republicans support Republicans. Ours is that the Federal Reserve institutionally backs Republicans and opposes Democrats; we do not inquire into the psychology or ethics of any particular Chairman or assume anything about power relations inside the Fed. The two hypotheses diverge only for the 1980 election; otherwise they basically coincide for the period after 1969. We suspect that the Abrams/Iossifov finding of a Democratic chair aiding a Democratic president goes back to William McChesney Martin and the Johnson administration, before the start of our sample.

1975II–1977II: All under the Ford administration, ending as Carter takes office.

1982III–1985IV: All in the Reagan administration, ending a year after his reelection.

1987II–1988II: Again under Reagan, starting *before* the stock market crash, and preceding the election of G.H.W. Bush.

1991II–1994IV: Beginning under G.H.W. Bush, ending under Clinton.

2001IV–2004III: Beginning with 9/11, continuing through the reelection campaign of G.W. Bush.

The pattern is reasonably plain: periods of sustained, abnormally low interest rates all begin during Republican administrations. All end following an election involving a Republican incumbent or his immediate successor. The one exception is the Nixon reelection campaign of 1972, during which there is a single quarter (1972I) of sharply lower-than-normal interest rates, but no sustained pattern.[12]

Of course, it could be coincidence. It could be that economic conditions called for such policies, as reflected in the Taylor Rule. The framework of the previous section permits a simple, clear-cut test of this possibility.

We frame the hypothesis starkly: *that the Federal Reserve systematically alters the term structure of interest rates, in advance of presidential elections, so as to assist Republicans and to harm Democrats, after controlling for the relevant economic variables.* To avoid data-mining, we define the relevant advance period uniformly, as one year, starting in the fourth quarter of the preelection year. The dummy variable (REPUP) takes the value one for four quarters in advance of the elections of 1972, 1976, 1984, 1988, 1992, and 2004—years when a Republican president held office—and zero otherwise. DEMUP takes the value one for four quarters in advance of the elections of 1980, 1996, and 2000—years when a Democratic president held office—and zero otherwise.

The hypothesis thus has two independent parts. On one side, it predicts that the variable REPUP will be positive and significant, indicating that, after controlling for the influences of inflation and unemployment, the term structure is steeper and monetary policy more permissive in years when a Republican administration is seeking renewal than when it is not. On the other side, the hypothesis predicts that DEMUP will be negative and significant, indicating that the term structure will be flatter and monetary policy more

[12] The period of Nixon's reelection campaign was anomalous in other respects as well, and the relatively normal aspect of the term structure at this time may be due to the effect of price controls on long-term interest rates.

restrictive, after controlling for the influences of inflation and unemployment, in years when a Democratic administration is seeking renewal. The two effects need not be symmetric. The hypothesis also has the virtue of measuring monetary stance directly, as money growth and the federal funds rate do not. It also does not require that any downstream effect, on growth or unemployment, be detectable. The entire consequence could be simply in the news and on the stock market.

We assert no prior view on the hypothesis itself. Many may consider it to be improbable: the Federal Reserve is formally independent of the executive branch, and the President certainly cannot order interest rates to be lowered or raised. Yet the President does appoint the chair and members of the Board of Governors, who in turn control the presidencies of the regional Federal Reserve Banks. In modern times, three Federal Reserve Chairman (Burns, Greenspan, Bernanke) have held prior high office in Republican administrations, while no partisan Democrat has held the post since the 1960s, with the brief and arguable exception of G. William Miller.[13] We choose the form of our hypothesis so as to express the suspicion in an extreme way. Since the hypothesis embodies a grave accusation, this seems appropriate. Confirmation must depend on strong evidence, robust across multiple specifications. The accused is given the full benefit of any uncertainty, and the conviction, should it come, needs to be beyond a reasonable doubt.

We enter the two dummy variables into our four models, so as to test them against the full range of possible ways in which inflation and unemployment might enter the reaction function. The results are given in Tables 3 and 4, for the same two subperiods analyzed previously, 1969–1983 and 1984–2006.

[13] Miller was a lawyer and businessman who had held only advisory political appointments before the Federal Reserve chairmanship. Paul A. Volcker was a registered Democrat, but he had served in the Nixon Treasury Department and his appointment was largely considered to be a concession to anti-inflation hard-liners.

Table 3. Is The Federal Reserve Biased Toward Republicans? 1969III–1983I

Variable	Model 1	Model 2	Model 3	Model 4
REPUP	1.15***	1.41***	1.08***	1.42***
DEMUP	-1.43*	-1.44*	-1.22*	-1.00
INFLABOVE	-0.87*			
INFLRISING	-0.22			
UNBELOW	-1.05**			
UNFALLING	-0.27			
INFLTIGHTEN		-0.15		
INFLEASE		1.02**		
UNTIGHTEN		-0.60		
UNEASE		0.62*		
TAYLORTIGHTEN			-1.05**	
TAYLOREASE			0.98**	
ALLTIGHTEN				-0.61
ALLEASE				1.79***
INTERCEPT	2.33***	0.83*	1.19***	0.97***
R2 adjusted	.26	.23	.27	.18
N=55	***significant .01 or better	**significant .05 or better	*significant .10 or better	

The results in Table 3 give striking confirmation to the most cynical historians of the 1970s. They show that, controlling for the impetus of inflation and unemployment, the Federal Reserve systematically intervened in election years. Both variables are independently significant, of opposite sign, and together they suggest a habitual *ceteris paribus* differential in the term structure of between 200 and 300 basis points, favoring Republicans. Apart from this, the results are consistent with the previous finding—that monetary policy in these years reacted to both unemployment and inflation. However, the effects of the economic variables on monetary policy are no stronger than the effect of the political cycle on the term structure of interest rates.

