THE CHANGING PROBABILITY OF A MONETARY POLICY RESPONSE TO INFLATION AND EMPLOYMENT ANNOUNCEMENTS

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INTRODUCTION

The response of Federal Reserve policymakers and financial market participants to news about the U.S. economy has varied over time.[1] Not only have the relevant economic indicators changed from one monetary policy regime to another, but the frequency with which the Fed has responded to news about the indicators has fallen over the past decade.[2] In the economic literature, numerous studies have investigated the intertemporal effects of various unanticipated announcements on interest rates and whether and how monetary policy rules have changed.[3] The empirical evidence from these studies indicates that, during the nonborrowed reserve period when the Federal Reserve targeted the money stock, news about an unanticipated increase in the money supply resulted in an increase in interest rates. After 1983, when the monetary aggregates were deemphasized, news about real activity and inflation dominated the effects of unanticipated money announcements on interest rates. An unexpected increase in nonfarm payroll employment, for example, resulted in an increase in interest rates, while a positive money surprise had little or no effect. In this literature, the policy anticipations hypothesis is the most widely accepted explanation for the positive relation between the response of interest rates and news about money or employment. According to this hypothesis, interest rates rise and the dollar appreciates as agents revise their expectations upward for the federal funds rate path in the face of a positive, unanticipated announcement.[4]

However, over the recent decade, the frequency of adjustment in the funds target has declined noticeably. For example, from March 1984 through March 1991, the funds target was altered at least once per month in 58 out of 85 months (68 percent); from April 1991 through January 2002, the target was changed in only 39 out of 130 months (30 percent) [Rudebusch, 1995; Kuttner, 2001]. Since Fed policymakers have an information advantage over financial market participants, (that is, they have perfect information regarding the FOMC's policy stance and its economic forecasts are superior to those of the private sector [Romer and Romer, 2000]), it is natural to ask: Is the evolution in Fed behavior due to the fact that there is less news? *Or* is the Fed responding less to the news? Moreover, if the link between news about current economic activity and the subsequent adjustment in the funds target has weakened,

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has the response of market interest rates to the news also changed as the policy anticipations hypothesis would imply? These questions are addressed in this paper. It is found that employment announcements are significantly linked to monetary policy behavior over March 1984–March 1991 and April 1991–January 2002, while inflation announcements are unrelated. However, the mean absolute value of the magnitude of employment announcements declines by 24 percent in the latter period and the probability of no change in the funds target more than doubles in going from the first sub-sample to the second. This sluggishness in policy is mirrored in the Treasury bill market; over the second sub-period employment surprises play little if any role in explaining fluctuations in the bill rate. Hence, there is in some sense less news and the Fed is responding less to the news. It is suggested that the increased reluctance on the part of Fed policymakers to change the funds target is a reflection of the uncertainties associated with the nature of the incoming data which contradicted the predictions of core models such as the natural rate hypothesis.

THE CHANGING PROBABILITY OF A MONETARY POLICY RESPONSE TO ANNOUNCEMENTS ABOUT EMPLOYMENT AND INFLATION

To investigate the changing probability of a response by Fed policymakers to economic announcements about inflation and employment and the changing relevance of these announcements in the conduct of monetary policy, a policy reaction function is estimated over the current Fed funds targeting operating procedure, which is divided at the trough of the 1990-91 recession into two sub-sample periods: March 1984–March 1991 and April 1991–January 2002.

