Central Bank Transparency and Market Efficiency: An Econometric Analysis

Matthew Rafferty[*] and Marc Tomljanovich[**]

March 19, 2001

Blinder [1998] argues that more open public disclosure of central bank policies may enhance the efficiency of markets. We empirically examine this claim by studying U.S. interest rates from 1983 to 1999. We incorporate the Federal Reserve System's 1994 policy shift toward more open disclosure in our analysis. Using time-series methods similar to Campbell and Shiller [1991], we find that the forecasting error has decreased since 1994 for interest rates on U.S. bonds of most maturity lengths. Also, markets have become less volatile in the more recent time period. Together, these results suggest that markets are not hurt by central banks revealing decision-making policy processes to the general public.

[*] Quinnipiac University. Hamdon, CT 06518. Phone: (203) 582-3396. Fax: (203) 582- 8664. . Email: matthew.rafferty@quinnipiac.edu.

[**] Corresponding author. Department of Economics, Colgate University. Hamilton, NY 13346. Phone: (315) 228 - 7537. Fax: (315) 228 – 7033. Email: mtomljanovich@colgate.edu.

1. Introduction

Does the degree of information a central bank releases to the public have any effect on the financial underpinnings of an economy? Does it actually matter whether Alan Greenspan explains the findings of an FOMC meeting to the American media, or remains quiet, letting the public ascertain the outcome on its own? Blinder [1998] argues that more open public disclosure of central bank policies may enhance the efficiency of markets. First, greater information about how a central bank makes policy decisions helps to reduce financial speculation. Second, clearer decision rules would help to reduce the volatility of markets, and thus enhance the predictability of future movements of financial assets. However, not everyone shares this view. Arguments have been made, claiming that too much information in the hands of the public could lead to, among other events, destabilizing speculation, and thus excess market volatility[1].

This issue is not confined solely to the United States. Australia has had in recent years an extremely transparent disclosure policy, and Japan has followed suit, to the point where weekly meetings are held between the head of the Central Bank and the press. The United Kingdom switched to a more open framework in 1992, citing a need to enhance the credibility of monetary policy[2]. However, both France and the U.S. refuse to divulge too much information, such as the minutes of the actual meetings, citing possible financial instability.

One way to tell which view may prevail is to examine U.S. interest rates from 1986 to 1999. In 1994, the Federal Reserve System underwent a policy shift, and began announcing their targets for the federal funds rate on the afternoon of FOMC meetings. Previously, the Fed had left the public to guess at their actions (either by studying leading economic indicators, or by watching the federal funds rate in the days and weeks following the announcement), leading some economists and the media to label U.S. monetary policy a veil of secrecy[3]. After 1994, then, did markets become more efficient? Did the degree of uncertainty in rate movements lessen after 1994 in response to the

---

[1] See Goodfriend [1986] for a thorough discussion of these arguments.

[2] Since 1992, regular policy meetings have been held between the Governor of the Bank and Chancellor of the Exchequer, with the minutes of these meetings released to the public within six weeks. Also, an Inflation Report that includes economic data and forecasts is published quarterly (King [1997]).

additional information released by the Federal Reserve System? One benefit of analyzing the United States between the given time span is that Fed maintained a consistent stated policy of interest rate targeting. Thus, any change between 1986 and 1994, and 1994 and 1999, is due to either the increased disclosure policy or outside market forces.

We conduct our analysis by using time-series methods and postwar term structure data incorporated by Campbell and Shiller [1991]. We reexamine the efficient market hypothesis, and calculate 1) the MSE, 2) the correlation between the actual and theoretical spread, and 3) the ratio of the standard deviations between the actual and theoretical spread for different maturities. If more transparent monetary policies improve the efficiency of markets, we would expect the MSE to decline, and 2) and 3) to move closer to 1.0 since 1994 for all maturities as the actual spread more closely approximates the theoretically efficient spread. Our results are consistent with the conclusion that markets became more efficient after the change in FOMC operating procedures.

The paper proceeds as follows. In section 2, a brief history of this subject is outlined. Section 3 describes the paper's methodology. Section 4 presents the results and offers policy recommendations. Section 5 concludes.

---

[3] Geraats [1999] defines five types of transparency: 1) openness about policy objectives, 2) disclosure of data and forecasts, 3) information about procedure, through minutes and voting records, 4) announcement about decisions and future actions, and 5) openness about policy actions and implementations.