Table 4. Is the Fed Biased Toward Republicans? 1984I–2006IV

Variable	Model 1	Model 2	Model 3	Model 4
REPUP	0.92***	1.18***	1.25***	1.37***
DEMUP	-0.61**	-0.57**	-0.53**	-0.76***
INFLABOVE	-0.03			
INFLRISING	-0.01			
UNBELOW	-1.47***			
UNFALLING	0.17			
INFLTIGHTEN		-0.06		
INFLEASE		0.13		
UNTIGHTEN		-1.02***		
UNEASE		0.29		
TAYLORTIGHTEN			-0.99***	
TAYLOREASE			0.52*	
ALLTIGHTEN				-0.61***
ALLEASE				0.61*
INTERCEPT	2.33***	2.01***	1.89***	1.76***
R2 adjusted	.62	.43	.46	.27
N=92	***significant .01 or better	**significant .05 or better	*significant .10 or better	

Table 4 gives information on the modern period. We find, as before, that the influence of movements of the unemployment rate on the term structure is strong, systematic, and asymmetric. The direct influence of inflation has, as before, largely disappeared, though now a weakly significant easing reaction is visible when both inflation and unemployment call for it. After controlling for these influences, the political variables remain significant and of the expected sign in all the models; they are, in fact, strengthened by the inclusion of the new dummies.[14] Over the years 1984 to 2006, monetary policy moves strongly in favor of Republicans and (less strongly) against Democrats in election years. The explanatory power of the model rises to a striking 62 percent (in Model 1) based

[14] In the appendix we comment on some alternative specifications and sensitivity tests.

on just three significant dummy variables, and is improved by around twenty percentage points in all of the other models.

VI. TENTATIVE CONCLUSIONS

To the extent that the Federal Reserve controls the yield curve by setting short-run interest rates, the following claims do not find support in our model:

– *Claim: Monetary policy is mostly aimed at "fighting inflation."* After 1983, we do not find that the term structure responds at all to inflation, neither to the level nor to changes in the inflation rate, unless unemployment is giving the same signal as inflation.

– *Claim: The Federal Reserve neglects unemployment*. To the contrary, we find that the Federal Reserve reacts to low unemployment—that is, to a real variable, strongly indicative of the state of demand.

– *Claim: The Federal Reserve fights recessions*. To the contrary, while after 1983 the Federal Reserve systematically tightens when unemployment is low, it does not ease simply because unemployment is high.

Further, our VAR analysis contradicts several major tenets of present monetary doctrine:

– *Claim: Low unemployment is an inflation risk.* Even though the Fed targets a real variable, nominal variables such as the CPI have not gotten "out of control." CPI inflation is stationary on 1984–2003, i.e., it has a stable mean, and it is impossible for a variable with a stable mean to bear any statistical relationship with a trended variable like unemployment. The perfect example is that of the late 1990s, when we saw steadily decreasing joblessness, up to the point of sustained quasi-full employment. Inflation did not rise.

– *Claim: Inequality is outside the scope of monetary policy*. To the contrary, we find that pay or earnings inequality in manufacturing reacts to the term structure, and therefore, partly to the rate-setting decisions of the Federal Reserve. Historically, recessions are prefigured by inverted yield curves; rises in both unemployment and inequality result. Inequality has always been the "recipient of shocks," among them the effects of unemployment and inflation. But we show here that inequality is also a direct product of monetary policy choices. It is not "outside the scope" of the issues with which the Federal Reserve must deal.

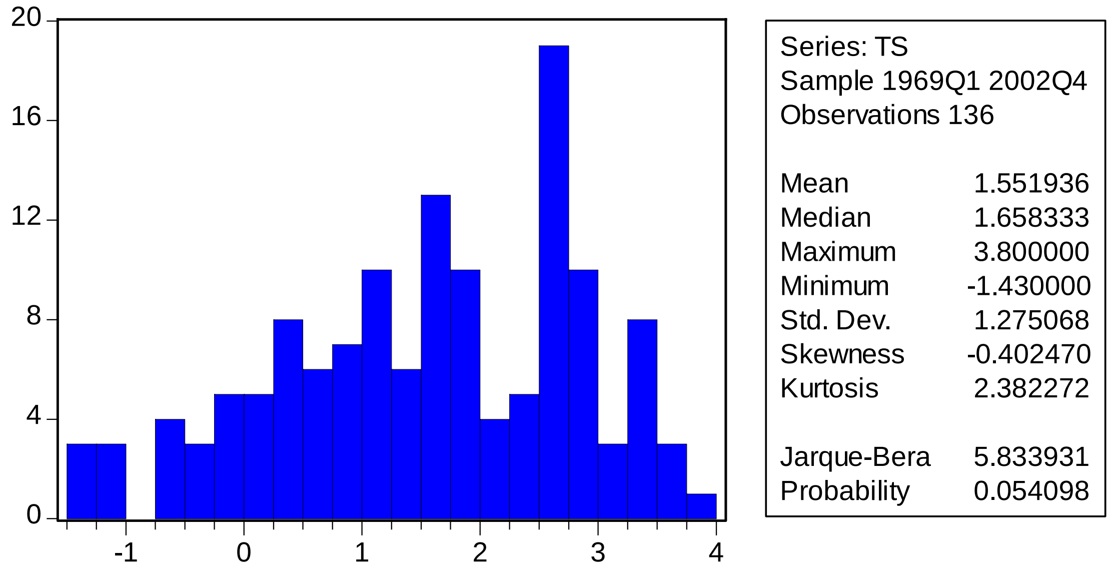
Our results contradict the widely-assumed connection between inflation and unemployment—whether in the form of the Phillips Curve or its successor, the natural rate of unemployment (NAIRU). These concepts have been proffered to justify persistent, higher-than-full-employment unemployment rates, and to rationalize raising rates when unemployment falls "too low." But since 1983 there is no evidence that violating those thresholds produces rising inflation.

Finally, there is the claim that the Federal Reserve is apolitical. We examine the hypothesis of a presidential election cycle in the term structure of interest rates. We find compelling evidence that such a cycle existed in both subperiods. Specifically, we find that in the year before presidential elections, the term structure deviates sharply from otherwise-normal values. When a Republican administration is in office, the term structure in the preelection year tends to be steeper, by values estimated at up to 150 basis points, and monetary policy is accordingly more permissive. When a Democratic administration is in office, the term structure tends to be flatter, by values also estimated at up to 150 basis points, and monetary policy is more restrictive. These findings are robust across model specifications and across time, though the anti-Democrat effect is smaller after 1983. Taken together, they suggest the presence of a serious partisan bias, at the heart of the Federal Reserve's policymaking process.