In this estimation, the response by Fed policymakers to these announcements is measured by discrete changes in the funds target. Since changes in the funds target are infrequent and appear in clusters over the business cycle, a limited-dependent variable technique is employed in this analysis as in Vanderhart [2000]. More specifically, since the changes in target can be ordered from large decrease to large increase, an ordinal probit estimation is employed, whereby the dependent variable, Y_t, takes on one of the following values that reflect the size of the total change in the funds target over month t: $Y_t = 1$, decrease of more than 25 basis points; $Y_t = 2$, decrease of less than or equal to 25 basis points; $Y_t = 3$, no change in target; $Y_t = 4$, increase of less than or equal to 25 basis points; $Y_t = 5$, increase of more than 25 basis points.[5]

The independent variables are monthly, real-time data as it became available to Fed policymakers in month t: initial, unrevised announced changes in M2, the percent change in the producer price index (PPI), and nonfarm payroll employment. Over the March 1984–March 1991 sub-sample, inflation is represented by changes in M2, the monetary aggregate that was given the most weight by Fed policymakers in the post-nonborrowed reserve period; over April 1991–January 2002, PPI announcements replace M2, since the relation between M2, interest rates and output broke down in the early 1990s.[6] In each case, the announcements that are released in month t reflect economic activity over the previous calendar month ($t-1$). (For more information see Appendix A.)

TABLE 1
The Probability of a Change in the Federal Funds Target

A. Ordinal Probit Estimation Results

	1984:03 - 1991:03		1991:04 - 2002:01	
	Coefficient	**(t-statistic)**	**Coefficient**	**(t-statistic)**
Δ*M2* ($Billion)	0.003	(0.27)		
Δ*Employment* (100's of Thous.)	0.215	(3.16)	0.355	(5.39)
%Δ*PPI*			0.065	(0.24)
α_1	−0.603	(2.37)	−1.325	(6.78)
α_2	0.050	(0.20)	−0.545	(3.68)
α_3	1.002	(3.81)	1.914	(9.10)
α_4	1.889	(6.28)	2.486	(9.68)

The coefficient on Δ*Employment* was tested for structural change in going from the first sub-sample to the second; the null hypothesis (no structural change) was not rejected (t-statistic = 0.48 on the differential slope coefficient). In addition, the Wald test was used to determine if the coefficients in each regression are simultaneously equal to zero (null). Test results yielded χ^2 (2) = 48.37 and 82.2 over each period, respectively. Given that the critical value χ^2 (2) = 9.2 (1 percent), the null was rejected.

B. Probabilities (Percent)

	1984:03 - 1991:03	1991:04 - 2002:01
$Pr(Y_t = 1$, Decrease: > 25 bp)	12.3	2.3
$Pr(Y_t = 2$, Decrease: ≤ 25 bp)	18.4	8.9
$Pr(Y_t = 3$, No Change)	36.6	78.1
$Pr(Y_t = 4$, Increase: ≤ 25 bp)	23.6	7.2
$Pr(Y_t = 5$, Increase: > 25 bp)	9.1	3.4

The probabilities were calculated using mean absolute values of the independent variables, which are displayed in Table 2.

In this model, the probability that $Y_t = j, j = 1, \ldots 5$, is expressed as:

$$\text{PR}(Y_t = j) = \Phi(\alpha_j - \beta' x_t) - \Phi(\alpha_{j-1} - \beta' x_t) \quad (1)$$

where Φ represents the cumulative normal distribution function, the α's are estimated threshold values, the β vector contains the estimated coefficients and x_t vector contains employment and M2 or PPI announcements for month *t*. Intuitively, if $\beta' x_t + \mu_t$ is between α_{j-1} and α_j, the Fed chooses $Y_t = j$. The probability that the Fed chooses *j* is the probability that $\beta' x_t + \mu_t$ is between the threshold values, α_{j-1} and α_j.[7] (Appendix B displays the probabilities associated with each of the 5 policy choices and the corresponding log likelihood function that is estimated.)

