Research Department
Federal Reserve
Bank of
San Francisco

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Term Structure Puzzles

The subject of interest rates has probably never received the attention from both the financial and nonfinancial press that it has in the last two and one-half years. The unusual behavior of interest rates here and abroad has been noted in recent reports of well-known international institutions such as the Bank for International Settlements (B.I.S.) in Basel, Switzerland. In its 52nd Annual Report, the B.I.S. paid particular attention to the behavior of interest rates:

"The behavior of interest rates over the past twelve to eighteen months has not only been characterized by very high and variable nominal interest rates, but interest rates have come to seem unusually high in real terms, especially considering the weakness of business activity... These developments may be explained by a number of both independent and interdependent forces, varying in strength between countries, but frequently originating in the United States and subsequently spreading to other countries."

Economists in the U.S. also appear puzzled by the unusual behavior of interest rates. With the rate of inflation (CPI) from June 1981 to June 1982 measuring 7.1 percent, the average 12.57 percent rate for the one-year Treasury bill in June seemed hardly consistent. Even with the rate decline in the last six weeks, rates are still historically high for a period of recession.

Term structure

In explaining the behavior of interest rates, economists often rely on two paradigms—the Fisher equation, which describes the level of interest rates, and the "exceptional theory" of the term structures, which describes the relation among interest rates on assets of different maturities.

Named after the American economist Irving Fisher, the Fisher equation relies on the argument that borrowers and lenders realize that interest rates ought to reflect any loss in real purchasing power due to inflation, and therefore must capture the anticipated capital loss in an inflation premium. According to the equation, interest rates must also have a "real" component, determined by underlying "real factors" such as the aggregate productivity of capital in the economy. The sum of the two components sets the level of interest rates and, in theory, should approximate the observed market rates of interest.

The expectational theory of the term structure, largely the invention of British Nobel Laureate Sir John Hicks, argues that since individuals can trade financial assets of different maturities, there must be an equilibrium relationship among the returns on these assets across the entire spectrum of maturities. In a world in which individuals have similar risk preferences, the Hicksian argument suggests that the observed long-term interest rate must equal the geometric average of the currently observable short-term interest rate and future *expected* short-term interest rates. This argument has led to rules-of-thumb for analyzing term structures. For example, a rising term structure—long-term rates higher than short-rates—by this theory would mean that the market expects short-term rates to increase in the future. In this way, the average of the current and future expected short-term rates would equal the presently available return on the long-term asset.

If current short-term interest rates rise there may or may not be a corresponding rise in long-term interest rates. The reason is that expected future short-term rates could move in the opposite direction to leave the average, and hence the long-term rate, unaffected. Nonetheless, movements in short-term rates theoretically have some impact on longer dated securities, with the impact smaller the longer the maturity of the asset.

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While considerable past empirical evidence favors both the Fisher equation and the expectational theory, the two related paradigms have more recently come under criticism. Nothing disturbs theory quite like the reality of high real interest rates in the U.S. These high real rates have made many suggest that an "uncertainty premium" needs to be added to the Fisher equations. Recent studies of the relationship between the variability of short- and long-term interest rates have also led to some serious questioning of the expectational theory of the term structure. Long-term rates appear to be too volatile in relation to short-term rates to be consistent with the Hicksian expectational theory.

Rate volatility and policy

On October 6, 1979, the Federal Reserve announced a major change in its monetary control procedures. The Federal Open Market Committee would no longer conduct open market operations (purchase and sell U.S. government securities) with the aim of keeping fluctuations in the Federal funds rate within a narrow band of 50-100 basis points between Committee meetings. Instead, it would attempt to control monetary growth by controlling the reserves of the banking system, principally nonborrowed reserves.

Many economists expected this change to lead to greater volatility in short-term interest rates but only small, if any, changes in the volatility of long-term interest rates. In fact, both short- and long-term interest rates became much more volatile after October 6, 1979.

