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An Empirical Investigation

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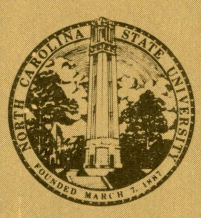

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Discount Rate Policy Under Alternative Operating Regimes: An Empirical Investigation

June 1988

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Discount Rate Policy Under Alternative Operating Regimes: An Empirical Investigation

Abstract

This paper uses a limited dependent variable approach to model the probability that the Federal Reserve will change its discount rate over a one-week horizon. The model assumes that the Federal Reserve looks at the spread between the federal funds rate and the discount rate, the level of bank borrowing at the discount window, movements in the foreign exchange value of the dollar, the rate of growth in the money supply, and general economic conditions when deciding whether to change the discount rate. The specific factors that affect the probability of a discount rate change should depend on the operating procedure that the Fed uses. We test this hypothesis by comparing discount rate policy under the federal funds rate targeting procedure (prior to October 1979), the nonborrowed reserves targeting procedure (October 1979 to October 1982), and the borrowed reserves targeting procedure (after October 1982). We find evidence that discount rate policy was substantially different under each of the three operating procedures.

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Discount Rate Policy Under Alternative Operating Regimes: An Empirical Investigation

1. Introduction

Considerable evidence supports the assertion that the Federal Reserve changed its short-run procedures for open market operations twice over the last decade. 1/ In October 1979, the Fed moved from targeting the federal funds rate to targeting nonborrowed reserves, supposedly placing greater emphasis on controlling short-run money growth, while in October 1982 it moved to targeting borrowed reserves, abandoning its money growth focus. Research demonstrates how alternative operating procedures may influence the role of discount rate changes in effecting monetary control and signaling the Fed's intentions. 2/ This work suggests that the Fed may have conducted discount policy differently under the alternative operating procedures. There has been little or no empirical evidence, however, on whether changes in discount rate policy were part of the regime changes.

The purpose of this paper is to examine whether there were differences in Federal Reserve discount policy, coincident with the changes in short-run operating procedures, that were potentially identifiable by financial market participants. Changes in discount rate policy have important implications for bank borrowing behavior and for asset price reactions to discount rate announcements. As Goodfriend(1983) has shown, optimizing bank behavior depends on expectations of future discount rate policy. Thus changes in discount rate policy should be taken into consideration in modeling bank behavior and, because predictions of bank borrowing play a crucial role in some operating procedures, analyzing the effects of alternative operating procedures (see, for example, Santomero(1983)).

Several event studies have examined the response of asset prices to discount rate changes. Under the efficient markets hypothesis, only unexpected discount rate changes should matter. While Lombra and Torto (1977) argue that discount rate changes were very predictable over the 1968-74 period and hence had no apparent "announcement effects," subsequent studies have shown that discount rate changes had announcement effects on interest rates and stock prices changes during the October 1979-October 1982 regime. 3/ What is less clear is whether this reflects changes in the information content of such announcements or, at least partially, less success on the part of market participants in predicting such changes.

The paper is organized as follows. The next section describes the model chosen to capture the reaction function of the Fed with respect to the discount rate. Because discount rate changes are infrequent and discrete, we employ a limited dependent variable approach that allows us to investigate what variables affect the probability of discount rate changes. 4/ The third section describes the data and the measurement problems encountered. The fourth section presents empirical results that indicate that discount rate policy did change with changes in operating procedures. Not only the relative predictability of discount rate changes but also the factors triggering the changes depended on the monetary policy regime. The last section gives our conclusions.

2. The Model

In practice, a change in the discount rate involves two steps. First, the board of directors of one of the regional Federal Reserve banks must request approval from the Board of Governors to change the rate for their region. Second, the Board must vote on whether to approve the request. The second step is not

perfunctory, since many such requests are denied. 5/ The Board is often thought to initiate discount rate changes by letting regional banks know that they would look with favor on a requested change. In this paper we assume that the Board has complete control over the decision to alter the discount rate.

The reasons for the Board's decisions both to approve or reject requested discount rate changes, given in the Board's annual reports, center on three types of concerns: (1) conditions in the market for bank reserves, as indicated by the spread between the federal funds rate and the discount rate and the level of borrowing at the discount window; (2) movements in intermediate targets such as the money supply and the foreign exchange value of the dollar; and (3) movements in ultimate targets such as inflation and economic growth. We assume that these concerns do, in fact, dominate the discount rate decision, but that the weights placed on such considerations may vary across operating regimes. The discount rate can be thought of as playing two roles. Changes in the rate because of type (1) factors are likely to be used to complement open market operations, while changes because of type (2) or (3) factors are more likely to be used as signals of future Fed policy.

With respect to the market for bank reserves, the role of the discount rate and the timing of changes in the rate should depend on the short-run operating procedure of the Federal Reserve. 6/ Under a federal funds operating procedure as employed prior to October 1979, the Fed sets a narrow federal funds rate target; changes in the discount rate alone only affect the composition of bank reserves. A rise in the discount rate, narrowing the spread between the funds rate and the discount rate, results in fewer borrowed reserves and, to prevent the funds rate from rising, more nonborrowed reserves. Changes in monetary policy are accomplished by changing the targeted funds rate, but such a policy is less

effective without a corresponding change in the discount rate. For example, reducing money growth is accomplished by raising the targeted funds rate through open market sales, but this reduction would be partially offset if the spread, and hence borrowed reserves, increased. Because an increase in the spread indicates that the Fed is tightening, discount rates are likely to follow market rates quite predictably to reinforce open market operations, and we should expect the probability of a discount rate increase to rise as the spread increases.

Under the nonborrowed reserves targeting procedure, employed from October 1979 to October 1982, the Fed determines a path for nonborrowed reserves consistent with a desired path for the money supply. The federal funds rate is allowed to vary within a wide range and hence fluctuations in the spread, given money growth, are unlikely to be a good predictor of the stance of monetary policy. Thus discount rate changes are less likely to follow changes in the spread. Under this procedure, for example, a wider spread that resulted from, say, an increased demand for excess reserves would be accompanied by slower money growth and would not be expected to increase the likelihood of a discount rate increase.

Under the borrowed reserves procedure adopted in October 1982, the Fed decides on a level of borrowing that it views as consistent with the desired path of the money supply. If the Fed decides to tighten, this translates into an increase in the borrowings target that, in turn, requires the Fed to drain reserves and widen the spread to induce a higher level of borrowing. In this case the wider spread is consistent with the desired policy action and thus the Fed would not want a discount rate increase. Moreover, for a given level of the money supply, if banks unexpectedly borrowed less than the targeted level at the discount window, the spread would rise, but there would be no reason to raise the

discount rate. An increase in money demand, on the other hand, would also cause the spread to rise and borrowing to exceed the targeted level. This might prompt an increase in the spread that would lead the Fed to raise the discount rate or inject nonborrowed reserves. In summary, it seems that the spread would also be a less reliable predictor of discount rate changes under a borrowed reserves target than under a federal funds target.7/

