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THE RELATIONSHIP BETWEEN UNITED STATES AND FOREIGN INTEREST RATES: A STUDY OF FINANCIAL MARKET INTEGRATION

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Anthony Q. Chua

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THE RELATIONSHIP BETWEEN UNITED STATES AND FOREIGN

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By

Anthony Q. Chua

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ABSTRACT

THE RELATIONSHIP BETWEEN UNITED STATES AND FOREIGN INTEREST RATES: A STUDY OF FINANCIAL MARKET INTEGRATION

By

Anthony Q. Chua

Research on financial market integration has concentrated on the existence of integration rather than on the structure of any relationship. With the exception of Hendershott (45) and Kwack (55), there has been no test of the speed of adjustment of interest rate changes among financial markets.

This study will examine the temporal and structural relationships involved in the adjustment of interest rates to one another. Instantaneous adjustment of foreign interest rates (holding-period returns) to changes in the United States interest rates is hypothesized. Invoking the concepts underlying the relative purchasing power parity theory, the interest rate theory of exchange rate expectation, and the interest rate parity theory, the foreign interest rates were adjusted to account for external factors such as the level of international trade and movements, the level of foreign exchange rates, and the relative price level. Because the adjustments were done such that a complete turnaround transaction was

obtained, the adjusted foreign interest rates were effectively holding-period returns.

The relationships examined include those of the United States interest rates with the Eurodollar rate, and the short-term and long-term interest rates of Canada, West Germany, United Kingdom, France, Netherlands, and Switzerland. The relationships were examined over the time periods from 1971-72, 1973-75, and 1975-78, using the methods developed by Box and Jenkins.

The results of the study provide evidence for the nonrejection of the hypothesis that financial markets are integrated. That there is instantaneous adjustment of foreign interest rates (holding-period returns) to changes in the United States interest rates cannot be rejected. This statement is supported by the magnitudes of the cross correlation coefficients depicting the relationships between the United States interest rates and foreign adjusted interest rates. However, financial market integration characterizes the May 1975-November 1978 period, but not the January 1971-April 1975 period. The exceptions are Canada and France. The Canadian adjusted interest rates are found to be consistently correlated to the United States interest rates over the entire sample period, while the French adjusted interest rates are found to be consistently unrelated to the United States interest rates over the entire sample period.

The implications of the results are twofold. On the microeconomic level, the lead-lag relationships imply little benefit to be derived from the transfer of funds across national boundaries.

This statement is based on the assumption that the transfer of funds takes place as a reaction to a change in the level of interest rates in the United States. Also, moving across boundaries to take advantage of lower financial costs provides little benefit to the firm.

On the macroeconomic level, the study implies that, on the one hand, governments have had some success in reducing foreign influences on their domestic financial rates, as shown by the somewhat weak coefficients found in the cross correlation analysis. On the other hand, the existence of lead-lag relationships suggests that governments have not been able to completely isolate their economies from events in the United States financial market. Hence, the use of interest rates as a tool of monetary policy has not necessarily been weakened.

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CHAPTER I

INTRODUCTION

The transfer of funds between savings-surplus and savings-deficit units occurs primarily in the domestic financial markets of a country. However, most financial markets have links abroad: domestic investors purchase foreign securities and may invest in foreign financial institutions. Conversely, domestic banks make loans to foreign residents who may issue securities or deposit funds with domestic banks. Such foreign borrowing and lending transactions have traditionally been directly subject to the public policy governing transactions in a particular market (6).

Since the early 1960s, the development of the Eurocurrency markets has removed both domestic and international borrowing and lending from the sole jurisdiction and influence of domestic financial markets. Particularly, the growth of the Eurodollar market in the late 1960s and the interaction of domestic financial markets with the Eurodollar market have increased the range of borrowing and lending alternatives available to economic entities. The Eurodollar market has become a link between domestic and foreign financial markets.

The phenomenon of the Eurocurrency markets has raised such questions as: What is the nature of the connection between financial markets? How sensitive are domestic financial markets to changes in external financial markets? Such questions have led to numerous studies on financial market integration. The studies focus primarily on the relationships between domestic and foreign financial markets, using interest rate relationships and capital movements as measures of integration. Although the evidence is conflicting, the results tend to support the view that the financial markets are interrelated or integrated. Most of the studies, however, deal with the existence of integration rather than on the structure of any relationship. With the exception of Hendershott (45) and Kwack (55), there has been no test of the speed of adjustment of interest rate changes among financial markets. There is no evidence regarding the degree of integration that characterized the financial markets under investigation.

Objective of the Study

This research will examine the temporal and structural relationships involved in the adjustment of interest rates to one another. Instantaneous adjustment of foreign interest rates (holding-period returns) to United States interest rate changes is hypothesized. The hypothesis is set forth after taking into consideration the findings of studies based on the interest rate parity theory and the concept of interest rate covariation. However, the hypothesis is contrary to the findings of Hendershott (45) and Kwack (55), who found some time lag in the adjustment of Eurodollar interest rates to domestic interest rates. However, the data employed in their studies were from the period of 1957-64, during which time the size of the Eurocurrency market was not comparable to that of the United States financial markets. In addition, the activities in foreign and international financial markets had not attracted the attention they have since the early 1960s. Finally, the international monetary system is characterized by a system of fixed but adjustable exchange rates. The Bretton Woods Agreement of 1944 was enforced during the period before 1973. Specifically, under the Agreement, each country agreed that the rates at which current foreign exchange transactions were carried out within its territory were not to vary by more than plus or minus 1 percent from an established par value. A country could not change the par value of its currency except to correct a fundamental disequilibrium.

The current study employs data from the 1970s--a period characterized by conditions different from those existing in the 1950s and 1960s. In 1971, the United States refused further convertibility of dollars into gold, which prompted some observers to say that the Bretton Woods system ended in 1971. The year 1973 marked the transition to a floating exchange rate system. The need for a transition to a different monetary system was found to be more urgent when a huge increase in the price of oil in late 1973 led to major shifts in the balance-of-payments positions for almost all countries. The oil crisis of 1973 precipitated the inflation rate spiral that also characterized the 1970s. The large amount of current account surpluses in the oil-producing countries was an impetus to the development of the Eurocurrency markets as members of the Organization of Petroleum Exporting Countries invested their surplus funds in Eurocurrencies in European banks and dollar deposits in United States banks.

Because of the dramatic fundamental changes that occurred in the 1970s, this study will not necessarily present support for or refute earlier analyses of financial market integration. Rather, the study will provide evidence of integration for the decade of the 1970s. The study examines the speed with which arbitrage activities minimize or eliminate interest rate differentials between financial markets. If the data show evidence of instantaneous adjustment of adjusted interest rates to changes in other markets, this will serve to support the contention that financial markets are integrated.

The remaining parts of this chapter discuss the importance and implications of the study, the background of the study, the definition of financial market integration, and summarize the previous studies undertaken in the area.

Chapter II presents the theories and concepts relevant to the study. Specifically, the interest rate theory of exchange rate expectations, the interest rate parity theory, and the relative purchasing power parity theory will be discussed.

Chapter III outlines the research hypotheses and the procedures to be applied in the testing of the hypotheses.

Chapter IV discusses and evaluates the results of the tests performed on short-term interest rates. Chapters V, IV, and VII discuss and evaluate the findings of the tests performed on long-term interest rates assuming holding periods of three months, six months, and one year, respectively. Chapter VIII presents an overall evaluation of long-term interest rates.

Finally, Chapter IX presents the summary of findings, conclusions and implications, and suggestions for future research.

Importance of the Study

The importance of the study is twofold. First, on the microeconomic level, the adjustment mechanism of interest rates to one another is a factor in decision-making processes. That is, the adjustment relationship provides investors with information on the potential risks resulting from the transfer of funds across boundaries. Moreover, an understanding of the adjustment mechanism will provide insight regarding the role of foreign investments in investors' portfolios. With respect to borrowers, the nature of the adjustment process may provide information on the timing of the firm's financing.

On the macroeconomic level, the research may have repercussions on the affected countries' autonomous pursuit of domestic economic policies. If the findings demonstrate a lead-lag relationship between United States interest rate and foreign adjusted interest rates, this will have an effect on the use of interest rates as a tool of monetary policy. However, should this study reveal instantaneous adjustment, it would not necessarily negate the use of interest rates altogether. On the one hand, the effectiveness of interest rates as a tool for changing domestic monetary conditions may be weakened. Such a weakening of monetary policy poses a serious stabilization problem for governments. On the other hand, monetary policy may be used to regulate the balance of payments, thereby freeing other instruments of economic policy for domestic economic objectives. If it is found that there exists a lead-lag relationship between interest rate changes, then the use of interest rates may be more effectively used as an instrument of monetary policy. The longer the lead or lag of the adjustment of interest rates to one another, the more effective interest rates will be in influencing domestic economic conditions.

Financial Integration Defined

The definition of financial integration adopted by this study follows basically that of Kenen (11). That is, financial integration is defined by the extent to which markets are connected. This definition can be employed to describe the degree to which participants in any financial market are able and obliged to take notice of events occurring in other markets (11). Market participants are able and obliged to do so in order to achieve their wealth maximizing objective. Although each country has its own particular set of domestic regulations, structure of interest rates, domestic currency, and cost structure of raising funds, the circumstances do not preclude the importance of interest rates in other countries as a significant contributor to the determination of domestic interest rates.

The study will proceed on the assumption that different markets have different specific risk levels, financial market structures, and cost structures. But the characteristics specific to each financial market do not necessarily insulate the markets from external influences occurring in other markets. To the extent that external occurrences also affect internal economic conditions, the domestic and foreign markets may be said to be integrated.

Background of the Study

The differences in timing of an economic entity's savings and investment behavior give rise to the creation of financial assets and liabilities. To meet an investment need for which it does not have ready capital, the economic entity can issue either equity or debt securities. In order for this economic entity to borrow or issue equity, some other economic entity must be willing to lend or provide capital. Such an economic entity would hold a financial asset because it had been able to accumulate savings in excess of its own investment needs. The determination of its willingness to hold a financial asset will depend on the perceived risk and expected return of the financial asset.

The interaction of the provider and user of funds can be either direct or indirect. A direct interaction between the user and the provider of funds occurs when savers purchase the securities issued by ultimate users of funds. Financial liabilities such as bonds, commercial papers, and equity securities would fall under this type of interaction. An indirect interaction between the user and the provider of funds involves a financial intermediary. Providers of funds can invest in the obligations of financial intermediaries, who in turn lend the funds to users of funds. Whereas in direct financing the provider of funds is confronted directly with the credit risk of the user of funds, in indirect financing a financial institution acting as the intermediary interjects itself between users and providers of funds.

The existence of financial intermediaries contributes to the formation of financial markets, the existence of which helps in the process of funds allocation. Financial intermediaries, by bringing together economic units to satisfy their savings-investment surplus or deficit needs in one market, enhance the efficient allocation of excess available funds. Funds are allocated only to those deficit units offering the highest investment return for the level of risk. This interaction of the savings-deficit unit, the savings-surplus unit, and a financial intermediary contributes to the determination of the interest rate. Although the allocation process is affected somewhat by capital rationing and government restrictions, interest rates are the primary mechanism whereby supply and demand are brought into balance for a particular instrument across financial markets (10).

The linking of the user and the provider of funds takes place not only in the domestic market, but also in the external financial markets. The interaction of users and providers of funds in foreign financial markets, however, is subject to the rules and institutional arrangements of the respective domestic markets. With the rapid growth of the Eurocurrency markets, the transition to floating exchange rates, the imposition and removal of flow of funds control programs (such as the Voluntary Restraint Program and the Interest Equalization Tax), and the increasing amount of capital flow movements, the question of the relationship of financial markets to each other has been raised. This question has led to studies on the integration of financial markets, which have mainly been focused in two directions: integration via interest rates and integration via capital movements. The next section of this chapter summarizes the research done on the issue of financial market integration.

Literature Review

Studies on financial market integration have focused mainly on the relationships between domestic and foreign financial markets. The studies employed capital flows and interest rate relationships as measures of integration. The remaining parts of this section provide a discussion of the studies undertaken.

Capital Flows as a Measure of Integration

The rationale behind the use of capital flows as a measure of financial market integration is that, as interest rates in different countries change in response to monetary policy, capital will flow among the countries. The greater the sensitivity of capital flows to interest rate differentials and the greater the magnitude of those flows, the lower the degree of a country's independence (88). The studies employing capital flow measurements involve two dimensions--magnitude and time lag adjustment.

Magnitude of capital movements.--Numerous studies have attempted to measure the sensitivity of capital flows to changes in interest rates between countries (90, 84, 68, 4, 89). A 1 percentage point covered interest differential in favor of the United States[1] is estimated to have induced inward capital movements from as low as \$210 million to as high as \$1.25 billion over a six-month period. The estimates vary depending on the time period studied and the interest rates involved. Table 1 provides a brief summary of the studies undertaken, all of which were conducted using regression analysis.

Explanations for the varying estimates have also been attempted. Stein (68) suggests that the inconsistency arises from the nonindependence of the independent variable--the covered interest differential--from the disturbance term. Moreover, the existence of speculative pressure confounds the interest rate-induced movements. Floyd (34) suggests that the relationship between interest rates and capital movements is a simultaneous one. Interest rates

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[1]Interest rates are said to be covered when the exchange rate risk inherent in any transaction involving two different currencies is eliminated by means of a forward exchange contract. Such contracts are bought or sold for future delivery against payment on delivery in national currency at a prearranged exchange rate. A covered interest differential is said to be "in favor of the United States" when the United States interest rate is higher than the foreign interest rate after adjustment is made for the foreign exchange risk via a forward exchange contract.

TABLE 1.--Studies on capital movements in response to interest rate changes

	Period	Data	Results
Bell (1962)	1959-61	Short-term claims on foreigners and covered interest rate differentials (monthly and quarterly)	A 1 percentage point increase in the United States interest rate induces:
		(1) United Kingdom	(1) Total movement of about $175 million.
		(2) Canada	(2) No effect.
Kenen (1963)	1959-61	Short-term capital flows and interest rate differentials (quarterly data) for the United States and United Kingdom	A 1 percentage point increase in the United Kingdom interest rate reduces inflows of $260 million per quarter
Stein (1965)	1958-62	Private foreign short-term capital and United States-United Kingdom Treasury bill rate differentials (monthly data)	A 1 percentage point increase in the United Kingdom interest rate induces:
		(1) no speculative flows	(1) Net inflow reduction of $462 million per year.
		(2) speculative flows	(2) Net inflow reduction of $2.5 billion per year
Branson (1968)	1959-64	Short-term claims on, and liabilities to foreigners and Treasury bill rate differentials	A 1 percentage point increase in the United States interest rate induces
		(1) United States-Canada	(1) Increase of $449 million in foreign deposits over a six-month period.
		(2) United States-Eurodollar	(2) Reduction in claims on foreigners of $210 million over a six-month period.

TABLE 1.--Continued

	Period	Data	Results
Miller and Whitman (1970)	1957-66	Long-term portfolio private capital in the United States and	
		(1) corporate bond yields in the United States and ten other countries	A 1 percentage point increase in the United States rate results in a one-time adjustment of $1,073 billion and a continuing flow of $21 million for each succeeding quarter.
		(2) government bond yields in the United States and ten other countries	A 1 percentage point increase in the foreign interest rate induces a one-time adjustment of $912 million and a continuous flow of $18 million for each succeeding quarter.
Branson and Willett (1972)	1960-64	United States short-term claims and Treasury bill rates of United States, United Kingdom, and Canada	A 1 percentage point increase in the United States interest rate induces a reduction in the outstanding stock of short-term claims on foreigners of about $300-$400 million in three quarters, and a reduction in subsequent flows of about $20-$30 million per year.

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have an influence only insofar as they determine investments. Therefore, the relationship is also an indirect one.

Using the magnitude of capital movements to measure financial integration does not provide a clear explanation of the effect capital flows have on the countries involved. Supposedly, capital movements will equate the marginal benefit of a dollar in the United States to the marginal benefit of a dollar in a foreign country. However, the length of time required for capital movements to induce interest rate equilibrium was not considered. Furthermore, the approach does not directly confront the issue of what ultimately happens in the countries involved (88).

Time lag of capital flow adjustment.--Investigating the speed at which capital movements react to interest rate differentials follows basically the same rationale as the measurement of the magnitude of capital movements discussed above. The speed of capital movements provides, however, an additional dimension. It suggests a direct measure of the degree of sensitivity that magnitude of capital movements does not provide.

Miller and Whitman (89) found that one-third of the adjustment between the desired level of foreign asset holdings and the actual level existing at the beginning of the period takes place within one quarter. Branson and Willett (78) found the same time lag using Treasury bill rates and short-term claims on foreigners.

Hendershott (45) used supply and demand schedules of the Eurodollar deposit and loan markets to study the relationship between the United States Treasury bill rates and Eurodollar rates. It is posited that the increase in the United States Treasury bill rate will shift the equilibrium Eurodollar deposit rate in the same direction immediately, but the market Eurodollar deposit rate is expected to respond to the higher equilibrium rate only over time due to the gradual shift of the existing demand and supply schedules. The relationship was empirically tested with monthly data from 1957 to 1964. The findings are: (1) the Eurodollar rate will increase by .14 percentage point during the current month in response to a 1 percentage point rise in the mean United States rate; (2) the monthly speed of adjustment is .131 percentage point, implying that adjustment takes about a year; and (3) changes in the United States Treasury bill rates have a geometrically declining impact on Eurodollar deposit rates.

Kwack (55) extended Hendershott's study by including three European interest rates (namely, the Frankfurt interbank loan rate and the Canadian and United Kingdom three-month Treasury bill rates) as determinants of Eurodollar deposit rates. Kwack estimated that a period of twelve quarters is required for a 1 percentage point change in Eurodollar rates in response to a 1 percentage point rise in United States Treasury bill rates. One problem with the study is that foreign interest rates may also be influenced by United States Treasury bill rates and, hence, multicollinearity may exist among the variables.

In the Hendershott and Kwack studies, the direction of the relationship was from the United States and/or foreign interest rates to the Eurodollar market. This same approach was taken by Mills (97) and Argy and Hodjera (23). The latter studies were different, however, in that Mills included Regulation Q, the reserve requirement, forward premiums, and the quantity of certificates of deposit as explanatory variables, whereas Argy and Rodjera included only Regulation Q.

The studies undertaken by Hendershott and Kwack proceeded one step further than the previous capital movement studies. They examined the ultimate effect in one market due to interest rate changes in the other markets. This was done by an analysis of demand and supply adjustments to interest rate changes.

Interest Rates as a Measure of Integration

Interest rates can be used to measure how two or more financial markets are connected. The logic supporting the use of interest rates as a measure of integration is that as the interest rate level in one country changes, other countries will be affected in several ways. First, capital may flow in reaction to higher or lower interest rates. The greater the sensitivity of capital flows to interest rate changes, the less independent a country is in pursuing its economic goals. This point has been discussed in the previous section. Second, exchange rates may adjust to counteract the effects of higher costs of trade and capital. This reaction to interest rate changes is discussed in the interest rate parity theory section that follows. Third, interest rates themselves may adjust in reaction to an external interest rate change. This occurrence is discussed under the section on the convergence and covariation of interest rates.

Interest rate parity theory.--Under the interest rate parity theory, interest rate differentials on assets of comparable risk are related to the forward premium or discount on one of the two currencies of asset denominations compared to the other. If the interest rate parity theory holds and international currency markets are efficient, the return on a domestic investment and the return on a hedged[2] foreign investment should be the same.

If financial markets are integrated, a rise in the interest rate differential in favor of one country will induce the movement of arbitrage funds, which will have the effect of increasing/reducing the forward discount/premium[3] on the domestic currency (23). The greater the sensitivity of arbitrage funds to changes in the interest rate differentials, the more integrated the financial markets involved may be.

Studies by Stoll (70), and by Kesselman (51) indicate that the forward premium adjusts by about 80 to 100 percent of the change in the uncovered interest rate differential. This finding implies that

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[2]Hedging is defined as buying or selling forward currency so as to eliminate or exchange risk due to (a) normal international commercial transactions or (b) foreign investment of short-term capital funds (9).

[3]A forward premium/discount exists if the forward exchange rate of a domestic currency is greater/less than the spot exchange rate of the currency.

a change in the uncovered interest differential is impacted in the forward rate via the forward market. However, it is argued that induced capital flows partially offset the initial change in interest rates. Hence, the full impact of the interest rate change is not shown in the forward rate.

To account for the effect of induced capital flows, Caves and Reuber (5) set up simultaneous equations determining forward and spot exchange rates and the uncovered interest rate differential. The result of the study was contrary to the assertion of the interest rate parity theory.

Researchers have tried to provide explanations for such deviations of empirical data from the interest rate parity theory. Table 2 summarizes the explanations as set forth by each researcher and the outcome of studies undertaken.

The interest rate parity theory was found to hold true only in the Eurocurrency markets. This is not surprising, as the assumptions of the theory are satisfied in such market environments.

<u>Convergence of interest rates</u>. The second interest rate approach to the study of financial market integration focuses on the convergence of interest rates. The less the divergence among interest rates, the greater the degree of integration will be.

Investigations undertaken with this approach (79, 80, 23) mainly employ standard deviations and coefficients of variation of average domestic interest rates. Countries examined included the United States, Canada, European countries and Japan. Generally, the

TABLE 2.--Studies on interest rate parity theory

	Explanation	Findings of the Study
1. Einzig (1967) Sohmen (1963 Canterberry (1969)	Institutional constraints on the availability of arbitrage funds	(No empirical study undertaken)
2. Branson (1969)	Transactions costs.	The spread between the forward premium/discount and the interest rate differential must exceed 0.18% per year in order to stimulate the movement of arbitrage funds. Data used were U.S., U.K., and Canadian Treasury bill rates and forward premium/discount.
3. Prachowny (1970)	Capital market imperfections.	Adjusted for transactions costs and differential borrowing and investing rates, found no profitable arbitrage opportunites exist between New York and London.
4. Stoll (1972)	Speculative expectations.	(No empirical study undertaken.)
5. Kaen (1972)	(No explanation provided.)	IRPT was found to hold with analysis of Eurocurrency rates and their respective forward premium/discount.
6. Aliber (1973)	Interest rates used in previous studies were of different risk levels.	Used rates on dollar-denominated securities issued in London and pound-denominated securities issued in Paris and similar other securities. Results supported the IRPT.
7. Minot (1974)	Interest rates used in previous studies were of different risk levels.	Used Eurodollars and Euro-sterling deposit rates and results supported the IRPT.
8. Frenkel and Levich (1975)	Transactions costs, demand and supply elasticities in various markets, and lags in executing arbitrage.	Using dollar-donominated and sterling-denominated securities and adjusting for transactions costs, found the IRPT to hold
9. Agmon and Bronfeld (1975)	Errors in measurements and inaccurate definitions.	Applying a trading model for covered arbitrage transactions to the Eurocurrencies, supported the IRPT.
10. Adler and Dumas (1976)	Existence of risks and the associated costs of default.	(No empirical study undertaken.)
11. Marston (1976)	Governmental restrictions on short-term capital movements and risks in shifting funds between markets.	Using Euro-sterling, Euro-swiss francs, and Euro-deutsche mark, found support for the IPRT.

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studies found no downward trend in the spread of interest rates from the mean rate.

Minot (60) conducted his study by dividing his tests into a nominal hypothesis and a real hypothesis. For the nominal hypothesis, Minot uses monthly averages of call money rates in the United Kingdom, Belgium, France, West Germany, and the Netherlands as his sample. The nominal hypothesis of convergence was not rejected using the variance calculated based on Model II testing. For the real hypothesis, Minot adjusted monthly averages of call money rates with the forward difference (exchange rate expectation) and the inflation rate. The analysis of the adjusted call money rates would seem to indicate that the convergence of nominal rates is largely due to the convergence of exchange rate expectations and inflation rates.

This approach is not without its problems. The use of average rates may obscure the behavior of interest rates. Moreover, the interest rates may be affected by inflation rates, exchange rate expectations, and other factors, as Minot pointed out in his study. The use of this approach, therefore, requires careful consideration of influencing factors to arrive at the appropriate interest rates for the analysis.

Covariation of interest rates. The third approach emphasizes interest rate covariability. This view implies that prices of financial assets in particular countries move together, but does not require similarity of actual interest rate levels. The approach is not so much concerned with the absolute level of interest rates as with changes and the extent to which changes occur in several countries at one time.

A major study using this approach was undertaken by Logue, Salant, and Sweeney (88). Logue et al., applied factor analysis to quarterly interest rates on medium- to long-term government bonds in seven countries of the Organization for Economic Cooperation and Development (OECD) for 1958-1973. A single market factor--interpreted as the international marginal monetary productivity of capital--was found to explain 82 percent of the variance in the level of interest rates in the fixed exchange rate period of 1958-1971 and 85 percent of the variance in the combined fixed/floating exchange rate period of 1958-1973. With first differences and percentage changes, two factors explained the variance. The first factor accounted for 38-41 percent of the variance, while the second factor showed the influences of variations in four "Germanic" countries (West Germany, the Netherlands, Switzerland and Sweden) versus variations in the United States, United Kingdom and France.

In the view of Logue et al., the international mobility of information would suffice to align national interest rates. There would be no capital flow, no effect on the exchange rate, and no change in the trade balance, even in the short run. The anticipation of arbitrage would be enough to alter the prices of capital assets, achieving long-run portfolio balance without any flow of securities (84).

It was argued, however, that the results obtained by Logue et al., could be interpreted to show that interest rates in those financial markets have responded to events that had impinged more or less simultaneously on all asset markets; e.g., expectations in inflation rates and exchange rate changes (84). It might, therefore, be more accurate if integration were assessed after making every feasible allowance for the influence of common causes.

Moreover, Hodjera (82) argued that the results on interest rate levels obtained by Logue et al., should be discounted, since the use of interest rate levels is open to a high degree of first order serial correlation that may give rise to spurious inferences about the cause of common movement. Therefore, the percentage changes in interest rates should be emphasized. Since the percentage of variance explained by the first factor is about 40 percent, the study suggested a degree of financial integration that is far from perfect.

Summary

The differences in timing of an economic entity's savings and investment behavior give rise to the creation of financial assets and liabilities. To meet an investment need for which it does not have ready capital, the savings-deficit unit issues a financial liability. The savings-surplus unit, because it has been able to accumulate savings in excess of its own investment needs, would hold a financial asset.

The interaction of savings-surplus and savings-deficit units can be direct or indirect. A direct interaction occurs when savers purchase the securities issued by ultimate users of funds. An indirect interaction involves a financial intermediary. Providers of funds invest in the obligations of financial intermediaries, who in turn lend the funds to users of funds. The interaction of the provider of funds, the user of funds, and the financial intermediary is an essential ingredient to the determination of the interest rate.