APPENDIX I. FURTHER NOTES ON THE TERM STRUCTURE

The graph of the term structure (Figure 1) shows a time series that is (1) very stationary and (2) very smooth. The first one deserves some attention,[15] but the smoothness is especially suspicious. To the contrary, a purely random, stationary time series is very volatile. Figure A1 provides a histogram of the distribution of this variable:

Figure A1. The Distribution of the Term Structure, 1969–2002.



Tests for heteroscedasticity indicate that TS is very persistent for any meaningful value of the parameter. We shall call that effect "persistence." In addition, TS is *not* normally distributed, suffering both from excess skewness (long left tail) and insufficient Kurtosis (platykurtic distribution). There are three possibilities: (1) TS is "naturally" skewed, (2) TS is non-normal for the simple reason that it contains anomalies, or (3) both.

There are two major reasons why a distribution may be non-normal: breaks and outliers (the "anomalies"). We will further distinguish between outliers in the *level* of TS and in the *changes* of TS. However, breaks in the level of TS would show up as outliers in its changes, so only one analysis is necessary. We will concentrate on the level of TS. In the present case, TS appears very stationary, so the presence of breaks is unlikely, and if there are any, those breaks are not likely to be very influential. However the location of the break(s) may be interesting for future analysis.

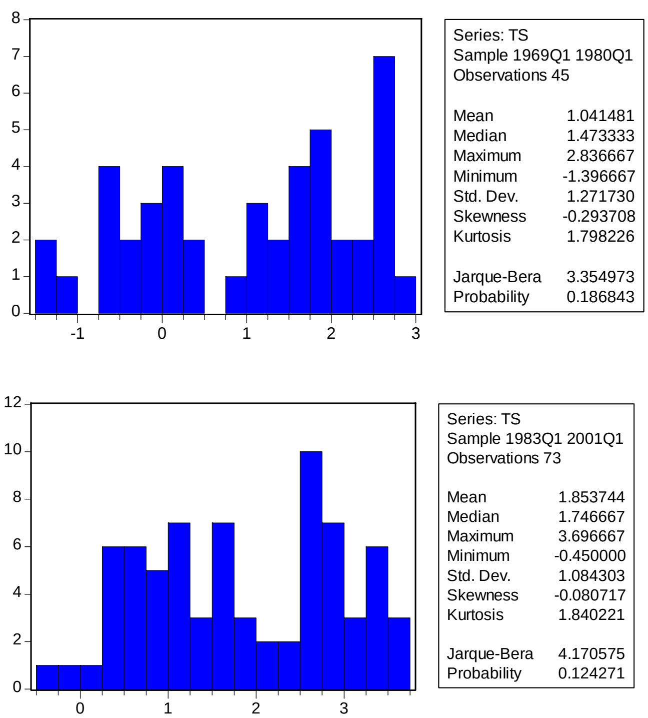
[15] The stationarity of TS implies that the short rate and the long rate are cointegrated, i.e., that they have the same trend in the long run. It also implies that some causality applies between the two rates, which is not surprising.

The procedure to identify breaks in TS is given in Lütkepohl and Krätzig (2004). The procedure identified *four* breaks that came out recurrent for almost all (reasonable) choices of the method parameter: 1980IV, 1981IV, 1982III–IV, and 2001II. Those break dates in the level of TS are worth discussing but are somewhat intuitive (except for 2001II). But let's see if the distribution of TS has changed on periods devoid of breaks (before 1980I, and between 1983III and 2001I).

– Before 1980I, TS is less stationary, though still roughly constant, but is normally distributed. (See Figure A20. However, we find evidence of a strong "persistence" again, with heteroscedasticity being very high.)

– Between 1983I and 2001I, TS is barely stationary, barely constant, and again, very heteroscedastic.

Figure A2. Distribution of TS Before and After Breaks in the Early 1980s.



Outliers

We shall distinguish between the outliers in the level of the series TS and in its changes over a handful of quarters. The method is the same and is inspired by the outlier search procedures in econometrics: an outlier is defined as standing out from the crowd. The crowd is the average standard deviation in the total period, and "standing out" means being a multiple of that standard deviation. The "multiple" takes values 1.96, 2.57, and 3.30 to denote outlier significance at the 5%, 1%, and 0.1% levels, respectively. Therefore an outlier at time *t* will be picked up by the rule:

$$TS_t \geq \alpha . \sigma_{TS}$$

where α =1.96, 2.57, or 3.30 is the confidence threshold and σ_{TS} is the standard deviation of TS. Equivalently this rule can be understood as a procedure to locate all the individual quarters when TS was abnormally above or below *average*.

Correlation between TS and the Discount Rate and Outliers in the Term Structure

To facilitate interpretation of future findings, we first apply the above "outlier detection rule" to the TS and the discount rate. This is done to see if TS is more influenced by the short-term rate (the Fed action) or the long-term rate, representing some other causal force. *The conclusion is that all the significant changes in TS coincide beautifully with changes in the discount rate.*

We first consider the changes over several periods in both TS and the discount rate, and then apply the rule above. This will allow us to find out what kind of influence the Fed exerts over TS. Specifically we look for the significant dates (at the 5% level) between:

(1) The set of dates at which there have been significant changes in TS within the last 1, 2, 4, 6, or 8 quarters.

(2) The set of significant changes in the discount rate with the same lags.

The comparisons are given in Table A1.

