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Inflation, Presidents, Fed Chairs, and Regime Shifts in the U.S. Real Interest Rate

Several recent papers agree on the existence of significant regime shifts in the U.S. real interest rate, but disagree on the proximate causes of the shifts. Caporale and Grier (2000) point to large political changes as correlates, while Rapach and Wohar (2004) show that real rate breaks are correlated with inflation regime shifts and argue that the inflation regime changes cause the real rate shifts. In this paper we show that, controlling for the timing of changes in the inflation regime, dummy variables representing either party change in the Presidency or change in the identity of the Fed Chair are still strongly significant for explaining real interest rate fluctuations. When we control for a fixed coefficient linear relationship between inflation and the real rate, we find two real rate regime shifts that line up almost exactly with the accessions of Paul Volcker and Alan Greenspan. Even if we first let inflation regime switches explain the real rate and then look for regime shifts in the residuals, we find almost exactly the same two breaks. These results imply that Fed Chairs sometimes differ with respect to their preferred equilibrium real interest rate.

JEL codes: E52, E58
Keywords: monetary regimes, structural break models.

THERE IS A significant body of evidence indicating that the U.S. real interest rate undergoes infrequent, but significant, mean shifts. Garcia and Perron (1996 [hereafter GP]), Bai and Perron (2003 [hereafter BP]), and Caporale and Grier (2000 [hereafter CG]) demonstrate this phenomenon. Recently, Rapach and Wohar (2004 [hereafter RW]) confirm this finding for the U.S. and show that these real rate regime shifts also occur in many other industrialized countries.

Given these results, a central question becomes, what causes these regime shifts in the real interest rate? GP suggest oil shocks and deficits, while CG point to

We thank Robin Grier, Aaron Smallwood, Mark Wohar, and an anonymous referee for their excellent comments and suggestions. Any remaining errors are ours alone.

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Received April 26, 2004; and accepted in revised form November 22, 2004.

Journal of Money, Credit, and Banking, Vol. 37, No. 6 (December 2005)

changes in the political party holding the presidency and a majority in congress. RW show that inflation rates also display multiple regime shifts and that these shifts are often closely correlated with real interest rate shifts. They conclude that real interest rate shifts are caused by "regime changes in the process governing inflation rates."

In this paper, we reconsider CG's claim that real interest rate regime shifts relate to political changes in the light of RW's interesting findings about how inflation regime shifts affect the real interest rate. We show that, controlling for the timing of changes in the inflation regime, dummy variables representing either party change in the Presidency or change in the identity of the Fed Chair are still strongly significant for explaining real interest rate fluctuations. We further show that when inflation is included as a fixed coefficient regressor in a BP style partial structural break model of the real rate, there are two regime switches that correspond quite closely to the inception of Paul Volcker's and Alan Greenspan's terms as Fed Chair. If we first allow inflation regime shifts to explain the real rate and then test for any remaining regime shifts in the residuals, we find the same basic results. Finally, we find that Fed Chair dummies are also strongly significant in regressions that control for a variety of macroeconomic factors.

Thus, while we agree with RW that inflation shifts are important for understanding real rate shifts, we find that even when allowing for the effects of inflation on the real interest rate, political–bureaucratic variables still help explain a significant amount of the movements in the U.S. real interest rate.[1]

1. PREVIOUS FINDINGS FOR THE U.S.

All of the results considered here use the same estimation technique, namely the time series methods developed by Bai and Perron (1998). As these methods are discussed in BP, RW, and CG, we do not review them here but rather concentrate on the results found in those three papers.

BP use a quarterly sample from 1961.1–1986.3 and calculate the real rate as the Treasury bill rate minus the inflation rate derived from the CPI. They find three breaks dated 1966.4, 1972.3, and 1980.3. CG use quarterly data from 1961.1–1992.4 and use the same definition of the real rate as BP. They find four breaks dated 1967.1, 1972.4, 1980.2, and 1986.2. RW use quarterly data from 1960.4–1998.3. They calculate a tax adjusted real rate using long term government bond rates from the IMF-IFS disk, inflation based on the CPI and tax rates from Padovano and Galli (2001). They also find four breaks dated 1966.1, 1973.1 1981.2, and 1986.4. Despite the variation in sample and interest rate measure, note the large amount of consensus here: the dates of the first three breaks in BP, CG, and RW are all very close to each other and the dates of the fourth break in CG and RW are also extremely close.