As the above discussion implies, the level of discount borrowing is assumed to be positively related to the spread. There may also be an independent role for changes in borrowing that reflect temporary liquidity needs. If borrowing rises at given spreads, the Fed may be reluctant to raise the discount rate, since "an adjustment in the discount rate would needlessly exacerbate money market pressures, and indeed be counterproductive." (Purposes and Functions, p.64.) On the other hand, the Fed traditionally views borrowing suspiciously, since the fed funds rate is usually above the discount rate so that discount borrowings are a tempting source of funds for banks. Thus the effect of changes in the level of borrowing on the probability of a discount rate change, holding the spread constant, is uncertain. 8/

With respect to intermediate targets, we examine the impacts of exchange rate movements and money growth on discount rate policy. At least in its official discussions, the Fed worries about the inflationary consequences of exchange rate movements. For example, the rise in the discount rate on November 1, 1978 was motivated by a desire to strengthen the dollar "thereby to counter continuing inflationary pressures." (1978 Annual Report, p.94.) A rapid fall in the dollar may raise short-run inflationary pressures and the Fed may want to signal that it is responding by tightening monetary policy. Thus we expect that rapid decreases in the foreign exchange value of the dollar will increase the

probability of a discount rate increase. Because the October 1979 operating regime switch supposedly was motivated by a desire to reduce inflationary pressures, we would expect the role of the exchange rate to be more important during this period. If only the inflationary effects of exchange rate depreciations are of concern, there may be an asymmetry in that depreciations raise the probability of discount rate increases, but appreciations do not trigger discount rate cuts.

To the extent that rapid money growth is undesired by the Fed, we would expect a tightening of policy that might be signaled by an increase in the discount rate. Similarly, slower than desired growth might prompt a discount rate cut. The impact of money growth on discount rate policy is expected to depend on the emphasis that the Fed is placing on money growth in its operating procedures. Thus we would also expect money growth to be more important during the October 1979-October 1982 period. As in the case of exchange rate movements, deviations from desired money growth may have asymmetric effects on the probability of discount rate changes. In particular, if inflation is the primary concern, it is more likely that rapid money growth will lead to a discount rate increase than that slow money growth will lead to a discount rate cut.

With respect to the ultimate targets of policy, we look at measures of the inflation rate and of real economic activity. We expect that higher inflation or more rapid economic growth, all else equal, will increase the probability of a discount rate increase, while lower inflation or sluggish growth will increase the likelihood of a discount rate cut. To the extent that more weight was placed on inflation in the nonborrowed reserves regime, we would expect a stronger effect from inflation on the probability of discount rate changes during this regime.

3. The Data

The period we examine runs from December 1977 through December 1986. During this period there were 36 discount rate changes, 16 increases and 20 decreases. We adopt a weekly horizon that begins on Thursday and ends on the following Wednesday. Since most discount rate announcements occur on either Thursday or Friday, this allows the latest information to be available. 9/ We assume the important decision is the direction of the change rather than its size. 10/ Thus we consider a model for the probability that a discount rate change will occur over the next week. For example, if there was a discount rate increase in the week running from Thursday, January 5, 1978 to Wednesday, January 11, 1978 the binary variable for a discount rate increase is coded one; if no increase occurred, it is coded zero. A similar procedure is used to code a second binary variable for discount rate decreases. The dates of the actual discount rate changes are the dates when they were announced rather than the dates when they became effective. Under the assumption that the Fed's operating procedures changed in October 6, 1979 and October 10, 1982, we split the sample at these dates. In the first period, December 1977-October 1979, there were 11 discount rate increases and no decreases. In the second period, October 1979-October 1982, there were 5 increases and 10 decreases. In the third period, October 1982-December 1986, there were 9 decreases and only one increase.

During 1980 and 1981, discount rate policy was complicated by the occasional use of surcharges on the basic discount rate for large banks that were frequent borrowers. Changes in the surcharge sometimes accompanied changes in the discount rate - in the same direction - and sometimes were announced as separate policy decisions. We are uncertain whether surcharge announcements should be treated as discount rate announcements and, therefore, we estimate separate models that

either include or exclude the surcharge changes.

The independent variables are initially measured as follows. The spread (SP) between the federal funds rate and the discount rate is the average spread, in percentage points, over the last five business days. Using the dating example above, if the dependent variable is for the week January 5 through 11, 1978, the spread is for the five business days prior to January 5. The level of adjustment borrowing (BOR) is the latest volume, in billions of dollars, announced each Wednesday. Thus BOR in the example would be the level announced on January 4. This is the level of borrowing that actually occurred during the previous week, that is, the week ending on December 28, 1977. 11/ The rate of change in the exchange rate (EX) is the annualized percentage change in the index of the trade-weighted exchange value of the dollar over the last five business days, defined so that a positive value of EX corresponds to an appreciation of the dollar. Money growth (MG) is measured as the latest announced weekly annualized percentage change in M1 where again the announcement is prior to the week over which the dependent variable is measured. Two measures of inflation are considered, the latest announced monthly pecentage changes in the CPI (CPL) and in the PPI (PPL). Real economic activity variables are the latest announced monthly civilian unemployment rate (UNL) and the latest announced monthly percentage change in the index of industrial production (IPL). 12/

Several comments about the data are in order. First, because we are interested in the relationship between observable variables and discount rate policy, care was taken that all variables are measured with data available at the time rather than revisions that were announced later. Second, since the horizon that the Fed considers in evaluating conditions is unknown, longer horizons for the explanatory variables were also investigated. Third, it might be argued that

the proper explanatory variables are deviations of the actual values from their desired values rather than simply the actual values themselves. This issue seems particularly important for money growth. Consequently, we also measured money growth as deviations from the mid-point of the Fed's announced long-run target ranges. To allow for the possibility that the Fed only responded to money growth outside the targeted ranges, we constructed two variables, one that equals the annualized growth rate over the last eight weeks if this exceeds the upper limit of the target range and zero otherwise, and a second equal to the annualized growth rate over the last eight weeks if this is less than the lower limit of the range and zero otherwise. This also permits us to test whether the Fed responds asymmetrically to deviations from the long-run targets. 13/

We also created separate variables for appreciations and depreciations of the dollar to allow for asymmetric effects. For the other variables, desired values are more difficult to quantify. The full-employment unemployment rate varied little over our sample, so adjusting UNL for this made no difference. To the extent that the Fed's preferences changed within our subperiods, our measures will contain errors.

4. Results

Since at any given time, the Fed has three choices in making discount rate policy - increase, no change, or decrease - a multinomial probit or logit procedure would appear appropriate. As noted above, however, the first time period contains no discount rate cuts, while the third period contains only one increase. Therefore we used a simple logit procedure to estimate separate models for increases in the first and second periods and decreases in the second and third periods. As a check on whether this distorts the results, we also estimated

the models using multinomial logit for the second period.

Table 1 presents the results for the probability of a discount rate increase. The upper panel gives the estimates for the first period, December 8, 1977-October 6, 1979. Equation (1.1) reports estimates of a model that includes all the explanatory variables. The likelihood ratio test of whether all coefficients are jointly zero is easily rejected. According to equation (1.1), the probability of a discount rate increase is positively associated with an increase in the spread (SP), negatively associated with an increase in borrowing (BOR), negatively associated with an appreciating dollar (EX), and possibly positively associated with an increase in produce price inflation (PPL). With the exception of the effect of borrowing, which was uncertain a priori, these signs are in accord with our expectations.