Table A1. Changes in TS and the Discount Rate. All dates significant at 5% for…

changes in TS (1)			*Changes in the discount rate* (2)		
	1973III	F		1973III	I
				1973IV	I
S	1975I		D	1975I	
S	1975II		D	1975II	
				1978IV	I
				1979I	I
				1979III	I
	1979IV	F		1979IV	I
				1980I	I
S	1980II			1980II	I
S	1980III		D	1980III	
	1980IV	F		1980IV	I
	1981I	F		1981I	I
				1981II	I
				1981III	I
S	1981IV				
S	1982I		D	1982I	
S	1982II				
S	1982III		D	1982III	
S	1982IV		D	1982IV	
S	1983I		D	1983I	
			D	1983II	
			D	1983III	
			D	1992I	
S	2001II		D	2001II	
			D	2001III	
S	2001IV		D	2001IV	
S	2002I		D	2002I	
S	2002II		D	2002II	
			D	2002III	
			D	2002IV	
				2003I	I

Note: Green indicates date significant at the 5% level; Blue indicates date significant at the 1% level; and Red indicates date significant at the 1‰ level

The table contains all the "exceptional" dates (at 5%) for the changes in TS and the changes in the discount rate. There are 32 exceptional dates out of more than 150 potential observations. This ratio of 20% is very high and denotes a very interventionist monetary policy. Virtually all "exceptions" in the changes of TS coincide with "exceptions" in the discount rate. For those 32 cases, at least, all discount rate increases (I) have translated into a flattening of TS, and all discount rate decreases (D) led to a steeper TS. Of course there remain 120 quarters beyond those exceptional 32, with more information to be analyzed.

However, the results prove that when the Fed wants to, it may influence and *has* influenced the TS *directly*.

The general conclusion is that nearly all the (significant) changes in TS happen at the same dates as the significant changes in the discount rate. However, the Fed is more successful at influencing the TS when it cuts rates than when it increases them.

Applying the rule above to the level of TS yields interesting results. The rule does not pick up any of the lows of TS—as would have been expected. Nor does the rule pick up *individual* observations (except for 1972I.) Rather, the rule picks up *entire periods* for which TS has been consistently above average. Statistically speaking, the persistence of abnormal periods means that it is very hard for TS to be heteroscedastic (as confirmed above). Economically speaking, this implies that TS is dominated by persistent forces.

This is evidence of sustained action of the Federal Reserve, which had, in some periods, a persistent policy of low interest rates (high TS). The question is when did those persistent actions happen, and is there a general pattern that can be observed?

In the period 1969I–2007I, five *periods* of intervention of the Federal Reserve turn out to be significant (at either the 5% or 1% level). These are periods of two to three years. The results are presented in Table A2.

Table A2. Abnormal and Sustained Periods of Easy Money

Significance in the level of TS on 1969I–2007I (*N*=153 observations)

Significant period	**# of quarters significant…** at 1%	at 5%	**Mean level of TS**	**Comments**	**Notes: Significantly high TS happens when…**
1975II–1977II	0	6	2.54	Short and mild	All in the whole Ford administration; ends as soon as Carter is in office
1982III–1985IV	4	9	2.91	Long and strong	Entirely in the Reagan term; ends after 1984 reelection
1987II–1988II	0	5	2.83	Short and mild	Run-up to G.H.W. Bush election. Precedes October 1987 stock market crash.
1991II–1994IV	5	10	3.01	Long and strong	All 5 quarters significant at 1% are in 1992I–1993I; Run-up to G.W.H. Bush reelection.
2001IV–2004III	5	7	3.03	Long and strong	The quarters significant at 1% coincide with 9/11. The whole significant period is during the first G. W. Bush term and ends with 2004 election.
All significant. *periods*	14	36	2.90	1. The "intervention" episodes see a mean level of TS that is 3.5 times higher than during the nonintervention periods 2. The "nonintervention" episodes have mean TS half as large as the overall mean, while the "intervention" quarters have a mean that is double that of the overall mean.	
All others	0	1 (*1972I*)	0.82		
TOTAL	**14**	**38**	**1.56**		

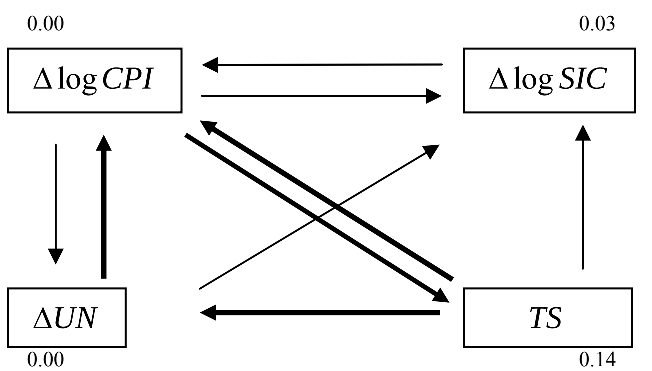
Notes: No period stands out as a below-average outlier.
Only one isolated quarter shows significant and above average. The rest consists of *periods* of persistently high TS.

APPENDIX II. VAR ESTIMATION ON THE SUBPERIOD 1969–1982

There exist coherent data for dates prior to 1984. The same VAR model was built for the 1969–1983 period (T=54) with the same variable transformations and the same lag length k=2 but different dummies. Stability tests indicate that there is indeed at least one break in the estimated relationships, around 1975. Indeed, the pre-1984 era is characterized by higher instability, which is likely to introduce biased estimates—and therefore, misleading inference. The usual practice in the presence of breaks is to split the sample; however, this cannot be done here due to a succession of breaks in a short period.

Should we refrain from reporting estimated results on a period that contains breaks? The answer is that in theory yes, because breaks introduce biases. However the extent of those biases is unknown and the effect of a break may be to lessen a coefficient without dramatically changing its interpretation. This might be the case of the 1975 break date. Because of this, it makes sense to estimate—cautiously—a model on 1969–1984, bearing in mind that the results may or may not be influenced by the break. On that sample, the Granger causality results are the following:

Figure A3. Granger Causality Results on 1969–1982



Note: Arrows represent Granger causality from past values to current values: temporal causality at the 5% level (thin lines) or 1% level (thick lines). The numbers are the probabilities of *not* being jointly caused by the other variables.

The interpretation of causality changes substantially. In this period the term structure (covering interest-rate decisions) turns out to be exogenous again, affecting mostly unemployment and inequality, but also strongly inflation. In return, the term structure is only influenced by inflation (very significantly so), consistent with the historical claim of the Federal Reserve.

Apart from that, the causal picture on 1969–1982 is somewhat similar to the post-1984 period: inflation, unemployment, and inequality are closely interrelated. The only two major differences are that:

– The term structure causes unemployment much more strongly pre-1984, with no feedback.