The results of the ordinal probit estimations are provided in Table 1. The coefficients or maximum likelihood estimates (MLE) do not have the same interpretation as ordinary least squares (OLS) regression coefficients. While an OLS regression coefficient represents the effect of a unit change in an independent variable on the

TABLE 2
Descriptive Statistics

	1984:03 - 1991:03		1991:04 - 2002:01	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
ΔM2 ($Billion)	13.57	8.46	12.43	11.65
ΔEmployment (100's of Thous.)	2.38	1.20	1.82	1.22
%ΔPPI	0.40	0.37	0.31	0.26

dependent variable, a MLE represents a variable's influence on the probability of each of the policy choices, ($Pr(Y_t = 1, 2, 3, 4, 5)$). In these estimations, the coefficient on the announced change in employment (Δ*Employment*) has the greatest influence compared to the coefficients on the announced change in M2 (*ΔM2*) and the percent change in the PPI (*%ΔPPI)*, which are smaller and statistically insignificant. The positive sign on the employment coefficient implies large increases in nonfarm payroll employment were more likely to result in an increase in the funds target rather than a decrease.[8]

To focus on the heterogeneity of Fed behavior within the current policy regime, the probabilities associated with each of the 5 policy choices were calculated using the estimated coefficients, threshold parameters and the mean absolute values of the explanatory variables over each sub-sample period (formulas are displayed in Appendix B). In going from the March 1984–March 1991 to the April 1991–January 2002 sub-sample, the probabilities associated with changing the funds target, $Pr(Y_t = 1, 2, 4, 5)$, decline by more than half, while the probability of *no change* in the target more than doubles from 37 percent to 78 percent (see Table 1, part B). In addition, the amount of news, in terms of the magnitude of the announced change in the right-hand side variables has declined. In going from the first sub-sample to the second, the mean absolute value of the change in employment, for example, declines by 24 percent (see Table 2). Hence, while there is in some sense less news, policymakers have responded less to the news.[9]

Gavin and Mandal [2000] show that, beginning in 1994, incoming data were giving policymakers "mixed signals". More specifically, the data were yielding *negative* inflation errors, implying actual inflation was less than predicted, and *positive* output errors, implying actual output was greater than expected. As a result, the incoming data of the 1990s contradicted the predictions of core models such as the natural rate hypothesis (that is, output growth beyond potential is inflationary) and the Taylor Rule (predicts the fed funds rate is a simple function of the real interest rate, the output gap and inflation away from the Federal Open Market Committee's target), and called into question the relevance of these models and the reliability and accuracy of measures of the natural rate of output and employment likely to trigger inflation. Chairman Greenspan put it this way (and repeated the basic points on many occasions):

> As Taylor himself has pointed out, these types of formulations are at best "guideposts" to help central banks, not inflexible rules that eliminate discretion. One reason is that their formulation depends on the values of certain key variables—most crucially the equilibrium real federal funds rate and the production potential of the economy. In practice these have been obtained by observation of past macroeconomic behavior—either through informal inspection of the data, or more formally as embedded in models. In that sense, like all rules, as I noted earlier, they embody a forecast that the future will be like the past. Unfortunately, however, history is not an infallible guide to the future, and the levels of these two variables are currently under active debate. [1997]

Policymakers therefore assigned less weight to the output gap, for example, in policy reaction functions because of the confusing nature of the incoming data. In this study, this change in the conduct of monetary policy is manifested by an increase in the probability of no change in the funds target in response to employment announcements.[10]

THE RESPONSE OF THE 3-MONTH TREASURY BILL TO THE NEWS

The purpose of this section is to determine if the change in probability of a policy change over the 1990s is mirrored in the way financial market participants responded to economic announcements. This is accomplished by estimating the following equations using OLS over the March 1984–March 1991 and April 1991–January 2002 sub-samples, respectively:

$$\Delta IN_t = b_0 + b_1 M_{t-1}^{u} + b_2 E_t^{u} + \varepsilon_t \tag{2}$$

$$\Delta IN_t = b_0 + b_2 E_t^{u} + b_3 PPI_t^{u} + \varepsilon_t \tag{3}$$

In the above, ΔIN_t represents the change in the 3-month Treasury bill rate (in basis points) from market close on day t-1 to market close on day t, M_{t-1}^{u} is the unanticipated change in the money stock (announcements occur on $t-1$ after market close), E_t^{u} is the unanticipated change in nonfarm payroll employment and PPI_t^{u} is unanticipated growth in the PPI (the latter two announcements occur before the market opens at time t).[11] In each case, these independent variables are constructed by taking the difference of the announced change in money, employment and the PPI from the expected change, where the market's expectations for the change in money, employment and the PPI are obtained from survey data collected by MMS International. (See the Appendix A for a detailed description of the data and the construction of the variables employed below.)