Equation 1.2 gives the estimates for a model that excludes the variables that appear statistically insignificant in the full model. Elimination of these variables produces qualitatively similar results and little decrease in explanatory power. The negative effect of borrowing, given the current level of the spread, indicates that the Fed viewed borrowing as reflecting short-term liquidity needs rather than profit-seeking borrowing. When money growth is defined over the last eight weeks (MG8), the resulting estimates, equation (1.3), show that increased money growth is positively related to discount rate increases, but the coefficient is not statistically significant. Defining the other variables over longer lags never improves the explanatory power of the model. In particular, the recent movement in the dollar (EX) is always more significant than the movement over longer periods. When separate variables for dollar appreciation and depreciation and for above-target money growth and below-target money growth are included, there is no evidence of asymmetric effects from

money growth or exchange rate movements.

The lower panel of Table 1 reports the results from estimating the probability of a discount rate increase during the second period - October 6, 1979 to October 10,1982. As expected, the results change dramatically. In particular, movements in the spread or bank borrowing no longer help predict discount rate increases. Changes in the exchange rate are also no longer important. Only the PPI inflation rate and the rate of growth of industrial production are significant when the full model is estimated (equation (1.4)); increases in these variables are associated with an increase in the probability of a discount rate increase, consistent with our expectation that inflationary pressures were of primary concern during this period. To see whether the statistical insignificance of SP and BOR was due to their higher correlation in this period -the correlation coefficient is .68, whereas it is .55 in the first period - models were also estimated excluding BOR, but SP was never significant. Since the switch in operating procedures on October 6, 1979 was supposed to signal more concern over short-run money growth, it is surprising that the results do not give strong support for this view. When the model is re-estimated suppressing all insignificant variables except MG (equation 1.5), money growth is positively associated with a discount increase but is still not statistically significant. Defining money growth over the longer horizon (MG8) does not improve the fit, as indicated by equation (1.6). Only when PPL is removed from the model, equation (1.7), does MG8 attain statistical significance. 14/ A formal test rejects the hypothesis that the model for the first period, equation (1.3), also holds over the second period. 15/

The upper panel of Table 2 presents estimates of the model for discount rate decreases over the October 11, 1979-October 7, 1982 period. For the full

TABLE 1

Logit Estimates for Discount Rate Increases

	Constant	SP	BOR	EX	MG	MG8	CPL	PPL	UNL	IPL	χ^2	R^2
1977(12)-79(10)												
1.1	-31.51	36.91*	-8.43*	-.11*	.007		-3.22	3.61	1.64	-2.08	47.53	.67
	(-1.67)	(2.29)	(-2.16)	(-2.08)	(.48)		(-.82)	(1.64)	(.80)	(-1.41)	(8)	
1.2	-15.87	24.95*	-8.10*	-.07*				3.57**			43.44	.62
	(-3.16)	(3.01)	(-2.40)	(-2.37)				(1.91)			(4)	
1.3	-18.01	28.00*	-10.44*	-.07*		.134		4.21*			46.07	.66
	(-2.88)	(2.71)	(-2.36)	(-2.16)		(1.48)		(2.14)			(5)	
1979(10)-82(10)												
1.4	-10.08	-.37	-.75	-.003	.010		1.21	3.31*	.39	3.48*	15.28	.31
	(-1.24)	(-.84)	(-.51)	(-.35)	(1.25)		(.52)	(1.99)	(.48)	(2.03)	(8)	
1.5	-7.33				.010			2.88**		2.34*	13.21	.28
	(-3.11)				(1.64)			(1.89)		(2.10)	(3)	
1.6	-6.77					.128		1.12		2.09*	13.75	.30
	(-3.44)					(1.59)		(.83)		(1.99)	(3)	
1.7	-5.98					.160*				1.75*	12.86	.28
	(-3.84)					(2.26)				(1.98)	(2)	
1.8	-6.71							2.68**		2.18*	10.98	.24
	(-3.20)							(1.89)		(2.11)	(2)	

Notes: Asymptotic t-values are in parentheses under estimated coefficients.

χ^2 is the likelihood ratio statistic for the test that all slope coefficients are jointly zero. The degrees of freedom are in parentheses underneath.

R^2 is McFadden's pseudo R^2 corrected for degrees of freedom.

* Significant at the .05 level.

** Significant at the .10 level.

model, equation (2.1), the likelihood ratio test rejects the hypothesis that the coefficients are jointly zero, but only the unemployment rate is individually significant. As noted above, SP and BOR are relatively highly correlated and only when BOR is eliminated does SP attain statistical significance, as shown in equation (2.2). The negative coefficient on SP indicates that a smaller spread increases the probability of a discount rate cut. As expected, higher unemployment raises the likelihood of a discount rate cut. It should be noted that this period was characterized by a rising unemployment rate. There was no evidence that fluctuations in money growth rates had any effect on discount rate policy, as equations (2.3) and (2.4) indicate. 16/

This last result is altered somewhat when the models are re-estimated under the assumption that surcharge decreases are equivalent to discount rate cuts, equations (2.6) - (2.8). For these models SP is adjusted by subtracting the surcharge. Equation (2.7) indicates that MG8 is negatively associated with the probability of a discount rate cut. There is, however, no evidence of asymmetric effects or that money growth outside the target range had larger impacts on discount rate policy.

The lower panel of Table 2 gives the estimates for the last period, October 14, 1982 to December 26, 1986. Equation (2.9) reports the estimate of the full model. Discount rate cuts in this period are associated with decreases in the spread, slower money growth, and slower economic growth. Eliminating the insignificant variables, equation (2.10), gives similar qualitative results. An anomalous result, given that the Fed de-emphasized money growth, is that short-run money growth (MG) is statistically significant, while the longer-run measure of money growth (MG8) is not. Tests that equations (2.5) or (2.7) also hold for the third period indicate that this hypothesis should be rejected. 17/

TABLE 2

Logit Estimates for Discount Rate Decreases

	Constant	SP	BOR	EX	MG	MG8	CPL	PPL	UNL	IPL	χ^2	R^2
1979(10)-82(10)												
2.1	-13.01	-.77	-.89	-.003	-.005		2.00	-.93	1.25*	.09	30.57	.38
	(-2.04)	(-1.57)	(-.48)	(-.51)	(-.45)		(1.27)	(-.68)	(2.08)	(.13)	(8)	
2.2	-14.41	-.94*		-.003	-.004		2.02	-1.01	1.35*	.01	30.32	.38
	(-2.51)	(-2.50)		(-.51)	(-.38)		(1.26)	(-.76)	(2.41)	(.02)	(8)	
2.3	-11.24	-1.03*			-.004				1.09*		27.51	.36
	(-2.97)	(-3.30)			(-.37)				(2.54)		(3)	
2.4	-11.38	-.92*				-.065			1.14*		29.06	.38
	(-2.97)	(-3.01)				(-1.26)			(2.59)		(3)	
2.5	-11.32	-1.03*							1.10*		27.36	.36
	(-2.98)	(-3.28)							(2.54)		(2)	
2.6 (surcharge)	-9.74	-.95*			-.013				.94*		25.24	.25
	(-3.31)	(-3.64)			(-1.18)				(2.69)		(3)	
2.7 (surcharge)	-9.21	-.79*				-.098*			.91*		28.66	.29
	(-3.12)	(-3.20)				(-2.14)			(2.60)		(3)	
2.8 (surcharge)	-9.57	-.94*							.90*		23.47	.24
	(-3.30)	(-3.60)							(2.64)		(2)	
1982(10)-86(12)												
2.9	3.20	-3.58*	1.56	.001	-.035**		-.86	.77	-.71	-2.90**	27.81	.35
	(.84)	(-2.56)	(1.14)	(.28)	(-1.96)		(-.39)	(.65)	(-1.52)	(-1.78)	(8)	
2.10	-2.09	-2.47*			-.034*					-1.81*	23.31	.30
	(-4.25)	(-2.26)			(-2.11)					(-2.04)	(3)	
2.11	-1.24	-3.02*				-.076				-1.86*	19.57	.25
	(-1.71)	(-2.65)				(-1.46)				(-2.06)	(3)	

Notes: See Table 1.