– There is a bicausal link between the term structure and inflation before 1984, which disappears after that date.

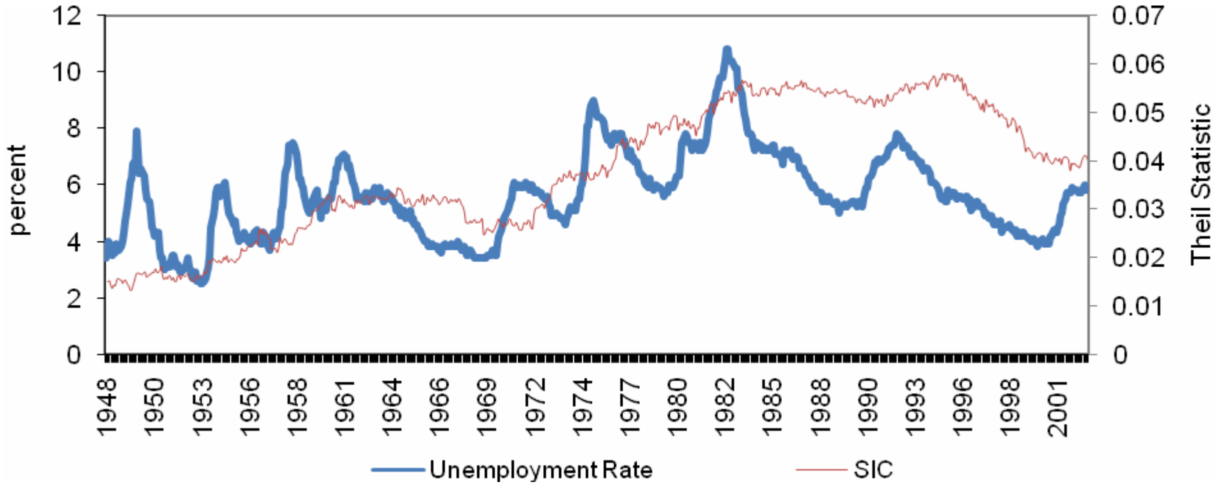
APPENDIX III. MONETARY POLICY AND PAY INEQUALITY[16]

Measuring Pay Inequality

We measure the inequality of manufacturing following Galbraith (1998), using the between-groups component of Theil's T-statistic measured across manufacturing sectors at the three-digit SIC level. This measure has the virtue of providing an accurate index on a monthly basis of the inequality of pay across jobs—as opposed to the pay earned by persons or households. It is relatively free of contamination from sources of income inequality arising in the capital markets (stock options, capital gains, and the disbursement of funds raised in IPOs), and therefore does not reflect that source of rising inequality, closely associated with the rising stock market, during the late 1990s technology boom (Galbraith and Hale 2006). It is, therefore, a measure well-suited to the thesis of "skill-biased technological change," which is supposed to be "outside the scope" of issues with which monetary policy deals. Figure A1 illustrates the trend in unemployment and in manufacturing wage rate inequality derived from all 31 manufacturing sectors from 1948 to 2002. There is a clear association though with some upward displacement of the inequality measure after 1983.

[16] This appendix is based on the work of Ann Russo.

Figure A1. Wage Inequality and Unemployment (1948–2002, monthly)



Source: University of Texas Inequality Project, http:// *www.utip.gov.utexas.edu*.

An ARIMA Approach to Term Structure and Inequality

According to the Taylor Rule, monetary policy responds to deviations of inflation and unemployment from their target values; the actions of the monetary authorities in turn have long-term impact on inflation and short-term impact on unemployment, for good or ill. Greenspan (1997) and Bernanke (2007) have explicitly or implicitly denied any association between monetary policy and inequality. The relationships between these four variables—unemployment, inflation, inequality, and the yield curve, each measured on a monthly basis—therefore form a well-defined hypothesis, suitable for testing using standard time-series techniques for assessing the directions of causality between variable pairs.

This appendix uses an atheoretic method derived from Box and Jenkins' (1976) Autoregressive Integrated Moving Averages (ARIMA) model. ARIMA is especially useful in analyzing equally-spaced time-series macroeconomic data that is that is commonly autoregressive in nature. In this method, variables are expressed in terms of their current and lagged "white noise" component known as the "innovation." After the removal of trends and periodicities, the ARIMA crosscorrelation procedure determines whether or not a significant direction of causality exists between the innovations of two variables at different points in time.

The general model is written as ARIMA (p,d,q) where "p" is the number of lags, "d" is the degree of differencing, and "q" is the moving average. This paper used ARIMA (24,1,0), (24,0,0), and (24,2,0). The process was divided into three stages; 1) data transformation, 2) autoregressive procedures, and 3) ARIMA crosscorrelation procedures.

Stage I

The original time-series data were first graphed to observe the original pattern, and to identify the existence of trends and periodicities common in many macroeconomic variables. For autoregressive methods to produce meaningful results the variables must stationary; the variable's mean must be stable over time (Stock and Watson 2003). If data have a unit root the series may trend over time, leading to perverse interpretation of the output.

The data for unemployment (UR), inequality (SIC), and inflation (ΔlogCPI) are nonstationary (the mean is changing throughout the time series) so these variables required transformation to induce stationarity. To remove the trend from in the data, the following equations were used:

Log first differences: $\Delta \log X_t = \log X_t - \log X_{t-1}$.

Log second differences: $\Delta^2 \log X_t = \Delta \log X_t - \Delta \log X_{t-1}$.

Stage II

With the variables stationary, an autoregression test was performed on the variables with a 24-period lag.