The interaction of economic entities takes place not only in the domestic market but also in the external financial markets. The rapid growth of the Eurocurrency markets, the transitions in the international monetary system, and the use of funds control programs by countries have brought to attention the question of financial market integration. This question has been studied by numerous researchers using either capital movments or interest rates as their approach to the question. The literature review provides a brief summary of the studies.

The current study will use interest rates to study financial market integration. Interest rates will be employed to define the extent to which markets are connected. The extent of the connection determines the degree to which participants in any financial market are able and obliged to take notice of events occurring in other markets.

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CHAPTER II

THEORETICAL CONSIDERATIONS

This study examines the integration of international financial markets using interest rate relationships as a measure. The findings of the study will have both microeconomic and macroeconomic decision-making implications. If it is found that lead-lag structures characterize the linkage of the financial markets, then a method will be demonstrated that will enable the decision maker to utilize the existing relationships.

The approach employed in the study will differ from those used in previous studies in that the influences of exchange rate expectations and inflation rates will be taken into account. Since domestic factors give rise to varying levels of interest rates, the study will not be concerned with convergence of interest rate levels. The main focus will be on the linkage of financial markets via lead-lag structures. By investigating lead-lag relationships, the study will not be concerned with convergence of interest rate levels. The main focus will be on the linkage of financial markets via lead-lag structures. By investigating lead-lag relationships, the study intends to show the extent of the influence of: (a) information on interest rate changes; (b) action to arbitrage interest rate changes; and (c) the possibility of arbitrage activity to counteract interest rate changes. The study will directly measure the relationship of one interest rate series to another by examining the speed of adjustment of interest rates in one market in response to interest rate changes in another market.

However, the interest rate series that form the sample of the study are affected by factors such as monetary and fiscal policies, exchange rate changes, and others. The influence of these factors necessitates that they be taken into account in the investigation. The remaining parts of this chapter discuss the relevant factors of the study. Particularly, the interest rate theory of exchange rate expectation, the interest rate parity theory, and the relative purchasing power parity theory are discussed. These three theories form the basis of the adjustment of the data employed in the study.

Factors Relevant to the Study

Financial markets are continually affected by internal and external factors. Such factors alter the financial markets' equilibrium positions, thereby possibly requiring very rapid adjustments to once again attain equilibrium.

Internal factors include the monetary and fiscal policies of the government, the employment and wage level conditions, the income level, changes in investors' preferences, and so on. External factors include the level of international trade and movements, the level of foreign interest rates, the level of relative foreign exchange rates, and the relative price level.

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Because the study will focus on the influence of domestic interest rate changes on foreign interest rates, it is necessary to account for numerous influences on foreign interest rates, including the external factors mentioned above. To the extent that trade flows and movements arise from differences in price levels and exchange rates, their influence on interest rate changes would be reflected in the adjustment for differential exchange rates and price levels. The study will, therefore, only adjust for differential exchange rates and differential general price levels. The theoretical considerations underlying the adjustment for price levels are discussed under the relative purchasing power parity theory, and those underlying differential exchange rates are expounded by the interest rate theory of exchange rate expectations and the interest rate parity theory.

Expected Price Level Change

The term purchasing power parity can be applied to a number of related but quite different interpretations within international trade theory. The first interpretation is a dogmatic one in which some ratio of prices will *exactly* determine the equilibrium exchange rate. The second variation on the theory claims that relative price change is the only variable of *any* importance in determining exchange rates. The third and most general interpretation assigns price change as the primary determinant of the exchange rate but also allows for important secondary factors such as tariffs and other trade hindrances, transport costs, capital flows, and expectations (37).

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Purchasing power parity as used in this study refers to the second interpretation. This variation of the theory is known as the relative purchasing power parity theory.

According to this theory, the difference between the rates of price inflation of two currencies tends over time to equal the rate of change of the exchange rate between the currencies. This theory premises that because international trade must equalize prices for equivalent goods in different countries, different rates of price changes must eventually induce offsetting exchange rate changes in order to restore approximate price equality (40).

The relative purchasing power parity theory further implies that the effects of differential inflation rates are reflected in the changes in the exchange rate. This follows from the notion that if the price level in one country rises at a rate greater than that of a trading partner, commodity arbitrage will act to alter the exchange rate such that relative price parity is restored. Thus, a rise in United States prices will reduce the domestic purchasing power of the dollar, which will, in turn, increase the demand for lower-priced foreign goods and assets. Finally, this increased demand will depreciate the dollar relative to the foreign currency. The incentive to increase demand for foreign goods will subside only when the dollar has depreciated by an amount equal to the decline in its domestic purchasing power, assuming foreign currency prices are unchanged (49).

The relationship posited by the relative purchasing power parity theory can be presented in the following way:

$$\frac{r_{t+n} - r_t}{r_t} = \frac{P_{d,t+n},/P_{f,t+n} - P_{d,t}/P_{f,t}}{P_{d,t}/P_{f,t}} \tag{1}$$

where r_{t+n}, r_t are the exchange rates in domestic currency per foreign currency unit at times t+n and t, respectively, and $P_{d,t+n}$, $P_{f,t+n}$, $P_{d,t}$, and $P_{f,t}$ are the price indices of the domestic and foreign countries at times t+n and t, respectively. In order to express the relative purchasing power parity theory in terms of inflation rates, let $\Delta P_{d,t}$ and $\Delta P_{f,t}$ be the rates of change of the price level in the domestic and foreign countries, respectively. Then it follows that

$$P_{d,t+n} = P_{d,t}\ (1 + \Delta P_{d,t}) \tag{2}$$

and

$$P_{f,t+n} = P_{f,t}\ (1 + \Delta P_{f,t}). \tag{3}$$

If foreign and domestic prices are equal at times t and t+n, then

$$P_{d,t} = r_t\ P_{f,t} \tag{4}$$

and

$$P_{d,t+n} = r_{t+n}\ P_{f,t+n} \tag{5}$$

Substituting (2), (3) and (4) into (5) gives

$$P_{d,t}\ (1 + \Delta P_{d,t}) = P_{f,t}\ (1 + \Delta P_{f,t})\ r_{t+n}$$

$$= \frac{P_{d,t}}{r_t}\ (1 + \Delta P_{f,t})\ r_{t+n}. \qquad (6)$$

Therefore,

$$\frac{(1 + \Delta P_{d,t})}{(1 + \Delta P_{f,t})} = \frac{r_{t+n}}{r_t}. \qquad (7)$$

Substracting one from both sides of equation (7) gives

$$\frac{\Delta P_{d,t} - \Delta P_{f,t}}{(1 + \Delta P_{f,t})} = \frac{r_{t+n} - r_t}{r_t} \qquad (8)$$

i.e., the relative price level change differential is equal to the rate of change in the exchange rate.

Empirical studies (24, 77, 37, 46, 73) have provided support for the relative purchasing power parity theory as it is interpreted in this study. It is generally accepted, however, that disturbances in income levels, capital flows, and seasonal factors have a significant short-term effect on exchange rates and thus weaken the fit of exchange rates on relative price levels (46, 73, 47, 37, 77). The theory is tested on wholesale price index and foreign exchange data obtained from the <u>OECD Economic Indicators</u> and the <u>IMF International Financial Statistics</u>. The data is found to exhibit deviations from the relative purchasing power parity theory, especially in the short run. A longer period of time is required for forces of adjustment to produce a close relationship between exchange rates and price levels (47). Nevertheless, following research by Giddy (40), Levich (95), Hodgson and Phelps (47), the relative purchasing power parity theory is assumed to be valid for the countries and the time period considered in this study. Since the exchange rate change is equal to the price level differential, the foreign interest rate series will be adjusted for the exchange rate change only.

Expected Exchange Rate Change

When interest rates on two comparable investments differ, arbitrageurs attempt to eliminate the rate difference by moving funds from the lower-yielding security to the higher-yielding security. In transactions involving different currencies, such interest rate arbitrage is complicated by the possibility of an unfavorable change in the exchange rate during the investment period. Such a change could make it more expensive to repurchase the domestic currency, thereby reducing the gain from the initial shifting of funds. As a result, investors will not transfer funds into other currency-denominated security to take advantage of interest rate differentials without protecting themselves against an unfavorable shift in exchange rates. The interest rate differential will equal zero only if the exchange rate is expected to change such that the advantage of the higher interest rate is offset by the loss on the foreign exchange transactions.

The equality of the interest rate differential and the expected exchange rate change is facilitated by covered interest arbitrage. Covered interest arbitage is an opportunity to make a profit from different effective rates of interest in different currencies after taking hedging costs into account (6). It involves the rapid movement of funds between securities denominated in different currencies in order to obtain a higher interest return with no loss on foreign exchange. Hedging costs in this context refer to the cost of the forward cover.

The following condition holds in equilibrium:

Value at t+n of domestic currenty earning interest rate i_d	=	Value at t+n of domestic currency converted into foreign currency at time t at a spot exchange rate[1] denoted r_t, invested to earn interest rate i_f until t+n when it is converted back to the domestic currency at spot exchange rate $E(t_{t+n})$.

where i_d is the domestic interest rate, i_f the foreign interest rate, and $E(r_{t+n})$ the exchange rate expected to prevail at time t+n.

This condition can be demonstrated with the hypothetical case of a United States investor who possesses one dollar for investment, with two alternatives available. The investor can invest in domestic securities and earn interest rate i_d. Or, the investor can convert the one dollar to a foreign currency at the spot exchange

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[1]The spot exchange rate is the cost of one unit of foreign currency, in terms of domestic currency, for delivery on the following day.

rate r_t, invest in foreign securities, earn interest rate i_f, and, upon maturity, convert the investment into United States dollars at the expected exchange rate $E(t_{t+n})$. At equilibrium, the investor should obtain the same return from either investment. The equilibrium condition can be represented by

$$\$1\ (1 + i_d) = \frac{1}{r_t}\ (1 + i_f)\ E(r_{t+n}) \tag{9}$$

$$\frac{(1 + i_d)}{(1 + i_f)} = \frac{E(r_{t+n})}{r_t}. \tag{10}$$

Subtracting one from both sides of equation (10) gives

$$\frac{i_d - i_f}{1 + i_f} = \frac{E(r_{t+n}) - r_t}{r_t}\ ; \tag{11}$$

i.e., the interest rate differential is equal to the expected rate of change in the exchange rate. The relationship is called the <u>interest rate theory of exchange rate expectation</u>. Note that this relationship is an <u>ex ante</u> relationship because the value of the expected exchange rate is unknown. It is necessary then to find a proxy for this unknown.

The expected exchange rate can be represented by the forward rate on the currency. This is not an unreasonable surrogate based on the efficiency argument of the foreign exchange market (35, 56, 87, 41). Studies by Frenkel (35), Kohlhagen (53), Kaserman (93), Levich (95) have shown that the forward rate is a predictor of the future spot exchange rate.[2]

Hence, equation (11) can be modified as

$$\frac{i_d - i_f}{1 + i_f} = \frac{r_f - r_t}{r_t} \tag{12}$$

where r_f is the forward exchange rate. Equation (12) also implies that the interest rate differential is equal to the forward premium/discount. A forward premium/discount exists if the forward exchange rate of a domestic currency is greater/less than the spot exchange rate of the currency. This means that more/less units of the domestic currency are required to obtain a unit of the foreign currency. Equation (12) summarizes the rationale for the <u>interest rate parity theory</u>, which reflects an actual, <u>ex post</u>, arbitraged relationship in the market.

At a point in time then, it can be assumed that an investor contemplating the transfer of funds for investment in securities denominated in another currency will consider not only the yields of the security, but also the foreign exchange risk assumed by investing in a foreign security. The assumption, of course, is that the investor intends to convert the foreign investment back to the domestic currency. A method of assuring the return of his investment

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[2]The relationship of the forward exchange rate and the future spot exchange rate is discussed in Appendix A. A test of the relationship is undertaken to determine the appropriateness of the forward exchange rate as a proxy for the future spot exchange rate.

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with the least exchange rate risk is through the purchase of a forward contract.

Depending on the length of maturity and holding period of the foreign investment, the investor may select the same maturity or holding period for the forward contract. Hence, a three-month holding period for an investment in United Kingdom local authority paper may be hedged by a three-month forward contract. By adjusting for expected exchange rate changes, the adjusted interest rate will appropriately restate the yield to be earned from foreign investments. For instance, a United States investor who purchases Swiss francs to invest in 4 percent Swiss franc commercial papers will actually realize a 12 percent return if, during the investment period, the Swiss franc appreciated 8 percent in relation to the United States dollar.

Empirical studies on the interest rate parity theory have generally found support for the theory. A detailed discussion of the studies undertaken can be found in Chapter I.

Summary

In this chapter, the study of interest rates as the measure of financial market integration is set forth. In order to study the relationships between the United States and foreign interest rates, it is necessary to account for the factors influencing financial markets' equilibrium. Specifically, external factors, such as the level of international trade and movements, the level of foreign exchange rates, and the relative price level, must be included in an analysis of interest rate relationships.

To the extent that international trade and movements arose from differences in exchange rates and price levels, the former's influence would have been reflected in the adjustments for differential inflation rates and exchange rates. To adjust for the latter two factors, two theories were discussed. These are the relative purchasing power parity theory and the interest rate parity theory.

The relative purchasing power parity theory states that the difference between the inflation rates of two currencies tends over time to equal the rate of change of the exchange rate between the currencies. Since the exchange rate change is equal to the inflation rate differential, the interest rate series will only be adjusted for the exchange rate change.

According to the interest rate parity theory, the interest rate differential between two comparable securities denominated in different currencies will be equal to the premium/discount on the exchange rate as reflected in the forward rate. The action of covered interest arbitrage is essential for the theory to hold. Hence, an investor can eliminate the exchange risk assumed by investing in a foreign currency-denominated security through the purchase of a forward contract. The concepts behind the interest rate parity theory are employed to adjust interest rates to account for foreign exchange rate changes.

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CHAPTER III

RESEARCH HYPOTHESES AND DESIGN

This chapter sets forth the hypotheses that will be tested together with the procedures that are applied to the sample data. Particularly, a description of the sample and time period will be provided. The concepts underlying the relative purchasing power parity theory and the interest rate parity theory will be used to adjust the interest rate series under investigation. The procedures for the adjustments of the sample will be detailed. And finally, the methodology employed in the analysis of the sample and test of hypotheses will be considered.

Research Hypotheses

The objective of the research study can be embodied in one major hypothesis: that there is high comovement of United States and foreign interest rates. That is, any change in the United States interest rate will be instantaneously disseminated to foreign and international financial markets.[1] This hypothesis applies to both the short-term and long-term financial markets.

[1]A foreign financial market refers to a country's financial market (such as the Canadian financial market), while an international financial market encompasses the Eurocurrency market. In the case of this study, the only Eurocurrency market considered is the Eurodollar market.

The nonrejection of the hypothesis will imply that changes in the United States interest rate are immediately incorporated into changes in foreign adjusted interest rates, implying that changes in interest rates are very closely, if not simultaneously, effected in the financial markets. This result will support the contention that financial markets are integrated. In addition, the nonrejection of the hypothesis will indirectly corroborate the findings under the interest rate parity theory. The integration of financial markets as measured by comovement of interest rates enables the quick adjustment of either interest rates or foreign exchange rates such that the interest rate parity is obtained. If, for instance, the United States interest rate is higher than the West German investment return after adjusting for a complete turnaround transaction, this will induce either the West German interest rate, the forward exchange rate, or the spot exchange rate to change in reaction to activities by arbitrageurs and speculators. Either one or a combination of these rates can change to attain interest rate parity.

The nonrejection of the hypothesis will also refute the studies on convergence of interest rates. These studies showed the lack of any trend toward convergence. Furthermore, the findings that interest rates are adjusting instantaneously to one another will provide support for the Logue et al., covariation study.

The rejection of the hypothesis will suggest that there is some lead-lag structure characterizing interest rate relationships. It will indicate that changes in the domestic interest rate may be used to predict or may be predicted by changes in the foreign interest rate. There will then exist opportunities for investor-arbitrageurs and speculator-arbitrageurs to take advantage of interest rate differentials. For firms considering the foreign financial market as a source of financing, this suggests that the constant monitoring of interest rates may enable the firm to lower its financial costs.

Research Design

Sample

The sample for this study will consist of short-term and long-term interest rates recorded at weekly intervals. Short-term interest rates include the three-month United States Treasury bill rate, three-month Eurodollar rate, three-month Canadian finance paper rate, and five three-month European interbank loan rates (West Germany, France, the Netherlands, Switzerland, and the United Kingdom). Long-term interest rates will consist of United States government bond yield, Canadian long-term government bond yield, West German long-term public authority loan rate, French long-term public sector bond yield, Dutch long-term government loan rate, Swiss long-term confederation bond yield, and British government 3½ percent war loan yield.

Data Source

Foreign interest rates and exchange rate data were obtained from the compiled series H.13 of the Board of Governors of the

Federal Reserve System International Finance Section. United States interest rates were obtained from data series compiled by the Government Finance Section of the Board of Governors of the Federal Reserve System. The source for six-month and one-year forward premiums/ discounts was the Harris Bank data file.

Time Period

The time period of the study is primarily from 1971-1978. Since data for certain foreign interest rates is not available prior to 1975, the analysis of weekly short-term interest rates (with the exception of the Eurodollar rate, the West German interbank loan rate, and the Canadian finance paper rate) will be limited to the time period starting 1975. For the three exceptions and the weekly long-term interest rates, the time period will be subdivided into three periods: 1971-1972, 1973-1975, and 1975-1978. This is done for several reasons: (1) to examine the stability of the relationships over major foreign exchange rate cycles; (2) to ensure that covariance stationarity (a basic assumption underlying time series analysis) is satisfied; and (3) to account for possible significant parameter shifts in the time series under study.

The first period, 1971-1972, is the period surrounding the August 15, 1971, announcement by the President of the United States regarding policy measures aimed at bringing about the devaluation of the dollar in relation to major Western European currencies and the Japanese yen. At the same time, the United States devaluated the dollar by 8 percent. In December, 1971, the Smithsonian

Agreement expanded the band of currency fluctuation to 4½ percent. The agreement also enabled the European Economic Community (EEC) to implement its own scheme for monetary union: the European Joint Float in which EEC countries agreed that the rates for their respective currencies would not diverge from one another by more than 2¼ percent. This narrower band became known as the "snake" inside the Smithsonian "tunnel," the snake being comprised of six European currencies--the West German mark, Belgian franc, Dutch guilder, Danish kroner, Norwegian kroner, and Swedish kroner.

The second period, January, 1973 to April, 1975, is representative of wide fluctuations in exchange rates. Moreover, it includes the period preceding and following the collapse of the Bretton Woods system. In March, 1973, the currencies of a number of industrial nations were placed on a hybrid of fixed and floating exchange rates. The pound sterling, Japanese yen, Italian lira, Canadian dollar, Swiss franc, Austrian schilling, and the French franc were allowed to float on the market, with their exchange rates determined by demand and supply conditions. Since governments often intervened to smooth out these rate fluctuations, such floats are known as <u>managed floats</u>. During this period, the snake continued to exist although the membership changed over the years. A further major event in this time period was the OPEC oil price increases, which contributed to the wide fluctuations experienced in exchange rates.

The third period, May, 1975 to November, 1978, is characterized by relatively stable exchange rates. In January, 1978, the

International Monetary Fund met to formalize the present system of floating rates. The joint float of currencies of major European Industrial countries continued. This period is one of relative calm following adjustment to the existence of floating exchange rates and higher oil prices.

Data Adjustment Procedure

The adjustment procedures for both the short-term interest rates and the long-term interest rates follow basically the same approach. Using the underlying concept of the relative purchasing power parity theory that the inflation rate differential is equal to the rate of change in the exchange rate, the adjustment will focus on expected exchange rate changes only.

The adjustment procedure to be applied to the interest rate series is as follows:

1. Holding other things constant, an investor will have no preference for either a domestic or foreign investment if the returns from both investment are equal; i.e.,

$$(1 + i_d) = \frac{r_f}{r_t}(1 + i_f)$$

$$i_d = \frac{r_f}{r_t}(1 + i_f) - 1; \qquad (1)$$

where i_d = domestic interest rate,

i_f = foreign interest rate,

r_f = forward exchange rate in domestic currency per foreign currency unit,

r_t = spot exchange rate in domestic currency per foreign currency unit.

This equation is the same as equation (9) in Chapter II except that the expected exchange rate has been substituted by the forward exchange rate.

The forward exchange rate used in the adjustment procedure will be different for the short-term and the long-term interest rate series. In the case of the short-term interest rates, it is assumed that the holding period of the financial instruments will be the same as the term of the financial instrument--three months. Hence, the three-month forward exchange rate is used in adjusting the short-term interest rate series. In the case of the long-term interest rate series, three different holding periods will be considered--three months, six months, and one year. Because the holding periods assumed are not of the same length as the maturity of the financial instruments, the adjusted interest rates are effectively the holding-period returns. The purpose of considering three different holding periods is to determine whether there is any difference in the time structure relationships of interest rates due to the length of the holding period. Consequently, the forward exchange rates used in the adjustment procedure will be the respective rates corresponding to the length of the holding period.

2. A change in the left-hand side of equation (1) will cause a change in either the forward rate, the spot rate, or the foreign interest rate. If the interest rate parity theory and the hypothesis of instantaneous adjustment of interest rates hold, it is expected that the ultimate change in the right-hand side of equation (1) will become equivalent to the left-hand side of the equation. After the change, the right-hand side is designated as i_d*

$$i_d* = \frac{r_f}{r_t}(1 + i_f) - 1 \qquad (2)$$

Hence, the foreign interest rate is not directly used as an input in the analysis. It is adjusted, rather, by the quantity r_f/r_t = (1 + forward premium or discount) to form a new variable called i_d*. This variable is the holding-period return.

3. If the hypothesis of instantaneous adjustment of interest rates to one another holds, then the new rate i_d* should adjust immediately to any changes in the domestic interest rate i_d.

The above procedure will be applied to each foreign interest rate time series.

Methodology

This study aims to provide evidence to either support or refute the contention that financial markets are integrated. The issue is examined via the lead-lag structures involved in the adjustment of interest rates to one another. The examination of lead-lag structures can be done in either the frequency or the time domain. When examining leads and lags, however, it is far more straightforward to present the information in the time domain by means of the cross correlation function. While the cross correlation and cross spectral statistics contain equivalent amounts of information, the spectral approach presents the information in a fundamentally different and potentially misleading way (27). Hence, the main tool to be employed in the examination of lead-lag relationships is the cross correlation function. This technique has been successfully applied by Brick and Thompson (27), Price and Brick (64), Umstead (75), and Umstead and Bergstrom (76).

Two types of results may be anticipated from the cross correlation analysis. The first is that there exists no relationship between the interest rates, implying the independence of the interest rates from one another. This finding refutes the contention of financial market integration. The alternate result is that some relationship exists between the United States interest rate and the foreign adjusted interest rate, thereby implying that the financial markets are integrated. The finding of instantaneous adjustment should be qualified, however, by the fact that the sample for the study represents weekly data. Hence, instantaneous adjustment refers to adjustment within a one-week period. Moreover, integration of the financial markets may be of a strong or a weak degree. In either case, the relationship of the interest rates may be exploited via a transfer function. A transfer function in this study uses two time series, with the United States interest rate as the input series and the foreign interest rate as the output series. Because of the existing lead-lag structure characterizing the relationship between the two time series, the United States interest rate can be used in estimating and forecasting the foreign interest rate.

To determine whether the transfer function model performs better than the univariate model, the models are tested over an interval of 25, 30, and 45 weeks for the 1971-72, 1973-75, and 1975-78 periods, respectively. Each of the forecast intervals is equivalent to approximately one-fourth of the respective estimation periods.

A transfer function is considered acceptable if it is able to estimate and forecast better than a simple univariate model. Through the application of three statistics, it will be determined whether the transfer function characterizing the structural relationship between the two time series is preferred over the univariate model.

The study of the time domain relationship between interest rates will be performed employing the method developed by Box and Jenkins (3). Box and Jenkins propose a class of models and a strategy by which a particular model is chosen from this class according to the properties of the individual time series under study. The method of analysis is based on the time dependency in a given data series.

The time series can be represented by a general class of models which can be written as

$$\Phi_P(B^s)\phi_p(B)(1 - B)^d(1 - B^s)^D z_t = \delta + \theta_q(B)\Theta_Q(B^s)a_t \qquad (3)$$

where $\phi(B)$, $\Phi(B^s)$, $\theta(B)$, and $\Theta(B^s)$ are polynomial equations in B of degrees p, P, q, and Q, respectively. The time series is denoted by z_t which is stationary or can be induced to stationarity by some finite number of differencing. The backshift operator, B, implies that $Bz_t = z_{t-1}$. The amount of consecutive and seasonal differencing necessary to induce stationarity is represented by d and D, respectively, with s representing the length of the seasonal span. Examples of the seasonal span are twelve and four months for monthly data. The symbol δ is a deterministic trend constant and a_t represents independently and identically distributed random disturbances with mean zero and variance σ_a^2 (often referred to as "white noise"). This general model encompasses the autoregressive (AR) models, moving average (MA) models, mixed autoregressive-moving average (ARMA) models, the integrated form (ARIMA), and the seasonal form of the three types of models. Box and Jenkins prescribe a three-step iterative procedure based on identification, estimation, and diagnostic checking to derive time series models.

Each of the sample time series in the study will be subjected to the three-step procedure in order to determine the generating function of the specific time series. Each time series is transformed to a white noise series which is then cross correlated with the white noise residuals from another time series at various time lags. Insignificant cross correlations will indicate that there is no relationship between the two time series. A significant cross correlation at lag zero will imply that adjustment of the second series to changes in the first series is contemporaneous. Significant cross correlations at leads or lags other than zero will imply that one time series leads the other time series. A transfer function model can be constructed to characterize the structural relationships that underlie various time series. The model can then be used for forecasting and decision making.

The concept of a transfer function derives from the idea that variations in the independent,or input, variable "transfer" over into the variations in the dependent, or output, variable (44). A transfer function describes the dynamic response of an output variable to a change in the input variable. Influences other than the input variable are represented by the noise or disturbance.

The transfer function model can be stated in the form

$$Y_t = \nu(B)\ X_t + N_t, \tag{4}$$

where Y_t is the output variable, X_t is the input variable, $\nu(B)$ the dynamic response (impulse response) function, and N_t the noise or disturbance. This equation can be parsimoniously parameterized in the form

$$Y_t = \delta^{-1}(B)\ \omega(B)\ X_{t-b} + N_t, \tag{5}$$

where $\delta(B) = 1 - \delta_1 B - \ldots - \delta_r B^r$, $\omega(B) = \omega_0 - \omega_1 B - \ldots - \omega_s B^s$, and b is the delay parameter. Similar to univariate time series modeling, a requirement of transfer function modeling is stationary-ity in the time series which can be achieved by differencing. This will reduce the model to

$$y_t = \nu_0 x_t + \nu_1 x_{t-1} + \ldots + n_t, \tag{7}$$

where y_t is the Y_t series, x_t the X_t series, and n_t the N_t series differenced d times to induce stationarity with zero means.