Since the estimated coefficients from logit models are not readily interpretable apart from their signs, Table 3 gives the predicted change in the probability of a discount rate change for discrete movements in the independent variables. Because the logit model is nonlinear, changes have to be calculated from a specific starting point. Our benchmark is the estimated probability of a discount rate change when the explanatory variables take on their sample means. The reported changes are the increases in the probability for one- and two-standard deviation changes in the independent variables from their means. The nonlinearity of the model is illustrated by the much larger increases associated with two-standard deviation changes. The calculations indicate that during the first period, large changes in the spread, adjustment borrowing or the exchange rate would have produced large increases in the probability of an increase in the discount rate. A two-standard deviation increase in the spread, for example, would raise the probabiltity of a discount rate increase to about 97 percent if all other variables remained at their means. Inflation (PPL), although statistically significant, was of minor importance as was money growth (MG8). In the second period only changes in industrial production seem quantitatively important for increases. A two-standard deviation increase in money growth (MG8) would have raised the probability of a discount rate increase only by about 6 percent.

For discount rate cuts in the October 1979 to October 1982 period, changes in the spread were larger but had substantially less effect on the probability of a discount rate change compared to the first period. This is consistent with the predicted effect of the Fed moving to a nonborrowed reserve procedure. This result occurred for both the model for the basic discount rate (equation (2.5)) and for the model that treats surcharge decreases as discount rate cuts (equation

Table 3
Effects of Discrete Changes in Independent Variables
on the Probability of a Discount Rate Change

I. Models for Rate Increases

A. 1977(12)-79(10)

Equation Number	Variable	Standard Deviation	Direction of Change	Increase in Probability for 1 s.d.	2 s.d.
1.3	SP	20 basis pts	increase	11.6%	97.1%
	BOR	$405,000	decrease	3.1	70.1
	EX	63.5%	decrease	4.0	77.8
	MG8	7.75%	increase	.1	.4
	PPL	.64%	increase	.2	.7

B. 1979(10)-82(10)

1.5	MG	49.7%	increase	.2	.4
	PPL	.49%	increase	1.1	5.2
	IPL	1.14%	increase	3.2	34.2
1.7	MG8	8.66%	increase	1.3	6.2
	IPL	1.14%	increase	2.7	19.2

II. Models for rate decreases

A. 1979(10)-82(10)

2.5	SP	220 basis pts	decrease	5.5	34.2
	UNL	1.14%	increase	1.6	7.0
2.7	SP	164 basis pts	decrease	6.6	24.5
	MG8	8.66%	decrease	3.4	10.5
	UNL	1.14%	increase	4.6	15.5

B. 1982(10)-86(10)

2.10	SP	65 basis pts	decrease	2.5	13.1
	MG	34.02%	decrease	1.4	5.5
	IPL	.64%	decrease	1.4	5.5

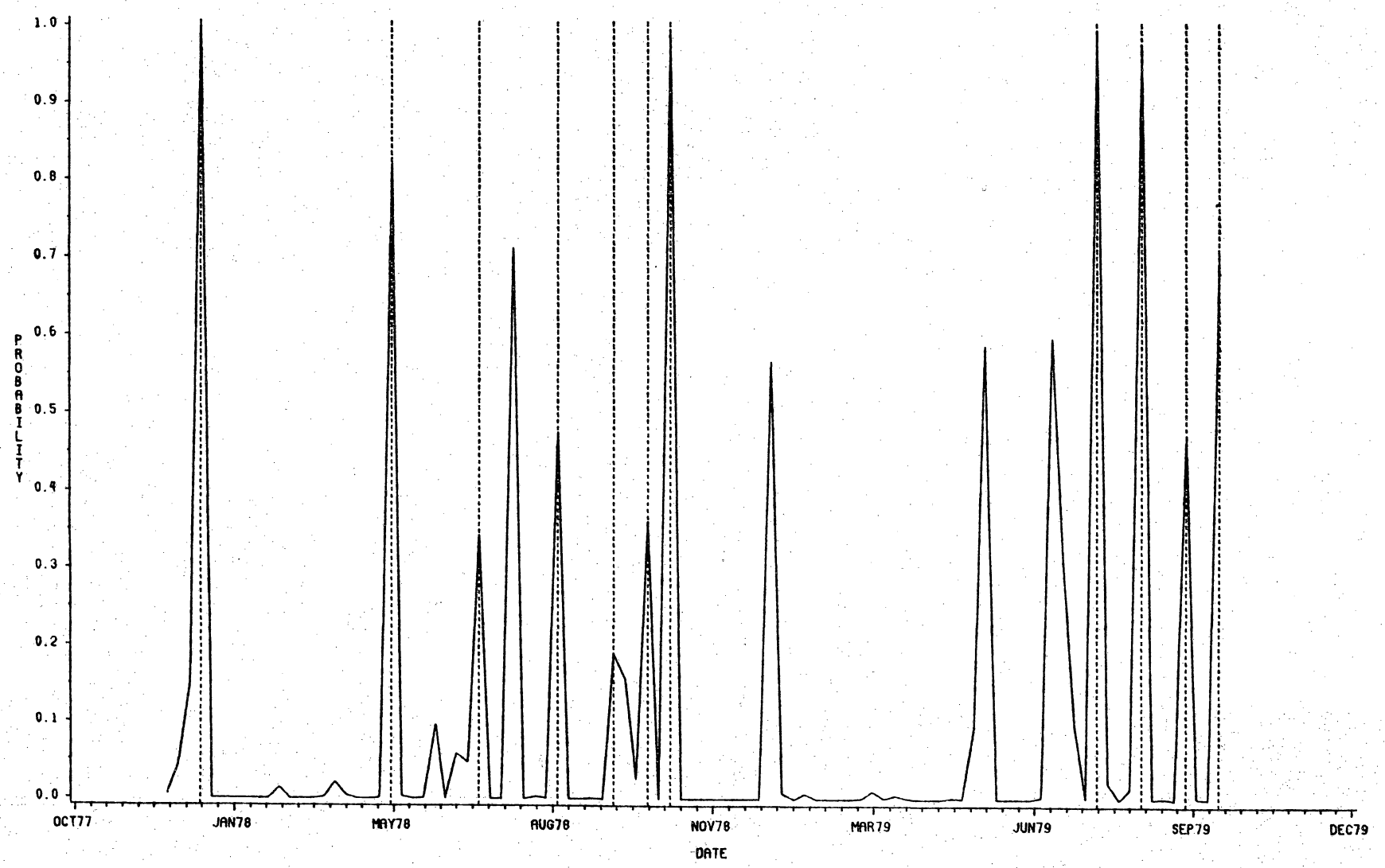
Note: Probability changes are measured from the estimated probabilities when all variables are at their sample means.