Variables: Term Structure of Interest Rates, Inequality (SIC), Consumer Price Index, and Unemployment Rate:

$TS_t = a + b_1 TS_{t-1} + b_2 TS_{t-2 \ldots} b_n TS_{t-24} + e$

$\Delta logSIC_t = a + \beta_1 \Delta logSIC_{t-1} + \beta_1 \Delta logSIC_{t-2 \ldots} \beta_n \Delta logSIC_{t-24} + e$

$\Delta logUN_t = a + \beta_1 \Delta logUN_{t-1} + \beta_1 \Delta logUN_{t-2 \ldots} \beta_n \Delta logUN_{t-24} + e$

$\Delta^2 logCPI_t = a + \beta_1 \Delta^2 logCPI_{t-1} + \beta_1 \Delta^2 logCPI_{t-2 \ldots} \beta_n \Delta^2 logCPI_{t-24} + e$

TS_t, SIC_t, UN_t, and CPI_t are the indicator variables "term structure of interest rates," "inequality," "unemployment rate," and "consumer price index," respectively, in time zero; TS_{t-1}, $\Delta logSIC_{t-1,}$ $\Delta logUN_{t-1}$, and $\Delta logCPI_{t-1}$ are the indicator variables in time t-1 period lagged for 24 periods; and e are the innovations.

If the indicator variable contains useful information we would expect some of the β coefficients to be significantly different from zero, as determined by T-tests at the 95 percent confidence interval. Using this threshold however failed to correct for autocorrelation, therefore t-values were lowered to whiten the variables, in order to test their innovations. For most lags, the autocorrelation check for white noise (Chi-Square) indicates whitening of the variables by greater than 90 percent. However, in some cases, the inherent trend in the variables prevented this level of whitening without "washing out" the data. In essence, too much of the variable was removed leaving little to interpret. In some autocorrelation tests, levels as low as 83 percent may be found, however, no lags violated the 95 percent boundary of statistical significance, therefore all are considered whitened by ARIMA standards.

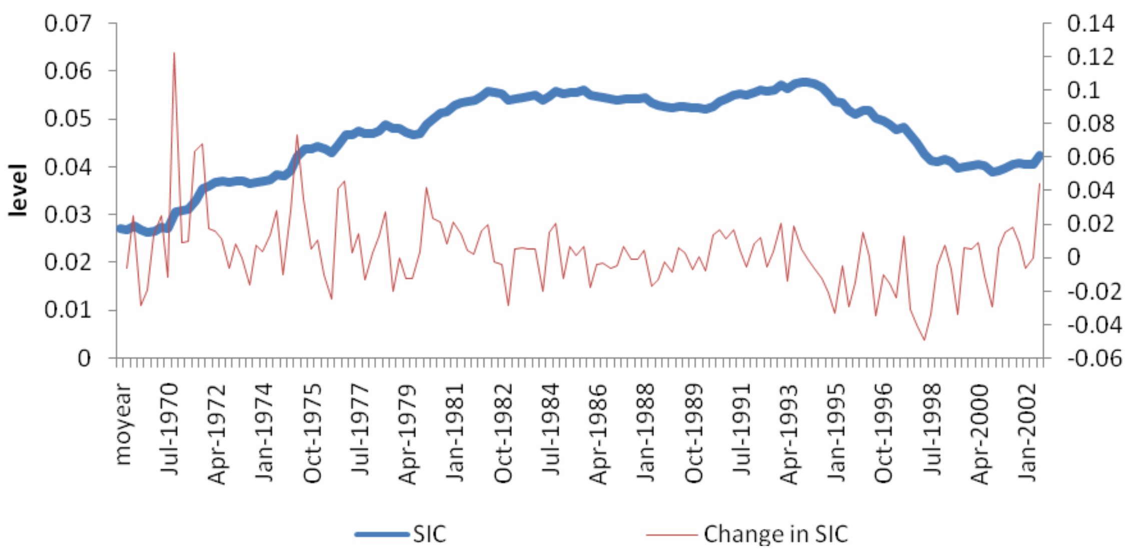
Stage III

Finally we performed ARIMA procedures testing autocorrelation and crosscorrelation of the variables. An autocorrelation check for white noise (Chi-Square) was used on all series. When no autocorrelations were found, the variables were considered whitened and innovations random. Crosscorrelation procedures were then carried out to determine whether or not a significant relationship between the innovations of the variables was detected to a 95% confidence level.

Variables and Transformations

Manufacturing Wage Rate Inequality (SIC). The inequality data are a Theil statistic derived from wage rates of production workers in all 32 manufacturing sectors for which continuous data are available since 1947.[17] Inequality is measured in weekly earnings (pay) in the manufacturing sector on a monthly basis and is seasonally adjusted. For stationarity, the data was transformed into rates of change. Figure A2 illustrates the inequality time-series data before and after transformation.

Figure A2. Manufacturing Wage Rate Inequality



Source: UTIP and Authors' calculation

Term Structure of Interest Rates—The Yield Curve. The term structure of interest rates was calculated as the difference between 10-year constant maturity rate and three-month Treasury bill rate from January 1969I to December 2006III. The 10-Year Constant

[17] The time-series for industrial pay inequality was computed by Olivier Giovannoni. See the University of Texas Inequality Project web-site at http://utip.gov.utexas.edu for further work of this type.

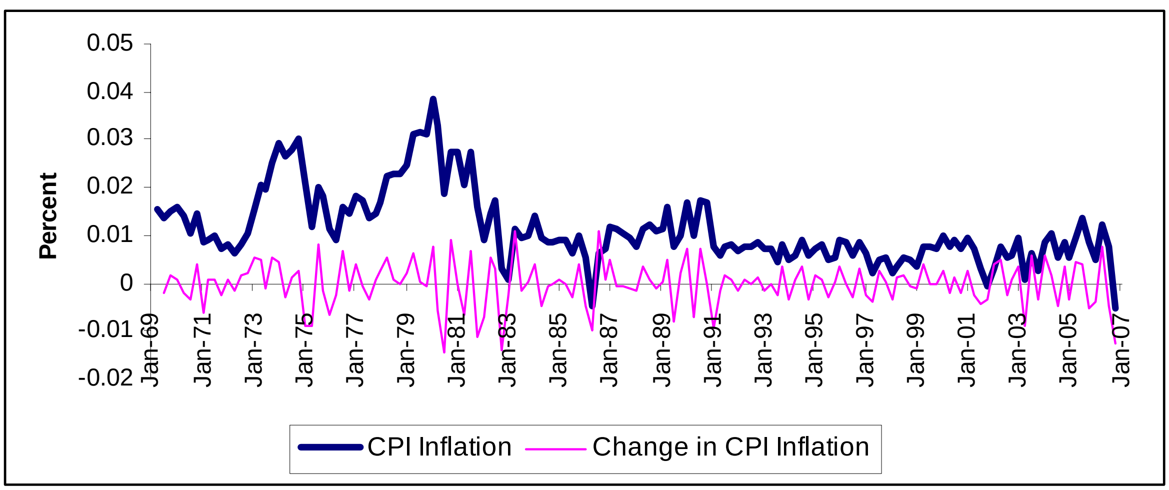
Maturity data were compiled using from The Federal Reserve Bank of Dallas (10-Year Constant Maturity) and Federal Reserve Statistics (3 month Treasury bills) as available through www.economagic.com.