1. It should be noted that RW do not claim that inflation shifts are the only factors which contribute to shifts in the real rate.

2. INFLATION, POLITICS, BUREAUCRACY, AND U.S. REAL RATE SHIFTS

In this paper we use quarterly data from 1961.1 to 2000.4. We follow BP and CG by calculating the real rate using a short term interest rate, in this case the Federal Funds rate. From this interest rate we create an ex post tax adjusted real rate using the CPI to measure inflation and the same tax adjustment used by RW.

2.1 Where are the Inflation Regime Breaks?

We begin by confirming RW's dating of U.S. inflation regime shifts in our longer sample. Table 1 presents our application of BP methods to the U.S. inflation rate. Both the global tests and the sequential BP procedure pick three as the optimal number of breaks with dates of 1967.2, 1973.2, and 1982.3.[2] These are each within one quarter of the dates reported in RW (1967.3, 1973.1, and 1982.1).

Now we consider whether taking these inflation dates as the proximate causes of real interest rate shifts (as argued by RW) eliminates the significance of political or bureaucratic explanations for real rate shifts.

2.2 Do Inflation Regime Shifts Eliminate the Significance of Political or Bureaucratic Variables?

Table 2 displays the relevant political and bureaucratic changes over the sample period. The political party holding the presidency changes in 1969.1, 1977.1, 1981.1, and 1993.1. The chairmanship of the Federal Reserve changes in 1970.1, 1978.2, 1979.4, and 1987.4. Table 3 presents estimates of how well each of these three alternative measures of policy regimes explains real rate movements. The first

TABLE 1

PURE STRUCTURAL BREAK MODEL FOR THE U.S. INFLATION RATE

Sup F_T (1)	Sup F_T (2)	Sup F_T (3)	Sup F_T (4)	Sup F_T (5)
33.58*	16.62*	27.01*	22.11*	17.72*
Sup F_T (2/1)	Sup F_T (3/2)	Sup F_T (4/3)		
18.61*	35.18*	8.41		
Ud_{max}	Wd_{max} (10%)	Wd_{max} (5%)	Wd_{max} (1%)	
33.58*	36.50***	38.89**	44.37*	
Number of Breaks Selected by Sequential Procedure = 3				
Break Point Dates and 95% Confidence Interval				
		$\hat{T}_1$	67.2	(66.1–68.1)
		$\hat{T}_2$	73.2	(68.3–73.3)
		$\hat{T}_3$	82.3	(82.1–86.1)

NOTES: *, **, ***: significant at 1%, 5%, and 10%, respectively. Sample 1961.1–2000.4.

2. The global tests are Sup $F(i + 1/i)$ tests comparing the fit of the globally best i break model to that of the globally best $i + 1$ break model. The sequential tests treat earlier determined break dates as given and tests for the significance of the next (marginal) break date. See BP, CG, or RW for more details.

TABLE 2

U.S. Presidential and Bureaucratic Regimes 1961.1–2000.4

Political		Fed Chairs	
Clinton	93.1–2000.4	Greenspan	87.4–2000.4
Reagan–Bush	81.1–92.4	Volcker	79.4–87.3
Carter	77.1–80.4	Miller	78.2–79.3
Nixon–Ford	69.1–76.4	Burns	70.1–78.1
Kennedy–Johnson	61.1–68.4	Martin	61.1–69.4

column gives the results using Presidential party change, the second column presents the Fed Chair turnover model, and the third column uses the estimated inflation regimes from Table 1. Each of the three equations is significant at the 0.01 level.[3]

We want to ascertain whether accounting for these inflation regimes makes political or bureaucratic regimes irrelevant for explaining real rates. Note that none of the three models exactly share any variables, though there is correlation between the dates of shifts, so we have completely non-nested hypotheses. We handle this situation by constructing three artificially comprehensive models which each including two sets of "competing" dummy variables and estimating the so called inclusive regression in each case.[4] Column 1 of Table 4 reports a regression consisting of both the inflation regime shift dummies and the Fed Chair dummies. The F-statistic testing the null hypothesis that the Fed variables are insignificant is 33.38, which rejects the null at the 0.001 level. The corresponding F-statistic testing the null that