(2.7)). The latter model predicts that a two-standard deviation decrease in money growth, as measured by MG8 would only raise the probability of a discount rate cut by 10.5 percent. Increases in unemployment have a larger impact on policy for the surcharge model. In the 1982(10) to 1986(12) period, the spread became less variable than in the second period but remained more variable than in the first period. Its effect on the probability of a discount rate decrease fell, however, so that even large decreases in the spread were unlikely to foreshadow a discount rate cut. Neither changes in money growth nor economic growth have substantial effects on the likelihood of a discount rate decrease.

Charts 1 through 5 plot the estimated probabilities of discount rate changes over the three periods using equations 1.3, 1.7, 2.5, 2.7 and 2.10, respectively, to compute the estimated probabilities. The dashed vertical lines indicate the discount rate announcements. As Chart 1 illustrates, the model for the first period performs reasonably well, with spikes at most of the discount rate increases. There are, however, several false signals, particularly in the first half of 1979, when the model produces relatively high estimated probabilities but no increase was announced. These spikes reflect weeks when the spread was relatively high but did not trigger a discount rate increase. Chart 2 shows that the increases that occurred in the second period were much less predictable, with no estimated probabilities exceeding 50 percent.

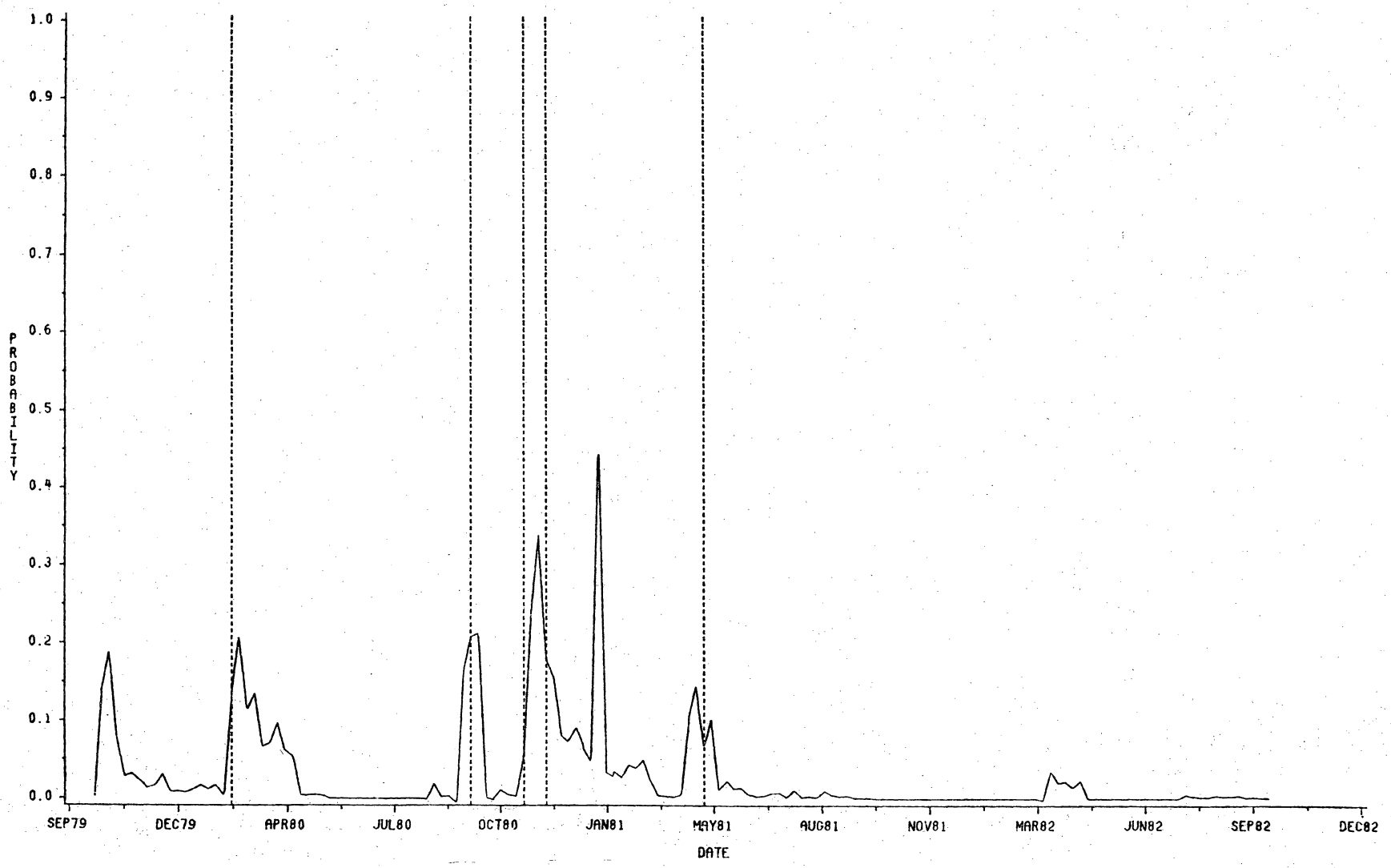
Chart 3 shows the predicted probabilities of decreases in the second period ignoring surcharges. While the estimated probabilities are higher around the periods of discount rate cuts, in only one case is the estimated probability above 50 percent. Chart 4 gives the probabilities when surcharge decreases are included and displays a similar pattern but with somewhat higher probabilities. Chart 5 indicates that discount rate cuts after October 1982 were even more