In general, the technique involves the same three-step iterative procedure applied to univariate analysis.

A schematic illustration of the analysis to be applied to three-month United States Treasury bill rates and three-month United Kingdom interbank loan rates is shown in Figure 1.

After the derivation of the models characterizing each of the interest rate series, the models will be examined for their accuracy. The tests of accuracy are divided into two parts, namely, the univariate and the multivariate. The main tests involve three statistics:

1. Mean Squared Error

$$MSE = \frac{1}{n} \sum_{i=1}^{n} (\text{Forecast Value}_i - \text{Actual Value}_i)^2,$$

where n is the number of observations.

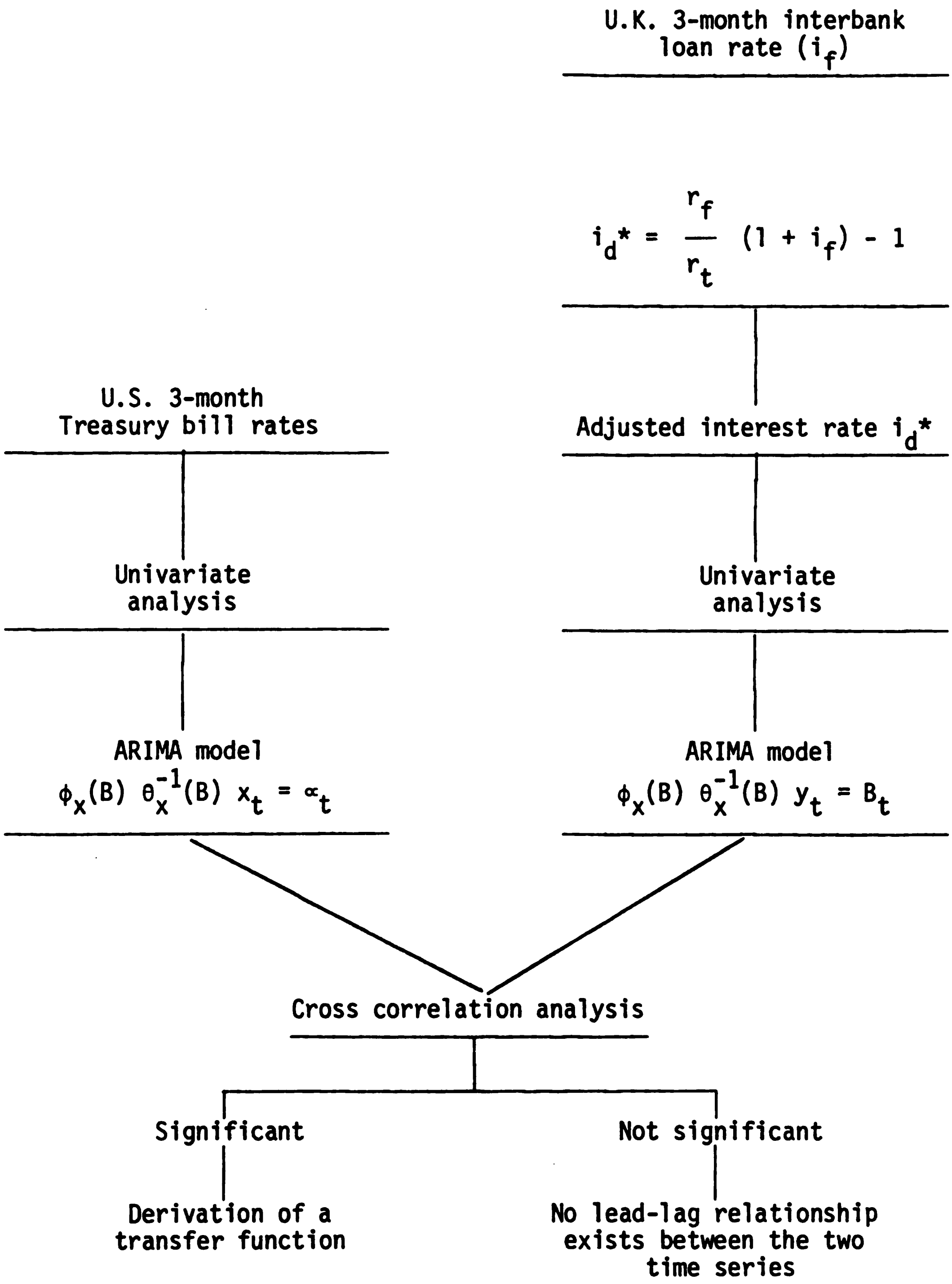

Figure 1.--A schematic illustration of the time series analysis (applied to U.S. three-month Treasury bill rates and U.K. three-month interbank loan rates).

2. Theil's U Coefficient

$$U = \frac{[\sum_{i=1}^{n} (\text{Forecast Value}_i - \text{Actual Value}_i)^2]^{\frac{1}{2}}}{[\sum_{i=1}^{n} (\text{actual Value}_i)^2]^{\frac{1}{2}}}$$

where n is the number of observations.

3. Variance of the Forecast Errors

a. Univariate Models

$$\text{var}\ [e_t(\ell)] = \sigma_a^2\ (1 + \Psi_1^2 + \Psi_2^2 + \ .\ .\ .\ + \Psi^2_{\ell-1})$$

where $e_t(\ell)$ is the error of the forecast $z_t(\ell)$ at lead time ℓ, σ_a^2 is the variance of the residuals, and Ψ's are the weights.

b. Multivariate Models

$$v(\ell) = \sigma_\alpha^2 \sum_{j=b}^{\ell-1} \nu_j^2 + \sigma_a^2 \sum_{j=0}^{\ell-1} \Psi_j^2$$

where σ_α^2 is the variance of the uncorrelated white noise series α_t obtained from a transformation of the input series x_t, σ_a^2 is the variance of the residuals, and the ν's and Ψ's are the weights.

In the evaluation of the accuracy of the univariate time series models, the Theil's U Coefficient is mainly used. The coefficient reaches its lower boundary of zero when there are perfect forecasts. It assumes the value of one when a forecasting model has the same standard error as the naive, no-change extrapolative model. The value will decrease monotonically as the forecasting model improves over the no-change model. If the coefficient is greater than one, the forecasting model should be rejected because it cannot beat the most simple no-change extrapolative model.

With respect to the multivariate time series models developed, the test of accuracy consists of three parts. As with the univariate tests, the first part involves the use of Theil's U Coefficient to determine whether the model can perform better than a simple no-change extrapolative model. The second part employs the mean squared error statistic to ascertain the benefit of adopting a multivariate forecasting model over a univariate model. The multivariate time series model is considered to be acceptable if the mean squared error of the forecast is lower than the same statistic in a univariate time series model when compared to the actual values. To reinforce the conclusions reached by examining the mean squared error statistic, the variance of the forecast errors is calculated. It is expected that the multivariate models will reduce the variance of forecast errors in a significant manner.

Summary

The major hypothesis of the study states that there is high comovement of United States and foreign adjusted interest rates. Instantaneous dissemination of any change in the United States interest rates to foreign and international financial markets is hypothesized for both short-term and long-term financial markets.

Short-term interest rates include the three-month United States Treasury bill rate, three-month Eurodollar rate, three-month Canadian finance paper rate, and five three-month European interbank loan rates (West Germany, France, the United Kingdom, the Netherlands, and Switzerland). Long-term interest rates consist of the government bond yields of the United States, Canada, the United Kingdom, West Germany, France, the Netherlands, and Switzerland.

The foreign interest rates were adjusted to incorporate the effects of exchange rate changes. A complete turnaround transaction was assumed to take place. That is, in order to invest in a foreign financial instrument, United States dollars were converted to a foreign currency which, upon maturity, were converted back to United States dollars. Hence, foreign interest rates were adjusted to reflect a complete transaction. In this sense, the adjusted foreign interest rates are holding-period returns.

The relationship of the United States interest rates to the adjusted foreign interest rates is examined over three time periods. These are 1971-72, 1973-75, and 1975-78. The time domain relationship between interest rates is examined employing the method developed by Box and Jenkins. A schematic illustration of the analysis was shown in Figure 1.

CHAPTER IV

SHORT-TERM INTEREST RATE RELATIONSHIPS

The main hypothesis of the study with respect to short-term interest rates is that there is high comovement between domestic and foreign adjusted interest rates. This hypothesis implies that foreign adjusted interest rates are expected to adjust instantaneously to changes in the United States short-term interest rate. This chapter determines the validity of this hypothesis by examining three-month United States interest rates in relation to those of the Eurodollar market, Canada, West Germany, the United Kingdom, the Netherlands, Switzerland, and France. The first section will discuss the univariate time series models characterizing the various interest rate series, followed by a discussion of the cross correlation relationships found. The analysis of the cross correlation relationships will determine whether a transfer function can be constructed to describe the interest rate relationships. This is presented in the third section. Finally, a summary of the findings is contained in the last section of this chapter.

Univariate Analysis

As set forth in Chapter III, the first step in the analysis of the time adjustment relationship is to determine the process underlying each individual time series. With the exception of the three-month United States Treasury bill rate and the three-month Eurodollar rate, the time series being examined have been adjusted according to the ideas underlying the interest rate theory of exchange rate expectation and the interest rate parity theory. That is, the nondollar interest rate series have been modified to account for exchange rate differentials. (This adjustment procedure was shown in Chapter III.)

The models resulting from the univariate analysis are shown in Table 3. All of the time series can be described as nonstationary, but are induced to stationarity by first differencing. In twelve of the seventeen time series studied, first differencing was sufficient to induce the time series not only to stationarity but also to white noise. These time series are described as random walk processes, which suggest that the observation in the previous period is the primary determinant of the realized value in the current period.

The Eurodollar time series did not exhibit a consistency in its behavior over the three subperiods under examination. The first subperiod, which encompasses a period of seventy-six weeks from January, 1971, to July, 1972, is characterized by a twenty-six week seasonality and a seasonal moving average parameter. The second and third subperiods, covering the weeks from January, 1973, to September, 1974, and from April, 1975 to January, 1978, respectively, can be described by autoregressive integrated models. Although the autoregressive parameters were statistically significant in both

TABLE 3.--Univariate time series models--short-term interest rates

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
1. United States three-month Treasury Bills	$z_t - z_{t-1} = a_t$	.185%
2. Three-month Eurodollar rate	$z_t - z_{t-1} - z_{t-26} + z_{t-27} = a_t - .582\ a_{t-26}$	.537
3. West German three-month interbank rate	$z_t - z_{t-1} = a_t$	.607
4. Canadian finance paper rate	$a_t - z_{t-1} = a_t$	.578
B. Period 2: January 5, 1973 - September 20, 1974 (n = 90)		
1. United States three-month Treasury Bills	$z_t - z_{t-1} = a_t$	.382
2. Three-month Eurodollar rate	$z_t - 1.304\ z_{t-1} + .304\ z_{t-2} = a_t$	.397
3. West German three-month interbank rate	$z_t - z_{t-1} = a_t$	.971
4. Canadian three-month finance paper rate	$z_t - 1.424\ z_{t-1} + .424\ z_{t-2} = a_t$	.296
5. United Kingdom three-month interbank rate*	$z_t - z_{t-1} = a_t$	.909

TABLE 3.--Continued

Series	Model	Standard Deviation of Residuals
C. Period 3: April 23, 1975 - January 27, 1978 (n = 145)		
1. United States three-month Treasury Bills	$z_t - z_{t-1} = a_t$	.151%
2. Three-month Eurodollar rate	$z_t - 1.244\ z_{t-1} + .244\ z_{t-2} = a_t$	.183
3. West German three-month interbank rate	$z_t - 1.213\ z_{t-1} + .213\ z_{t-2} = a_t$	.230
4. Canadian three-month finance paper rate	$z_t - z_{t-1} = a_t$	.254
5. United Kingdom three-month interbank rate	$z_t - z_{t-1} = a_t$	.693
6. French three-month interbank rate	$z_t - z_{t-1} = a_t$	.916
7. Dutch three-month interbank rate	$z_t - z_{t-1} = a_t$	.279
8. Swiss three-month interbank rate**	$z_t - z_{t-1} = a_t$	.220

*n = 76
**n = 127

cases, the magnitudes of the parameter values may be considered small such that the time series models are essentially "noisy" random walk models. The parameter values in the two models were found to be insignificantly different from each other, as shown in Table 4.

TABLE 4.--Comparison of ARIMA (1,1,0) models fitted to the second and third subperiods of the Eurodollar time series

Period	n	σ	$\lambda=1-\phi$	$\sigma(\lambda)$*		df
Second subperiod 1973-75	90	.304	.696	$\pm$.0485	33.9	35
Third subperiod 1975-78	145	.244	.756	$\pm$.0357	40.7	35

Note: Standard error of $\lambda^{(1)}-\lambda^{(2)} = \sqrt{(.0485)^2 + (.0357)^2}$

$= \pm\ .0602$

$\lambda^{(1)}-\lambda^{(2)} = .696 - .756 = -.06$

Therefore, there is no real change in λ.

$^*\sigma(\lambda) = \left(\frac{\lambda(1-\lambda)}{n}\right)^{\frac{1}{2}}$

1973-75: $\sigma(\lambda) = \left(\frac{.696(.304)}{90}\right)^{\frac{1}{2}} = \pm\ .0485$

1975-78: $\sigma(\lambda) = \left(\frac{.756(.244)}{145}\right)^{\frac{1}{2}} = \pm\ .0357$

The difference in the models characterizing the first period and the other subperiods was an unusual finding. Considering that the Eurodollar market is basically an extension of the United States market, one would expect that models for the Eurodollar market to remain consistent over the three time periods, as did the models for the United States Treasury bill rate. Perhaps an explanation for this contradiction lies in the stage of development of the Eurodollar market during the 1971-72 time period. It was in the early 1970s that the Eurodollar market began its phenomenal rise as a major financial market separate from other national financial markets. The imperfections in the Eurodollar market at this early developmental stage may have induced the seasonality found in its behavior during this first subperiod.

West Germany and Canada also showed some changes in the process characterizing the generation of the respective time series. In the case of West Germany, the model changed during the third subperiod while in the case of Canada, the change occurred in the second subperiod. The change in the process underlying the West German interbank rate is worth noting. Although the autoregressive parameter is statistically significant, its magnitude is rather small, thus raising doubt as to its economic meaning. Hence, the process may be considered a "noisy" random walk. On the other hands, the autoregressive parameter for the Canadian finance paper rate has a value of 0.424, which is both statistically and economically meaningful.

In examining the univariate models for which observations for all three time periods are available, the United States Treasury bill rate and the West German interbank rate are the only time series that show stability in the underlying stochastic processes over time.

The validation of the models describing each time series is performed using Theil's U Coefficient (see Table 5). The models showed no worse forecasts than a naive, no-change extrapolative model, except for the Eurodollar rate in the first subperiod. It is during this time period that the underlying process of the time series differs from that of the other subperiods.

The peculiarity of the model is again evident when the standard deviations of residuals are examined. Most of the time series models exhibit an increase in the statistic for the second subperiod, except for the Eurodollar and Canadian rates. In these two time series, the first subperiod exhibits the highest standard deviation of residuals. The magnitude decreases as the time period progresses toward the third subperiod. The second subperiod is expected to show a higher standard deviation of residuals due to the volatility of the world economy, specifically prices, during this time period. In addition, the standard deviations of residuals during the third subperiod are smaller than those of the first subperiod. The behavior of the standard deviations of residuals can be explained in the following way.

The industrialized economies had been experiencing growth and relative stability since the end of World War II. Disruptive events, such as the devaluation of the United States dollar, the instability of the world financial system, the spiralling of prices,

TABLE 5.--Theil's U Coefficient for the Univariate Time Series Models short-term interest rates

	Period 1	Period 2	Period 3
1. United States three-month Treasury bills	1.000	1.000	1.000
2. Three-month Eurodollar rate	1.558	.961	.954
3. West German three-month interbank rate	1.000	1.000	.961
4. Canadain three-month finance paper rate	1.000	.894	1.000
5. U.K. three-month interbank rate	--	1.000	1.000
6. French three-month interbank rate	--	--	1.000
7. Dutch three-month interbank rate	--	--	1.000
8. Swiss three-month interbank rate	--	--	1.000

and so on, had not been expected. At this time, different national economies had not yet developed the abilities to cope and deal with such events effectively. By the 1975-78 period, after experiencing the effects of disruptive world events, economies gradually adjusted and had acquired and adopted the mechanics to deal with them.

The univariate models shown in Table 3 characterize the stochastic processes underlying each time series. These models were used as filters in the cross correlation analysis. The findings are discussed in the next section.

Cross Correlation Analysis

Since the three-month United States Treasury bill rate is used as an input in the analysis, any evidence of contemporaneous relationship between the United States interest rate and the foreign adjusted interest rate is shown by statistically significant cross correlation coefficients at lag zero. If the United States rate leads the other country rate, this would be indicated by significant correlation coefficients for the plus lags. If the other country's rate leads the United States rate, then significant correlation coefficients would show up for the minus lags. Significant coefficients for both the plus and minus lags would imply a complex feedforward-feedback relationship. The cross correlation analysis provides a starting point for the determination of a transfer function involving both the input (the United States Treasury bill rate) and the output (other country's interest rate) series.

The cross correlation analysis was conducted over an interval of plus thirty-six and minus thirty-six weeks. Since the coefficients beyond a thirteen week lag rarely show any statistical significance, only an interval of plus thirteen and minus thirteen weeks is shown in Table 6. The first panel of Table 6 shows that there is no significant cross correlation between the United States rate and the Eurodollar, West German, and Canadian rates except for the minus five lag for West Germany and the minus two lag for Canada. To the extent that any lead-lag relationship exists, the minus five lag for West Germany implies that the West German interbank rate leads the United States Treasury bill rate by five weeks while the minus two lag for Canada suggests that the Canadian finance paper rate leads the United States bill rate by two weeks. An examination of the impulse response weights exhibited by the United States-West German relationship does not show any discernible pattern. This does not allow for the modeling of a transfer function. With respect to the United States-Canadian relationship, the impulse response weights resulting from the cross correlation analysis are all insignificant both in the statistical and economic sense. Hence, no transfer function may be formulated. These findings indicate that the significant cross correlation coefficients in the United States-West German and the United States-Canadian relationship are not sufficiently strong to allow the use of the West German and Canadian time series as leading indicators of the United States bill rate. Hence, the significant coefficients are most likely spurious.

TABLE 6.--Cross correlations of weekly interest rates January 29, 1971 - December 8, 1978 (Input in U. S. 3-month Treasury Bill Rate)

	Output						
Lag	Eurodollar 3-month rate	West German 3-month interbank rate	Canadian 3-month interbank rate	United Kingdom 3-month interbank rate	French 3-month interbank rate	Dutch 3-month interbank rate	Swiss 3-month interbank rate
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)							
-13	.184	-.083	-.015				
-12	.070	-.063	.000				
-11	-.091	-.024	-.028				
-10	.132	-.053	.050				
- 9	.026	-.067	-.001				
- 8	.009	.211	.030				
- 7	.094	.173	-.039				
- 6	.087	.049	.028				
- 5	.123	.290*	.099				
- 4	-.026	.043	.109				
- 3	-.024	.035	.179				
- 2	-.005	.107	.343*				
- 1	-.067	.009	.158				
0	-.135	-.175	.083				
+ 1	.135	.092	-.022				
+ 2	.081	.010	.022				
+ 3	-.152	-.095	.163				
+ 4	.119	.094	.180				
+ 5	.084	.066	-.149				
+ 6	.017	-.072	.016				
+ 7	-.014	.090	-.029				
+ 8	.086	.050	.105				
+ 9	.166	.168	.012				
+10	-.018	.044	.164				
+11	-.034	-.076	-.061				
+12	.112	.094	-.094				
+13	-.034	-.023	.102				
B. Period 2: January 5, 1973 - September 20, 1974 (n = 90)							
-13	.129	-.002	.006	-.057			
-12	-.235*	-.134	-.037	-.004			
-11	.030	.016	-.075	.002			
-10	-.040	.116	.019	-.117			
- 9	-.087	.017	-.019	-.003			
- 8	.077	-.026	.042	.166			
- 7	-.062	-.061	-.044	-.027			
- 6	-.011	.177	-.027	-.064			
- 5	.144	.074	-.055	.035			
- 4	.137	.123	.168	.090			
- 3	.018	-.081	.194	.009			
- 2	-.042	.075	.093	-.147			
- 1	.099	.048	.309*	-.043			
0	.139	.072	.207*	.157			
+ 1	.195*	.068	.142	.063			
+ 2	.176	-.001	.035	-.077			
+ 3	.105	.041	-.055	-.033			

TABLE 6.--Continued.

Lag	Eurodollar 3-month rate	West German 3-month interbank rate	Canadian 3-month interbank rate	United Kingdom 3-month interbank rate	French 3-month interbank rate	Dutch 3-month interbank rate	Swiss 3-month interbank rate
+ 4	-.008	.091	.067	.135			
+ 5	.071	.131	-.060	.204			
+ 6	.081	.011	.103	.142			
+ 7	.123	-.118	.155	-.092			
+ 8	-.087	-.044	-.003	-.252*			
+ 9	-.066	.098	.001	-.076			
+10	-.079	-.038	-.126	.018			
+11	-.083	-.083	-.167	-.066			
+12	-.006	-.134	-.070	-.036			
+13	.116	.121	.022	.039			
C. Period 3: April 25, 1975 - January 27, 1978 (n = 145)							
-13	.006	.030	.065	.042	.196*	.018	.062
-12	.190*	.035	.148	.181*	.182*	.080	.153
-11	.066	.178*	.064	.016	.142	.073	.231*
-10	-.062	-.042	-.004	-.022	.148	.011	-.090
- 9	.048	-.077	-.012	.075	.102	.032	.126
- 8	-.006	.001	-.042	.073	.065	.010	-.044
- 7	.004	-.056	-.119	-.035	.047	-.092	.032
- 6	-.052	.057	.071	-.043	.050	.029	-.045
- 5	.039	-.018	-.050	-.019	.041	-.043	-.051
- 4	-.102	-.054	-.046	-.115	-.000	.006	.055
- 3	.111	.089	.133	-.059	.004	.085	.111
- 2	-.089	-.056	.121	-.030	-.016	.013	-.010
- 1	.447*	.425*	.393*	-.178*	.069	.384*	.515*
0	.393*	.318*	.163*	.185*	.005	.305*	.264*
+ 1	.135	.135	.179*	.028	-.024	.087	.207
+ 2	.172*	.109	.130	-.002	-.053	.118	.143
+ 3	-.014	.048	.026	-.071	-.037	-.008	.026
+ 4	.031	.027	-.022	.140	-.015	-.015	-.011
+ 5	-.130	-.119	-.023	-.031	-.019	-.103	-.096
+ 6	-.119	-.104	-.032	.091	-.050	-.121	-.083
+ 7	-.017	-.055	-.073	.047	-.037	.061	.033
+ 8	-.023	.041	.033	.042	-.084	.011	.012
+ 9	.023	.125	-.062	-.013	-.039	.061	.088
+10	.088	-.005	.153	.041	-.008	.035	.144
+11	-.024	-.022	-.079	-.020	.044	.006	-.004
+12	.079	.045	.066	-.028	.104	.024	.078
+13	.100	.112	.011	.007	.097	.067	.152

*Indicates that the correlation coefficient is statistically significant at the 95 percent level.

The second panel of Table 6 reveals that the United States bill rate is correlated to the Eurodollar rate at the minus twelve lag and to the United Kingdom interbank rate at the plus eight lag. The significant coefficients, however, have negative signs, which has no economic meaning. Therefore, it is likely that the coefficients are spurious.

Significant cross correlation coefficients are found for the United States-Canadian relationship. The minus one lag and zero lag coefficients indicate that the relationship may be one in which the Canadian rate leads the United States rate, or one in which the Canadian rate is contemporaneously determined by the United States rate, or both. The significant minus one lag, together with the zero lag coefficient, indicate that the Canadian finance paper rate may be used to estimate the United States Treasury bill rate. However, an examination of the impulse response weights does not verify this statement. The impulse response weights exhibit a pattern suggesting two possibilities: first, that the United States Treasury bill rate can be used to estimate the Canadian finance paper rate; and second, that a feedback-feedforward relationship exists.

The third panel of Table 6 reveals that all lag zero coefficients are statistically significant except for France. The cross correlation analysis with the United States Treasury bill rate as the input and the French interbank rate as the output shows significant coefficients at the minus twelve and thirteen lags. However, these coefficients are barely significant at the 95 percent confidence level. Moreover, the magnitudes of the coefficients suggests little economic significance. The lack of any relationship between the United States Treasury bill rate and the French interbank rate is not surprising. The Directorate of the Treasury of the Ministry of Economy and Finance, the coordinating agency in the field of foreign relations with foreign countries, has imposed a set of restrictions with regard to foreign exchange, import and export payments, and general capital movements. The restrictions on capital movements have rendered the French financial market relatively free of foreign influences. Movements in the financial market are largely dictated by restrictive regulations pronounced by the Directorate of the Treasury. Because of the high degree of restrictive controls characterizing the French financial market, it is not unusual that the French interbank rate does not show any significant relationships with the United States Treasury bill rate.

Of the time series considered, the Eurodollar rate shows the highest correlation with the United States Treasury bill rate. The lag zero coefficient signifies a contemporaneous relationship between the time series. The significant coefficients at the minus twelve and one lags, and at plus two lag should be noted. The coefficients bear the correct sign and the coefficient at minus one lag is highly significant. The coefficients imply a complex feedback-feedforward relationship between the United States Treasury bill rate and the Eurodollar rate. This relationship is expected, given the fact that the United States and Eurodollar markets are closely tied together, with funds flowing freely and easily between the two markets. An investor considering an investment in a United States security has another viable alternative in the Eurodollar security. In many ways, the United States and Eurodollar markets are a single market.

The West German and Swiss interbank rates show significant cross correlation with the United States Treasury bill rate at the minus eleven, minus one and zero lags. However, the coefficients at minus eleven lag are barely significant in both the United States-West German and the United States-Swiss cross correlation analysis. Moreover, an examination of the impulse response weights reveals that the coefficients are most likely spurious. The coefficients at the minus one and zero lags indicate a feedback-feedforward relationship. The situation in which the West German and the Swiss interbank rates are estimators of the United States Treasury bill rate is discarded because of the insignificance of the impulse response weights.