2. Background Literature

As stated in the previous section, Blinder [1998] argues that a nation's Central Bank should explain its actions to the people, so as to remove the mystery behind the decision-making process. Though it would make bank officials, and the entire process, more accountable to the public, greater openness is a fundamental part of a democracy. If the bank cannot provide a clear explanation of a decision, then the decision may not be a good one.

Blinder [1998] also claims that greater transparency may improve the efficiency of monetary policy. Greater openness will allow the public to adjust their expectations of future interest rate movements in a more systematic manner. More information leads to more predictability, which allows the public to more clearly anticipate monetary policy. Thus, one source of market volatility, in the form of speculative bubbles, can be reduced if not avoided.

Goodfriend [1986] attacks the Fed's five principle arguments for maintaining policy secrecy. The Fed claimed, through the Merrill vs. FOMC legal case, that secrecy was needed for the following reasons. First, FOMC secrecy prevents unfair speculation. Second, if policy prescriptions were made public, inappropriate market reaction may occur if the public incorrectly anticipates the Fed's reaction to newly released information. Third, current disclosure may harm the government's commercial interests by raising the cost of borrowing. Fourth, the Fed would rather not take a stand, a priori, on policy prescriptions, but would rather have the flexibility to deal with events on a case-by-case basis. Fifth, disclosure would make it harder for the Fed to smooth interest rates, as the public would react immediately to key economic indicator announcements. Goodfriend [1986] systemically argues against each of these arguments, and comes to the conclusion that there are very few circumstances under which secrecy is desirable for a Central Bank.

There are several theoretical papers that examine conditions under which transparency may not be the best course of action for a Central Bank to pursue, most notably Cukierman and Metzler [1986], and also Balke and Haslag [1992] and Haslag [2001]. However, Rudin [1988] develops a model by which reducing the amount of

Central Bank secrecy can increase the forecasting accuracy of interest rates by agents in the economy. Tabellini [1987] also finds this result, while Dotsey [1987] finds that secrecy tends to raise the variance of the forecasting error of the federal funds rate.

On the econometric front, Thornton [1996] econometrically examines the consequences of the Fed's policy shift towards immediate disclosure on the federal funds rate. After 1994, much of the Fed's supposed secrecy was removed. Thornton [1996] argues that the new policy has reduced financial market uncertainty, which should result in a lower forecast error (represented by a lower Mean Squared Error) since 1994. He finds this is the case, though at least part of the reduced volatility may be due to relatively quiet financial markets, rather than the change in Fed policy.

There are two questions about Thornton's approach, however, both involving his use of the Federal Funds futures rate to measure anticipated future changes in interest rates. First, this rate may not be the appropriate measure of market interest rates, since we are most interested in the interest rates that individuals and firms pay to borrow funds. Second, during the time span studied, the Federal Funds futures market was relatively new. As such, the volume of transactions was relatively small. Thin markets could induce large movements in futures prices as new information became known to participants. However, after 1994 the futures market increased in volume. See Figure 1. Thus, if volatility decreased since 1994, it cannot be determined whether this is due to Fed policy or a thickening of the Federal Funds future market.

Campbell and Shiller [1991] look at U.S. interest rate data to study yield spreads and the expectations theory of the term structure. If the expectations theory of the term structure holds, rational expectations of future interest rates drive current long-term interest rates. The authors use a VAR approach (outlined in the next section) to compare the theoretically efficient spread to the actual spread for both ends of the term structure. They reject the theory, as do most other authors[4], stating "when the spread is high the long rate tends to fall and the short rate tends to rise". However, their sample data only encompasses up to 1987. Our results show that markets have become more efficient since 1994 when the change in FOMC procedure occurred.

[4] See, for example, Pepper [1995], Froot and Takatoshi [1989], and Mankiw and Summers [1984].

3. Methodology:

Following Campbell and Shiller [1991], we utilize a vector-autoregressive method approach for analyzing the theoretical versus actual yield spread among interest rates of varying maturities. The general approach is to use a VAR to predict interest rate spreads and changes in short and long interest rates and compare these forecasts the actual values. If the lagged values of interest rate spreads and changes in interest rates summarize all the available market information then the forecasted values of these variables will represent the theoretically efficient values, i.e. the values one would expect if the efficient market hypothesis were true.