CHART 1
ESTIMATED PROBABILITY OF DISCOUNT RATE INCREASE
DECEMBER 1977 TO OCTOBER 1979



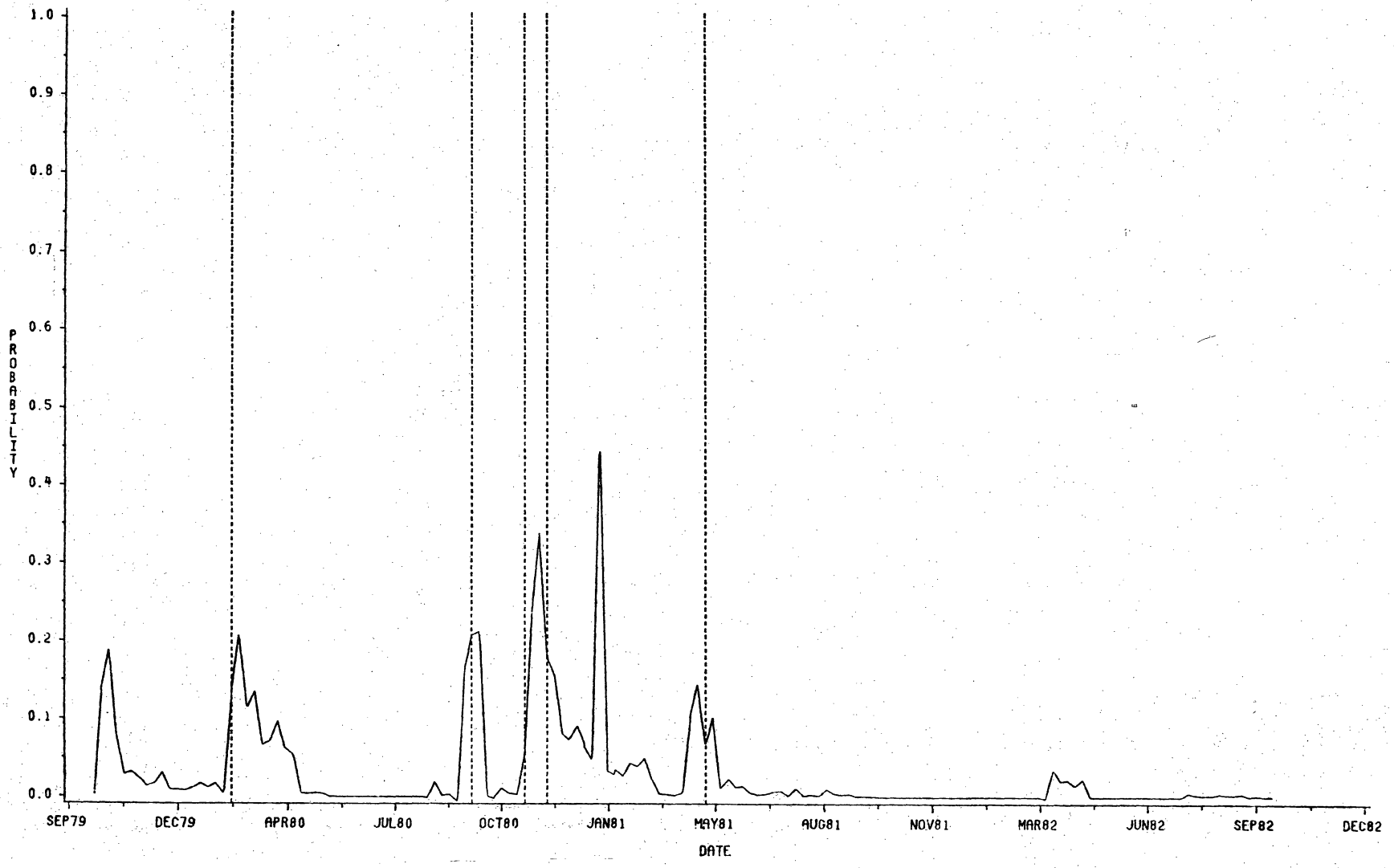
VERTICAL DASHED LINES INDICATE DISCOUNT RATE INCREASES

CHART 2
ESTIMATED PROBABILITY OF DISCOUNT RATE INCREASE
OCTOBER 1979 TO OCTOBER 1982



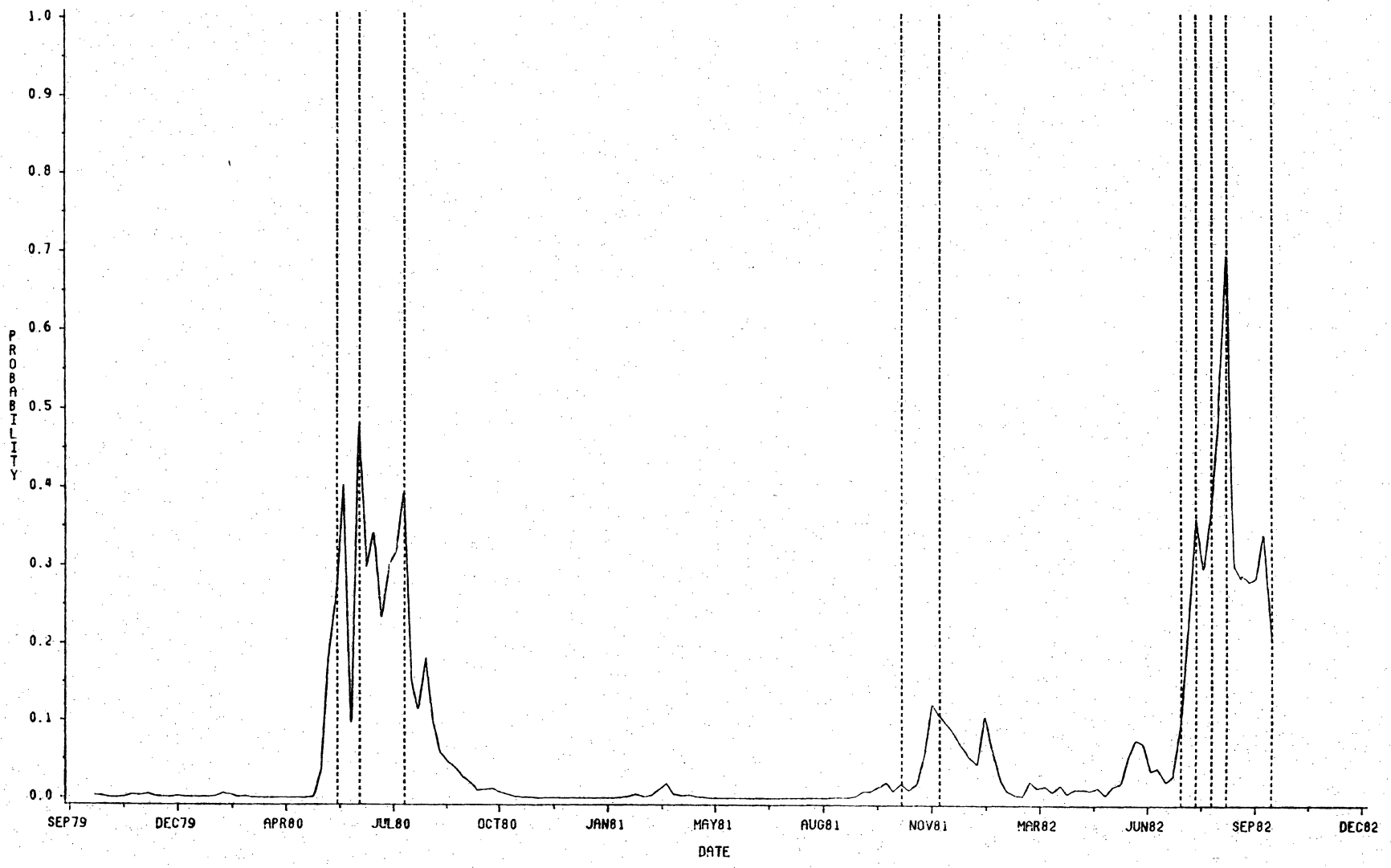
VERTICAL DASHED LINES INDICATE DISCOUNT RATE ICCREASES

CHART 2
ESTIMATED PROBABILITY OF DISCOUNT RATE INCREASE
OCTOBER 1979 TO OCTOBER 1982



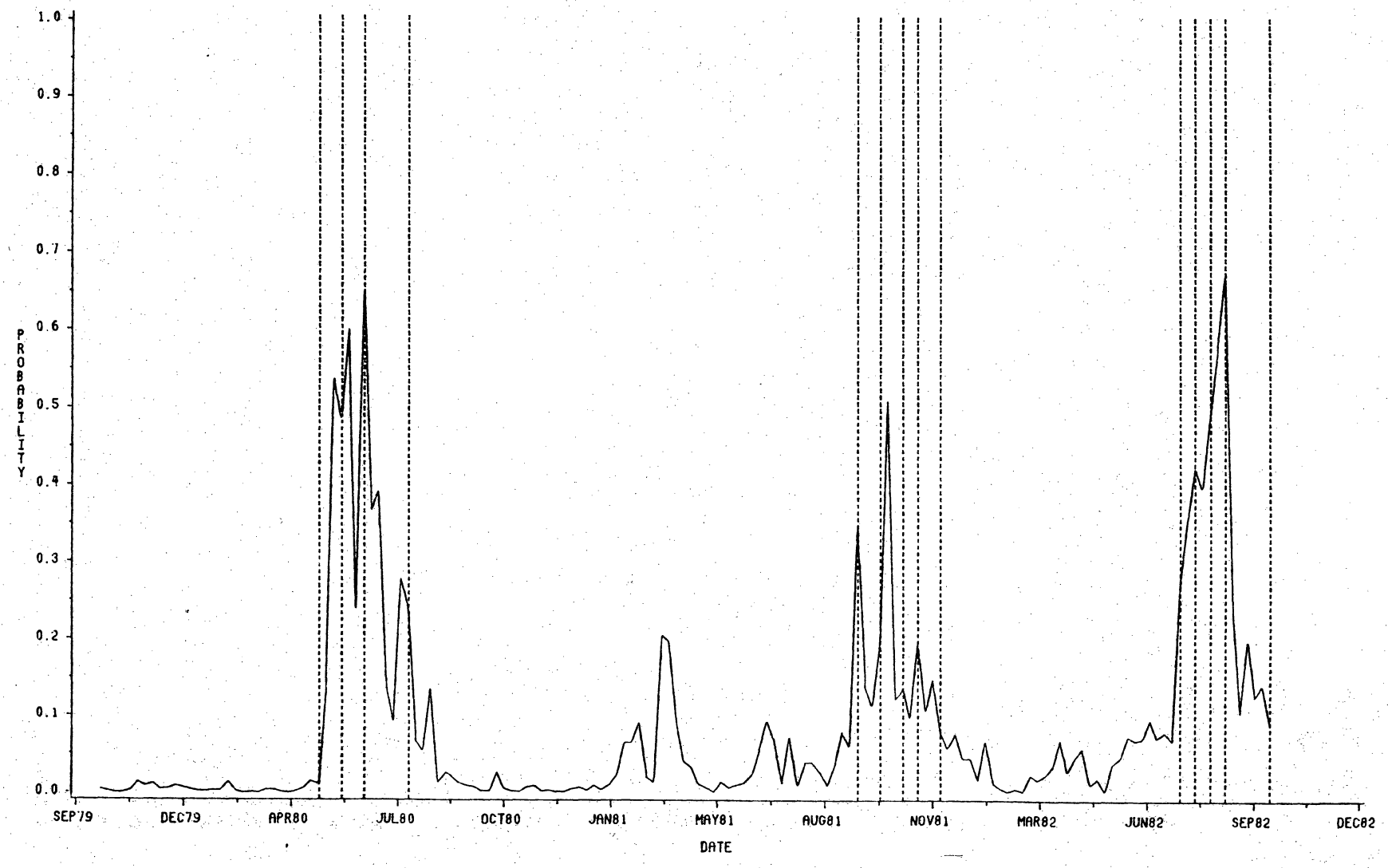
VERTICAL DASHED LINES INDICATE DISCOUNT RATE ICCREASES

CHART 3
ESTIMATED PROBABILITY OF DISCOUNT RATE DECREASE
OCTOBER 1979 TO OCTOBER 1982 - SURCHARGE EXCLUDED



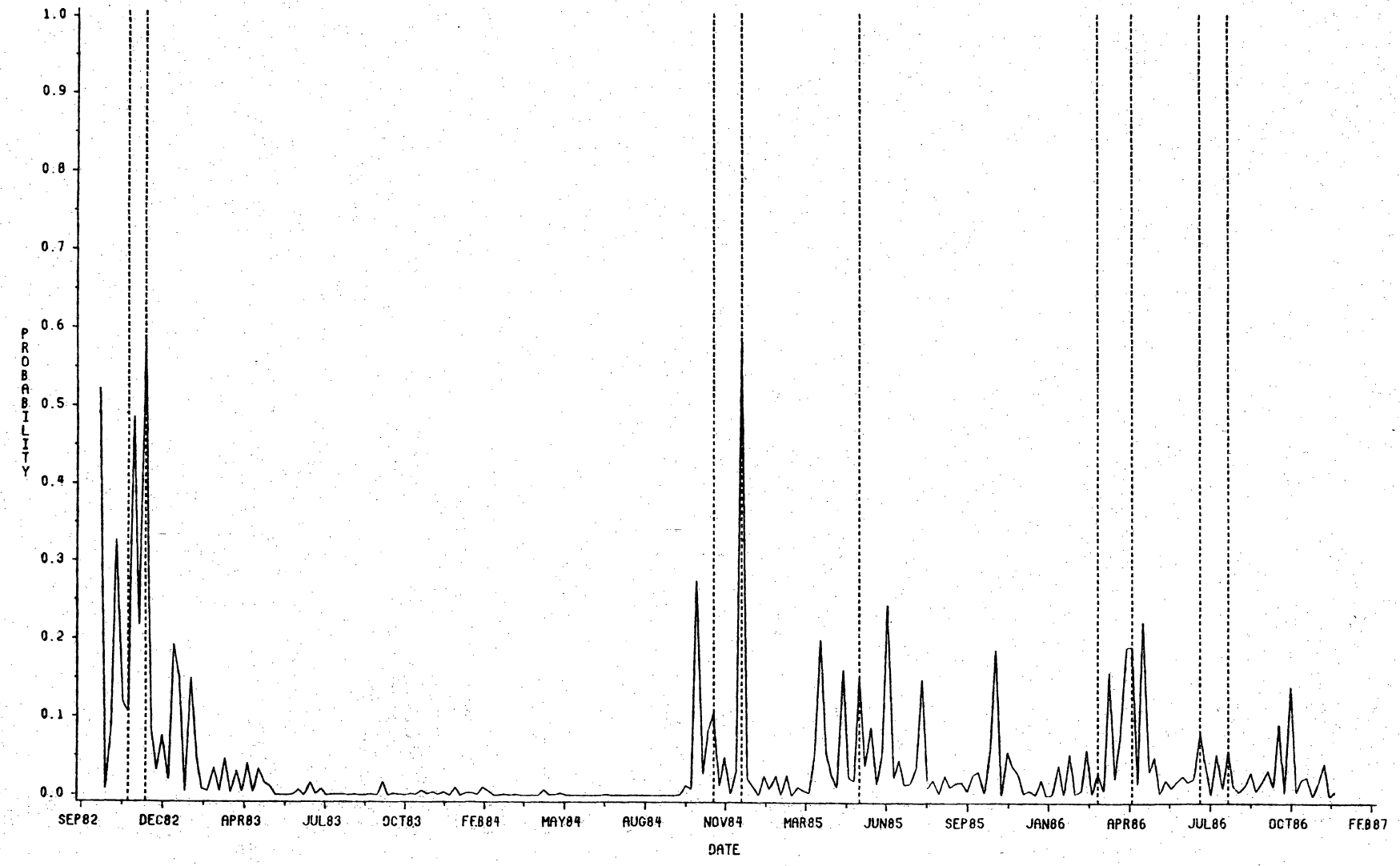
VERTICAL DASHED LINES INDICATE DISCOUNT RATE DECREASES

CHART 4
ESTIMATED PROBABILITY OF DISCOUNT RATE DECREASE
OCTOBER 1979 TO OCTOBER 1982 - SURCHARGE INCLUDED



VERTICAL DASHED LINES INDICATE DISCOUNT RATE DECREASES

CHART 5
ESTIMATED PROBABILITY OF DISCOUNT RATE DECREASE
OCTOBER 1982 TO DECEMBER 1986



VERTICAL DASHED LINES INDICATE DISCOUNT RATE DECREASES

difficult to predict. The last five discount rate decreases were particularly poorly predicted.

4. Summary and Conclusions

Using a limited dependent variable approach, we estimated models for the probability that the Federal Reserve will change its discount rate over a one-week horizon. Our results indicate that there were significant changes in the estimates across the alternative policy regimes that characterize our sample. When the Fed was targeting the federal funds rate, discount rate changes were reasonably predictable and were very sensitive to movements in the spread between the federal funds rate and the discount rate. Only during this period is there evidence that changes in the exchange rate were an important factor in discount rate policy.

When the Fed changed to a nonborrowed reserves target in October 1979, discount rate changes became less predictable and less sensitive to the spread. There is only weak support for the hypothesis that discount rate policy focused on money growth. Discount rate changes became even less predictable after October 1982 when the Fed moved to a borrowed reserve target, consistent with the view that this operating procedure is not similar to the fed funds targeting procedure.

FOOTNOTES

1. See, for example, papers by Wallich(1984) and Spindt and Tarhan(1987).

2. See the papers by Sellon(1980,1986), Sellon and Seibert(1982), Goodfriend(1983), and Thornton(1986,1988) for detailed discussions of the role of discount policy under different operating procedures.