TABLE 3

Alternative Mean Shifting Models of the Tax Adjusted Real Fed Funds Rate

	Presidential regime model	Federal Reserve Chair model	Inflation regime model
Constant	0.56 (2.56)	0.50 (2.31)	0.88 (6.11)
Clinton	1.00 (2.30)		
Reagan–Bush	2.18 (3.94)		
Carter	−2.50 (−3.55)		
Nixon–Ford	−1.40 (−2.79)		
Burns		−1.58 (−3.21)	
Miller		−3.59 (−6.59)	
Volcker		2.59 (3.40)	
Greenspan		1.03 (2.77)	
Inflation regime 2			−1.00 (−3.93)
Inflation regime 3			−0.75 (−0.80)
Inflation regime 4			2.96 (3.13)
Adjusted R^2	.36	.37	.21

Notes: All regressions are estimated using the Newey–West (1987b) HAC corrected standard errors with lag truncation = 4. t-Statistics are in parentheses. Sample 1961.1–2000.4.

3. Note, however, that the Presidential and Fed Chair models each have an adjusted R-square over 75% larger than the inflation break model.

4. See Davidson and MacKinnon (2004) pp. 665–669 for a guide to the type of non-nested hypothesis tests conducted here. Note that the relevant test statistic is the overall group F-test and not the individual coefficient t-statistics.

TABLE 4

POLITICAL, BUREAUCRATIC, AND INFLATION SHIFTS AS ALTERNATIVE MODELS OF THE REAL TAX ADJUSTED FED FUNDS INTEREST RATE

	1	2	3
Constant	0.88 (6.03)	0.89 (6.03)	0.57 (2.53)
Inflation Regime 2	−1.22 (−4.27)	−1.44 (−7.92)	—
Inflation Regime 3	−1.94 (−4.73)	−1.91 (−4.24)	—
Inflation Regime 4	1.26 (0.74)	−1.94 (−2.36)	—
Greenspan	2.55 (1.44)	—	−1.64 (−0.88)
Volcker	4.56 (2.65)	—	0.61 (0.35)
Miller	−0.80 (−1.20)	—	−2.14 (−1.72)
Burns	0.41 (1.41)	—	−0.99 (−1.76)
Clinton	—	5.97 (6.00)	2.65 (1.40)
Reagan–Bush	—	6.91 (8.43)	2.56 (1.42)
Carter	—	0.53 (0.63)	−1.50 (1.26)
Nixon–Ford	—	0.62 (2.74)	−0.53 (−1.45)
F-statistic (*P*-value) Fed dummies = 0	33.38 (.001)	—	5.44 (.001)
F-statistic (*P*-value) Pres. dummies = 0	—	18.20 (.001)	4.71 (.002)
F-statistic (*P*-value) Inf. regimes = 0	4.26 (.006)	4.92 (.002)	—
Adjusted R^2	.41	.40	.42

NOTES: All regressions are estimated using the Newey–West (1987b) HAC corrected standard errors with lag truncation = 4. *t*-Statistics are in parentheses. Sample 1961.1–2000.4.

the inflation shift variables are insignificant in this regression is 4.26, which rejects the null at the 0.01 level. We repeat this procedure using the Presidential dummies and the inflation shifts (as shown in column 2), finding the Presidential variables significant at the 0.001 level and the inflation shift variables significant at the 0.01 level. Finally, Column 3 shows that when artificially nested, both the Fed and Presidential dummies are significant at the 0.01 levels.

2.3 Testing for Regime Shifts Allowing for a Fixed Linear Effect of Inflation on the Real Rate

Another way to look at this issue is to allow inflation to affect the real rate on a quarterly basis via a fixed coefficient regression relationship and then, holding the effect of inflation constant in this way, test for the existence of significant shifts in the estimated intercept of the real rate. We consider exactly this case in Table 5.

Here both the global tests and the sequential BP procedure pick two as the optimal number of breaks with dates of 1979.4 and 1986.2. The constant inflation coefficient is −0.54 and is significant at the 0.01 level, while the equation with this effect plus the three intercept values has an adjusted R^2 of 0.75.[5]

5. Straightforward application of the BP procedure requires the underlying series to be stationary. We tested for a unit root in our real rate series allowing for one break in the intercept using Zivot and Andrews (1992) method. We can reject the null of a unit root at the 0.01 level. Details of this testing are available from the authors upon request.