The expectations theory of the term structure of interest rates focuses on the spread between interest rates of differing maturities. According to the theory, the premium between an n-period rate and an m-period rate ($n > m$) is equal to the optimal forecast of changes in future interest rates, as well as a constant risk premium. Thus, if $S^{(n,m)}{}_t = R^{(n)}{}_t - R^{(m)}{}_t$, then according to the theory,

$$(m/(n-m))S^{(n,m)}{}_t = E_t R^{(n-m)}{}_{t+m} - R^{(n)}{}_t \qquad (1)$$

where the constant is suppressed. Now, if $n = 2m$ (for example, when comparing three-month and six-month Treasury bills), then (1) reduces to

$$S^{(n,m)}{}_t = E_t R^{(m)}{}_{t+m} - R^{(n)}{}_t \qquad (2)$$

Equation (2) can be tested via regression analysis, by simply regressing the spread ($R^{(m)}{}_{t+m} - R^{(n)}{}_t$) on a constant and its predicted value ($S^{(n,m)}{}_t$). If markets are efficient, then the slope should equal one, implying that the best predictor of the yield spread is the current spread. Also, Equation (2) can be rewritten as

$$S^{(n,m)}{}_t = (1/2)E_t \Delta^m R^{(m)}{}_{t+m} = (1/2)E_t[R^{(m)}{}_{t+m} - R^{(m)}{}_t] \qquad (3)$$

This equation states that the current spread is half of the expected difference between the interest rates on the shorter maturity bond between the current period and the next period. Again, it is straightforward to test this prediction econometrically, and conducting a hypothesis test on whether the slope coefficient equals one.

As mentioned in the previous section, many studies, using bonds of various maturities and different countries, have rejected this version of the efficient markets hypothesis. Turning to a VAR approach, and employing (3), we hope to eliminate some of the multiple forecasting errors and simultaneity issues that plague the single regression analysis.

Let $x_t = [\Delta R^{(m)}_t, S^{(n,m)}_t]$, and assume that x_t can be represented as a p-th-order VAR (where p is finite). An assumption currently made in our analysis is that $\Delta R^{(m)}_t$ and $S^{(n,m)}_t$ are stationary processes, thus avoiding potential problems involving unit roots[5]. Then this system can also be written as a first-order VAR $z_t = Az_{t-1} + u_t$, where z_t is comprised of $\Delta R^{(m)}_t$ and its p-1 lags, followed by $S^{(n,m)}_t$ and its p-1 lags (for $2p$ terms in total). Next, define a ($2p \times 1$) vector g such that $g' z_t = S^{(n,m)}_t$, where all the elements of g equal zero except for the first element (which equals one). Finally, we can compute the VAR forecast of the perfect-forecast spread, defined as $S'^{(n,m)}_t$; this is the spread which would hold if markets were efficient (and expectations were thus rational), which can be obtained by using (3). If markets are indeed efficient, then the following equation should hold, on average:

$$S^{(n,m)}_t = g' z_t = S'^{(n,m)}_t \tag{4}$$

That is, the expected yield spread (at time t) should equal the actual yield spread (observed upon maturity of all relevant bonds that were issued at time t).

We use the VAR to compare the behavior of the theoretical and actual spreads over time. In particular, we look at 1) the correlation between the actual and theoretical spread, and 2) the ratio of the standard deviations between the actual and theoretical spread for different maturities. We compute these statistics for VARs of different periods: one set for the time period before 1994, and one set for the time period after the Federal Reserve System's policy shift in February of 1994. If markets have become more efficient in this latter period of greater openness, we would expect to see both the correlations and the ratio of the standard deviations move closer to +1.

We also calculate the Mean Squared Error (MSE) of the forecast for each VAR both before and after 1994. Again, a drop in MSE would lend support to the hypothesis that market efficiency has increased in the latter period. If the increased transparency provided new and valuable information to markets then one would expect that the errors caused by incorrect guesses regarding FOMC interest rate changes would become less

---

[5] Unit roots are likely not a problem, since most macroeconomic data is I(0) or I(1) and our dependent variables in question are in differenced form.

frequent. This would eliminate one source of error in the market and reduce the MSE of forecasts based upon market information, such as the VAR procedure used in this paper. Additionally, the standard error of the forecasts should decrease as well.

Federal Open Market Committee dates were obtained from the Federal Reserve Bulletin[6]. Daily and Monthly interest rate data are in nominal terms, and come from the Federal Reserve Economic Data series. The bond maturity lengths used in this analysis are detailed in the next section.