Consumer Price Inflation. The Consumer Price Index covers all items in all cities for all urban consumers (CPI-U) on the period 1969I–2006IV. The reference base is 1982–84 equals 100 and is provided by "Economagic" at www.economagic.com.

The CPI-U covers approximately 87 percent of the total population. In addition to clerical and wage earners, the CPI-U includes professionals, managers, technical workers, those self-employed, unemployed, short-term workers, retirees, and others not in the labor force. To produce stationarity, data for CPI required transformation into log second differences denoted by the equation, Δ2logCPIt = ΔlogCPIt - ΔlogCPIt-1.

Figure A3 illustrates the time series data before and after transformation.

Figure A3. Consumer Price Inflation

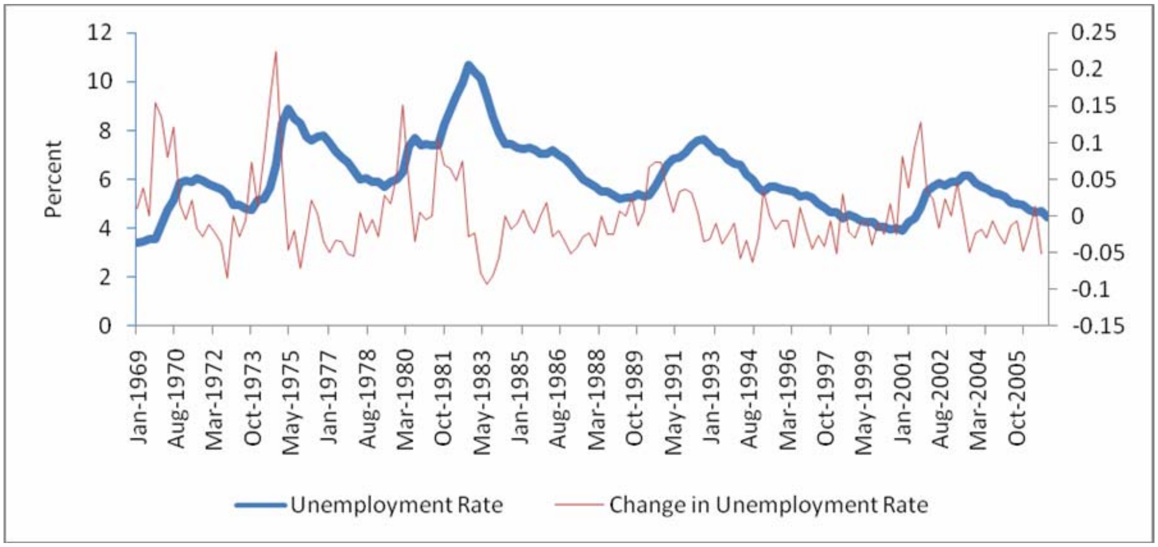


Source: Authors' calculation

Unemployment Rate. We used the Civilian Unemployment Rate: Seasonally Adjusted (SA) data for the unemployment variable. Data are sourced from the Federal Reserve Economic Data (FRED), as available through the "Economagic" database. Data were collected on a monthly and quarterly basis. Monthly data were collected from January

1969 through February 2007, with quarterly data collected from 1969I to 2006IV. To produce stationarity, data were transformed into rates of change (Figure A4).

Figure A4: Unemployment Rate



Source: Authors' calculation.

Results

The results of the crosscorrelation procedures found to be significant at the 95 percent level are summarized in the Table A3 below. Data were transformed to quarters for this analysis and the lags are therefore measured in quarters.

Table A3. Summary of Crosscorrelation Results

Significant Finding	Correlation	Lag
Term Structure Granger-Causes Inequality	-.18 -.20	6 11
Term Structure Granger-Causes Inflation	-.19 .18	1 14
Term Structure Granger-Causes Unemployment Rate	-.13 -.10	10 14
Unemployment Rate Granger-Causes Term Structure	.12 .12 -.08	1 3 12
Inflation does not Granger-Cause Term Structure	--	--
Inequality does not Granger-Cause Term Structure	--	--

Source: Authors' calculations

The results are striking in several respects. First, they indicate causality from the term structure to inequality: statistical evidence against the Greenspan-Bernanke consensus. A reduction (flattening) of the yield curve, indicating a tighter monetary policy, raises inequality six quarters out, with a second significant impact at eleven quarters. A steepening of the yield curve tends to reduce inequality, with a similar lag.

Second, there is causality from the term structure to inflation. A flatter yield curve raises inflation with a lag of just one quarter, though it tends to reduce inflation 14 quarters hence. This is consistent with the idea that short-term interest costs are immediately passed through into prices, while the squeeze on economic activity of a tighter monetary policy is felt later on. Obviously, this raises a grave concern. If the Federal Reserve reacts to the inflation it has itself caused, monetary policy could go on a cumulative process of successive tightenings, each leading to higher inflation in the short run and to a deeper recession after a lag.

The crosscorrelations are also interesting for what they do not say. In contradiction to the Taylor Rule, this analysis lends no support to the idea that innovations in the CPI affect the term structure. In other words, there is no evidence here—despite the massive ideological commitment of the Federal Reserve to price stability—that the FOMC actually reacts to rising (or falling) inflation.

On the other hand, innovations of unemployment do Granger-cause changes in the term structure at a horizon of one to three quarters. The relationship is positive, which indicates a fall in unemployment is correlated to a rise in interest rates (resulting in a flatter term structure). It would therefore appear that, much official rhetoric to the contrary, the Fed in fact operates on a single mandate, and it isn't price stability.