Table 3 shows the estimation results for equations (2) and (3). Consistent with most earlier findings (see note 3), unanticipated M2 and PPI are not statistically significant over each sub-sample. In sharp contrast, however, is the behavior of the

TABLE 3
Response of the Treasury Bill Rate to the "News"

Sample Period	b_0	b_1	b_2	b_3	$\overline{R}^2$	SEE	DW	N
$\Delta TB_t = b_0 + b_1 M_{t-1}^{u} + b_2 E_t^{u} + \varepsilon_t$								
03/84 - 03/91	−0.89	−0.25	5.25		0.171	8.09	1.91	271
	(1.80)	(1.43)	(7.46)					
$\Delta TB_t = b_0 + b_2 E_t^{u} + b_3 PPI_t^{u} + \varepsilon_t$								
04/91 – 01/02	1.81		2.62	0.98	−0.002	32.95	1.99	425
	(1.13)		(1.07)	(0.10)				

Absolute value of t-statistics in parentheses; N is the number of usable observations in the regression; DW is the Durbin-Watson test statistic. These estimations were examined for heteroskedasticity using White's test. In each case, the null hypothesis of homoskedasticity could not be rejected at the $\alpha = 5\%$ level.

coefficient on unanticipated employment, b_2. Over March 1984–March 1991, the parameter estimate of b_2 indicates that an unanticipated increase of 100,000 in nonfarm payrolls resulted in a 5 basis-point increase in the T-bill rate (t-statistic = 7.46). Over the subsequent sample period, April 1991–January 2002, however, the results indicate employment report surprises were largely disregarded by financial market participants: b_2 is less than half of its previous estimated value, and is not statistically significant. Since this lack of significance corresponds with the dramatic increase in the probability of *no change* in the funds target, the inference is, unanticipated employment announcements received less attention in financial markets because they no longer had much value in anticipating future monetary policy actions.

CONCLUSION

The change in the conduct of monetary policy over the 1990s appears to correspond with the fact that incoming data on output and inflation were inconsistent with the predictions of core models such as the natural rate hypothesis. In this paper, the uncertainties in this environment are manifested by the increase in probability of no change in the funds target in response to employment announcements and, in the OLS regressions of the change in the T-bill rate on unanticipated employment and inflation, a lack of significance in the coefficient on unanticipated employment over April 1991–January 2002. As the policy anticipations hypothesis would imply, financial market participants ceased to respond to employment report surprises, because they no longer had much value in anticipating future monetary policy actions.

APPENDIX A

Interest Rates: Daily, 3-month Treasury bill rates (adjusted to constant maturity) and monthly, federal funds rates (effective) from the Federal Reserve's H.15 historical data bank at http://www.federalreserve.gov.

Money Announcements: Change in the unrevised level of M2, in billions of dollars, as reported in the Federal Reserve's H.6 release. The announced level of M2 reflects the daily average level of M2 over the previous calendar month.

Employment Announcements: Change in nonfarm payroll employment (hundreds of thousands) over the previous calendar month reported by the U.S. Department of Labor in the Employment Situation on the first Friday of every month.

PPI Announcements: Percent change in the PPI index from the previous month reported by the U.S. Department of Labor monthly.

Expected Change in Money and the PPI: Obtained from Money Market Services International over the full sample period.