TABLE 5

PARTIAL STRUCTURAL BREAK MODEL FOR THE REAL TAX ADJUSTED FED FUNDS RATE

Sup F_T (1)	Sup F_T (2)	Sup F_T (3)	Sup F_T (4)	Sup F_T (5)
25.95*	50.28*	57.08*	48.41*	52.96*
Sup F_T (2/1)	Sup F_T (3/2)	Sup F_T (4/3)		
21.52*	3.19	7.44		
Ud_{max}	Wd_{max} (10%)	Wd_{max} (5%)	Wd_{max} (1%)	
57.08*	81.03*	89.75**	106.26**	
Number of Breaks Selected Sequential Procedure	2			
Break Point Dates and 95% Confidence Interval				
		$\hat{T}_1$	79.4	(78.1–80.1)
		$\hat{T}_2$	86.2	(85.1–88.4)

Parameter Estimates from the Partial Break Model (t-Statistics in Parentheses)
Inflation parameter: −0.54 (16.14)
Regime 1 intercept: 2.06 (9.36)
Regime 2 intercept: 6.51 (20.12)
Regime 3 intercept: 3.20 (15.67)
R-bar squared = .75

NOTES: *, **: significant at the 1% and 5% level, respectively. Sample 1961.1–2000.4. The inflation rate is included in the model and estimated with a fixed coefficient.

As in the previous results, these findings also show that while inflation is significantly correlated with the real interest rate, there are significant mean shifts in the real interest rate that are unrelated to inflation.

Interestingly, accounting for the effects of inflation on the real rate change what factors are more closely related to the estimated (independent of inflation) mean shifts.

The first breakpoint in Table 5 matches up exactly with the ascension of Paul Volcker to the Fed chair and the 95% confidence interval for the second break contains the appointment of Alan Greenspan as his successor. The coefficients indicate that controlling for inflation the real interest rate was highest under Volcker, and somewhat lower than Volcker, but higher than the rest of the sample under Greenspan.

We also investigated whether the real rate changes found during the advent of the Volcker and Greenspan terms as Fed Chair simply coincided with other large events, such as oil price shocks, that may be the true source of the real rate shifts. Specifically, we estimated the same partial structural break equation presented in Table 5 but added the growth rate in relative price of crude oil as an additional fixed coefficient regressor. Although the coefficient on the oil price growth variable is negative (−3.53) and significant (*t*-statistic = −2.29), we again found the optimal number of breaks to be two, with the start of Volcker and Greenspan chairmanships both again within the 95% confidence interval of the break dates.[6]

6. These results are not tabulated here but are available from the authors upon request, as is the data used in this analysis. The Gauss program used to estimate the structural breaks is available directly from Pierre Perron's website. We thank him for this courtesy.

TABLE 6

MEAN SHIFTING MODELS: REAL TAX ADJUSTED FED FUNDS INTEREST RATE 1961.1–2000.4

	Central Bank Chair Model	Presidential Model	Pres. plus fitted CB Chair Model	CB Chair plus fitted Pres. Model
Constant	1.94 (8.72)	1.73 (8.09)	0.04 (0.08)	1.42 (2.95)
Inflation	−0.55 (10.8)	−0.53 (6.98)	−0.07 (0.43)	−0.39 (2.80)
Greenspan	1.30 (3.39)			0.75 (1.46)
Volcker	4.13 (6.38)			3.29 (3.53)
Miller	0.73 (1.25)			0.29 (0.43)
Burns	0.40 (1.20)			0.19 (0.50)
Clinton		1.19 (3.62)	0.01 (0.04)	
Reagan–Bush		3.22 (5.50)	0.64 (0.88)	
Carter		1.57 (1.80)	0.33 (0.48)	
Nixon–Ford		0.72 (1.76)	0.56 (1.41)	
Pres fitted				0.29 (1.17)
Chair fitted			0.92 (3.75)	
Adjusted R^2	.71	.60	.71	.71

NOTES: All regressions are estimated using the Newey–West (1987b) HAC corrected standard errors with lag truncation = 4. *t*-Statistics are in parentheses.