3. Roley and Troll(1984) examine the interest rate response, Pearce and Roley(1985) look at stock prices, and Smirlock and Yawitz(1985) investigate both. Batten and Thornton(1984) report that some discount rate announcements, those categorized as nontechnical, did affect exchange rates prior to October 1979 and Cook and Hahn(1988), using a similar approach, report that interest rates also responded to nontechnical changes. Changes were labeled as nontechnical if the wording of the announcement mentioned factors other than a desire to return the spread to a more normal level.

4. Smith and Aquais(1985) also estimate probabilities of discount rate changes, but they use a different model and examine only the post-October 1979 period. An earlier paper by Froyen(1975) estimated monthly models for the level of the discount rate.

5. For example, there were eleven times during 1979 when the Board disapproved regional bank requests for discount rate changes. These discount rate decisions are chronicled in the Annual Report of the Board of Governors.

6. The following discussion draws on the analysis of Sellon(1980,1986) and Thornton(1986,1988).

7. As Sellon(1986) and Thornton(1988) note, a borrowings target resembles a fed funds rate target in that shocks to money demand are accommodated under both procedures.

8. It should be noted that borrowing at the discount rate is "a privilege not a

right" and the regional Federal Reserve Banks may impose other costs if a bank borrows frequently.

9. Of the 36 discount rate announcements in our sample, 18 were made on Thursday and 12 were made on Friday.

10. Of the announced changes, 22 were 50 basis points, 12 were 100 basis points, and 2 were 25 basis points.

11. Two outliers in the adjustment borrowing series were eliminated since they were known to be temporary and should have had no effect on discount rate policy. The first occurred in late May 1984 when the Continental Bank of Illinois run resulted in that bank borrowing heavily and the second in late November 1985 when the Bank of New York had a computer failure that forced it to borrow a substantial amount. See Thornton (1986, p.9).

12. Timing of the discount rate announcements is obtained from telegrams to regional bank presidents informing them of when the announcement would be made. The data on the daily federal funds rate, the daily exchange rate, and the level of adjustment borrowing were supplied by the Federal Reserve Bank of Kansas City. The M1 money supply growth measures were computed from the weekly H.6 Release of the Board of Governors of the Federal Reserve System. The latest announced figures for the percentage changes in the CPI and PPI came from the BLS press releases. The civilian unemployment rate is from the BLS press release, The Employment Situation. The percentage change in the index of industrial production is from Statistical Release G.12.3 of the Board of Governors. All data are available from the authors.