Expected Change in Employment: Obtained from Money Market Services from 1985 through January 2002. Expectations for employment announcements from October 1977 through 1984 are unavailable. They were computed as in Cook and Korn [1991], which involves (1) estimating an autoregressive time series model using revised historical nonfarm payroll employment from January 1960 through September 1977 and (2) computing the market's expectations for the change in employment (Δe_t^e) using the estimated coefficients of the model and the *initial* (i.e., unrevised) release, as reported in the *Wall Street Journal* on the day immediately following the announcement, for Δe_{t-1}, $i = 1$ to 3, to represent agents' information sets just prior to the announcement at time t. The estimated coefficients of the autoregressive model (t statistics are in parentheses) are the following:

$$\underset{}{\Delta e_t^e} = \underset{(2.85)}{39.79} + \underset{(3.26)}{0.22}\,\Delta e_{t-1} + \underset{(4.60)}{0.31}\,\Delta e_{t-2} + \underset{(2.96)}{0.20}\,\Delta e_{t-3}$$

where the number of lags was determined by statistical significance of the coefficients and properties of the residuals ($\bar{R}^2 = 0.33$).

Cook and Korn compared expectations for the employment report that were generated with an autoregressive model against MMS survey expectations available after 1985. They find the expectations computed with the autoregressive model yield somewhat lower response coefficients when regressing the change in interest rates on unanticipated employment but the level of significance of the coefficients and $\bar{R}^2$ of the regressions are roughly the same.

Unanticipated Money Announcements, M_t^u, are defined as unanticipated M2, the aggregate which was given the greatest weight by the FOMC from October 1982 and through the early 1990s. More information about M2 announcements is available in Kearney [1996].

Unexpected Employment Announcements, E_t^u are based on the change in nonfarm payroll employment (hundreds of thousands) over the previous month which is released by the U.S. Dept. of Labor in the *Employment Situation* on the first Friday of every month.

Unexpected PPI Announcements, PPI_t^u are based on the percent change in the PPI over the previous month which is released by the U.S. Department of Labor.

APPENDIX B

In the probit estimation, the dependent variable, Y_t , takes on one of the following values that reflect the size of the total change in the funds target over month t: $Y_t = 1$, decrease of more than 25 basis points; $Y_t = 2$, decrease of less than or equal to 25 basis points; $Y_t = 3$, no change in target; $Y_t = 4$, increase of less than or equal to 25 basis points; $Y_t = 5$, increase of more than 25 basis points.

In this model, the probability that $Y_t = j, j = 1,...5$, is expressed as:

$$\text{PR}(Y_t = j) = \Phi(\alpha_j - \beta' x_t) - \Phi(\alpha_{j-1} - \beta' x_t) \tag{4}$$

where Φ represents the cumulative normal distribution function, the α's are estimated threshold values, the β vector contains the estimated coefficients and x_t vector contains employment and M2 or PPI announcements in month t.

Accordingly, the probabilities associated with each of the 5 policy choices are listed below:

$$\text{PR}(Y_t = 1) = \Phi(\alpha_1 - \beta' x_t)$$

$$\text{PR}(Y_t = 2) = \Phi(\alpha_2 - \beta' x_t) - \Phi(\alpha_1 - \beta' x_t)$$

$$\text{PR}(Y_t = 3) = \Phi(\alpha_3 - \beta' x_t) - \Phi(\alpha_2 - \beta' x_t)$$

$$\text{PR}(Y_t = 4) = \Phi(\alpha_4 - \beta' x_t) - \Phi(\alpha_3 - \beta' x_t)$$

$$\text{PR}(Y_t = 5) = \Phi(\beta' x_t - \alpha_4)$$

The log likelihood estimation that corresponds with the probabilities defined above consists of:

$$\log(L) = \sum_{j=1}^{5} \sum_{Y_t = j} \log[\Phi(\alpha_j - \beta' x_t) - \Phi(\alpha_{j-1} - \beta' x_t)] \tag{5}$$

whereby the maximum likelihood estimate of the β coefficients reflects the explanatory variables' influence on the probability of a given response by Fed policymakers. (See Vanderhart [2000] and Maddala [1983] for more information.)