[6] Published monthly by the Board of Governors.

4. Results:

Table 1 shows the estimation of (1) for bonds of different maturity lengths between 1983 and 1999. We test the null hypothesis that the slope coefficient equals one. Since the form of serial correlation is unknown, we use the Newey-West estimator with bandwidth of five to calculate the standard errors. The lag length (*p*) of each VAR was chosen using the Akaike Information Criterion (AIC) and Schwarz Criterion (SC). Tables 2 and 3 repeat this exercise using the sub-periods 1983:03 – 1994:02 and 1994:02 – 1999:06 respectively. For most pairs of Treasury bills, it can be seen that the null hypothesis is rejected, meaning that the efficient market hypothesis does not seem to hold. The exceptions are the 3-month/36-month regressions, and the 6-month/36-month regressions in Tables 1 & 2, and the 3-month/12-month, 6-month/12-month, and 12-month/24-month regressions in Table 3. These results are analogous to what other authors have found.

Tables 4 & 5 report the MSE for the VAR described in the previous section, for the periods before and after the policy change respectively. Again, VARs for many different maturity length bond pairs were run. It immediately becomes apparent that the MSE decreases after 1994 for all combinations of m and n. Thus, it seems that the volatility of markets fell after the Fed changed to a policy of greater openness. Also, Table 6 reports F-tests on the null hypotheses that the MSE (for each separate VAR) are identical for the two sample periods. The null hypothesis is rejected for all maturity length bond pairs, indicating that the drop in MSE is statistically significant.

However, these results should be regarded with a note of caution. We are not saying that it is precisely because the Fed adopted a policy of immediate public disclosure of rate targets that volatility fell. MSE could have decreased for any number of reasons after 1994, such as the absence of strong business cycle forces. Our results, however, do support the notion that greater public disclosure did not destabilize markets to any noticeable degree. In addition, the post-1994 period includes the Asian financial crisis, the Russian debt default and the Long-Term Capital Management bailout so the period was not entirely tranquil.

Tables 7 & 8 report the correlation between the actual and theoretical spread ($S^{(n,m)}_t$ and $S'^{(n,m)}_t$) for the two sub-periods. It can be seen that for all maturity lengths m and n, the correlation has moved closer to 1 since the policy shift. This is also is in line with the hypothesis that openness helps the predictability of markets.

Finally, Tables 9 & 10 report the ratio of the standard deviations between the theoretical and actual spreads. In contrast to the aforementioned results, this ratio moves further away from 1.0 for many maturity lengths m and n. The theoretical and actual spreads both decline in the post-1994 period, but the theoretical spread declines even more than the actual spread which causes the ratio of the two spreads to decline. This suggests that the relative tranquility of financial markets may explain the results. More tests are needed to evaluate the robustness of these results, but Tables 9 & 10 are not inconsistent with the notion that the increased transparency of FOMC policy decisions contributed to an increase in market efficiency.

5. Conclusion:

This paper has set out to show that a more open dialogue between Central Bank policymakers and the general public is conducive to greater market efficiency. For the majority of interest rate maturities, we have found that the time periods in the United States with greater information disclosure coincides with lower interest rate volatility and greater market predictability. Though we have not completely eliminated the possibility that the reduced volatility was due to smoother economic conditions, rather than due to a more accurate estimation of future monetary policy predictability, the data does not reject the hypothesis either. In fact, even if smoother economic conditions explain the drop in the ratio of the standard deviations of theoretical and actual spreads, it would be much harder to argue that smoother economic conditions increased the correlation of theoretical and actual spreads or the closer approximations of regressions based upon equations (2) and (3) to the efficient market hypothesis during the post-1994 period. At any rate, it does not appear that the proponents of Central Bank secrecy have a strong argument – our findings show that the destabilization that many have warned about does not seem to have occurred. Though much more research has yet to be done, both in expanding the analysis to other countries (such as the United Kingdom, Japan, Australia, Germany, and France) and in constructing a more quantitative measure of policy openness, the data suggests that greater information helps make for a more efficient market.

Bibliography:

Balduzzi, Pieruigi, et al, 1997, Interest Rate Targeting and the Dynamics of Short-Term Rates, National Bureau of Economic Research Working Paper #5944: Cambridge, MA.

Balke, Nathan S. and Joseph H. Haslag, 1992, A Theory of Fed Watching in a Macroeconomic Policy Game, International Economic Review, 33 (3), 619 – 628.