13. Deviations from the mid-points of the ranges were computed using the growth rate over the last eight weeks. The long-run target ranges are from the April issues of the Review of the Federal Reserve Bank of St. Louis.

14. Re-estimating the models when surcharge increases are included as discount rate increases does not change the results. There was only one increase in the surcharge that was not accompanied by an increase in the basic rate.

15. The χ^2 statistic for this test is 18.54 with 6 degrees of freedom, so the hypothesis of identical coefficients across the two periods can be rejected at the .05 level. All logit estimates and test statistics are computed using version 6 of SHAZAM. See White(1987).

16. The full model was estimated for increases and decreases in the October 1979 to October 1982 period using multinomial logit to determine whether the estimates differed. Appendix A reports these results along with the simple logit estimates. Since the estimates are very similar, we assume that the use of the simple logit model does not bias the results. Smith and Aquais(1985) report a similar finding.

17. The relevant χ^2 statistics are 12.00 with 4 degrees of freedom for equation (2.5) and 12.23 with 4 degrees of freedom for equation (2.7). Both hypotheses can be rejected at the .05 level.

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Appendix A

Comparison of Multinomial Logit and Binomial Logit Estimates

1979(10)-82(10)

	CONS	SP	BOR	EX	MG	CPL	PPL	UNL	IPL
ML(+)	-11.00	-.39	-.81	-.003	.01	1.49	3.29*	.51	3.44*
	(-1.33)	(-.88)	(-.54)	(.39)	(1.21)	(.61)	(2.00)	(.61)	(2.01)
L(+)	-10.08	-.37	-.75	-.003	.01	1.21	3.31*	.39	3.48*
	(-1.24)	(-.84)	(-.51)	(.35)	(1.25)	(.52)	(1.99)	(.48)	(2.03)
ML(-)	-12.97	-.77	-.90	-.003	-.005	2.00	-.91	1.25*	.11
	(-2.01)	(-1.57)	(-.48)	(-.52)	(-.44)	(1.26)	(-.65)	(2.05)	(.15)
L(-)	-13.01	-.77	-.89	-.003	-.005	2.00	-.93	1.25*	.09
	(-2.04)	(-1.57)	(-.48)	(-.51)	(-.45)	(1.27)	(-.68)	(2.08)	(.13)

Notes: ML(+) indicates multinomial logit estimates for discount rate increases and ML(-) for decreases
L(+) indicates binomial logit estimates for increases and L(-) for decreases
Asymptotic t statistics are in parentheses
* Significantly different from zero at .05 level (2-tail test)
Number of observations is 157.