Our results differ from those of CG, who argue that political change is more highly correlated with real rate regime shifts than are changes in the Fed Chair. Using a tax adjusted real rate and controlling for inflation as in RW reverses this result. Table 6 shows that, controlling for a linear effect of inflation on the real rate, the Fed Chair dummies fit the data better than do the Presidential dummies. In fact columns 3 and 4 show that the fitted values of the Fed Chair (Presidential) model are significant (not significant) when included as an additional regressor in the Presidential (Fed Chair) model. These results comprise a pair of Davidson and Mackinnon *J*-tests and show that the Fed Chair model statistically dominates the Presidential regime model via.[7]

2.4 Testing for Additional Regime Shifts after Controlling for Inflation Shifts

Here we take the effects of inflation regimes as given and then test to see whether, after accounting for their effect on the real rate, there are any additional real rate regime shifts.[8] These results are reported in Table 7. The dependent variable here is the residual from regressing the real rate on the inflation shift dummy variables. The BP program now finds three additional breaks dated 1974.1 (with a 95% confidence interval of 1968.1–1974.3), 1980.3 (with a 95% confidence interval of 1978.3–1981.2), and 1987.1 (with a 95% confidence interval of 1986.2–1989.3).[9] As before,

7. Since inflation is a common variable in both models, the artificial nesting approach used above is problematic. Here we use the *J*-test method. For more details, again see Davidson and MacKinnon (2004).

8. It was suggested to us by an anonymous referee that RW's model (where inflation shifts predict real rate shifts) is better represented in this way than by the linear inflation–real rate relationship used in Section 2.3 above.

9. These results do not contradict earlier results in CG or RW about the dating of real rate shifts as they are asking a different question. Accounting for real rate shifts related to inflation first before checking for additional breaks creates a different series with potentially different total number and location of breaks.

TABLE 7

PURE STRUCTURAL BREAK MODEL FOR THE RESIDUALS OF THE REAL TAX ADJUSTED U.S. FEDERAL FUNDS RATE AFTER CONTROLLING FOR REGIME INFLATION SHIFTS

Sup F_T (1)	Sup F_T (2)	Sup F_T (3)	Sup F_T (4)	Sup F_T (5)
6.53	12.98*	12.79*	12.23*	14.95*
Sup F_T (2/1)	Sup F_T (3/2)	Sup F_T (4/3)		
16.95*	12.72*	3.31		
Ud_{max}	Wd_{max} (10%)	Wd_{max} (5%)	Wd_{max} (1%)	
14.95*	22.87***	25.34**	30.01*	
Number of Breaks Selected by the Global Optimization Procedure = 3				
Break Point Dates and 95% Confidence Interval				
		$\hat{T}_1$	74.1	(68.1–74.3)
		$\hat{T}_2$	80.3	(78.3–81.2)
		$\hat{T}_3$	87.1	(86.2–89.3)

NOTES: *, **, ***: significant at 1%, 5%, and 10%, respectively. Sample 1961.1–2000.4.

these last two breakpoints contain the Volcker and Greenspan accessions in their confidence regions. The first break, while somewhat imprecisely estimated (it has a much larger confidence interval), does contain the accession of Arthur Burns in its confidence interval. Taken literally these results say that the part of the real rate uncorrelated with inflation regime shifts has additional structural breaks that line up well with changes in the Fed chairmanship.

2.5 Allowing Other Macro-Factors to Affect the Real Rate

Of course, other factors can affect interest rates beyond those studied above. In Table 8 we make a preliminary attempt to allow for these factors. Column A reports a model where the tax adjusted real rate is regressed on the contemporaneous inflation

TABLE 8

ALLOWING OTHER MACROECONOMIC FACTORS TO INFLUENCE THE REAL INTEREST RATE

Variable	Equation (1) (OLS)	Equation (2) (GMM)
Intercept	−14.58 (2.29)	−13.37 (2.76)
Inflation (t)	−0.63 (12.05)	−0.31 (2.44)
(Deficit/GDP)($t-1$)	0.24 (2.13)	0.13 (1.43)
Monetary base growth ($t-1$)	−0.10 (2.44)	−0.17 (5.25)
(Investment/GDP) ($t-1$)	0.33 (2.01)	0.38 (3.00)
Real stock returns ($t-1$)	−0.03 (1.50)	−0.01 (0.53)
(Govt. spending /GDP) ($t-1$)	0.53 (2.66)	0.44 (2.71)
Growth of relative price of oil ($t-1$)	1.62 (1.19)	0.13 (0.40)
Greenspan	3.86 (4.67)	3.18 (4.70)
Volcker	6.00 (5.97)	4.26 (4.96)
Miller	1.98 (2.82)	−1.06 (0.95)
Burns	1.54 (3.74)	0.28 (0.52)