Blinder, Alan S., 1998, Central Bank Independence in Theory and Practice, MIT Press: Cambridge, MA.

Campbell, John Y., 1995, Some Lessons from the Yield Curve, National Bureau of Economic Research Working Paper #5031: Cambridge, MA.

Campbell, John Y. and Robert J. Shiller, 1991, Yield Spreads and Interest Rate Movements: A Bird's Eye View, Review of Economic Studies, 58 (3), 495-514.

Campbell, John Y. and Robert J. Shiller, 1987, Cointegration and Tests of Present Value Models, Journal of Political Economy, 95, 1062 – 1088.

Capie, Forrest et al, 1997, The Future of Central Banking: The Tercentiary Symposium of the Bank of England. Cambridge University Press (Cambridge, UK).

Carlson, John B., Jean M. McIntire et al, 1995, Federal Funds Futures as an Indicator of Future Monetary Policy: A Primer, Economic Review (Federal Reserve Bank of Cleveland), Vol. 31 (1).

Cosimano, Thomas F. and John B. Huyck, 1993, Central Bank Secrecy, Interest Rates, and Monetary Control, Economic Inquiry, XXXI, 370 – 382.

Cukierman, Alex and Allan H. Metzler, 1986, A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information, Econometrica, 54 (5), 1099 – 1128.

Dotsey, Michael, 1987, Monetary Policy, Secrecy, and Federal Funds Rate Behavior, Journal of Monetary Economics, 20, 463 – 474.

Froot, Kenneth A. and Ito Takatoshi, 1989, On the Consistency of Short-run and Long-run Exchange Rate Expectations, Journal of International Money and Finance, Vol. 8 (4), 487-510.

Geraats, Petra M., 1999, Transparency and Reputation: Should the ECB Publish Its Inflation Forecasts?, Conference on Monetary Policy-Making under Uncertainty, Frankfurt am Main (Germany).

Goodfriend, Marvin, 1986, Monetary Mystique: Secrecy and Central Banking, Journal of Monetary Economics, 17, 63 – 92.

Haslag, Joe, 2001, On Fed Watching and Central Bank Transparency, manuscript.

King, Mervyn, 1997, Changes in UK Monetary Policy: Rules and Discretion in Practice, Journal of Monetary Economics, 39, 81 – 97.

Krueger, Joel T. and Kenneth N. Kuttner, 1999(?), The Federal Funds Rate as a Predictor of Federal Reserve Policy, Federal Reserve Bank of Chicago.

Mankiw, Gregory N. and Lawrence J. Summers, 1984, Do Long-Term Interest Rates Overreact to Short-Term Interest Rates? Brookings Papers on Economic Activity, Vol. 0 (1), 223 – 242.

Pepper, Gordon, 1995, The 'Efficient Market Hypothesis:' An Incomplete Theory, St. Martin's Press: New York.

Rudenbusch, Glenn D., 1995, Federal Reserve interest rate targeting, rational expectations, and the term structure, Journal of Monetary Economics, 35, 245-274.

Rudin, Jeremy R., 1988, Central Bank Secrecy: 'Fed Watching', and the Predictability of Interest Rates, Journal of Monetary Economics, 22, 317 – 334.

Tabellini, Guido, 1987, Secrecy of Monetary Policy and the Variability of Interest Rates, Journal of Money, Credit and Banking, 19 (4), 425 – 436.

Thornton, Daniel, 1996, Does the Fed's New Policy of Immediate Disclosure Affect the Market? Review (Federal Reserve Bank of St. Louis), November/December, 77 – 86.

TABLE 1

Estimation of $(m/(n-m))S^{(n,m)}_t = E_tR^{(n-m)}_{t+m} - R^{(n)}_t$

Sample period: 1983:03- end of sample

	m			
n	3	6	12	24
6	0.609			
	(0.130)			
	[0.003]			
12	0.434	0.298		
	(0.281)	(0.408)		
	[0.044]	[0.085]		
24	0.380	0.246	-0.048	
	(0.330)	(0.380)	(0.340)	
	[0.060]	[0.047]	[0.002]	
36	0.580	0.610	0.609	
	(0.355)	(0.385)	(0.130)	
	[0.239]	[0.312]	[0.000]	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds. For each pair of maturity dates, the first number is the coefficient estimate, the second number is the standard error and the third number is the probability that the data reject the null hypothesis that the coefficient equals one. Newey-West estimator with bandwidth of five is used to calculate all the standard errors.