The Dutch interbank rate is found to be correlated to the United States Treasury bill rate at the minus one and zero lags. Similar to the relationships found in the United States-Swiss and the United States-West German cross correlation analysis, the significant coefficients indicate a feedback-feedforward relationship.

The lag zero coefficients for the United Kingdom and Canada are rather small and are of little economic significance. However, the significant minus lag coefficients in the two relationships warrant further examination. The implication of these significant coefficients is that the Canadian finance paper rate and the United Kingdom interbank rate lead the United States bill rate by one week, and by one week and twelve weeks, respectively. Because the coefficients in the United States-United Kingdom relationship are quite small, the economic significance of these values is doubtful. Hence, it is likely that the coefficients are spurious. The surprising case of the Canadian rate leading the United States bill rate with a significant coefficient at minus one lag suggests that the Canadian rate leads the United States bill rate by one week. To verify the importance of this finding, the impulse response weights are examined. The weights do not exhibit a discernible pattern and are all very small. This questions the validity of the implication that the Canadian rate leads the United States bill rate. The relationship is possibly a more complex one, where some feedback and feedforward occur.

Other than these significant coefficients as discussed above, the other significant cross correlation coefficients are considered small and most likely spurious.

In general, the relationships found in the cross correlation analysis seem to indicate that the markets show closer movement in the third subperiod, 1975-78. Some development occurs in the relationships, as seen by the increasing number of significant cross correlation coefficients as the time period moves toward 1978. However, none of the foreign interest rate series is found to have a consistent relationship with the United States Treasury bill rate.

The comovements found between the interest rate series are generally of a feedback-feedforward nature. This is the case in which the United States Treasury bill rate affects and is affected by changes in the foreign interest rate.

In the next section, the relationships found in the cross correlation analysis are examined further via their respective transfer functions.

Multivariate Analysis

Based on the cross correlation analysis, an attempt is made to construct transfer functions for the time series. The transfer functions formulated assume the input series to be the three-month United States Treasury bill rate and the output series to be the other time series concerned. Transfer functions are modeled for only some of the time series. The reasons are: (1) not all of the time series are found to have statistically significant cross correlation coefficients; (2) even in those cases where statistically significant coefficients exist, the size of the coefficients indicate no economic significance such that no transfer function is warranted; (3) statistically significant coefficients may be found for lags that make no economic sense; (4) negative coefficients at either plus or minus lags suggest virtually no economic meaning; and (5) the feedback-feedforward relationships cannot be represented in a transfer function as laid out in this study's methodology. Hence, in some cases, only the portion depicting the United States rate as the sole input series is modeled. The multivariate models or transfer functions are found in Table 7.

The second part of the exhibit sets out the transfer function depicting the relationship between the United States bill rate and the Canadian finance paper rate from 1973-75. The current value of the input series contributes to the estimation of the Canadian rate. This is evidenced by the reduction in the standard deviation of residuals from .296 percent to .271 percent. Moreover, when this function is used to forecast values of the Canadian finance paper rate, the values generated are better than when the univariate model is used. The mean squared error of the forecasts is .1126 percent without the leading input series. The benefit of employing the United States rate in estimating the Canadian finance paper rate is reinforced by the variance of the forecast errors, as shown in Table 9.

Theil's U Coefficient of the transfer function is also calculated. The transfer function, with a Theil's U Coefficient of .854 (as shown in Table 10), proved to forecast better than either the naive, no-change extrapolative model or the univariate model reported in Table 3.

In the case of the Eurodollar time series for 1975-78, the univariate model set forth in Table 3 was originally employed in the modeling of the transfer function. However, the use of this univariate model does not allow the reduction of the noise series to white noise. It was found that the output series, the Eurodollar

TABLE 7.--Multivariate time series models--short-term interest rates

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
B. Period 2: January 5, 1973 - September 20, 1974 (n = 90)		
Canadian three-month finance paper rate	$y_t - .834\ y_{t-1} = .273\ x_t + \frac{1}{(1 - .278B)} a_t$	.271%
C. Period 3: April 23, 1975 - January 27, 1978 (n = 145)		
Three-month Euro-dollar rate	$y_t = .468\ x_t - .410\ x_{t-1} + a_t - .891\ a_{t-1}$	.182
West German three-month interbank rate	$y_t = .408\ x_t - .346\ x_{t-1} + a_t - .916\ a_{t-1}$	.238
Canadian three-month finance paper rate	$y_t = .300\ x_t + .622\ x_{t-1} + a_t$	.233
U. K. three-month interbank rate	$y_t = .871\ x_t + .803\ x_{t-1} + a_t$	.675
Dutch three-month interbank rate	$y_t = .558\ x_t + .745\ x_{t-1} + a_t$	.243
Swiss three-month interbank rate	$y_t = .356\ x_t - .404\ x_{t-1} + a_t - .921\ a_{t-1}$	.231

TABLE 8.--Mean squared error of the forecast of the output series with and without the input series--short-term interest rates

	With input series	Without input series
A. Period 1: January 29, 1971 - July 7, 1972 (n - 76)		
B. Period 2: January 5, 1973 - September 20, 1975 (n = 90)		
Canadian three-month finance paper rate	.1126	.1248
C. Period 3: April 23, 1975 - January 27, 1978 (n - 145)		
Three-month Eurodollar rates	.0400	.0440
West German three-month interbank rate	.0755	.0754
Canadian three-month finance paper rate	.0582	.0538
U.K. three-month interbank rate	.2672	.2138
Dutch three-month interbank rate	.0868	.0902
Swiss three-month interbank rate	.0826	.0888

TABLE 9.--Variance of the forecast errors made with and without the input series--short-term interest rate

	Lead	With Input Series	Without Input Series
A. Period 1: January 29, 1971-July 7, 1972 (n = 76)			
B. Period 2: January 5, 1973 - September 20, 1974 (n = 90)			
Canadian three-month finance paper rate	1	.0840	.0841
	2	.1270	.2546
	3	.1970	.4710
	4	.3020	.7084
C. Period 3: April 25, 1975 - January 27, 1978 (n = 145)			
Three-month Eurodollar rate	1	.0380	.0330
	2	.0563	.0841
	3	.0568	.1402
	4	.0573	.1976
West German three-month interbank rate	1	.0604	.0529
	2	.0740	.1307
	3	.0744	.2145
	4	.0748	.2996
Canadian three-month finance paper rate	1	.0561	.0645
	2	.1296	.1290
	3	.1836	.1935
	4	.2376	.2580
U.K. three-month interbank rate	1	.4734	.4802
	2	.9939	.9605
	3	1.4499	1.4407
	4	1.9059	1.9209
Dutch three-month interbank rate	1	.0662	.0778
	2	.1642	.1557
	3	.2232	.2335
	4	.2822	.3113
Swiss three-month interbank rate	1	.0559	.0484
	2	.0695	.0968
	3	.0698	.1452
	4	.0701	.1936

TABLE 10.--Theil's U Coefficient multivariate time series models--short-term interest rates

	Period 1	Period 2	Period 3
Three-month Eurodollar rate	--	--	.899
West German three-month interbank rate	--	--	.962
Canadian three-month finance paper rate	--	.854	1.040
U. K. three-month interbank rate	--	--	1.118
French three-month interbank rate	--	--	--
Dutch three-month interbank rate	--	--	.981
Swiss three-month interbank rate	--	--	1.004

rate, has to be differenced twice in order to generate white noise. The original integrated autoregressive model assigned to the Eurodollar series with one order regular differencing was not sufficient to induce white noise in multivariate modeling. A revision was made in the univariate model to an integrated moving average model with second order regular differencing. The final univariate model used was

$$z_t - 2\, z_{t-1} + z_{t-2} = a_t - .928\, a_{t-1} \qquad (1)$$

Although the residuals show a standard deviation of .195 percent, higher than that of the original model, this univariate model enabled the construction of a transfer function the residuals of which can be reduced to white noise. The result of the change in the univariate model are twofold. On the one hand, the standard deviation of residuals of the new model (.195 percent) is slightly higher than that of the original univariate model (.183 percent). This difference implies that the new model is not performing as well as the original model in estimating the time series. On the other hand, the transfer function constructed based on the new model shows a standard deviation of residuals (.187 percent) almost equal to that of the new univariate model. The mean squared error of the forecasts is smaller, as shown in Table 8. The reduction in the mean squared error, however, is small. Based on this statistic, the transfer function forecasts better than the original univariate model and the new univariate model. When the variance of the forecast error is examined, the forecast of the Eurodollar rate is not consistently improved by the employment of the leading input series. The contradictions found in the statistics examined for the transfer function cast doubt on the transfer function as a better model for forecasting the Eurodollar series.

For the same reasons as for the Eurodollar time series, the model for the Swiss interbank rate for 1975-78 was also changed to a second order differenced integrated moving average model. The final univariate model was

$$z_t - 2\, z_{t-1} + z_{t-2} = a_t - .884\, a_{t-1}, \qquad (2)$$

with a standard deviation of residuals equal to .235 percent. The result of this change is somewhat different than that of the

Eurodollar rate. The new univariate model does not estimate the underlying process better than the original univariate model in terms of the standard deviations of residuals. The original model has a standard deviation of residuals of .220 percent, while the new model has a standard deviation of residuals of .235 percent. The mean squared errors of the forecasts for the original and the new models are .0888 percent and .0775 percent, respectively. With regard to the transfer function modeled based on the new univariate model, the standard deviation of residuals is .231 percent, which is slightly lower than that of the new univariate model. Compared to the original model, the standard deviation of residuals of the transfer function is higher. For forecasting purposes, the transfer function performs worse than both the original and the new univariate models. Since the main benefit to be derived from a transfer function is to be able to improve forecasts, the transfer function for the Swiss interbank rate should be rejected.

The univariate model for the West German interbank rate also required a change in the context of transfer function modeling. The new univariate model is

$$z_t - 2\, z_{t-1} + z_{t-2} = a_t - .932\, a_{t-1} \tag{3}$$

with a standard deviation of residuals of .245 percent. Note that this is higher than that of the original model. The mean squared error of the forecasts is .0764 percent for the new model, thereby indicating that the original model is superior. The transfer function, as reported in Table 7, shows a standard deviation of residuals of .248 percent, which is higher than that of either the original or the new univariate models. The mean squared error of forecasts (.0755 percent) is also slightly higher than the value for the original univariate model, but lower than the value for the new univariate model. The variance of the forecast errors confirms the findings that the transfer function does not forecast better than the original univariate model. Hence, the transfer function is rejected.

The Canadian and the United Kingdom transfer functions have basically the same structure, with two significant parameters determined by the values of the United States Treasury bill rate. The time series show a reduction in the standard deviations of residuals. This finding, however, is not reinforced by their mean squared error statistics. The implication of the mean squared error statistics is corroborated by the inconsistency in the variance of the forecast errors. The contradictions among the residual standard deviations, the mean squared errors of forecasts, and the variances of the forecast errors raise doubt on the benefits of the transfer function over the univariate model for forecasting purposes. Further evidence of the above finding is the Theil's U Coefficient of forecast accuracy. The United Kingdom and Canadian transfer functions have a Theil's U Coefficient of 1.118 and 1.040, respectively. These coefficients suggest that the two transfer functions provided worse forecasts than a naive, no-change extrapolative model.

Finally, examine the transfer function for the Dutch interbank rate. Similar to the models in the 1975-78 period, the current and the latest previous observation in the input series help determine the value for the output series. The residual standard deviation, the mean squared error of forecasts, and the Theil's U coefficient are consistent in their findings. These statistics point to the advantage of employing the transfer function. However, inconsistency does exist in the variance of the forecast errors. Although the variance of the forecast errors at the one week lead time with an input series is lower than the variance of the forecast errors without the input series, this statistic is not consistently lower as the lead time is varied. Thus, the use of a transfer function is suspect.

Summary

The study hypothesizes high comovement of domestic and foreign interest rates. Instantaneous adjustment of foreign interest rates is expected in reaction to a change in the United States short-term interest rates.

The underlying processes characterizing each of the time series were employed in the cross correlation analysis. The United States Treasury bill rate was used as the input series, while the other countries' interest rates were used as the output series. The cross correlation analysis indicates an increase in the degree of comovement of short-term interest rates from the 1971-72 period to the 1975-78 period. Each of the time series in the sample was found to be correlated with the United States Treasury bill rate in 1975-78 except for France. Significant cross correlation coefficients were found to exist principally in the minus one and zero lags, with the Eurodollar rate exhibiting the highest cross correlation coefficient. Because of the existence of significant correlation at both minus and zero lags and, in the case of Canada and the Eurodollar rates, at plus lags, the relationships were of a feedback-feedforward nature. None of the time series was found to be consistently correlated with the United States Treasury bill rate over the entire sample period. However, the Canadian finance paper rate was correlated with the United States Treasury bill rate in the second and third time periods.

The cross correlation analysis provided the first step in the construction of transfer functions. The advantage of the transfer function over the univariate model is evaluated with four statistics: the standard deviation of residuals, the mean squared error of forecasts, the variance of the forecast errors, and the Theil's U Coefficient of forecast accuracy. Based on these statistics, only the transfer function for the Canadian finance paper rate in 1973-75 was superior to the univariate model. The transfer functions for the Eurodollar rate, the West German interbank rate, the Canadian finance paper rate, the United Kingdom interbank rate, the Dutch interbank rate, and the Swiss interbank rate in 1975-78 were rejected. For each of these time series, the univariate model provided better forecasts than the transfer function.

CHAPTER V

LONG TERM INTEREST RATE RELATIONSHIPS

THREE-MONTH HOLDING PERIOD

The hypothesis of the study with respect to long-term interest rates states that there is high comovement of United States and foreign adjusted interest rates. Foreign long-term adjusted interest rates are expected to adjust instantaneously to a change in the domestic long-term interest rate. In the analysis of these relationships, it is necessary to assume three different holding periods, due to the fact that the long-term interest rate series included in the study have maturity periods extending over a period of at least five years. It is assumed that investors will not hold the financial instrument for its entire life; particularly, the holding period will not exceed a one-year period. Hence, holding periods of three months, six months, and one year have been assumed. Invoking the concepts underlying the relative purchasing power parity theory, the interest rate theory of exchange rate expectation, and the interest rate parity theory, the nondollar denominated long-term interest rate series were adjusted to account for exchange rate differentials. In effect, the adjustment performed makes the long-term interest rates holding-period returns. As stated in Chapter III, the corresponding forward exchange rates are used as proxies for the exchange rates expected to prevail three months, six months, and one year hence.

The analysis of long-term interest rate relationships is divided into four chapters. This chapter discusses the analysis performed on the three-month holding period returns. Chapters VI and VII deal with six-month and one-year holding-period returns, respectively. Finally, the findings with respect to the three holding-period returns are summarized in Chapter VIII. In the final chapter on the long-term interest rate series, the underlying stochastic processes for each individual time series will be compared. In addition, the cross correlation coefficients and the transfer functions constructed will be examined for consistency in structure.

The three-month holding-period returns will be examined in this chapter. The adjustment of the nondollar interest rate series to obtain the holding-period return uses the three-month forward exchange rate as a proxy for exchange rate expectations.

Univariate Analysis

The models for each of the time series under study are found in Table 11. The United States constant maturity bond yield is characterized by an autoregressive integrated model during the first (1971-72) and second (1973-75) subperiods. The parameter values in each of the two subperiods are statistically significant. Because the magnitude of the parameter coefficients in the first time period is relatively small, the model in 1971-72 may be considered a "noisy"

TABLE 11.--Univariate time series models--Long-term interest rates (Three-month holding period returns)

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - 1.289\ z_{t-1} + .289\ z_{t-1} = a_t$	.109%
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t + .227\ a_{t-1}$	.584
3. Canadian Long-Term Government Bond Yield	$z_t - z_{t-1} = a_t$	.290
4. U. K. Government 3½% War Loan Yield	$z_t - z_{t-1} = a_t$	.702
5. French Long-Term Public Sector Bond Yield	$z_t - z_{t-1} = a_t + .542\ a_{t-1}$	1.158
6. Dutch Long-Term Government Loan Rate	$z_t - 1.138\ z_{t-1} + .138\ z_{t-2} = a_t$	.536
7. Swiss Long-Term Confederation Bond Yield	$a_t - 1.225\ z_{t-1} + .225\ z_{t-2} = a_t$	.503

TABLE 11.--Continued

Series	Model	Standard Deviation of Residuals
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - 1.428\ z_{t-1} + .428\ z_{t-2} = a_t$	.067%
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t + .173\ a_{t-1}$	.950
3. Canadian Long-Term Government Bond Yield	$z_t - 1.364\ z_{t-1} + .364\ z_{t-2} = a_t - .403\ a_{t-11}$	.304
4. U. K. Government 3½% War Loan Yield	$z_t - z_{t-1} = a_t$	.853
5. French Long-Term Public Sector Bond Yield	$z_t - z_{t-1} = a_t$	1.039
6. Dutch Long-Term Government Loan Rate	$z_t - z_{t-1} = a_t$	.809
7. Swiss Long-Term Confederation Bond Yield	$z_t - z_{t-1} = a_t$	.843

TABLE 11.--Continued

Series	Model	Standard Deviation of Residuals
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - z_{t-1} = a_t$	.100%
2. West Germany Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t - .610\ a_{t-1}$	.875
3. Canadian Long-Term Government Bond Yield	$z_t - 1.154\ z_{t-1} + .154\ z_{t-2} = a_t$	.239
4. U. K. Government 3½% Bond Yield	$z_t - z_{t-1} = a_t$	.834
5. French Long-Term Public Sector Bond Yield	$z_t - z_{t-1} = a_t$	.988
6. Dutch Long-Term Government Loan Rate	$z_t - 1.442\ z_{t-1} + .442\ z_{t-2} = a_t$	.527
7. Swiss Long-Term Confederation Bond Yield	$z_t - 1.269\ z_{t-1} + .269\ z_{t-2} = a_t$	.279

random walk. However, the 1971-72 and 1973-75 periods cannot be considered characterized by one same exact model because the parameter values were tested and found to be significantly different from each other as shown in Table 12. The third subperiod is characterized by a random walk model. An unusual finding in this time series is that that standard deviation of residuals is lower in the second subperiod than it is in the first and third subperiods. The second subperiod is generally considered to be a relatively volatile time period. Thus, one would expect that the residuals would exhibit more volatility as reflected in a higher standard deviation of residuals. The expected volatility is not characteristic of the United States bond series.

The West German public authority loan rate can be described as an integrated moving average model. The current observation is determined by the latest previous observation plus the current disturbance and the latest previous disturbance. Note that the sign on the moving average parameter changes as the time period moves into the third subperiod. The significant coefficients in the first and second subperiods are much smaller in magnitude in comparison to the third subperiod. As shown in Table 13, the coefficients in the first two subperiods are found to be insignificantly different from each other but different individually from that of the third subperiod. Because the parameter values are rather small in the first and second subperiods, the underlying stochastic processes may be regarded as essentially "noisy" random walk models. The behavior of the standard

TABLE 12.--Comparison of ARIMA (1.10) models fitted to the first and second subperiods of the United States ten-year constant maturity bond yield

Period	n	ϕ	$\lambda = 1-\phi$	$\sigma(\lambda)$*	Q	df
First Subperiod 1971-72	72	.279	.711	±.0520	31.5	35
Second Subperiod 1973-75	92	.428	.572	±.0516	22.3	35

Standard error of $\lambda^{(1)} - \lambda^{(2)} = \sqrt{(.0520)^2} + (.0516)^2 = \pm.0733$

$$\lambda^{(1)} - \lambda^{(2)} = .711 - .572 = .1390$$

Therefore, there is a real change in λ.

$$*\sigma(\lambda) = \left(\frac{\lambda(1 - \lambda)}{n}\right)^{\frac{1}{2}}$$

$$1971\text{-}72: \quad \sigma(\lambda) = \left(\frac{.711\ (.289)}{76}\right)^{\frac{1}{2}} = \pm.0520$$

$$1973\text{-}75: \quad \sigma(\lambda) = \left(\frac{.572\ (.428)}{92}\right)^{\frac{1}{2}} = \pm.0516$$

TABLE 13.--Comparison of ARIMA (0.1.1) models fitted to the West German long-term public authority loan rate (Three-month holding-period return)

Period	n	ϕ	$\lambda = 1-\phi$	$\sigma(\lambda)$*	Q	df
First Subperiod 1971-72	76	-.227	1.227	±.0605	40.4	35
Second Subperiod 1973-75	92	-.173	1.173	±.0470	30.2	35
Third Subperiod 1975-78	141	.610	.390	±.0411	6.74	35

Standard error of $\lambda^{(1)} - \lambda^{(2)} = \sqrt{(.0605)^2 + (.0470)^2} = \pm\ .0766$

$$\lambda^{(1)} - \lambda^{(3)} = \sqrt{(.0605)^2 + (.0411)^2} = \pm\ .0731$$

$$\lambda^{(2)} - \lambda^{(3)} = \sqrt{(.0470)^2 + (.0411)^2} = \pm\ .0624$$

$$\lambda^{(1)} - \lambda^{(2)} = 1.227 - 1.172 = .0540$$

$$\lambda^{(1)} - \lambda^{(3)} = 1.227 - .390 = .8370$$

$$\lambda^{(2)} - \lambda^{(3)} = 1.173 - .390 = .7830$$

Therefore, there is no real change in λ from 1971-72 to 1973-75.
There is a real change in λ from 1971-72 to 1975-78.
There is a real change in λ from 1973-75 to 1975-78.

$$*\sigma(\lambda) = \left(\frac{\lambda(1-\lambda)}{n}\right)^{\frac{1}{2}}$$

$$\sigma(\lambda) = \left(\frac{1.227(\pm.227)}{76}\right)^{\frac{1}{2}} = \pm\ .0605$$

$$\sigma(\lambda) = \left(\frac{1.173(.173)}{92}\right)^{\frac{1}{2}} = \pm\ .0470$$

$$\sigma(\lambda) = \left(\frac{.390(6.10)}{141}\right)^{\frac{1}{2}} = \pm\ .0411$$

deviation of residuals as expected, with the second subperiod exhibiting more volatility.

In the models characterizing the process generating the Canadian goverment bond yield, there is a strong difference in the models over the three subperiods. The first subperiod is a random walk model. The third subperiod is characterized by an autoregressive integrated model. The parameter coefficient in this model may be considered insignificant in the economic sense although significant statistically. This implies a "noisy" random walk process. The model for the second subperiod is very different from many of the models in the study. It can be described as an autoregressive integrated moving average model with first order regular differencing. The moving average parameter in the model is an eleven order seasonal moving average parameter which is very unusual. The magnitude of the parameter, however, is relatively small. Hence, the model may be considered an autoregressive integrated model. The behavior of the standard deviation of residuals turned out as expected, with the second subperiod showing a higher value. However, the magnitude of the statistic are close to one another, lying in the range of .230 percent and .310 percent.

The United Kingdom war loan yield can be described by random walk processes with the second subperiod exhibiting more volatility than the first and third subperiods. Among all the time series considered in this section, the French public sector bond series has the largest standard deviation of residuals, hovering at about the

1 percent level. The French long-term rate series are random walk models in the second and third subperiods, but is an integrated moving average model in the first subperiod.

For the Dutch long-term government loan rate, the models found to describe the series are autoregressive integrated model for 1971-72 and 1975-78 and a random walk model for 1973-75. The autoregressive parameter values are tested to determine statistical difference and, as shown in Table 14, the autoregressive parameter values are found to be different. The first subperiod is essentially characterized by a "noisy" random walk model. As expected, the 1973-75 period showed more volatility than the other time periods.

Finally, the Swiss long-term confederation bond yields are examined. Note that the first and third subperiods are characterized by autoregressive integrated models. The significant parameter coefficients in the first and third time periods were determined to be insignificantly different from each other as shown in Table 15. However, the values are rather small to have any economic meaning. The underlying stochastic process in the second subperiod is a random walk model. The standard deviations of residuals confirmed the expected higher volatility during the second subperiod.

A general observation that can be made from Table 11 is that the standard deviations of residuals in the first subperiod are higher in comparison to those of the third subperiod. The exceptions are West Germany and the United Kingdom. In many instances, the magnitudes of the differences are quite small.

TABLE 14.--Comparison of ARIMA (1,1,0) models fitted to the first and third supberiods of the Dutch long-term government loan rate (Three-month holding-period return)

Period	n	ϕ	$\lambda = 1-\phi$	$\sigma(\lambda)$*	Q	df
First Subperiod 1971-72	76	.138	.862	±.0396	42.4	35
Third Subperiod 1975-78	141	.442	.558	±.0418	32.2	35

Standard error of $\lambda^{(1)} - \lambda^{(2)} = \sqrt{(.0396)^2 + (.0418)^2} = \pm\ .0576$

$$\lambda^{(1)} - \lambda^{(2)} = .862 - .558 = .304$$

Therefore, there is a real change in λ.

$$*\sigma(\lambda) = \left(\frac{\lambda(1-\lambda)}{n}\right)^{\frac{1}{2}}$$

$$\sigma(\lambda) = \left(\frac{.862(.138)}{76}\right)^{\frac{1}{2}} = \pm\ .0396$$

$$\sigma(\lambda) = \left(\frac{.558(.442)}{92}\right)^{\frac{1}{2}} = \pm\ .0418$$

TABLE 15.--Comparison of ARIMA (1,1,0) models fitted to the first and third subperiods of the Swiss long-term confederation bond yield (Three-month holding-period return)

Period	n	ϕ	$\lambda = 1-\phi$	$\sigma(\lambda)$*	Q	df
First Subperiod 1971-72	76	.225	.775	±.0479	30.4	35
Third Subperiod 1975-78	141	.269	.731	±.0373	35.7	35

Standard error of $\lambda^{(1)} - \lambda^{(2)} = \sqrt{(.0479)^2 + (.0373)^2} = \pm .0607$

$$\lambda^{(1)} - \lambda^{(2)} = .775 - .731 = .0440$$

Therefore, there is no real change in λ.

$$*\sigma(\lambda) = \left(\frac{\lambda(1-\lambda)}{n}\right)^{\frac{1}{2}}$$

$$\sigma(\lambda) = \left(\frac{.775(.225)}{76}\right)^{\frac{1}{2}} = \pm .0479$$

$$\sigma(\lambda) = \left(\frac{.731(.269)}{141}\right)^{\frac{1}{2}} = \pm .0373$$

Table 16 provides the Theil's U Coefficients for each of the time series models. All the models can forecast better or at least as well as a naive, no-change extrapolative model except for the West German model for 1975-78 and the Canadian model for 1973-75. Nevertheless, these two models are selected because they best characterize the time series.