NOTE: Equation (1) is OLS with Newey–West (1987b) HAC t-stats. Equation (2) is GMM using four lags of inflation to overidentify the endogenous RHS variable, contemporaneous inflation. Sample is 1961.1–2000.4 for Equation (1) and 1962.1–2000.4 for Equation (2).

rate, the lagged deficit ratio, lagged growth of the monetary base, the lagged investment ratio, lagged real stock market returns, the lagged government spending ratio, lagged growth in the relative price of oil, and four dummies to account for the five different Fed chairs that served during our 1961–2000 sample.[10] In column B, we rerun this regression assuming that inflation is an endogenous regressor. We use four lags of inflation as instruments and estimate the model via GMM using the Bartlett kernal and a fixed bandwidth of four as chosen by the Newey–West (1994) criterion.

In both regressions, inflation and money growth are negative and significant predictors of the real rate. The investment ratio and government spending ratio enter positively and significantly in both cases, as do the dummy variables for the Greenspan and Volcker eras. The other two Fed Chair dummies are significant in the OLS regression but insignificant in the GMM regression.[11] These last results provide some additional evidence that the real rate breakpoints occurring at the same time as the Volcker and Greenspan accessions to the Chairmanship are not artifacts produced by other omitted macro-variables influencing the real rate.

3. DISCUSSION

Building on previous research which argues that U.S. monetary regime changes are related to changes in the behavior of real interest rates (i.e. Huizinga and Mishkin, 1986 and Bonser-Neal, 1990), CG were able to show that monetary regime shifts are best explained by large political changes and largely unrelated to Central Bank turnover. Recently, RW presented cross-national evidence that structural breaks in inflation are correlated with observed real rate shifts. They interpret the inflation breaks as switches in monetary policy regimes.

We find, after controlling for inflation, that the two significant breaks in our tax adjusted real interest rate series line up almost perfectly with the beginning of the Volcker and Greenspan terms as Fed Chair and that our central bank turnover model statistically dominates a political regime model of monetary policy. Although our finding that changing Fed chairs can cause changes in monetary policy certainly corresponds with popular views of how monetary policy works, we are able to demonstrate that these changes occur even when we control for the effect of inflation (and other macro-variables) on the real rate. That is, our results show that beyond differences in the target rate of inflation, different Fed chairs have different equilibrium real interest rate targets.[12]

10. These regressors are suggested in Barro and Sala-i-Martin (1990) and the regression is closely related to the results in the appendix of CG.

11. The OLS regression fails a simple Hausman (1978) test for the exogeneity of contemporaneous inflation at the 0.01, while the validity of the three over-identifying instruments cannot be rejected at the 0.10 level via a Newey–West (1987a) test, so on the margin the results in column 2 are statistically more reliable than those in column 1.

12. We thank Mark Wohar for raising this point. He suggested to us that the effect may come another way, namely through changes in the risk premium.

The results support earlier work by Hakes (1990), who shows that, ceteris paribus, changes in the Fed Chair significantly affects the probability of a change in monetary policy.[13] Further, they provide empirical backing for the seemingly prevalent view that Paul Volcker, and to perhaps a lesser extent Alan Greenspan, are unique among U.S. Fed chairs.[14]

Lastly, our results highlight the usefulness and importance of the BP methodology. Although each of the three models of real interest rate regimes shifts considered here were statistically significant, only the Greenspan and Volcker central bank switches were within the confidence interval of the optimal breakpoints. This provides an additional example of the potential value of the BP method for determining whether commonly used dummy variables are truly significant, or whether they simply appear to be significant because they have a non-zero correlation with excluded regime shifts.[15]

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13. Hakes uses a dichotomous dummy dependent variable measuring whether monetary policy is tight or easy and several macro-control variables on the right hand side of the model.

14. For one example see Estrella and Fuhrer (2003, p. 95) who say "we have the benefit of information about the timing of important changes in monetary policy that occurred within our sample period. three key dates are 1979.3, 1982.3, and 1987.2. October 1979 is well known as the start of the tenure of Chairman Volcker ... The Third date corresponds to the appointment of Chairman Greenspan."

15. For an elaboration of this point see Caporale and Grier (2004).

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