The increased volatility of both short- and long-term interest rates has not been restricted to the United States. The West German Federal Republic provides a parallel example. To measure the volatility in interest rates across the term structure, we have computed the standard deviation in the change in interest rates of assets of different maturities for two periods, February 1976-September 1979 and November 1979-December 1981.* This measure, for both the U.S. and West Germany, shown in Chart 1, might be described as the "term structure of yield volatility." As expected, the term structure of yield volatility is generally downward sloping because short-term rates are usually more volatile than long-term rates.

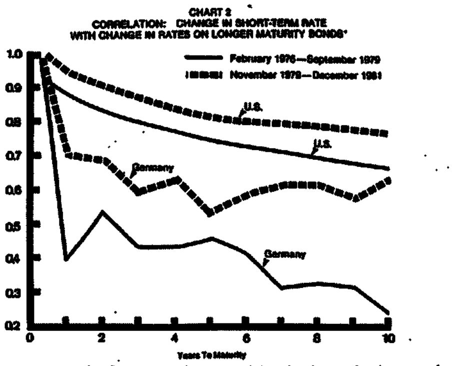
In the period between February 1976 and September 1979, the term structures of yield volatility for the U.S. and West Germany were surprisingly alike, that is, the interest rates in both countries were almost equally volatile. After October 1979, the term structures of yield volatility rose for both countries. Both long-term and short-term interest rates in the two countries became more volatile, but the increase was greater for the U.S. where long-term rates appeared 3-4 times more variable than before.

The expectational theory of the term structure argues that current and expected short-term rates "determine" long-term rates. What then is the pre- and post-October 1979 relationship between changes in the rate on the shortest asset and changes in rates on assets of longer maturities?

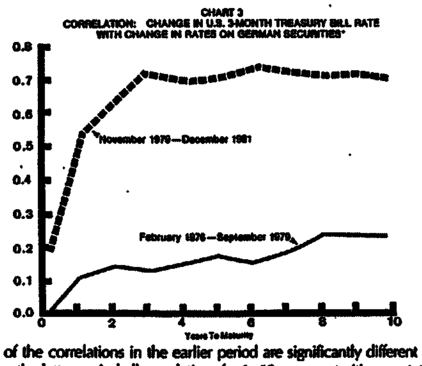
In Chart 2 we have plotted for the U.S. the simple (contemporaneous) correlations between the changes in the 3-month Treasury bill rate and the changes in rates on U.S. Government assets of maturities up to 10 years. They show that longer-dated U.S. government securities appear more sensitive to changes in the yield on the 3-month Treasury bill after October 1979.

Before October 1979 the change in the German 3-month interbank rate had little relation to changes in rates on longer-maturity German government bonds (also Chart 2). However, after October 1979, long-term German interest rates apparently became much more sensitive to changes in German money mar-

*Data for the German term structure include yields on Federal government bonds (including the Federal railway and post office) for maturities of one to ten years, and the three-month interbank rate. U.S. data are for U.S. Treasury securities.



*The short-term rate for Germany is the 3-month interbank rate; the short-rate for the U.S. is the 3-month Treasury bill rate.



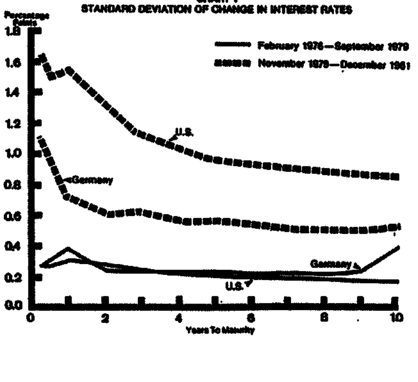
*None of the correlations in the earlier period are significantly different from zero. For the latter period all correlations for 1–10 years maturities are statistic ally different from zero at the .99 significance level.

ket rates. Since long-term interest rates influence decisions on residential construction and business fixed investment, this increased sensitivity is worth noting.