Conclusion

This appendix mainly set out to answer the following question: Does monetary policy influence inequality? More specifically, does information contained in the term structure of interest rates extend beyond inflation and unemployment to a measure of inequality in earnings? The answer is that it does.

APPENDIX IV. ADDITIONAL TESTS OF TAYLOR RULES

To check the robustness of the political variables, a dummy (DEMSIN) was created with a value set to 1 in years of Democratic administrations and zero otherwise. Two dummies (MIDTERMSR and MID-TERMSD) were created with values equal to 1 in the year before congressional midterm elections under Democratic and Republican presidents, respectively. Results for 1984–2006 are presented in Table A4.

TableA4. Sensitivity Tests on the Political Bias Variables, TS on 1984I–2006IV

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
REPUP	0.80***	1.04***	1.08***	1.21***
DEMUP	-0.67**	-0.66**	-0.59**	-0.82**
DEMSIN	-0.08	-0.07	-0.18	-0.14
MIDTERMSR	-0.46*	-0.53*	-0.52**	-0.59
MIDTERMSD	-0.11	-0.02	0.37	-0.11
INFLABOVE	-0.08			
INFLRISING	0.02			
UNBELOW	-1.46***			
UNFALLING	0.15			
INFLTIGHTEN		-0.10		
INFLEASE		0.10		
UNTIGHTEN		-1.02***		
UNEASE		-0.29		
TAYLORTIGHTEN			-0.98***	
TAYLOREASE			0.60**	
ALLTIGHTEN				-0.63**
ALLEASE				0.74**
INTERCEPT	2.50***	2.18***	2.10***	1.96***
R2 adjusted	.63	.44	.47	.27
N=92	***significant .01 or better	**significant .05 or better	*significant .10 or better	

The presidential election years dominate, though with a small backlash effect in midterm elections under Republicans, in three of four models. Note that in these specifications the Fed again responds to unemployment rather than inflation, and it does ease, weakly, when both inflation and unemployment call for it.

APPENDIX V. VAR SPECIFICATION CHECKS

Table A5. Unit Root Tests Results, 1994I–2002III (*T*=75)

	Unit root tests statistics		
	Plillips-Perron	ERS DF-GLS	ERS Point Optimal
TS	-2.48	-2.75***	2.00**
$\Delta \log CPI$	-4.94***	-2.02**	3.70*
ΔUN	-4.79***	-1.65*	6.86
$\Delta \log SIC$	-6.05***	-2.22**	0.86***
Critical values at 1%, 5% and 10%	*-3.52* *-2.90* *-2.59*	*-2.60* *-1.94* *-1.61*	*1.91* *3.04* *4.04*

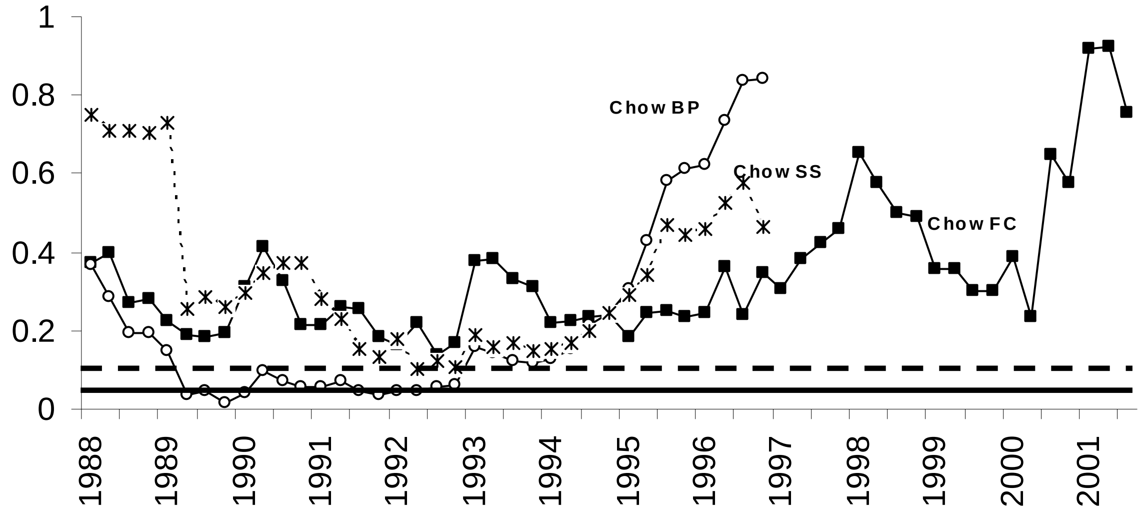
Note: The tests were run with a constant only in the model. The Phillips-Perron test is used with the Hannan-Quinn criterion, whereas the ERS tests were run using the Newey-West bandwidth. ERS stands for Elliott, Rothenberg, and Stock (1996) tests.

Table A6. Residuals Specification Tests, 1984I–2002IV, *T*=76

	Individual normality			Joint tests
	Skewness	Kurtosis	*p*(N)	
TS	-0.46	3.56	0.81	*p*(*LM*(1))=0.36 *p*(*VARCH*(1))=0.51 *p*(*N*)=0.78 p(skew)=0.57, p(kurt)=0.75
$\Delta \log CPI$	0.67	4.17	0.16	
$\Delta \log SIC$	0.07	2.84	0.93	
ΔUN	0.24	2.63	0.57	

Note: *p*(*N*) represents the probability of being normally distributed, using the Doornik and Hansen (1994) procedure. *P*(*LM*(1)) and *p*(*VARCH*(1)) are the probabilities of absence of autocorrelation and heteroscedasticity, respectively, both at order one.

Figure A6. System-wide Stability Tests for the VAR Model



Note: *BP*, *SS*, and *FC* are three system-wide versions of Chow (1961) tests (breakpoint, sample-split, and forecast). The reported statistics are the bootstrapped *p*-values calculated using 10,000 replications in JMulTi [see Lütkepohl and Krätzig (2004)]. The horizontal lines represent the 5% and 10% confidence levels.

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