TABLE 16.--Theil's U Coefficient for the univariate time series models--Long-term interest rates (three-month holding period return)

	Period 1	Period 2	Period 3
1. U.S. 10-year Constant Maturity Bond Yield	.830	.900	1.000
2. West German Long-Term Public Authority Loan Rate	.991	.962	1.533
3. Canadian Long-Term Government Bond Yield	1.000	1.164	.990
4. U. K. Government 3½% War Loan Yield	1.000	1.000	1.000
5. French Long-Term Public Sector Bond Yield	.782	1.000	1.000
6. Dutch Long-Term Government Loan Rate	.992	1.000	.911
7. Swiss Long-Term Confederation Bond Yield	.956	1.000	.975

Cross Correlation Analysis

The findings from the cross correlation analysis are tabulated in Table 17. Although the time series are cross correlated

TABLE 17.--Cross correlations of weekly interest rates--January 29, 1971 - November 24, 1978 (Three-month holding period returns) (Input is U. S. 10-Year constant maturity bond yield)

	Output					
Lag	West German Long-Term Public Authority Loan Rate	Canadian Long-Term Government Loan Rate	United Kingdom Government 3½% War Loan Yield	French Long-Term Public Sector Bond Yield	Dutch Long-Term Government Loan Rate	Swiss Long-Term Confederation Bond Yield
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)						
-13	.138	-.103	-.118	-.128	.135	.030
-12	.007	-.001	-.088	.042	-.080	.063
-11	-.033	.013	.009	.198	.012	.100
-10	.032	-.032	.021	-.063	-.015	-.130
- 9	-.121	-.097	.068	-.085	.005	-.084
- 8	-.006	.091	.062	.021	-.011	.219*
- 7	-.194	-.050	-.017	.131	.015	-.040
- 6	.000	-.073	.019	.012	.060	.087
- 5	-.021	.013	.007	.058	.156	-.135
- 4	.031	-.072	.007	-.150	.008	-.007
- 3	.110	-.003	.013	.050	.081	-.019
- 2	.193	-.021	-.048	.015	-.018	.066
- 1	.000	.129	.039	-.081	-.077	-.023
0	-.095	.467*	-.008	.115	-.125	.150
+ 1	-.196	-.209	-.047	-.151	.051	-.357*
+ 2	.065	.147	.088	.075	.113	-.056
+ 3	.165	.085	.070	.003	-.008	.103
+ 4	-.103	-.098	.005	-.182	-.040	-.136
+ 5	.178	.068	-.018	-.016	.083	.085
+ 6	.001	.044	.025	.025	.219*	.009
+ 7	-.144	.028	-.059	-.036	-.089	.053
+ 8	.124	.150	.089	.014	-.164	-.041
+ 9	.051	-.030	-.072	-.034	.110	-.096
+10	.025	.045	-.106	-.016	-.033	.021
+11	.111	.216*	-.006	.013	.071	.197
+12	-.287*	-.167	-.055	-.088	-.059	-.169
+13	.204	.127	.015	.041	.051	.112
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)						
-13	.023	.060	.014	-.086	.026	.010
-12	-.052	-.137	.142	-.083	-.042	.028
-11	.020	.055	.068	-.012	.072	-.054
-10	.024	-.012	.083	.016	-.039	.028
- 9	.070	.066	.218*	-.106	-.002	.003
- 8	.077	.088	.187	-.122	.105	.098
- 7	.071	-.129	-.013	.026	.065	.160
- 6	.062	-.045	-.045	.115	-.029	-.074
- 5	.026	.093	-.052	.028	.042	.206*
- 4	.080	.041	.148	-.022	.140	.240*
- 3	.029	.181	.142	.076	.156	.146
- 2	.124	.051	.154	.077	.090	-.000
- 1	.182	.085	.122	.219*	.073	.162
0	.159	.204*	-.004	.017	.092	-.074
+ 1	-.112	.189	-.004	.017	.092	-.074
+ 2	.037	-.053	-.003	.105	-.081	.180
+ 3	.001	-.091	-.020	-.063	-.053	-.243*

TABLE 17.--Continued

Lag	West German Long-Term Public Authority Loan Rate	Canadian Long-Term Government Loan Rate	United Kingdom Government 3½% War Loan Yield	French Long-Term Public Sector Bond Yield	Dutch Long-Term Government Loan Rate	Swiss Long-Term Confederation Bond Yield
+ 4	-.002	.180	.022	-.089	-.057	.127
+ 5	.016	-.001	.097	.002	-.034	-.017
+ 6	.000	.191	.030	-.010	.082	-.142
+ 7	-.162	.007	-.074	.048	.091	.102
+ 8	-.022	.030	.049	-.170	-.001	-.011
+ 9	.099	.043	.003	.125	.183	-.001
+10	.056	-.087	.009	-.061	-.111	-.033
+11	.085	-.114	.053	-.037	-.015	.109
+12	-.064	.031	-.053	.147	.001	-.023
+13	.124	-.046	.051	-.206*	.009	.096
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)						
-13	.016	.099	.132	.111	-.018	.100
-12	.029	-.008	.028	.084	-.001	-.008
-11	.043	.078	-.147	.004	.105	.021
-10	.026	.032	.210*	.011	.016	-.065
- 9	-.021	-.056	.000	-.012	-.100	-.063
- 8	.013	-.024	.011	.031	.003	.083
- 7	.030	-.038	-.029	-.017	-.066	-.009
- 6	-.048	-.081	-.016	.038	.074	.109
- 5	-.050	.125	-.153	.043	-.093	-.142
- 4	-.005	.032	-.058	.015	.015	-.007
- 3	.047	.053	.097	.104	-.151	.038
- 2	.133	.000	.139	-.053	-.031	-.040
- 1	-.015	.208*	.120	.093	.167*	-.009
0	.532*	.262*	.110	.065	.216*	.188*
+ 1	-.170*	.011	-.143	.057	.192*	.135
+ 2	.016	.181*	-.115	-.060	.003	.068
+ 3	.064	.115	-.066	-.032	-.088	.148
+ 4	-.033	-.169	.038	.030	-.133	.143
+ 5	.005	-.014	.052	.144	-.061	.054
+ 6	.062	.067	.023	.083	.043	-.019
+ 7	.001	-.047	-.051	-.075	.085	-.041
+ 8	-.064	.020	.139	-.114	.093	-.052
+ 9	.083	.067	.107	-.091	-.014	-.102
+10	-.129	.054	.106	-.066	-.021	-.012
+11	.028	.028	.002	.042	.145	.125
+12	-.049	.058	.022	-.022	.086	.051
+13	.091	-.151	.031	-.003	.133	.044

*Indicates that the correlation coefficient is statistically significant at the 95 percent level.

over an interval of plus thirty-six and minus thirty-six weeks, only the interval from minus thirteen to plus thirteen weeks is included in the table. In the 1971-72 period, only three time series show some relationship with the United States bond yield. These are the West German, Swiss, and Canadian time series.

In the United States-West German cross correlation analysis, a significant coefficient exists at the plus twelve lag. This implies almost a three-month lag relationship. However, the sign of the coefficient is contrary to expectation. The impulse response weights do not exhibit any discernible pattern. Moreover, the parameter estimates based on the impulse response weights are small, suggesting little economic significance. Hence, the coefficient is most likely spurious.

In the United States-Switzerland cross correlation, the only significant correlation is at the plus one lag. However, the sign of the coefficient is negative which implies an inverse relationship between the United States bond rate and the Swiss confederation bond rate. Although the significant coefficient at the plus one lag appears to be spurious, the impulse response weights are quite sizable. Hence, the United States-Swiss relationship will be examined further in the next section on transfer functions.

In the case of the United States-Canada relationship, the coefficients at the zero and plus eleven lags are significant. They also bear the correct sign. Since the coefficient at the plus eleven lag and the corresponding impulse response weights are small, the coefficient is likely spurious. The coefficient at zero lag implies a contemporaneous relationship between the two time series.

The second panel of Table 17 shows the lead-lag relationships for 1973-75.

The United States bond yield and the French public sector bond yield are found to be significantly correlated at the minus one and the plus thirteen lags. The significant coefficient at plus thirteen lag suggests a three-month lag. Since the coefficient bears the wrong sign, the coefficient is most likely spurious. The signicant coefficient at minus one lag suggests that the French public sector bond yield leads the United States bond rate by one week. The magnitude of the coefficient is small and barely significant at the 95 percent confidence level. Moreover, when the impulse response weights are examined, the pattern cannot be interpreted to be of any possible structure and the magnitudes of the weights are rather small. This implies that the estimates for the transfer function parameters are small, indicating little economic significance.

In the United States-Swiss cross correlation analysis, significant coefficients are at the minus four and the plus three lags. The plus three lag coefficient carries a negative sign and makes no economic sense. The coefficient at minus four lag implies that the bond rate lags behind the Swiss confederation bond yield. The coefficients, however, is small. The impulse response weights are also small and exhibit no discernible pattern. Hence, the coefficient is likely spurious.

The behavior of the United States-Canada long-term interest rate relationship should be noted. The only significant coefficient appears at the zero lag. Although the coefficient is small and barely significant at the 95 percent confidence level, the coefficient implies a contemporaneous relationship between the two time series. The impulse response weights are sizable. Therefore, in the next section, the relationship will be examined further to determine if the coefficient can be employed for forecasting and decision-making purposes.

The analysis of the third subperiod, 1975-78, is found in Panel C of Table 17. Except for France and the United Kingdom, the table shows some relationships existing between the time series examined. Note that most of the significant cross correlation coefficients are at either minus one lag, zero lag, or plus one lag. This suggests that the relationships are mostly of a contemporaneous nature. Also, the significant coefficients are mostly of the correct sign.

The significant coefficients in the United States-West German relationship are at the zero and plus one lags. The plus one lag coefficient does not have the expected sign. Moreover, the magnitude of the coefficient is rather small. These suggest that the coefficient is most likely spurious. The significant coefficient at the zero lag implies that the West German public authority loan rate is contemporaneously related to the United States bond yield.

The significant cross correlation coefficient at the minus ten lag for the United States-United Kingdom relationship suggests that the United Kingdom rate leads the United States rate by ten weeks. The coefficient is rather small and is barely significant at the 95 percent confidence level. Moreover, a lead of ten weeks has little economic meaning.

The United States-Netherlands cross correlation analysis shows significant coefficients at the minus one, zero, and plus one lags. Even though the coefficients are not large, the implication is that a feedback-feedforward relationship exists between the two time series. The same situation exists for the United States-Canada cross correlation. The existence of significant coefficients at the minus one, zero, and plus two lags signify a feedback-feedforward relationship.

Finally, examine the cross correlation analysis for the United States and Swiss long-term interest rates. The only significant coefficient appears at the zero lag. The coefficient bears the correct sign and is significant at the 95 percent confidence level, thereby indicating a contemporaneous relationship.

From an evaluation of the coefficients, it appears that the significant relationships are not strong except for the United States-West German relationship. The magnitudes of the coefficients are relatively small. This raises doubt as to whether the relationships have economic meaning. Similar to the relationships found on the short-term interest rates, there seems to be a change in the correlations from one time period to another. In the first subperiod, the lead-lag relationships were of a very low level. In the second subperiod is found either a low level relationship or none at all. The third subperiod shows the increase in the interaction of the different financial markets as countries start experiencing more flows of funds with the easing of restrictions and controls between countries. This is evidenced by the larger number of significant cross correlation coefficients at the zero lag.

The cross correlation results in this study do not provide clear evidence of high comovement between holding-period returns. Although the analysis indicates some correlation between the various time series, the comovement is not of a sufficient magnitude to justify a conclusion that the holding-period returns exhibit a strong relationship. Moreover, the degree of comovement is not consistent over the entire time period and for the sample under study. The only time series consistently showing comovement with the bond yield over the entire time period from 1971-78 is the Canadian long-term government bond yield. However, the degree of comovement is not stable over the period. The first subperiod is found to have the highest cross correlation coefficient.

Multivariate Analysis

This section will discuss the transfer functions suggested by the cross correlation analysis performed in the previous section. The transfer functions modeled are shown in Table 18.

The inclusion of the input series in the estimation of the 1971-72 Canadian long-term government bond rate reduces the standard deviation of residuals of the output series. The use of the United

TABLE 18.--Multivariate time series models--Long-term interest rates (Three-month holding-period returns)

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
Canadian Long-Term Government Bond Yield	$y_t = 1.270\ x_t + a_t + .381\ a_{t-1}$	.247%
Swiss Long-Term Confederation Bond Yield	$y_t = .780\ x_t + \frac{(1 - .255B)}{(1 - .526B)}\ a_t$	.502
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
Canadian Long-Term Government Bond Yield	$y_t - .655\ y_{t-1} = .825\ x_t + \frac{(1 - .371B^{11})}{(1 - .242B)} a_t$	.295
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
West German Long Term Public Authority Loan Rate	$y_t = .322\ y_{t-1} = -2.270\ x_t + 5.700\ x_{t-1} + a_t - .549\ a_{t-1}$	.666
Canadian Long-Term Government Bond Yield	$y_t = .610\ x_t + .592\ x_{t-1} + a_t + .237\ a_{t-1}$	.223
Dutch Long-Term Government Loan Rate	$y_t = .861\ x_t + .958\ x_{t-1} + \frac{1}{(1 - .413B)}\ a_t$	.280
Swiss Long-Term Confederation Bond Yield	$y_t = -.195\ x_t + \frac{1}{(1 - .289B)}\ a_t$	

States bond series reduces the statistic from .290 percent to .246 percent. An examination of the mean squared error of the forecasts, as provided in Table 19, reveals an increase with the inclusion of the input series. This fact suggests that the input series does not improve the forecasts of the output series. The second statistic employed to determine the benefit of the transfer function is the variance of the forecast errors. The variance is not consistently smaller with the transfer function, as shown in Table 20. The Theil's U Coefficient for the transfer function in Table 21 is 1.167, which implies worse forecasts than a naive, no-change extrapolative model. Hence, the transfer function is rejected.

In the Swiss transfer function for 1971-72, the amount of reduction in the standard deviation of residuals with the input series is only .001 percent. The reduction in the mean squared error of forecasts is also very small, from .2063 percent to .2007 percent. Although these two statistics point to the benefit of employing an input series in estimating and forecasting the Swiss confederation rates, this implication is not corroborated by the variance of the forecast errors. The variance of the forecast errors is not consistently lower with the inclusion of an input series. Hence, the advantage of using the transfer function is doubtful.

Recall that the cross correlation analysis performed over the second subperiod resulted in no economically significant coefficient except for the United States-Canada relationship. The resulting

TABLE 19.--Mean squared error of the forecast of the output series with and without the input series--Long-term interest rates (three-month holding period returns)

	With Input Series	Without Input Series
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
Canadian Long-Term Government Bond Yield	.0211	.0155
Swiss Long-Term Confederation Bond Yield	.2007	.2063
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
Canadian Long-Term Government Bond Yield	.0598	.0620
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
West German Long-Term Public Authority Loan Rate	.1795	.2334
Canadian Long-Term Government Bond Yield	.0496	.0512
Dutch Long-Term Government Loan Rate	.5134	.5195
Swiss Long-Term Confederation Bond Yield	.1078	.1089

TABLE 20.--Variance of the forecast errors made with and without the input series--Long-term interest rates (three-month holding period returns)

	Lead	With Input Series	Without Input Series
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)			
Canadian Long-Term Government Bond Yield	1	.0804	.0841
	2	.2285	.1682
	3	.3813	.2523
	4	.5453	.3364
Swiss Long-Term Confederation Bond Yield	1	.2593	.2520
	2	.2899	.6302
	3	.3088	1.0402
	4	.3245	1.4576
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)			
Canadian Long-Term Government Bond Yield	1	.0901	.0924
	2	.1014	.2643
	3	.1097	.4712
	4	.1183	.6917
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)			
West German Long-Term Public Authority Loan Rate	1	.4852	.7656
	2	.8458	1.0081
	3	.9360	1.1412
	4	1.0262	1.2743
Canadian Long-Term Government Bond Yield	1	.0534	.0571
	2	.1476	.1331
	3	.2236	.2123
	4	.2996	.2878
Dutch Long-Term Government Loan Rate	1	.2777	.2777
	2	.3569	.8551
	3	.3648	1.5996
	4	.3662	2.4247
Swiss Long-Term Confederation Bond Yield	1	.0788	.0778
	2	.0853	.2031
	3	.0860	.3431
	4	.0861	.4872

TABLE 21.--Theil's U coefficient multivariate time series models--Long-term interest rates (Three-month holding-period Returns)

	Period 1	Period 2	Period 3
West German Long-Term Public Authority Loan Rate	--	--	1.345
Canadian Long-Term Government Bond Yield	1.167	1.143	.975
U. K. Government 3½% War Loan Yield	--	--	--
Franch Long-Term Public Sector Bond Yield	--	--	--
Dutch Long-Term Government Loan Rate	--	--	.760
Swiss Long-Term Confederation Bond Yield	.947	--	.971

transfer function is reported in the second panel of Table 18. The reduction in the residual standard deviation with the input series is only .009 percent. The mean squared error of forecasts is reduced from .0620 percent to .0598 percent. The advantage of the transfer function over the univariate model is reinforced by the lower variance of forecast errors.

Four transfer functions are modeled for the third subperiod. These include that of West Germany, Canada, the Netherlands, and Switzerland. Only in the case of West Germany is there an output lag parameter. This parameter points out the contribution of the latest previous observation of the output series in the generation of the current observation for the output series. In general, the output series are highly affected by the level of the current and latest previous observations of the input series.

Only in the time series for Switzerland is the residual standard deviation increased with the transfer function. This suggests that the univariate model estimates the time series better than the transfer function. This result, however, does not necessarily negate the use of the transfer function. Validation of the conclusion suggested by the residual standard deviation can be derived from the mean squared error of forecasts, the variance of the forecast errors, and the Theil's U Coefficient. Table 19 reveals that the mean squared error of forecasts with the leading input series is .1078 percent, as compared to .1089 percent without the leading input series. The leading input series does reduce the error of the forecasts, but the magnitude of the reduction is quite small. The Theil's U coefficient equals .971 which indicates better forecasts than a naive, no-change extrapolative model. However, the variance of the forecast errors provides a contradictory finding. With a one-week lead time, the variance is higher with the leading input series. The conflicting results render the benefit of the transfer function for forecasting suspect.

In the case of the transfer function for both West Germany and the Netherlands, the standard deviation of residuals is reduced slightly with the inclusion of the United States bond rate as the input series. This reduction suggests that the input series helps in the estimation of the process underlying the output series, a finding that is corroborated by the mean squared error of forecasts. With the leading input series, the mean squared error of the forecasts decreased from .2334 percent to .1795 percent for the West German public authority loan rate, and from .5195 percent to .5134 percent for the Dutch long-term government bond yield. The Theil's U coefficient of forecast accuracy also showed improvements over their univariate counterparts. The implications of the standard deviations of residuals,the mean squared errors of forecasts, the Theil's U coefficient are supported by the variance of the forecast errors. The transfer functions for the West German and the Dutch bond rates provide consistently lower variances of forecast errors than do the univariate models for these time series.

The transfer function for the Canadian government bond rate shows a standard deviation of residuals, a mean squared error of forecasts, and a Theil's U coefficient lower than the forecasts employing the univariate model. However, the variance of the forecast errors does not corroborate these findings, as it is not consistently lower as the lead times are varied. The benefit of the transfer function for forecasting and decision-making purposes are therefore subject to question.

Summary

In the examination of the relationship among various long-term interest rates, three different holding periods were assumed. These are three months, six months, and one year. In this chapter, the relationship between the United States and foreign three-month holding-period returns was investigated. To adjust for differential exchange rates, three-month forward exchange rates were used as proxies for the exchange rates expected to prevail three months hence.

The univariate analysis provided the models characterizing the underlying processes of each of the time series. These models were employed in the cross correlation analysis. The United States constant maturity bond yield was used as the input series, while the foreign three-month holding-period returns were each used as the output series. The number of lead-lag relationships was found to increase from 1971-72 to 1975-78. Moreover, the relationships were either of a contemporaneous or a feedback-feedforward nature. Whereas in the 1975-78 period, the United States bond yield was contemporaneously related to the West German and the Swiss bond rates, its relationship with the Dutch and Canadian rates was of a feedback-feedforward nature. The relationships were not consistent over the entire time period under study except for the case of the United States-Canadian cross correlation relationship.

The results of the cross correlation analysis form the basis for the modeling of transfer functions. The transfer functions constructed for the Canadian government bond yield in 1973-75, the West German public authority loan rate and the Dutch government loan rate in 1975-78 were found to provide better forecasts than their univariate models. The other transfer functions were rejected due to the inconsistencies found in the standard deviation of residuals, the mean squared error of forecasts, the variance of the forecast errors, and the Theil's U coefficient of forecast accuracy.

CHAPTER VI

LONG-TERM INTEREST RATES
SIX-MONTH HOLDING PERIOD

The hypothesis states that foreign long-term adjusted interest rates adjust instantaneously to changes in the United States bond rate. This chapter specifically examines the lead-lag relationship between the United States and foreign interest rates, assuming a six-month holding period. In order to do this, the nondollar interest rate series are adjusted for exchange rate differentials using six-month forward exchange rates as the proxy for exchange rate expectations. The results of the analysis are discussed in the sections that follow.

Univariate Analysis

Table 22 contains the univariate models underlying each of the time series in the study. Due to the unavailability of six-month forward exchange rate data for France and the Netherlands during the 1971-72 period, the univariate analyses of the French public sector bond yield and the Dutch government loan rate start with the second subperiod.

The United States constant maturity bond yield was discussed in the previous chapter. In summary, the first two subperiods are

TABLE 22.--Univariate time series models long-term interest rates--(Six-month holding period returns)

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - 1.289\, z_{t-1} + .289\, z_{t-2} = a_t$	.109%
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t$	.530
3. Canadian Long-Term Government Bond Yield	$z_t - z_{t-1} = a_t$	.238
4. U. K. Government 3½% War Loan Yield*	$z_t - z_{t-1} = a_t$	1.067
5. French Long-Term Public Sector Bond Yield	--	
6. Dutch Long-Term Government Loan Rate	--	
7. Swiss Long-Term Confederation Bond Yield	$z_t - z_{t-1} = a_t$	.483

TABLE 22.--Continued

Series	Model	Standard Deviation of Residuals
B. Period 2: January 5, 1973 - October 4, 1975 (n = 92)		
1. U. S. 10-Year Constant Maturity Bond Yield	$z_t - 1.428\ z_{t-1} + .428\ z_{t-2} = a_t$	.067%
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t$	.725
3. Canadian Long-Term Government Bond Yield	$z_t - z_{t-1} = a_t$	.332
4. U. K. Government 3½% War Loan Yield	$z_t - .609\ z_{t-1} - .391\ z_{t-2} - z_{t-4}$	
	$+ .609\ z_{t-5} + .391\ z_{t-6} = a_t - .843\ a_{t-4}$	.647
5. French Long-Term Public Sector Bond Yield	$z_t - z_{t-1} = a_t - .217\ a_{t-9}$	.937
6. Dutch Long-Term Government Loan Rate	$z_t - z_{t-1} = a_t$	.630
7. Swiss Long-Term Confederation Bond Yield	$z_t - z_{t-1} - z_{t-4} + z_{t-5} = a_t - .299\ a_{t-1}$	.717
	$- .649\ a_{t-4} + .192\ a_{t-5}$	

TABLE 22.--Continued

Series	Model	Standard Deviation of Residuals
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - z_{t-1} = a_t$	.100%
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t$	.991
3. Canadian Long-Term Government Bond Yield	$z_t - z_{t-1} = a_t$	.284
4. U. K. Government 3½% War Loan Yield	$z_t - z_{t-1} = a_t$	.616
5. French Long-Term Public Sector Bond Yield	$z_t - z_{t-1} = a_t$	.803
6. Dutch Long-Term Government Loan Rate	$z_t - z_{t-1} = a_t + .299\ a_{t-2}$	.528
7. Swiss Long-Term Confederation Bond Yield	$z_t - z_{t-1} = a_t$	.313

*n = 61.

characterized by autoregressive integrated models. Because the magnitude of the autoregressive parameter is relatively small in the first subperiod, the model may be considered a "noisy" random walk process. The third subperiod can be described as generated by a random walk model. Contrary to expectations, the second subperiod exhibited less volatility as revealed by the standard deviation of residuals.

The West German long-term public authority loan rate is characterized by random walk models for all three subperiods. The period of most volatility, which is measured in terms of the magnitude of the standard deviation of residuals, is the third subperiod. There is a gradual increase in the variability of the residuals from the first time period to the third time period. This increase is unusual since the 1973-75 period is generally considered the more volatile period.

The Canadian government bond yield exhibits little variation in volatility in all three time periods. The range of the standard deviation of residuals extends over an interval of .238 percent to .332 percent. All three time periods are characterized by random walk models. The first subperiod for the United Kingdom war loan yield exhibits a much higher volatility than the other time periods. In many of the time series examined, because the second subperiod shows more instability, the time series proved to be more difficult to model. In the United Kingdom long-term interest rate series, however, the first subperiod is more unstable but is characterized by a simple random walk model. The second subperiod is much less volatile, but is characterized by a more complex model: an autoregressive integrated moving average model with first order regular differencing and fourth order seasonal differencing. The model suggests that the observation of the current period is determined by previous observations up to the fifth period back and by the current disturbance and the fourth disturbance back. The third subperiod is the lowest in volatility and is characterized by a random walk model.

The French public sector bond yield has observations only from 1973 to 1978. The second subperiod, 1973-75, is characterized by an integrated moving average model, while the third subperiod reveals a random walk model. The model for the 1973-75 period has a statistically significant moving average parameter but in all practical sense, the model may be considered a "noisy" random walk model. The volatility in the second subperiod is evidenced by the higher standard deviation of residuals in that time period. However, note that the difference between the standard deviations of residuals in the second and third subperiods is small.

The Dutch long-term government loan rate is characterized by a random walk model in the second subperiod and by an integrated moving average model in the third subperiod. The standard deviations of residuals show that the third subperiod is less volatile than the second subperiod. However, the difference in the degree of volatility is small.

Finally, the Swiss long-term confederation bond yield is considered. The underlying stochastic processes characterizing the series in the first and third subperiods is the random walk model. The 1973-75 time period is described by an integrated moving average model with first order regular differencing and fourth order seasonal differencing. This model indicates that the current value of the time series is a weighted combination of previous observations up to the fifth period back and disturbances starting with the current period up to the fifth period back. Note, however, that the parameter coefficients for the t-5 disturbance term at .192 is not large and hence, has little economic meaning. The second subperiod exhibits more instability as expected.