TABLE 2

Estimation of $(m/(n-m))S^{(n,m)}_t = E_t R^{(n-m)}_{t+m} - R^{(n)}_t$

Sample: 1983:03 – 1994:01

		m		
n	3	6	12	24
6	0.547			
	(0.166)			
	[0.000]			
12	0.174	0.107		
	(0.249)	(0.511)		
	[0.001]	[0.080]		
24	0.342	0.258	-0.086	
	(0.351)	(0.446)	(0.374)	
	[0.061]	[0.096]	[0.004]	
36	0.646	0.722	-0.357	
	(0.416)	(0.425)	(0.353)	
	[0.397]	(0.512)	[0.000]	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds. For each pair of maturity dates, the first number is the coefficient estimate, the second number is the standard error and the third number is the probability that the data reject the null hypothesis that the coefficient equals one. Newey-West estimator with bandwidth of five is used to calculate all the standard errors.

TABLE 3

Sample: 1994:02 – end of sample

		m		
n	3	6	12	24
6	0.680			
	(0.111)			
	[0.003]			
12	0.668	0.692		
	(0.244)	(0.424)		
	[0.174]	[0.467]		
24	0.506	0.422	0.438	
	(0.221)	(0.332)	(0.532)	
	[0.025]	[0.082]	[0.291]	
36	0.528	0.453	0.247	
	(0.184)	(0.272)	(0.174)	
	[0.010]	[0.044]	[0.000]	

TABLE 4
MEAN SQUARE ERROR

Sample: 1983:03 – 1994:01

	m			
n	3	6	12	24
6	0.001654			
12	3.85E-05	2.32E-05		
24	0.000127	0.000108	6.62E-05	
36	0.000213	0.000194	9.76E-05	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds. The number in each cell is the mean square error for the sample period.

TABLE 5
MEAN SQUARE ERROR

Sample: 1994:02 – end of sample

	m			
n	3	6	12	24
6	0.000572			
12	9.09E-06	7.37E-06		
24	1.97E-05	1.88E-05	1.42E-05	
36	2.44E-05	2.43E-05	4.08E-06	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds. The number in each cell is the mean square error for the sample period.

TABLE 6
FTEST OF EQUALITY(Probability)

	m			
n	3	6	12	24
6	7.08244E-06			
12	2.50487E-08	2.68567E-06		
24	9.40009E-10	2.02853E-09	9.29836E-09	
36	5.22494E-09	3.15218E-09	1.16564E-18	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds. The number in each cell is the p-value for rejecting the hypothesis that the mean square errors for each time period are equal. A value of less than 0.05 indicates that the data reject the hypothesis of equality at the 95% level. The test statistic is biased toward failure to reject the null.

TABLE 7
CORELLATION BETWEEN ACTUAL AND THEORETICAL SPREAD

Sample: 1983:03 – 1994:01

	m			
n	3	6	12	24
6	0.5864			
12	-0.0468	0.3179		
24	-0.2413	0.2730	0.1256	
36	0.1234	0.5086	0.6475	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds.

TABLE 8
CORELLATION BETWEEN ACTUAL AND THEORETICAL SPREAD

Sample: 1994:02 – end of sample

	m			
n	3	6	12	24
6	0.9055			
12	0.0241	0.6979		
24	0.1489	0.7813	0.2094	
36	0.8688	0.9318	0.6660	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds.

TABLE 9
RATIO OF THEORETICAL TO ACTUAL SPREAD'S STANDARD DEVIATION

Sample: 1983:03 – 1994:01

	m			
n	3	6	12	24
6	0.6404			
12	0.5311	0.8681		
24	0.5343	0.4253	0.3270	
36	0.2954	0.3524	0.3144	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds.

TABLE 10
RATIO OF THEORETICAL TO ACTUAL SPREAD'S STANDARD DEVIATION

Sample: 1994:02 – end of sample

	m			
n	3	6	12	24
6	0.4909			
12	0.3166	0.6052		
24	0.2577	0.3167	0.3914	
36	0.0455	0.3940	0.3672	

NOTE: M is the length, in months, of the short-period bond and N is the length, in months, of the long-period bonds.

Figure 1: Volume of Federal Funds Futures

source: Chicago Board of Trade