NOTES

I am indebted to Raymond E. Lombra for his insightful comments and suggestions that greatly improved the quality of this effort. I would also like to thank the three anonymous referees for their helpful comments.

1. Typically, "news" refers to what is unanticipated or unexpected. From the perspective of financial market participants, "news" refers to the difference between an announcement of, say, the change in employment and the market's expectation; from policymakers' perspective, "news" refers to the gap between the economic release and the Federal Reserve's forecast.
2. As explained in Lombra [1994], the terms "operating procedure," "policy rule," and "policy regime" can in practice be used interchangeably. A change in "policy rule" refers to a change in the degree to which the intermediate targets, e.g., the monetary aggregates, are adjusted when final goal variables, e.g., GDP and inflation, deviate from desired values. A change in "operating procedure" (e.g., to nonborrowed reserves) affects the degree to which policy instruments (for example, open market operations) are adjusted in response to deviations of intermediate target variables from a prespecified target. As detailed in Heller [1988], a change in operating procedure has usually also involved an accompanying change in policy rule/regime.
3. For more information about the impact of money and employment announcements on asset prices see Sheehan and Wohar [1995], Kearney [2002], Cook and Korn [1991], Ederington and Lee [1993], Moorthy [1995], Santomero [1991], Hardouvelis [1987] and the references cited therein. Also, for a comprehen-

sive investigation and review of changes in interest rate rules over the pre- versus post-nonborrowed reserve reserve targeting period, see Fair [2000] and references cited therein.

4. Two alternative hypotheses offered to explain the rise in interest rates, and most often refuted by the data, are the expected inflation hypothesis: i.e., inflation expectations increase in the face of a positive, unanticipated money announcement because the Fed is expected to accommodate; and the real activity hypothesis: i.e., real rates are expected to rise because unanticipated money and employment announcements reflect strong real economic growth. A thorough examination and review of these hypotheses is beyond the scope of this paper. For more information, see Moorthy [1995], Cook and Korn [1991], Engel and Frankel [1984], Santomero [1991], Sheehan and Wohar [1995] and the references cited therein.
5. The advantage of this approach to investigating changes in Fed policy is that it directly examines the link between adjustments in the fed funds target rate and economic announcements and circumvents the problems associated with estimating a proxy for an optimal policy rule that is necessary in testing for structural change in the coefficients. For more insight see Fair [2000].
6. After the FOMC ceased to target M1, it assigned the most weight to M2 which had exhibited a stable relation with output and interest rates from the early 1960s. However, in the early 1990s, this relation broke down and M2 was deemphasized by Fed policymakers. For more information, see Greenspan [1996, 1997] and Meulendyke [1998].
7. In this estimation, μ_t is assumed to be normally distributed. For more information, see Vanderhart [2000], Greene [2000], Davidson and MacKinnon [1993], Terza [1985], Doan [2000].
8. As in Vanderhart [2000], the coefficient on the percent change in the PPI is significant over the late 1980s and early 1990s. However, in this study, this coefficient does not remain significant over the rest of the 1990s as in Vanderhart. It appears these results are dependent upon the composition of the independent variables contained in the various estimations. Whatever the explanation, my core findings are not sensitive to the inclusion or exclusion of a proxy for inflation.
9. As one of the referees correctly points out, a separate but relevant question is whether changes in M2 and employment have been less correlated with the Fed's ultimate goals of inflation and sustainable growth over the current policy regime. This question will be the topic of future research.
10. For more information, see the "New Challenges For Monetary Policy", A symposium sponsored by the Federal Reserve Bank of Kansas City, August, 1999.
11. Cook and Hahn [1989] have investigated the influence of changes in the federal funds target on interest rates. More specifically, over the September 1974 to September 1979 sample period, the 3-month T-bill increased by 55 basis points on the day of a target change while longer term Treasuries responded by less. Since the 3-month Treasury bill rate is more sensitive to changes in the funds target, it is employed in this analysis.

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