Looking at the time series models in Table 22, it can generally be stated that the second subperiod shows more volatility as originally expected, except for the case of the United States and West German interest rates. Comparing the standard deviations of residuals of the first and third subperiods, the magnitudes of this statistic are larger for the first subperiod, which can probably be explained by the events that led to the instability of the second subperiod (including the inconvertibility and the devaluation of the United States dollar). The models for the second time period also appear to be more complex in structure than the other time periods, which is explained by the events that affected the level of interest rates and exchange rates. The events during this time period affected different countries in different ways such that a wide range of volatility arose in the behavior of the time series under examination.

The Theil's U coefficient is calculated to test for forecast accuracy, the results of which are shown in Table 23. Two univariate models are found to perform worse than a naive, no-change extrapolative model. That is, all models except the Swiss confederation bond yield for 1973-75 and the Dutch loan rate for 1975-78 can perform at least as well as a simple random walk model. Nevertheless, the two univariate models are considered the underlying stochastic processes to best describe the generation of the respective time series in the particular time periods. These models are employed as the underlying models in the cross correlation analysis in the next section.

Cross Correlation Analysis

The residuals from the time series models set forth in Table 22 and discussed in the previous section are cross correlated to determine their time lead-lag relationship. This procedure is also used to determine whether a transfer function can be constructed. The United States constant maturity bond yield is used as the input series while the foreign holding-period returns are each used as the output series.

Panel A of Table 24 reveals that only West Germany, Switzerland, and Canada have significant coefficients. The analysis shows that the West German bond yield is correlated with the United States bond rate at the plus thirteen and fourteen lags. However, the coefficient at plus thirteen lag does not show the correct sign. Although the negative sign does raise questions as to the economic meaning of the relationship, the impulse response weights near this particular

TABLE 23.--Theil's U Coefficient for the univariate time series models--long-term interest rates (six-month holding period returns)

	Period 1	Period 2	Period 3
1. U. S. 10-year Constant Maturity Bond Yield	.830	.900	1.000
2. West German Long-Term Public Authority Loan Rate	1.000	1.000	1.000
3. Canadian Long-Term Government Bond Yield	1.000	1.000	1.000
4. U. K. Government 3½% War Loan Yield	1.000	.980	1.000
5. French Long-Term Public Sector Bond Yield	--	.915	1.000
6. Dutch Long-Term Government Loan Rate	--	1.000	1.026
7. Swiss Long-Term Confederation Bond Yield	1.000	1.214	1.000

TABLE 24.--Cross correlations of weekly interest rates--January 29, 1971 - November 24, 1978 (Six-month holding-period returns) (Input in U. S. 10-year constant maturity bond yeild

Lag	West German Long-Term Public Authority Loan Rate	Canadian Long-Term Government Loan Rate	United Kingdom Government 3½% War Loan Yield	French Long-Term Public Sector Bond Yield	Dutch Long-Term Government Loan Rate	Swiss Long-Term Confederation Bond Yield
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)						
-13	.210	-.095	-.032			.290
-12	.028	-.003	.040			.166
-11	.013	.070	-.026			-.021
-10	-.009	.004	-.031			-.011
- 9	.033	-.090	-.062			-.068
- 8	-.167	.053	.006			.038
- 7	.077	.007	.085			.133
- 6	-.185	-.035	.018			-.002
- 5	.031	.005	.090			.110
- 4	-.020	-.032	.140			-.102
- 3	.012	.001	.047			-.132
- 2	.108	-.041	-.104			.033
- 1	.055	.142	-.016			-.006
0	-.060	.390*	.070			-.002
+ 1	.045	.022	-.056			-.007
+ 2	-.208	-.166	.046			-.178
+ 3	.066	.229	.056			.017
+ 4	.131	-.104	-.002			.081
+ 5	-.045	-.009	.068			-.035
+ 6	.126	.089	-.026			.108
+ 7	-.095	-.067	-.104			-.077
+ 8	.020	.141	.045			.039
+ 9	.030	-.008	.070			-.074
+10	-.022	-.063	-.049			-.060
+11	.080	.373*	-.096			.110
+12	.101	-.142	-.007			.082
+13	-.292*	-.038	-.027			-.153
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)						
-13	.028	.037	-.099	-.046	.053	.009
-12	-.029	-.098	.120	-.034	.004	-.016
-11	.017	-.066	.004	-.055	-.055	-.034
-10	.054	-.107	-.085	.009	.021	.025
- 9	.054	.015	.150	.148	.050	-.015
- 8	.086	.110	-.179	-.105	.104	.110
- 7	.047	-.023	.068	-.055	.067	.133
- 6	.126	-.026	-.010	.002	.066	.027
- 5	.087	-.022	-.008	.056	.071	.081
- 4	.107	.077	.062	.003	.050	.155
- 3	.099	.204	-.052	-.032	.140	.189
- 2	.047	.119	.016	.125	.112	.158
- 1	.197	.141	-.071	.124	.176	.097
0	.254*	.250*	.300*	.174	.052	.076
+ 1	.077	.140	-.030	-.057	.007	.030
+ 2	-.111	-.021	.004	.028	.085	.018
+ 3	-.012	-.017	-.050	.150	-.035	-.005

TABLE 24.--Continued

Lag	West German Long-Term Public Authority Loan Rate	Canadian Long-Term Government Loan Rate	United Kingdom Government 3½% War Loan Yield	French Long-Term Public Sector Bond Yield	Dutch Long-Term Government Loan Rate	Swiss Long-Term Confederation Bond Yield
+ 4	.070	.099	.027	-.246*	-.083	.008
+ 5	-.048	-.006	.075	.067	-.046	.054
+ 6	-.017	.127	-.024	.003	.079	-.111
+ 7	.039	-.009	.026	.004	.034	.033
+ 8	-.104	.047	-.064	-.077	.018	.025
+ 9	-.004	-.055	.083	.057	.050	-.136
+10	.080	.014	-.011	-.040	.045	.180
+11	.012	-.087	-.063	-.068	-.060	-.134
+12	.090	-.026	.185	.044	.087	.071
+13	-.064	-.009	-.120	.089	-.079	.017
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)						
-13	.019	-.014	.086	.002	-.105	.194*
-12	-.000	-.023	.025	.107	.035	.056
-11	.018	.058	.050	.055	.008	-.032
-10	.054	.124	-.038	-.018	.043	.019
- 9	-.063	-.001	.134	-.052	-.012	-.013
- 8	-.020	-.164	-.117	.013	-.103	-.138
- 7	.079	.031	.043	.070	-.014	.043
- 6	-.059	-.130	-.101	-.029	-.129	.009
- 5	-.019	-.099	.060	.081	.080	-.012
- 4	-.011	-.108	-.166	.075	-.206*	-.018
- 3	-.029	.069	-.003	-.034	.069	.024
- 2	-.198*	.040	.140	.112	-.048	.056
- 1	.535*	.076	.096	-.057	-.082	.044
0	.390*	.418*	.116	.148	.398*	.197*
+ 1	.022	.095	.050	-.005	.055	.011
+ 2	-.166	.051	-.086	.109	.116	.017
+ 3	.228*	.114	-.118	-.102	-.074	.073
+ 4	-.104	-.014	-.057	-.031	-.071	.090
+ 5	-.009	-.092	.048	.013	.006	.070
+ 6	.089	-.013	.025	.166	-.075	.087
+ 7	-.067	.027	.006	-.021	.052	-.058
+ 8	.141	-.042	.004	-.074	-.031	-.031
+ 9	-.008	.092	.119	.134	.030	-.065
+10	-.063	.058	.098	.012	.075	-.053
+11	.373*	.046	.035	-.043	.125	-.003
+12	-.142	.037	.077	.081	.194*	.173
+13	-.038	-.076	.044	-.021	.067	.027

*Indicates that the correlation coefficient is statistically significant at the 95 percent level.

lag do show sizable magnitudes. In addition, the significant coefficient at plus fourteen lag could very well be related to the significant coefficient at plus thirteen lag. Hence, the relationship at plus thirteen and fourteen lags is further examined in the section on multivariate analysis.

In the case of the United States and Swiss long-term rate relationship, the series are significantly correlated at the minus thirteen lag. This implies that the United States bond rate lags behind the Swiss confederation bond rate by thirteen weeks, or about one quarter. This lag structure provides an opportunity to decision makers only if the relationship can be transformed into a forecasting function. The impulse response weights were examined to determine if such a transfer function is possible. The magnitude of the weights was found to be rather small; thereby rendering impossible the construction of a transfer function characterizing the lead-lag structure.

The significant coefficient at lag zero for the United States-Canadian cross correlation analysis indicates that the two time series have a contemporaneous relationship. The coefficients at plus eleven lag also signifies some possible relationship. An examination of the impulse response weights shows no discernible pattern. Hence, the coefficient is most likely spurious.

During the second subperiod, there is an increase in the number of time series found to have lead-lag relationships with the United States bond rate. Three of the time series--the West German loan rate, the United Kingdom war loan yield, and the Canadian government bond yield--show contemporaneous relationships with the United States bond rate. Their lag zero coefficients all show statistical as well as economic significance.

The United States-France cross correlation coefficient at plus four lag is statistically significant but bears the wrong sign. Despite the negative sign, it is conceivable that the United States bond rate would lead the French bond rate by a period of four weeks. A discernible pattern in the impulse response weights characterizing the cross correlation may be an indication of a significant relationship. Such is the case with the United States-French relationship, which is further examined in the next section.

For the third subperiod, 1975-78, all the nondollar time series show some relationship with the United States bond rate except for the United Kingdom and France (see Table 24, Panel C).

In the cross correlation analysis of the United States and the West German rates, significant coefficients are found at the minus two, minus one, zero, and plus eleven lags. The minus two lag is considered spurious because it carries the wrong sign. The fact that the other significant coefficients bear the correct sign and are relatively large in magnitude indicates that there exist a feedback-feedforward relationship between the United States bond rate and the West German loan rate.

The cross correlation analysis of the United States and Dutch time series reveals significant coefficients at minus four, zero, and plus twelve lags. The coefficient at minus four lag bears the wrong sign and hence is considered spurious. The lag zero coefficient suggests a contemporaneous relationship. Since a lag of twelve weeks is close to a quarter lag period, the coefficient may suggest benefits for forecasting. However, the impulse response weights do not show a discernible pattern. Moreover, the fact that the coefficient is barely significant at the 95 percent confidence level adds doubt to the benefit of a transfer function.

Finally, the United States-Canada cross correlation analysis shows that the two time series are contemporaneously related. The relationship is evidenced by the significance of the coefficients at the zero lag.

For the overall time period from 1971 to 1978, the number of coefficients signifying a relationship between the interest rate series increases from the earliest subperiod to the latest subperiod. The strength of the relationships also tends to increase. Larger cross correlation coefficients characterize the relationships in the third subperiod, 1975-78. This is possibly a consequence of the development that is evident in the "opening" of the different financial markets as policies began to be geared toward those both of a national and international nature, as controls on foreign exchange and funds flow began to ease up, and as benefits of international trade began to be emphasized.

It appears that the Canadian government bond yield is the only time series exhibiting consistency in its relationship with the United States bond rate. In all three time periods, the relationship is at the zero lag, indicating a contemporaneous relationship. This is expected since Canada has always been closely linked with the United States. Events affecting the United States market also strongly affects the Canadian market.

Multivariate Analysis

The transfer functions modeled based on the cross correlation analysis are set forth in Table 25. Consider the transfer functions for 1971-72. The multivariate analysis applied to the West German public authority loan rate reveals that although the sign of the correlation coefficient is wrong, the importance of the coefficient is reflected in the significance of the coefficient for the thirteenth lag input value in estimating the output series. The transfer function depicts this finding. However, whether the thirteenth lag input value does make the transfer function a better model characterizing the process generator of the West German loan rate is questioned when attention is directed to the standard deviation of residuals. The transfer function, in comparison to the univariate model, does not reduce the standard deviation of residuals. With respect to the forecasting ability, the mean squared error of the forecasts with a leading input series (.2235 percent) is lower than that without a leading input series (.2353 percent), as shown in Table 26. However, Table 27 reveals that the advantage of the transfer function over the univariate model is not reflected in the variance of the forecast errors. Moreover, the Theil's U coefficient is found to be higher than the coefficient based on the univariate model, indicating worse forecasts than the univariate

TABLE 25.--Multivariate time series models--Long-term interest rates (Six-month holding-period returns)

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
West German Long-Term Public Authority Loan Rate	$y_t - .299\ y_{t-1} = .999\ x_{t-13} + a_t$	.561%
Canadian Long-Term Government Bond Yield	$y_t = .793\ x_t + a_t + .253\ a_{t-1}$	.213
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
West German Long-Term Public Authority Loan Rate	$y_t - .234\ y_{t-1} = 3.410\ x_t + a_t$	.676
Canadian Long-Term Government Bond Yield	$y_t = 1.690\ x_t + a_t$	.310
U. K. Government 3½% War Loan Yield	$y_t = 1.240\ x_t + \frac{(1 + .241\ B^4)}{(1 + .372B)}\ a_t$	.583
French Long-Term Public Sector Bond Yield	$y_t = .557\ x_{t-4} + a_t$	.960

TABLE 25.--Continued

Series	Model	Standard Deviation of Residuals
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
West German Long-Term Public Authority Loan Rate	$y_t = -1.330\ x_t + 6.020\ x_{t-1} - 2.710\ x_{t-2} + a_t - .626\ a_{t-1}$	.663
Canadian Long-Term Government Bond Yield	$y_t = 1.230\ x_t + a_t$	.256
Dutch Long-Term Government Loan Rate	$y_t = 1.990\ x_t + a_t + .237\ a_{t-2}$	.458
Swiss Long-Term Confederation Bond Yield	$y_t = .612\ x_t + a_t$	.307

TABLE 26.--Mean squared error of the forecast of the output series with and without the input series (Long-term interest rates, six-month holding-period returns)

	With Input Series	Without Input Series
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
West German Long-Term Public Authority Loan Rate	.2235	.2353
Canadian Long-Term Government Bond Yield	.0136	.0123
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
West German Long-Term Public Authority Loan Rate	.1727	.1565
Canadian Long-Term Government Bond Yield	.0472	.0443
U. K. Government 3½% War Loan Yield	.5792	.5499
French Long-Term Public Sector Bond Yield	1.0161	1.0427
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
West German Long-Term Public Authority Loan Rate	.2128	.0829
Canadian Long-Term Government Bond Yield	.0659	.0659
Dutch Long-Term Government Loan Rate	.3336	.3405
Swiss Long-Term Confederation Bond Yield	.1533	.1533

TABLE 27.--Variance of the forecast errors made with and without the input series--Long-term interest rates (Six-month holding-period returns)

	Lead	With Input Series	Without Input Series
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)			
West German Long-Term Public Authortiy Loan Rate	1	.3267	.2809
	2	.6716	.5618
	3	1.0235	.8427
	4	1.3777	1.1236
Canadian Long-Term Government Bond Yield	1	.0529	.0566
	2	.1368	.1132
	3	.2225	.1698
	4	.3087	.2264
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)			
West German Long-Term Public Authority Loan Rate	1	.5093	.5256
	2	1.1108	1.0512
	3	1.7406	1.5768
	4	2.3740	2.1024
Canadian Long-Term Government Bond Yield	1	.1090	.1102
	2	.2313	.2204
	3	.3607	.3306
	4	.4935	.4408
U. K. Government 3½% War Loan Yield	1	.3468	.4186
	2	.4079	.4415
	3	.4729	.4672
	4	.5396	.4677
French Long-Term Public Sector Bond Yield	1	.9230	.8780
	2	1.8474	1.7560
	3	2.7726	2.6340
	4	3.6982	3.5120

TABLE 27.--Continued

	Lead	With Input Series	Without Input Series
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)			
West German Long-Term Public Authority Loan Rate	1	.4573	.9821
	2	.7388	1.9642
	3	1.3479	2.9463
	4	1.4094	3.9284
Canadian Long-Term Government Bond Yield	1	.0806	.0807
	2	.1461	.1614
	3	.2116	.2421
	4	.2771	.3228
Dutch Long-Term Government Loan Rate	1	.2777	.2786
	2	.5158	.5572
	3	.8801	1.0273
	4	1.2444	1.4974
Swiss Long-Term Confederation Bond Yield	1	.0979	.0980
	2	.1921	.1960
	3	.2863	.2940
	4	.3805	.3920

TABLE 28.--Theil's U coefficient multivariate time series models--Long-term interest rates (Six-month holding-period returns

	Period 1	Period 2	Period 3
West German Long-Term Public Authority Loan Rate	.975	1.050	1.611
Canadian Long-Term Government Bond Yield	1.053	1.032	1.000
U. K. Government 3½% War Loan Yield	--	1.006	--
French Long-Term Public Sector Bond Yield	--	.987	--
Dutch Long-Term Government Loan Rate	--	--	1.015
Swiss Long-Term Confederation Bond Yield	--	--	1.000

model. The conflicting results from the statistics render suspect the use of a transfer function in estimating and forecasting the West German public authority loan rate.

The Canadian transfer function for 1971-72 shows that its current value is determined by the current value of the input series. The reduction in the standard deviation of residuals with an input series is .025 percent, implying some benefit is derived from the additional information provided by the input series. The additional benefit is also reflected in the variance of the forecast errors and the Theil's U coefficient. A conflict arises from the mean squared error of forecasts. The transfer function is found to have a higher mean squared error of forecasts (.0136 percent) than the univariate model (.0123 percent). The contradiction makes the employment of the transfer function doubtful.

Four transfer functions were modeled for the second subperiod. The multivariate model characterizing the West German loan rate includes an output lag parameter. The sizable coefficient for the input series indicates its importance in the estimation of the output series. The same case applies for the Canadian government bond rate and the United Kingdom war loan yield. The transfer function for the United Kingdom loan rate is a complex model. Similar to the other models for the time period, the current value of the United States bond rate helps in determining the values of the time series. However, the noise model includes both an autoregressive parameter and a fourth order seasonal parameter. Each of the above three transfer functions exhibits standard deviations of residuals that are lower than that of their respective univariate models. Although the reductions in this statistic are not large, they show the advantage of using an additional variable in the estimation. However, the advantage of using a transfer function is not borne out by the mean squared error of forecasts and the variance of forecast errors. In Tables 26 and 27, it is shown that the transfer functions have higher values for these statistics. Moreover, the Theil's U coefficients are all greater than one. The evidence does not clearly support the benefit of employing a transfer function.

The last transfer function for 1973-75 depicts the relationship between the United States bond rate and the French bond yield. The coefficient for the fourth lag input value shows up as significant. However, the transfer function performs worse than the univariate model in estimating the output series as reflected in the standard deviation of residuals. Looking at the mean squared error of the forecasts, note that the statistic shows a small decrease, and the Theil's U coefficient also shows an improvement. However, the variance of the forecast errors increased with the leading input series. The unclear support for the transfer function makes its acceptability dubious.

Four transfer functions are modeled for the third time period, 1975-78. These transfer functions confirm the findings of the cross correlation analysis, that the West German, Canadian, Dutch, and Swiss long-term interest rate series are contemporaneously related to the United States bond rate.

The West German model shows that not only is the contemporaneous input value important, but so are the t-1 and t-2 observations. In fact, the magnitude of the parameter coefficients points to their being more important than the current input value. As shown in Table 25, the transfer function led to a reduction in the standard deviations of residuals. The mean squared error of the forecasts is higher with the input series than it is without the input series. The disadvantage of including the input series is corroborated by the Theil's U coefficient. However, the variance of the forecast errors decreased using the transfer function. These contradictions in the statistics raise doubts on the use of the transfer function for decision-making purposes.

The Canadian and Swiss transfer functions both depend for their values on the current input observation and the current disturbance of the output series. The Canadian transfer function reduces the standard deviation of residuals by about .028 percent, while the Swiss transfer function reduces the statistic by .006 percent. The beneficial effect of using the United States bond rate as an input is further elaborated by the mean squared error of forecasts and the variance of the forecast errors. The statistics indicate that the input series--the United States constant maturity bond yield--is able to contribute to the estimation and forecasting of the Canadian government bond yield and the Swiss confederation bond yield. Hence, the transfer functions are acceptable.

The Dutch transfer function is determined significantly by the current value of the input series. In addition, it has one other parameter in the noise model: the t-2 disturbance term, which is an offshoot from the univariate model for the time series. The time series is an integrated second order seasonal moving average model in the univariate analysis. Since the seasonality is not accounted for in any way through an output lag parameter, it is reflected in the noise model. The transfer function for the time series is considered better for both estimating and forecasting the Dutch long-term rates. The standard deviation of residuals decreased from .528 percent to .488 percent. Moreover, the mean squared error of forecast also decreased, from .3405 percent to .3336 percent. There is also an improvement in the Theil's U coefficient. With varying lead times, the model with the input series showed a lower variance of forecast errors.

Summary

The lead-lag relationship between the United States interest rate and six-month holding-period returns is examined in this chapter. Six-month forward exchange rates were used as proxies for the exchange rates expected to prevail in six months.

In the 1971-72 period, the West German, Swiss, and Canadian holding-period returns were found to be correlated with the United States bond rate at various lags. The correlations, however, did not produce transfer functions that can provide better forecasts than the respective univariate models, suggesting that lead-lag relationships were not strong enough.

In the 1973-75 period, the United States bond rate is found to be contemporaneously related to the West German, the United Kingdom, and the Canadian holding-period returns. This implies that these rates adjust instantaneously to changes in the United States bond rate. The transfer functions modeled based on the cross correlation analysis did not unequivocally show the benefit of using the United States rate to estimate and forecast the foreign holding-period return.

In the third time period, 1975-78, an increase in the number of significant cross correlation coefficients is noted. The United States bond rate is found to be contemporaneously related to the Dutch, Swiss, and Canadian rates. The transfer functions for these time series are preferred over their univariate models for forecasting. The relationship between the United States and West German rates is a complex one, with significant coefficients at the minus, zero, and plus lags, thereby implying a feedback-feedforward relationship.

Assuming a six-month holding period, the strength of the relationship between the time series is found to increase from the 1971-72 period to the 1975-78 period. Consequently, the transfer functions modeled in the third subperiod produced better forecasts of the time series than their univariate models. The use of the United States bond rate as an input series in the modeling of the foreign interest rates is able to improve forecasting, thereby indicating their benefit for decision-making purposes.

CHAPTER VII

LONG-TERM INTEREST RATES
ONE-YEAR HOLDING PERIOD

The hypothesis with respect to long-term interest rates states that there is contemporaneous adjustment of foreign interest rates to changes in the United States interest rates. The relationship between United States interest rates and holding-period returns of three months and six months was examined in Chapters V and VI. This chapter will assume that long-term financial instruments are held for one year. The lead-lag structures characterizing the relationship of long-term interest rates with a holding period of one year will be evaluated. Nondollar interest rates are adjusted by one-year forward exchange rates to account for expected exchange rates. Due to the unavailability of one-year forward exchange rates for the 1971-72 period, the analysis centers around two time periods only, 1973-75 and 1975-78.

Univariate Analysis

The univariate models assuming a one-year holding period are reported in Table 29. The United States constant maturity bond yield was discussed in detail in Chapter V; hence it will be reiterated here only very briefly. The United States bond yield is

TABLE 29.--Univariate time series models--Long-term interest rates (One-year holding-period returns)

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - 1.428\ z_{t-1} + .428\ z_{t-2} = a_t$	.067%
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t$	.471
3. Canadian Long-Term Government Bond Yield	$z_t - z_{t-1} = a_t$	.243
4. U. K. Government 3½% War Loan Yield	$z_t - 1.518\ z_{t-1} - .116\ z_{t-2} + .482\ z_{t-3}$ $= a_t - .866\ a_{t-1}$	.404
5. French Long-Term Public Sector Bond Yield	$z_t - z_{t-1} = a_t$	.605
6. Dutch Long-Term Government Loan Rate	$z_t - z_{t-1} = a_t$	.466
7. Swiss Long-Term Confederation Bond Yield	$z_t - z_{t-1} - z_{t-4} + z_{t-5} = a_t - .805\ a_{t-4}$	.491

TABLE 29.--Continued

Series	Model	Standard Deviation of Residuals
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
1. U. S. 10-year Constant Maturity Bond Yield	$z_t - z_{t-1} = a_t$	.100
2. West German Long-Term Public Authority Loan Rate	$z_t - z_{t-1} = a_t$	.978
3. Canadian Long-Term Government Bond Yield	$z_t - z_{t-1} = a_t$	.247
4. U. K. Government 3½% War Loan Yield	$z_t - z_{t-1} = a_t$	.444
5. French Long-Term Public Sector Bond Yield*	$z_t - .362\ z_{t-1} - .638\ z_{t-2} = a_t + .437\ a_{t-1}$	.459
6. Dutch Long-Term Government Loan Rate	$z_t - z_{t-1} = a_t$	.406
7. Swiss Long-Term Confederation Bond Yield	$z_t - z_{t-1} = a_t$	.242

*n = 140

characterized by an autoregressive integrated model in the second time period. The model results in residuals having a standard deviation of .069 percent. The coefficient for the autoregressive parameter is both statistically and economically significant. During the third subperiod, the process generating the time series is a random walk model. The standard deviation of residuals is .094 percent which is higher than that of the second subperiod. It is unusual for the third subperiod to be more volatile than the second subperiod.

The models characterizing the West German bond rate are random walks in both time periods. The standard deviations of residuals exhibit the same behavior as the United States bond rate. The statistic is higher in the third subperiod than in the second subperiod, which is also characteristic of the long-term interest rate for West Germany assuming a six-month holding period.

The Canadian government bond yield has similar characteristics to the West German loan rate, as both can be described by random walk models and as having more volatility in the third subperiod. But unlike the West German time series, the degrees of volatility in the second and third time periods are low and virtually equal.

The United Kingdom government loan yield is found to be stationary only after a second order regular differencing is applied during the 1973-75 period. The model is an autoregressive integrated moving average model. It should be pointed out that in the ultimate model, the coefficient for the t-2 parameter has a value of

.116, which is very small and, hence, has little economic significance. The 1975-78 subperiod is described by a random walk process. For all practical purposes, the two time periods can be considered to have the same level of volatility.

The French public sector bond yield is characterized by a random walk process in the second subperiod and by an autoregressive integrated moving average model in the third subperiod. The volatility is of the expected behavior, with a higher standard deviation of residuals in the second subperiod than in the third subperiod.

The process generating the Dutch long-term government loan rate is a random walk in both time periods. The second subperiod exhibits more volatility.

The Swiss long-term confederation bond yield also shows more volatility in the second subperiod. The time series in this period is described as an integrated seasonal moving average model with one order regular differencing and a fourth order seasonal differencing. The 1975-78 period is modeled as a random walk process.