"Coupling" or "Decoupling"

A country can partially insulate itself from the financial conditions in other countries by allowing its exchange rate to adjust. If interest rates rise abroad and the home country wishes to keep its domestic interest rates from following the trend, it can choose, as a matter of policy, to allow its exchange rate to depreciate. Thus, under a system of floating exchange rates some "decoupling" of interest rate movements can occur because exchange rates would move to reflect the interest rate differentials between countries.

Chart 3 shows the degree of "decoupling" and "recoupling" between American and West German interest rates in the period February 1976-September 1979 and the period November 1979-December 1981 when the value of the U.S. dollar rose in the exchange markets. The simple correlations between changes in the 3-month U.S. Treasury bill rate and changes in rates over the entire German term structure show that German interest rates were relatively insensitive to changes in short-term U.S. rates in the earlier period. In the later period, however, long-term German rates seem remarkably sensitive to changes in U.S. money market rates.



While in theory interest rates can be decoupled internationally by permitting exchange rates to adjust, in practice, exchange rate intervention can recouple rates, causing them to move in tandem across countries. The reason is simple enough. When a country purchases its own currency in the foreign exchange market, the action has the effect of reducing domestic liquidity, causing interest rates to rise. But such intervention would more likely result in related changes in short-term rates than in long-term rates.

In our example, changes in U.S. short-term rates appear to have had a substantial impact on German long-term rates. The reason for this inter-relationship is a mystery only partly explained by the expectational model of the term structure. Long-term German interest rates may be reflecting the expectation that future *U.S.* short-term rates will be higher and that the Bundesbank, the German central bank, will take policy actions to prevent the Deutschemark from depreciating. Thus the long end of Germany's term structure may be reflecting a forecast of future U.S. short-term rates and the expected behavior of the German central bank.

We should note that simple correlations between interest rates are not sufficient to confirm a casual relationship. The interaction between U.S. and German interest rates could be produced by a common third factor which these correlations have neglected.

Whether the change in the Federal Reserve's monetary control procedures is the cause of higher domestic interest rates or whether high interest rates are the result of an anti-inflationary monetary policy, regardless of the control rule employed, is still an open question. For the international market, the puzzle may be the apparent increase in the interdependence of interest rates across oceans. The high U.S. rates appear to have had rippling effects on foreign long-term as well as short-term interest rates.

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BANKING DATA—TWELFTH FEDERAL RESERVE DISTRICT
(Dollar amounts in millions)

Selected Assets and Liabilities Large Commercial Banks	Amount Outstanding 8/4/82	Change from 7/28/82	Change from year ago Dollar	Percent
Loans (gross, adjusted) and investments*	160,893	567	9,297	6.1
Loans (gross, adjusted) — total#	141,102	726	10,630	8.1
Commercial and industrial	44,543	276	4,817	12.1
Real estate	57,198	52	3,413	6.3
Loans to individuals	23,423	− 29	456	2.0
Securities loans	2,790	26	1,452	108.5
U.S. Treasury securities*	6,227	− 119	54	0.9
Other securities*	13,564	− 40	− 1,387	− 9.3
Demand deposits — total#	40,821	2,743	− 1,317	− 3.1
Demand deposits — adjusted	27,732	447	− 1,072	− 3.7
Savings deposits — total	31,020	706	669	2.2
Time deposits — total#	99,247	− 97	15,273	18.2
Individuals, part. & corp.	89,844	136	14,054	18.5
(Large negotiable CD's)	37,427	− 265	3,310	9.7

Weekly Averages of Daily Figures	Week ended 8/4/82	Week ended 7/28/82	Comparable year-ago period
Member Bank Reserve Position			
Excess Reserves (+)/Deficiency (−)	94	56	32
Borrowings	76	25	44
Net free reserves (+)/Net borrowed(−)	18	31	− 12

* Excludes trading account securities.
# Includes items not shown separately.

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