The Theil's U coefficient of forecast accuracy is calculated for each of the univariate models discussed above, as shown in Table 30. Generally, the models can predict at least as well as a naive, no-change extrapolative model. There are three exceptions, namely, the United Kingdom loan rate for 1973-75, the Swiss confederation bond yield for 1973-75, and the French public sector bond yield for 1975-78. Recall that these three models are the more complex models. The Theil's U coefficients for these time series models are

TABLE 30.--Theil's U coefficient for the Univariate Time Series Models--Long-term interest rates (One-year holding-period returns)

	Period 1	Period 2	Period 3
1. U. S. 10-year Constant Maturity Bond Yield	--	.900	1.000
2. West German Long-Term Public Authority Loan Rate	--	1.000	1.000
3. Canadian Long-Term Government Bond Yield	--	1.000	1.000
4. U. K. Government 3½% War Loan Yield	--	1.012	1.000
5. French Long-Term Public Sector Bond Yield	--	1.000	1.079
6. Dutch Long-Term Government Loan Rate	--	1.000	1.000
7. Swiss Long-Term Confederation Bond Yield	--	1.029	1.000

greater than one, which implies poorer forecasts than a simple random walk model. Regardless of the statistic, these univariate models are accepted because they best describe the process generating the respective time series.

The next section discusses the cross correlation analysis performed employing the univariate models found in Table 29.

Cross-Correlation Analysis

Table 31 provides evidence on the types of relationships that exist between the United States bond rate and the foreign holding-period returns.

The first panel of the table depicts the cross correlation coefficients for the second subperiod, 1973-75. Three of the non-dollar time series appear to have some relationship with the United States bond rate. These are the West German public authority loan rate, the French public sector bond yield, and the Canadian government bond yield. The coefficients are statistically significant, although relatively small. In the United States-West German cross correlation analysis, a significant coefficient appears at the minus one lag. The coefficient is barely significant at the 95 percent confidence level. Moreover, an examination of the impulse response weights reveals that this coefficient is most likely spurious. The significant coefficient at minus three lag for the United States-Canada cross correlation analysis is evaluated in the same manner and is also found to be spurious. The West German, the French, and the Canadian

TABLE 31.--Cross correlation of weekly interest rates January 5, 1973 - November 24, 1978 (One-year holding period returns) (Input in U. S. 10-year constant bond yield)

Lag	Output: West German Long-Term Public Authority Loan Rate	Canadian Long-Term Government Loan Rate	United Kingdom Government 3½% War Loan Yield	French Long-Term Public Sector Bond Yield	Dutch Long-Term Government Loan Rate	Swiss Long-Term Confederation Bond Yield
B. Period 3: January 5, 1973 - October 4, 1974 (n = 92)						
-13	.026	.070	-.077	-.086	.097	-.008
-12	-.013	-.050	-.053	-.083	-.058	-.206
-11	.050	-.055	-.022	-.128	-.050	-.090
-10	.108	.086	-.038	-.053	.055	-.002
- 9	.134	.069	-.008	.010	.029	-.024
- 8	.089	.090	.044	-.115	.118	-.126
- 7	.054	-.012	.074	-.086	.056	-.027
- 6	.129	-.007	.080	.071	.074	-.012
- 5	.080	.047	.064	.135	.048	.034
- 4	.124	.120	.051	.042	.058	.003
- 3	.086	.236*	.089	.052	.142	.073
- 2	.055	.145	.089	.047	.118	.025
- 1	.211*	.142	.062	.045	.251*	.042
0	.265*	.264*	.198	.269*	.041	.005
+ 1	.073	.097	-.062	-.019	-.105	.031
+ 2	-.142	-.006	.058	-.057	.169	.078
+ 3	.065	-.041	-.015	.110	-.032	-.027
+ 4	.045	.135	-.107	-.181	-.051	.044
+ 5	-.073	-.011	.124	.051	-.077	.004
+ 6	-.042	.122	-.028	-.030	.095	-.166
+ 7	.052	-.056	.029	.047	.060	.088
+ 8	-.063	.129	-.092	-.065	-.042	.015
+ 9	.031	-.057	.085	.087	.124	-.094
+10	.124	.020	.005	-.062	-.029	.207
+11	-.085	-.082	-.130	-.079	-.047	-.160
+12	.121	-.008	.164	.059	.060	.030
+13	-.045	-.006	-.123	.058	-.098	.067

TABLE 31.--Continued

Lag	West German Long-Term Public Authority Loan Rate	Canadian Long-Term Government Loan Rate	United Kingdom Government 3½% War Loan Yield	French Long-Term Public Sector Bond Yield	Dutch Long-Term Government Loan Rate	Swiss Long-Term Confederation Bond Yield
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)						
-13	.017	-.036	.118	.091	-.112	.146
-12	-.003	-.053	.021	.050	.024	.063
-11	.012	.060	.037	.095	.037	.001
-10	.066	.113	-.107	.119	.035	.002
- 9	-.063	.043	.159	-.055	.019	-.018
- 8	-.018	-.134	-.118	.002	-.069	-.096
- 7	.075	-.003	.040	.154	.034	.052
- 6	-.053	-.078	-.110	-.071	-.122	-.014
- 5	-.012	-.130	.075	.033	.068	.011
- 4	.002	-.112	-.110	.129	-.204*	-.015
- 3	-.034	.083	.003	-.079	.116	.053
- 2	-.203*	-.008	.183	.071	-.056	.050
- 1	.533*	.086	.106	.024	-.055	.085
0	-.126	.411*	.100	.125	.399*	.120
+ 1	-.015	.103	.021	-.072	-.023	.012
+ 2	.011	.072	-.110	.108	.168	.058
+ 3	.045	.135	-.115	-.053	-.031	.035
+ 4	-.051	-.002	-.075	-.126	-.036	.057
+ 5	.023	-.123	.046	.071	.027	.108
+ 6	.067	-.002	.038	.057	-.093	.035
+ 7	-.002	.026	-.011	.072	.084	-.020
+ 8	-.079	-.033	.017	.016	-.051	-.011
+ 9	.068	.090	.079	-.029	.000	-.044
+10	-.128	.019	.141	-.023	.107	-.069
+11	.058	-.004	.006	.027	-.131	.048
+12	-.029	.052	.065	.061	.150	.071
+13	.034	-.058	.057	-.037	.022	.022

*Indicates that the correlation coefficient is statistically significant at the 95 percent level.

coefficients at zero lag point toward the possibility of constructing transfer functions for these relationships.

The United States-Dutch interest rate cross correlation analysis results in a significant coefficient at the minus one lag. The impulse response weights for the relationship were examined to determine the importance of the coefficient. It was found to be spurious.

Surprisingly, there are less significant cross correlation coefficients in the third subperiod than in the second subperiod. This is contrary to the findings in the previous cross correlation analyses. No cross correlation coefficient turned out significant for the United Kingdom, the French, and the Swiss long term rates. The United States-Swiss and the United States-United Kingdom interest rate relationships were consistent over the six-year period. That is, no significant cross correlation coefficient was found.

There are two significant coefficients in the United States-West German cross correlation analysis. These are at the minus two and minus one lags. Note the signs and magnitudes of these coefficients. The negative sign for the minus two lag coefficient points to an inverse relationship, which makes no economic sense. Hence, the coefficient is most likely spurious. The magnitude of the coefficient at the minus one lag suggests a strong relationship between the United States bond rate and the West German public authority loan rate. However, this relationship implies that the West German rate leads the United States bond rate by one week.

In the United States-Dutch relationship, the significant cross correlation coefficients are at minus four and zero lags. The minus four lag coefficient has a negative sign and is most likely spurious. The coefficient at zero lag implies a contemporaneous relationship between the two time series. And, finally, the cross correlation analysis of the United States and Canadian rates reveals a contemporaneous relationship.

The coefficients in the second subperiod were of smaller magnitudes than those in the third subperiod, which were fairly large. This behavior can be explained by the following. In the 1973-75 period, the different markets were under heavy strains which resulted from the oil crisis and the consequent worldwide redistribution of dollar reserves. During this unstable time period, different national governments tried to minimize the effects of worldwide events on their economies by subjecting them to more government controls. Governments made their respective economies less accessible to the free movements of funds as dictated by market supply and demand. Therefore, the different financial markets were not as closely related as would be expected. In the 1975-78 period, as the different economies began to adjust to world events, economic and otherwise, government controls were reduced. The different economies began to slowly allow market forces to dictate the workings of the financial markets. Hence, the relationship between financial markets started to increase.

Multivariate Analysis

The transfer functions modeled are reported in Table 32. In the 1973-75 period, four transfer functions were modeled, all of which have the same structure. The output value is determined by the

TABLE 32.--Multivariate time series models--Long-term interest rates (one-year holding-period returns)

Series	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
West German Long-Term Public Authority Loan Rate	$y_t = 2.550\ x_t + a_t$	.436%
Canadian Long-Term Government Bond Yield	$y_t = 1.330\ x_t + a_t$	.224
French Long-Term Public Sector Bond Yield	$y_t = 1.720\ x_t + a_t$	.595
Dutch Long-Term Government Loan Rate	$y_t = .824\ x_t + a_t$	.465
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
West German Long-Term Public Authority Loan Rate	$y_t = -1.590\ x_t + 3.990\ x_{t-1} + a_t - .660a_{t-1}$	.696
Canadian Long-Term Government Bond Yield	$y_t = 1.100\ x_t + a_t$	.221
Dutch Long-Term Government Loan Rate	$y_t = 1.680\ x_t + a_t$	.370

current input observation and the current disturbance term. These models are able to reduce the standard deviation of residuals from that of the univariate model for each of the time series. This indicates that the employment of the input series contributes to the estimation of the generating process of the output series. To determine whether the relationship found in the cross correlation analysis can be utilized to advantage in forecasting and decision making, refer to Tables 33 and 34.

Consider the transfer function for the West German loan rate. Although the input series helps in estimating the process generating the time series (as evidenced by the standard deviation of residuals), the mean squared error of the forecasts does not indicate the advantage of including the input series in forecasting the West German rate. Moreover, the variance of the forecast errors shows that the leading input series reduces the variance of the forecast errors with a lead period of one week, but increases the variance with a different lead time. These conflicts in the statistics render the benefits of the transfer function doubtful.

In the transfer function for the Canadian long-term government loan yield, there is a reduction in the standard deviation of residuals and the Theils' U coefficient (Table 35). The mean squared error of forecasts did not show any improvement with the leading input series. Moreover, the variance of forecast errors is not consistently lower with the input series than without the input series. The statistics raise doubt on the use of the transfer function.

TABLE 33.--Mean squared error of the forecast of the output series with and without the input series--Long-term interest rates (One-year holding-period returns)

	With Input Series	Without Input Series
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		
West German Long-Term Public Authority Loan Rate	.0849	.0819
Canadian Long-Term Government Bond Yield	.0227	.0227
French Long-Term Public Sector Bond Yield	.3862	.3809
Dutch Long-Term Government Loan Rate	.0567	.0585
C. Period 3: May 9, 1975 - January 13, 1978 (n = 141)		
West German Long-Term Public Authority Loan Rate	.1472	.0621
Canadian Long-Term Government Bond Yield	.0782	.0782
Dutch Long-Term Government Loan Rate	.3135	.3135

TABLE 34.--Variance of the forecast errors made with and without the input series--Long-term interest rates (One-year holding-period returns)

	Lead	With Input Series	Without Input Series
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)			
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)			
West German Long-Term Public Authority Loan Rate	1	.2192	.2218
	2	.4691	.4436
	3	.7351	.6654
	4	1.0087	.8872
Canadian Long-Term Government Bond Yield	1	.0582	.0590
	2	.1246	.1180
	3	.1954	.1770
	4	.2683	.2360
French Long-Term Public Sector Bond Yield	1	.3673	.3660
	2	.7484	.7320
	3	1.1370	1.0980
	4	1.5290	1.4640
Dutch Long-Term Government Loan Rate	1	.2193	.2172
	2	.6658	.6516
	3	.6658	.6516
	4	.8907	.8688
C. Period 3: May 9, 1975 - January 13, 1977 (n = 141)			
West German Long-Term Public Authority Loan Rate	1	.5097	.9565
	2	.6233	1.9130
	3	.6793	2.8695
	4	.7353	3.8260
Canadian Long-Term Government Bond Yield	1	.0609	.0610
	2	.1097	.1220
	3	.1585	.1830
	4	.2073	.2440
Dutch Long-Term Government Loan Rate	1	.1651	.1648
	2	.3020	.3296
	3	.4389	.4944
	4	.5758	.6592

TABLE 35.--Theil's U coefficient multivariate time series models--Long-term interest rates (one-year holding-period returns)

	Period 1	Period 2	Period 3
West German Long-Term Public Authority Loan Rate	--	.982	1.540
Canadian Long-Term Government Bond Yield	--	1.009	1.000
United Kingdom Government 3½% War Loan Yield	--	1.027	--
French Long-Term Public Sector Bond Yield	--	1.007	--
Dutch Long-Term Government Loan Rate	--	.984	1.000
Swiss Long-Term Confederation Bond Yield	--	--	--

The transfer function for the French public sector bond yield estimates the process generating the time series better than the univariate model. The improvement, however, is very small. For forecasting purposes, the transfer function performs worse than the univariate model, as evidenced by the mean squared error of forecasts, the variance of the forecast errors, and the Theil's U coefficient of forecast accuracy.

Examination of the transfer function for the Dutch long-term government loan rate reveals that the standard deviation of residuals does not show any improvement over the univariate model. Although the forecasts are more accurate than the univariate model forecasts (as the mean squared error of forecasts suggests), the variance of the forecast errors does not confirm this. Hence, the benefit of the transfer function is dubious.

Three transfer functions were modeled for the 1975-78 sub-period. The West German transfer function consists of an input lag parameter and a moving average noise model. The Canadian and Dutch transfer functions contain an input lag factor consisting of one parameter and the disturbance term.

The West German transfer function provides a significant improvement in estimating the time series. This is shown by the reduction in the standard deviation of residuals. However, the statistics do not consistently show that the transfer function is a better forecasting model than the univariate model. The mean squared error of forecasts is larger with the inclusion of the input series, having increased from .0621 percent to .1472 percent. The variance of the forecast errors also did not improve with the inclusion of the input series. These two statistics imply that the United States bond rate does not help in forecasting the West German rate. Hence, the transfer function is rejected.

The Canadian transfer function does reduce the standard deviation of residuals, indicating the advantage of including the input series in estimating the Dutch rate. There is no change in the mean squared error of forecasts. However, the variance of the forecast errors exhibits an improvement in comparison to the variance of the forecast errors of the univariate model. With respect to the Theil's U coefficient, the transfer function performs as well as a simple, no-change extrapolative model. The transfer function is, therefore, acceptable.

Finally, the transfer function for the Dutch government loan rate is considered. The model shows improvements in estimation as evidenced by the standard deviation of residuals. The variance of the forecast errors is consistently smaller with the leading input series and as the lead time is varied. The inclusion of the input series also does not diminish the forecast accuracy as measured by the mean squared error of forecasts and the Theil's U coefficient. The implications of the statistics is that the transfer function is acceptable.

Summary

In this chapter, one-year forward exchange rates were used to adjust for exchange rate differentials. This is because the holding period for financial instruments is assumed to be one year.

The cross correlation analysis of long-term interest rates reveals that the 1973-75 period is characterized by more cross correlation relationships than the 1975-78 period. However, most of the significant coefficients in the 1973-75 period were found to be spurious. The significant coefficients in the 1975-78 period, particularly in the cross correlation of the United States bond rate with the Dutch and Canadian rates, were at the zero lag. This indicates a contemporaneous relationship. The relationships were utilized to advantage in the form of transfer functions. Based on the standard deviations of residuals, the mean squared error of forecasts, the variance of the forecast errors, and the Theil's U coefficient of forecast accuracy, the transfer functions for the Canadian and Dutch bond rates were found to be better models than their respective univariate models not only in estimating the time series but also in forecasting the time series. This fact points out the benefit of the transfer function for decision-making purposes.

CHAPTER VIII

LONG-TERM INTEREST RATE RELATIONSHIPS
OVERALL EVALUATION

This chapter provides an overall evaluation of long-term interest rate relationships. Specifically, three questions will be examined. First, are the stochastic processes underlying each of the time series similar across the holding periods? Second, is there a consistent lead-lag relationship across the different holding periods? And third, do the transfer functions modeled exhibit simil-tarity in structure as the length of the holding period is varied?

Univariate Analysis

Panel A of Table 36 outlines the univariate models for the first time period, 1971-72. In the case of the U. S. constant maturity bond yield, the same autoregressive integrated model characterizes the time series without regard to the length of the holding period.

With respect to the other time series involved, two types of situations exist. One is exemplified by the cases of the French public sector bond yield and the Dutch government loan rate, where no comparison is undertaken due to the unavailability of data for the six-month and one-year holding periods. The second type of situation is exemplified by the West German, Canadian, United Kingdom, and Swiss

TABLE 36.--Univariate time series models--Long-term interest Rates

Series	Holding Period	Model	Standard Deviation of Residuals
A. Period 1: January 29, 1971 - July 7, 1972 (n = 76)		$z_t - 1.289\, z_{t-1} + .289\, z_{t-2} = a_t$	.109%
West German Long-Term Public Authority Loan Rate	3-month	$z_t - z_{t-1} = a_t + .227\, a_{t-1}$	.584
	6-month	$z_t - z_{t-1} = a_t$	.530
	1-year	$z_t - z_{t-1} = a_t$	
Canadian Long-Term Government Bond Yield	3-month	$z_t - z_{t-1} = a_t$	.290
	6-month	$z_t - z_{t-1} = a_t$	.238
	1-year		
U. K. Government 3½% War Loan Yield	3-month	$z_t - z_{t-1} = a_t$	.702
	6-month	$z_t - z_{t-1} = a_t$	1.067
	1-year		
French Long-Term Public Sector Bond Yield	3-month	$z_t - z_{t-1} = a_t + .542\, a_{t-1}$	.158
	6-month		
	1-year		
Dutch Long-Term Government Loan Rate	3-month	$z_t - 1.138\, z_{t-1} + .138\, z_{t-2} = a_t$	.536
	6-month		
	1-year		
Swiss Long-Term Confederation Bond Yield	3-month	$z_t - 1.225\, z_{t-1} + .225\, z_{t-2} = a_t$	.503
	6-month	$z_t - z_{t-1} = a_t$	.483
	1-year		

TABLE 36.--Continued

	Holding Period	Model	Standard Deviation of Residuals
B. Period 2: January 5, 1973 - October 4, 1974 (n = 92)		$z_t - 1.428\ z_{t-1} + .428\ z_{t-2} = a_t$	.067%
West German Long-Term Public Authority Loan Rate	3-month	$z_t - z_{t-1} = a_t + .173\ a_{t-1}$	.950
	6-month	$z_t - z_{t-1} = a_t$	.725
	1-year	$z_t - z_{t-1} = a_t$	.471
Canadian Long-Term Government Bond Yield	3-month	$z_t - 1.364\ z_{t-1} + .364\ z_{t-2} = a_t - .403\ a_{t-11}$	.304
	6-month	$z_t - z_{t-1} = a_t$	.332
	1-year	$z_t - z_{t-1} = a_t$	.243
U. K. Government 3½% War Loan Yield	3-month	$z_t - z_{t-1} = a_t$	.853
	6-month	$z_t - .609\ z_{t-1} - .391\ z_{t-2} - z_{t-4} + .609\ z_{t-5}$ $+ .391\ z_{t-6} = a_t - .843\ a_{t-4}$	.647
	1-year	$z_t - 1.518\ z_{t-1} - .116\ z_{t-2} + .482\ z_{t-3} = a_t - .866\ a_{t-1}$	.404
French Long-Term Public Sector Bond Yield	3-month	$z_t - z_{t-1} = a_t$	1.039
	6-month	$z_t - z_{t-1} = a_t - .217\ a_{t-9}$	.937
	1-year	$z_t - z_{t-1} = a_t$	.605
Dutch Long-Term Government Loan Rate	3-month	$z_t - z_{t-1} = a_t$	.809
	6-month	$z_t - z_{t-1} = a_t$	.630
	1-year	$z_t - z_{t-1} = a_t$	.466
Swiss Long-Term Confederation Bond Yield	3-month	$z_t - z_{t-1} = a_t$	.843
	6-month	$z_t - z_{t-1} - z_{t-4} + z_{t-5} = a_t - .299\ a_{t-1} - .649_{t-4} + .192\ a_{t-5}$	.717
	1-year	$z_t - z_{t-1} - z_{t-4} + z_{t-5} = a_t - .805\ a_{t-4}$	.491

TABLE 36.--Continued

Series	Holding Period	Model	Standard Deviation of Residuals
C. Periods: May 9, 1975 - January 13, 1978 (n = 141)		$z_t - z_{t-1} = a_t$	.100%
U. S. Ten-Year Constant Maturity Bond Yield	3-month	$z_t - z_{t-1} = a_t$	.875
	6-month	$z_t - z_{t-1} = a_t$	.991
	1-year	$z_t - z_{t-1} = a_t$	.978
Canadian Long-Term Government Bond Yield	3-month	$z_t - 1.154\ z_{t-1} + .154\ z_{t-2} = a_t$	.239
	6-month	$z_t - z_{t-1} = a_t$	.284
	1-year	$z_t - z_{t-1} = a_t$	.247
U. K. Government 3½% War Loan Yield	3-month	$z_t - z_{t-1} = a_t$	.834
	6-month	$z_t - z_{t-1} = a_t$	.616
	1-year	$z_t - z_{t-1} = a_t$	.444
French Long-Term Public Sector Bond Yield	3-month	$z_t - z_{t-1} = a_t$	.988
	6-month	$z_t - z_{t-1} = a_t$	.803
	1-year	$z_t - .362\ z_{t-1} - .538\ z_{t-2} = a_t + .437\ a_{t-1}$	.459
Dutch Long-Term Government Loan Rate	3-month	$z_t - 1.442\ z_{t-1} + .442\ z_{t-2} = a_t$	.527
	6-month	$z_t - z_{t-1} - a_t + .299\ a_{t-1}$	.528
	1-year	$z_t - z_{t-1} = a_t$	.406
Swiss Long-Term Confederation Bond Yield	3-month	$z_t - 1.269\ z_{t-1} + .269\ z_{t-2} = a_t$	.279
	6-month	$z_t - z_{t-1} = a_t + .299\ a_{t-1}$	.313
	1-year	$z_t - z_{t-1} = a_t$	.242

rates. The availability of forward exchange rates for the three-month and the six-month holding periods allows comparison for these holding periods only.

The models characterizing the Canadian and the United Kingdom long-term rates are the same whether the holding period is three months or six months. The effect of adjusting for exchange rate differentials did not change the process generating the time series. With respect to the effect of holding periods on volatility, note that the standard deviations of residuals for the Canadian rate are virtually the same. However, this condition is not true of the United Kingdom loan rate. The longer holding period is seen to exhibit a higher degree of volatility.

The West German and the Swiss rates are described by both simple random walk models and complex models. The more complex model occurs when a three-month holding period is assumed. Since the magnitude of the significant parameters is rather small, these models are essentially "noisy" random walk models. Not only are the univariate models describing these time series essentially the same despite different holding periods, the standard deviations of residuals are virtually equal in each time series.

Panel B of Table 36 reports the univariate models describing each of the time series for the second subperiod across three different holding periods. The United States bond rate is again characterized by an autoregressive integrated model. There is no change in the model since there was no adjustment necessary for the dollar-denominated time series.

In examining the univariate models for the West German, French, and Dutch long-term rates, note that these three time series are essentially random walk models regardless of the length of the holding periods. Despite the existence of moving average parameters in the West German model (three-month holding period) and in the French model (six-month holding period), these parameters are rather small and have little economic meaning. The similarity in the models does not hold true for the standard deviations of residuals for the three time series. The time series exhibit different levels of volatility although the behavior appears to be similar. Specifically, the degree of volatility decreases as the holding period is lengthened.

The unusual univariate model for the Canadian government bond yield assuming a three-month holding period does not consistently characterize the time series. In fact, the univariate models for the other holding periods are random walk models. The degree of volatility is low and virtually equal in the three different holding periods.

The diversity of the univariate models for the United Kingdom loan rate is worth noting. The change from one holding period to another is quite drastic. The process generating the time series changed from a simple first order differenced model in the three-month holding period to an autoregressive integrated seasonal moving average model for a six-month holding period, and to a second order differenced autoregressive integrated moving average model for the one-year holding period. Except for the t-2 term at .116 in the model for a one-year holding period, all the parameters in the three different holding periods are large and statistically significant; hence, they are economically meaningful. As the holding period lengthens, the degree of volatility of the time series decreases.

Finally, examine the models for the Swiss confederation bond rate. There is a difference between the models as the holding period is varied. The models for the six-month and one-year holding periods may be considered the same. The size of the parameter for the t-5 term at .192 in the six-month holding period model is small and, in effect, makes the model essentially the same as the model for the one-year holding period. In the case of the Swiss rate, the degree of volatility of the residuals also decreases as the length of the holding period is increased.

In the third time period, 1975-78, many of the time series are essentially random walk models. This includes the United States bond rate, the Canadian government loan rate, the United Kingdom war loan yield, and the Swiss confederation rate. Although the parameter values for the Canadian rate (three-month holding period) and the Swiss confederation rate (three-month holding period) are significant statistically, the values are not significant in the economic sense. For these four time series, the underlying stochastic processes are considered generally the same across holding periods. The degree of volatility of the processes are of the same level except for the United Kingdom loan rate. The standard deviations of residuals of the United Kingdom loan rate decrease as the length of the holding period increases to one year.

The West German loan rate is characterized by a first order moving average process when a holding period of three months is assumed, and a random walk process in the other holding periods. Although the underlying processes are different, the standard deviations of residuals show practically the same level of volatility.

The French long-term rate is described by random walk models in the three-month and six-month holding periods. The process becomes complex as the holding period is increased to one year. The degree of volatility is reduced when the holding period is lengthened.

The Dutch long-term rate is characterized by three different models for the three different holding periods. The univariate model for the six-month holding period can be considered a "noisy" random walk model because the significant moving average parameter is not large. The degree of volatility for the three models is very close to one another.

In the examination of the univariate models for the entire time period and for the three different holding periods, several general observations can be made. First, there seems to be a decrease in the degree of volatility as the length of the holding period is increased. That is, the standard deviation of residuals is reduced as the holding period is changed from three months to six months to one year. Additional indication of this finding is reported in Table 37. The coefficients of variation of each time

TABLE 37.--Means, standard deviations, and coefficients of variation of each interest rate series

	Holding Period	Period 1			Period 2			Period 3		
		Mean	σ	CV	Mean	σ	CV	Mean	σ	CV
U. S. Three-Month Treasury Bill Rate		4.2155	.5874	.139	7.2367	1.0938	.151	5.7603	1.0169	.177
U. S. Ten-Year Constant Maturity Bond Yield		6.1853	.2805	.045	7.2559	.4789	.066	7.8363	.4463	.057
Three-Month Eurodollar Rate		6.0021	.9598	.195	9.8110	1.9682	.201	6.6938	1.4341	.214
West German Three-Month Interbank Rate		8.1058	1.5818	.195	13.1200	3.7620	.287	7.1072	1.6467	.232
West German Long-Term Public Authority Loan Rate	3-mo.	9.7101	1.7359	.179	12.6480	2.7576	.218	9.6510	1.5888	.165
	6-mo.	9.6093	1.4291	.149	12.2420	2.1985	.180	9.8096	1.5433	.157
	1-yr.				11.6880	1.5776	.135	9.7260	1.3770	.142
Canadian Three-Month Finance Paper Rate		5.0102	.6797	.136	9.4766	1.9036	.209	6.4599	1.5027	.233
Canadian Long-Term Government Bond Yield	3-mo.	6.8287	.9501	.139	9.1498	1.1804	.129	6.9311	1.5969	.230
	6-mo.	6.7786	.6885	.102	8.9166	1.0633	.119	7.2264	1.4117	.195
	1-yr.				8.5478	.8645	.101	7.5044	1.1595	.155
U. K. Three-Month Interbank Rate					7.4900	2.2121	.295	4.7876	1.8962	.396
U. K. Government 3½% War Loan Rate	3-mo.	8.0473	1.6738	.208	7.9699	3.0270	.380	7.7526	2.7922	.360
	6-mo.	8.1994	1.4465	.176	7.9529	2.4190	.304	8.0063	2.3474	.293
	1-yr.				8.3365	1.9836	.238	8.3694	1.8497	.221
French Three-Month Interbank Rate								4.2190	1.9356	.459
French Long-Term Public Sector Bond Yield	3-mo.	9.3958	2.7923	.297	6.2969	3.4470	.547	6.0251	2.4862	.413
	6-mo.				6.2788	3.0141	.480	6.1719	2.2829	.370
	1-yr.				6.7640	2.0276	.300	5.8959	1.5123	.257
Dutch Three-Month Interbank Rate								6.4077	1.3723	.214
Dutch Long-Term Government Loan Rate	3-mo.	9.2649	1.3387	.144	9.9869	2.3738	.238	8.5613	2.6167	.306
	6-mo.				9.7582	1.9286	.198	8.6693	2.0470	.236
	1-yr.				9.3963	1.3308	.142	8.6070	1.4627	.170
Swiss Three-Month Interbank Rate								6.4973	1.2047	.185
Swiss Long-Term Confederation Bond Yield	3-mo.	8.5840	1.6308	.190	8.7752	2.2663	.258	9.1966	1.4588	.159
	6-mo.	8.1022	1.2036	.149	8.3922	1.6865	.201	9.0950	1.4476	.159
	1-yr.				8.1460	1.2764	.157	8.9440	1.2773	.143

series over the three time periods decreases as the length of the holding period is increased. Second, there are several exceptions to the first general observation. For those time series that do not show a decrease as the length of the holding period is increased, the degree of volatility appears to be about the same in all holding periods. However, the standard deviations of residuals still exhibit some pattern. The magnitude of the standard deviations of residuals in the six-month holding period is slightly larger than those in the three-month and one-year holding periods. Moreover, the standard deviations of residuals in the three-month holding period are larger than in the one-year holding period. Note that this observation is applicable only to the 1973-75 and 1975-78 periods. Third, the foreign time series show higher degrees of volatility than the United States bond rate, probably due to the instability that is characteristic of the foreign exchange markets in each of the countries considered. Canada, being closest in its relationship with the United States, exhibited the lowest variation in its residuals.

Cross Correlation Analysis

Table 38 shows the significant coefficients pertaining to each set of cross correlation analysis. In the 1971-72 period, only the Canadian rate shows a consistent lead-lag relationship with the United States rate. If the interest rate series adjusted for a holding period of one year were available, lead-lag relationships probably would have also existed at the zero lag.

TABLE 38.--Cross correlation coefficients--Long-term interest rates (Holding-period returns)
(Input is U. S. 10-year constant maturity bond yield)

	Holding Period	Period 1		Period 2		Period 3	
		Lag	Coefficient	Lag	Coefficient	Lag	Coefficient
West German Long-Term Public Authority Loan Rate	3-mo.	+12	-.287			0	.532
						+ 1	-.170
	6-mo.					- 2	-.198
		+13	-.292	0	.254	- 1	.535
						0	.390
						+11	.373
	1-yr.	N.A.		- 1	.211	- 2	-.203
				0	.265	- 1	.533
Canadian Long-Term Government Bond Yield	3-mo.	0	.467	0	.204	- 1	.208
		+11	.261			0	.282
						+ 2	.181
	6-mo.	0	.390	0	.250	0	.418
		+11	.373				
	1-yr.	N.A.		- 3	.236	0	.411
				0	.264		
United Kingdom 3½% War Loan Yield	3-mo.			- 9	.218	-10	.210
	6-mo.			0	.300		
	1-yr.	N.A.					

TABLE 38.--Continued

	Holding Period	Period 1		Period 2		Period 3	
		Lag	Coefficient	Lag	Coefficient	Lag	Coefficient
French Long-Term Public Sector Bond Yield	3-mo.			- 1	.219		
				+13	-.206		
	6-mo.		N.A.	+ 4	-.246		
	1-yr.		N.A.	0	+.269		
Dutch Long-Term Government Loan Rate	3-mo.					- 1	.167
						0	.216
						+ 1	.192
	6-mo.		N.A.			- 4	-.206
						0	.397
						+12	.194
	1-yr.		N.A.	- 1	.251	- 4	-.204
						0	.399
Swiss Long-Term Confederation Bond Yield	3-mo.	+ 1	-.357	- 4	.240	0	.188
				- 3	-.243		
	6-mo.	-13	.290			-13	.194
						0	.197
	1-yr.		N.A.				

In the 1973-75 period, the West German and Canadian rates exhibit some consistency of lead-lag relationships with the United States bond rate. Note, however, that the magnitudes of the coefficients are not large and, hence, may signify weak relationships. The consistency is seen to be at zero lag and carrying the expected sign for the coefficient.

The third panel of Table 38 shows the significant coefficients for the 1975-78 period. Two time series show a consistency in their relationships with the United States bond rate: the Canadian and Dutch long-term rates. The consistent relationships for these two series are contemporaneous ones. Compared to the first and second subperiod, the coefficients in the 1975-78 period are larger in magnitude. Moreover, there is an increase in the number of significant coefficients, indicating a closer relationship during this time period as governments begin to reduce the restrictions that prevented free interactions between markets.

The above evaluation of the cross correlations between the time series indicates an increase in the comovement of interest rates as the time period progresses toward 1978, regardless of a change in the length of the holding period. However, there is no conclusive evidence of any type of consistency describing the lead-lag relationships. Any consistency found is peculiar to each individual time series only. Neither can there be any general conclusion with respect to the time series being consistently cross correlated with the United States bond rate in the entire time period included in the study. The only exception is the United States-Canadian relationship. The lead-lag structure describing this relationship is characterized by significant zero lag coefficients in all subperiods and lengths of holding period.

Multivariate Analysis

Table 39 consolidates the transfer functions formulated according to the time periods across different holding periods. The transfer functions applicable to the West German long term rates show some similarity in the third subperiod. The only factors that caused some differences are the y_{t-1} term in the three-month holding period and the x_{t-2} term in the six-month holding period. The standard deviations of residuals of these three transfer functions are virtually the same. Of the six transfer functions modeled, only that which assumes a three-month holding period during the third subperiod is acceptable because it was able to utilize effectively the lead-lag structure characterizing the United States-West German relationship. This transfer function is a better model than its univariate model in describing the process generating the West German public authority loan rate. It is also a better model for forecasting and decision-making purposes.

The other transfer functions showing similarity in their structures are those of the Canadian long-term government bond yield. With the exception of the transfer functions for the second and third period assuming a three-month holding period, the models are alike in structure and also in their standard deviations of residuals. However,

TABLE 39.--Multivariate time series models--Long-term interest rates (Holding-period returns)

			Standard Deviation of Residuals
West German Long-Term Public Authority Loan Rate			
Period 1:	3-mo. 6-mo.* 1-yr.	$y_t - .299\, y_{t-1} = .999\, X_{t-13} + a_t$	.561%
Period 2:	3-mo. 6-mo.	$y_t - .234\, y_{t-1} = .341\, X_t + a_t$	.676
	1 yr.*	$y_t = 2.550\, X_t + a_t$	.436
Period 3:	3-mo.	$y_t + .322\, y_{t-1} = -2.270\, X_t + 5.700\, X_{t-1} + a_t - .5499\, a_{t-1}$	.666
	6-mo.	$y_t = -1.330\, X_t + 6.020\, X_{t-1} - 2.710\, X_{t-2} + a_t - .626\, a_{t-1}$	
	1-yr.*	$y_t = -1.590\, X_t + 3.990\, X_{t-1} + a_t - .660\, a_{t-1}$	.696
Canadian Long-Term Government Bond Yield			
Period 1:	3-mo.*	$y_t = 1.270\, X_t + a_t + .381\, a_{t-1}$	.247
	6-mo.*	$y_t = .793\, X_t + a_t + .253\, a_{t-1}$	.213
Period 2:	3-mo.	$y_t - .655\, y_{t-1} = .825\, X_t + \frac{(1 - .371B^{11})}{(1 - .242B)} a_t$	.295
	6-mo.*	$y_t = 1.690\, X_t + a_t$	.310
	1-yr.*	$y_t = 1.330\, X_t + a_t$	.224
Period 3:	3-mo.*	$y_t = .610\, X_t + .592\, X_{t-1} + a_t + .237\, a_{t-1}$	.223
	6-mo.	$y_t = 1.230\, X_t + a_t$	.256
	1-yr.	$y_t = 1.100\, X_t + a_t$	.221
United Kingdom Government 3½% War Loan Yield			
Period 1:	3-mo. 6-mo. 1-yr.		
Period 2:	3-mo. 6-mo.* 1-yr.	$y_t = 1.240\, X_t + \frac{(1 + .241B^4)}{(1 + .372B)} a_t$	.583

TABLE 39.--Continued

			Standard Deviation of Residuals
Period 3:	3-mo.		
	6-mo.		
	1-yr.		
French Long-Term Public Sector Bond Yield			
Period 1:	3-mo.		
	6-mo.		
	1-yr.		
Period 2:	3-mo.		
	6-mo.*	$y_t = .557\ X_{t-4} + a_t$	.960
	1 yr.*	$y_t = 1.720\ X_t + a_t$	.595
Period 3:	3-mo.		
	6-mo.		
	1-yr.		
Dutch Long-Term Government Loan Rate			
Period 1:	3-mo.		
	6-mo.		
	1-yr.		
Period 2:	3-mo.		
	6-mo.		
	1-yr.*	$y_t = .824\ X_t + a_t$	.960
Period 3:	3-mo.	$y_6 = .861\ X_t + .958\ X_{t-1} + \frac{1}{(1 - .413B)}\ a_t$	
	6-mo.	$y_t = 1.990\ X_t + .207\ a_{t-2}$	.488
	1-yr.	$y_t = 1.680\ X_t - a_t$	.370
Swiss Long-Term Confederation Bond Yield			
Period 1:	3-mo.*	$y_t = .780\ X_t + \frac{(1 - .255B)}{(1 - .526B)}\ a_t$	.520
	6-mo.		
	1-yr.		
Period 2:	3-mo.		
	6-mo.		
	1-yr.		
Period 3:	3-mo.*	$y_t = -.195\ X_t + \frac{1}{(1-.289B)}\ a_t$	.280
	6-mo.	$y_t = .612\ X_t + a_t$	.307
	1-yr.		

*Rejected

the higher degree of volatility of the second time period is not clearly reflected in the statistic. Three transfer functions are acceptable for forecasting. These are the models with a three-month holding period in the 1973-75 period and the models with a six-month and one-year holding period in the 1975-78 period.

The Dutch and the Swiss transfer functions do not show any similarity in their structures. Three transfer functions for the Dutch government loan rate are considered better than their univariate counterparts for forecasting purposes. Of the three transfer functions formulated for the Swiss confederation bond yields, only one is found to be acceptable.

None of the transfer functions modeled for the United Kingdom government loan yield and the French public sector bond yield is found to reflect effectively the relationships of the time series to the United States bond rate. Hence, the respective univariate models are better models for forecasting and decision-making purposes.

CHAPTER IX

CONCLUSION

The relationships between United States and foreign interest rates were examined in this study. There are two major sets of interest rates, the short-term and the long-term. Short-term interest rates consist of the three-month United States Treasury bill rate, the three-month Eurodollar rate, the three-month Canadian finance paper rate, and the three-month interbank rates of West Germany, the United Kingdom, the Netherlands, France, and Switzerland. The long-term interest rates include the United States constant maturity bond yield and the government bond yields of West Germany, Canada, the United Kingdom, the Netherlands, France, and Switzerland.

The hypothesis for both the short-term and long-term interest rates states that there is instantaneous adjustment of foreign adjusted interest rates in reaction to changes in the United States interest rates. The hypothesis implies comovement of interest rates across national boundaries.

Due to the different monetary systems existent over the 1971-78 period, the hypotheses are examined over three separate time periods: 1971-72, 1973-75, and 1975-78.

Summary of Findings--Short-Term Interest Rates

The underlying models characterizing each time series were mostly of a random walk nature. The time series were found to exhibit most volatility in the second subperiod, 1973-75. The third period, 1975-78, showed the least volatility. The behavior of the time series as described by the standard deviation of residuals reflect the state of the world economy in each time period. Several events contributed to the volatility in the 1971-72 period, including the refusal of the United States to allow further convertibility of dollars into gold, the devaluation of the dollar, and the consequent exchange realignment of practically all major currencies. Many major currencies stopped pegging their currency to the dollar and permitted them to float. However, this was a "dirty" float because monetary authorities of each country were intervening in the foreign exchange markets by buying and selling their own currencies to control the exchange rate. In addition, the United States imposed an import surcharge that obscured the true exchange rates by artificially keeping imports out of the United States. The fluctuations in the exchange rates were viewed by most countries as undesirable and transitory rather than as a basic change in the system.

The year 1973 marked the second devaluation of the dollar and the official transition to a floating exchange rate system. The huge oil price increase led to major shifts in the balance-of-payments positions for many countries. The transition to a different monetary system together with shifts in balance-of-payments positions were major factors giving rise to the volatility characterizing the 1973-75 period. In the 1975-78 period, countries began to adjust to major changes in the world economy. Governments gradually took steps designed to reduce the adverse impacts of world events.

To determine the lead-lag relationships between the United States Treasury bill rate and the interest rate of other countries, the time series were cross correlated. The analysis indicates that the markets show closer movement in the third subperiod, 1975-78, and an increasing number of significant cross correlation coefficients increasing in magnitude as the time period moves toward 1978. None of the foreign interest rate series was found to be consistently correlated with the United States rate in all three periods except the Canadian finance paper rate. Although the lag zero coefficients for all series, except France, were significant, the existence of some significant coefficients at both the plus and minus lags suggests a feedback-feedforward relationship between the time series.

The lead-lag relationships of the time series form the bases upon which transfer functions were modeled. Of the models set forth in Table 7 on page 70, only that of the Canadian finance paper rate for the 1973-75 period was considered acceptable, based on an evaluation of the estimation and forecasting ability of the model. The rejection of the other transfer functions implies that the univariate models describing the time series perform better than the transfer functions.

Summary of Findings--Long-Term Interest Rates

Three different holding periods were assumed in the examination of the long-term interest rates. Adjustments of the interest rates were done employing three-month, six-month, and one-year forward exchange rates. Hence, when adjusted, the long-term interest rates are effectively three-month, six-month, and one-year holding-period returns.

About three-quarters of the underlying models characterizing each time series were of a random walk nature. The time series were found to exhibit a decrease in the degree of volatility as the holding period was lengthened. That is, one-year holding-period returns show lower standard deviations of residuals than the six-month holding-period returns, and six-month holding-period returns have lower standard deviations of residuals than three-month holding-period returns.

The U. S. ten-year constant maturity bond yield was cross correlated with the holding-period returns of other countries to determine the lead-lag relationship between the time series. Similar to the findings in the short-term interest rate cross correlation analysis, an increase in the comovement of interest rates is evident as the time period progresses toward 1978. This increase can be attributed to the reduction by governments of restrictions that prevented free interactions between markets. Only one time series exhibited a consistent lead-lag relationship with the United States bond rate. This is the Canadian long-term government bond yield.

The lead-lag relationships between the time series form the bases upon which transfer functions were modeled. Based upon an evaluation of the estimation and forecasting ability of the model, eight transfer functions were found to be acceptable: the West German three-month holding-period return (1975-78); the Canadian three-month holding-period return (1973-75); the Canadian six-month and one-year holding-period returns (1975-78); the Dutch three-month, six-month, and one-year holding-period returns (1975-78); and the Swiss six-month holding-period return (1975-78). The rejection of the other transfer functions implies that the univariate models describing the time series are superior to the transfer functions.

Results of the Study

The findings of the study as summarized in the previous sections of this chapter provide evidence for the nonrejection of the hypothesis that financial markets are integrated. The magnitude of the cross correlation coefficients depicting the relationship between the United States interest rates and foreign interest rates supports the nonrejection of the hypothesis. However, financial market integration characterizes the May 1975-1978 period, but not the 1971-April 1975 period, with two exceptions. The first is the lead-lag structure describing the United States-Canadian relationship. The Canadian interest rate, both the short-term and the long-term, is found to be consistently correlated to the United States interest rate at lag zero, implying a contemporaneous relationship. The second exception is the lead-lag structure describing the United

States-French relationship. In both the short-term and the long-term cross correlation analyses, the French interest rate is found not to be significantly correlated with the United States interest rate.

The length of the holding period in the analysis of the long-term interest rates did not make any significant difference in the lead-lag relationship characterizing the time series. Although significant coefficients appear at different lags as the length of the holding period is varied, the general observation that can be drawn from it is that if there is a contemporaneous relationship, it is found in all three different holding periods.

The study adds new evidence to previous research on financial market integration without necessarily refuting or supporting previous studies. With respect to the interest rate parity theory as proof of financial market integration, the study does not provide additional support. The underlying ideas of the theory suggest that forward rates for longer periods tend to exhibit more fluctuations because of the higher risk inherent in a longer-term contract. In this research, forward rates of three different time period lengths were employed in adjusting the nondollar time series. It was expected that since there is more risk in the one-year holding period, the adjusted time series would exhibit more instability as measured by the coefficient of variation. Surprisingly, however, as the length of the holding period increased, the coefficient of variation decreased. This is contrary to general expectations based on the interest rate parity theory.

The current research neither refutes nor supports the convergence studies. The means and standard deviations of the individual time series shown in Table 37 reveals no evidence that the interest rates are converging. However, these time series are adjusted time series. Hence, the idea of convergence as applied in the previous convergence studies may not apply here. With respect to the covariation study by Logue et al., this research provides a continuation in the sense that the time period examined follows from that of the previous study.

Implications of the Result

The implications of the results of the study were twofold. On the microeconomic level, the lead-lag relationships imply little benefit to be derived from the transfer of funds across national boundaries, based on the assumption that transactions are undertaken at a minimum period of one week. Also, the transfer of funds is assumed to take place as a reaction to a change in the level of interest rates in the United States. This assumption does not preclude an individual or firm-investor from transferring funds for investment overseas because of higher effective (adjusted) interest rates. In fact, holding investors' risk preference constant, the effective long- and short-term interest rates in the Eurodollar market and in the West German, Canadian, Dutch and Swiss markets are higher than the United States interest rates. Of course, the decision by an investor to transfer funds will depend on his or her risk-return preference.

The results of the study should be taken into consideration in timing a firm's financing. The existence of significant coefficients at the zero lag indicates that moving across boundaries to take advantage of lower financial costs will not provide any benefits to the firm. However, if firms can anticipate changes in the interest rate level and produce timely forecasts of the resultant change in the foreign interest rates by employing an appropriate transfer function, the information will be important input in reducing the cost of financing to the firm. Holding risk constant, the firm should consider the French and Canadian financial market as additional funds sources. The effective interest rates in these markets, after taking into account the foreign exchange adjustments, are lower than the United States interest rate.

The French interest rate does not seem to relate to changes in the United States interest rates. As mentioned in a previous chapter, the French financial market is very much under government control. In this perspective, the market may be considered independent of outside forces. For investment and financing purposes, the investor or the borrower should take the French market independently, with strong emphasis on how the government exerts its control over the influence of outside forces on its domestic market.

On the macroeconomic level, the results of the study imply that governments have had some success in reducing foreign influences on their domestic financial rates. One interpretation of the less than strong relationships found between the interest rate series is that national governments, to some degree, have been able to control their domestic financial condition. On the other hand, the existence of lead-lag relationships suggests that governments have not been able to completely isolate their economies from events in the United States financial market. The magnitude of the cross correlation coefficients suggests the possibility of government intervention. However, it is difficult to determine what the probability of success of the intervention would be. Because the coefficients do not imply strong reactions of foreign interest rates to changes in the United States interest rates, governments have a certain degree of independence in effecting certain economic policies. Hence, the use of interest rates as a tool of monetary policy has not necessarily been weakened. The existence of relationships of a feedback-feedforward nature indicates the need to closely monitor the effects on both the domestic and foreign markets by a change in the domestic interest rate level.

Suggestions for Future Research

This research suggests several possible paths for future studies. The current study employs weekly data in the analysis of relationships. The use of daily data may show a relationship that may be more effectively used for forecasting and decision-making purposes. For instance, foreign interest rates may lag behind the

United States rate changes, implying that the timing of the relationship may be employed to advantage.

The financial markets studied included only Canada and five European countries. The inclusion of developed markets in Asia, such as Tokyo and Hongkong, would have been desirable. The development of a good data base for these markets will be a major factor for their future inclusion in studies such as the current research.

The study suggests that there may be some benefit to the transfer of funds across national boundaries. The benefits in terms of dollars or some monetary unit may be studied.

The Eurodollar market is generally considered an extension of the United States financial market. This is questioned by the results of the study. The United States and the Eurodollar markets are found to be cross correlated at magnitudes not greater than 0.5. If the two markets are extensions of one another, then why are they not more highly correlated? This question suggests another possibility for future research.

APPENDICES

APPENDIX A

THE RELATIONSHIP BETWEEN THE FORWARD EXCHANGE RATE AND THE FUTURE SPOT EXCHANGE RATE

APPENDIX A

THE RELATIONSHIP BETWEEN THE FORWARD EXCHANGE RATE AND THE FUTURE SPOT EXCHANGE RATE

The explanations on the forward rate as an unbiased predictor of the future spot rate is the subject of this appendix. Various viewpoints and the corresponding studies will be discussed. In order to determine which viewpoint is applicable in this study, a regression analysis was performed on the foreign exchange time series available from the Harris Bank data file. The results of the analysis are presented and discussed.

There are three views on the extent to which the forward exchange rate is considered to represent the market's forecast of the future spot exchange rate. The first viewpoint argues that the forward rate is an unbiased estimator of the future spot rate because speculative transactions always bid the forward rate up or down to the point at which it equals the expected spot rate. Frenkel (35), Kohlhagen (53), Aliber (21), and Giddy (40) provide empirical support for this argument.

The second approach involves the consideration of transaction costs. This approach argues that any change in the expected spot rate will be accompanied by a change in the forward rate in an amount equal to the change in the forward rate less the transaction costs of forward speculation. The hypothesis implies that no change in the forward rate will occur if the change in the expected spot rate is not sufficiently large to offset the transaction cost of acting on one's expectations. Consequently, the forward rate will be consistently higher than the expected spot rate whenever the latter is falling, and will remain below when it is rising, as long as the change in the expected future rate is larger than the transaction cost.[1] Both Kaserman (93) and Levich (95) presented evidence to support this hypothesis.

The third approach on exchange rate expectation argues that perceived currency risk may deter investors from profiting fully from a difference in the level of the forward rate and the expected future spot rate. The riskiness of speculative transactions may mean that the demand for forward currency by investors is not infinitely elastic at the forward rate that equals the expected future spot rate.[2] Solnick (66) and Roll and Solnick (98) have tried to specify and test the relationship. However, there have been questions on the formulation due to the specification of the currency risk.

Levich (86), in a recent study (1979), reports new empirical evidence on the relationship between the forward exchange rate and the future spot exchange rate during the period from January 1967 to May 1978. Levich employed end-of-week bid quotations from the

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[1]Gunter Dufey and Ian H. Giddy, The International Money Markets (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1978), p. 98.

[2]Ibid., p. 100.

interbank market reported by the Harris Bank weekly Review. He performed the following tests: mean squared forecasting error, frequency distribution of forecasting errors, mean forecasting error, serial correlation of forecast errors, Chi-square test for forecasting bias, mean absolute forecast error, and regression analysis. His tests showed that the market is volatile and that large profit opportunities are possible. However, the evidence does not provide conclusive proof that the market is inefficient.

Levich, in his regression analysis, tested the following models.

$$S_{t+n} = a + b\, F_{t,\, n} + u_t \tag{1}$$

and

$$\frac{S_{t+n}}{S_t} = a + \frac{b\, F_{t,n}}{S_t} + e_t; \tag{2}$$

where S_{t+n} = spot exchange rate in period t+n,

$F_{t,n}$ = forward exchange rate in period t for delivery in the nth period.

In both equation models, the joint hypothesis that a = 0 and b = 1 cannot be rejected at the 5 percent significance level. There is some question, however, on how Levich formed his sample for testing. He set up independent samples by taking observations 1, 14, 27, . . . or observations 2, 15, 28, . . ., etc. His preocedure resulted in sample sizes that do not exceed 31 observations. His sampling procedure suggests bias in his test results.

In order to verify Levich's conclusions, the current study undertook a regression analysis of the same data set. However, instead of following his sampling procedure, the current test employed available observations from January 1971 to December 1978. The countries examined included the United Kingdom, West Germany, Canada, France, the Netherlands, and Switzerland. The regression statistics for equation (1) are shown in the accompanying table. The tests showed different results than those of Levich. In no instance can it be said that the joint hypothesis of a = 0 and b = 1 is acceptable. The evidence implies that the forward rate is not an unbiased estimator of the future spot exchange rate.

To justify the employment of the forward exchange rate as the proxy for the expected future spot exchange rate, the modern theory of forward exchange is invoked. According to this theory, the forward exchange market is characterized by three types of activities: (1) pure interest arbitrage, (2) pure speculation, and (3) commercial hedging.

Arbitrageurs enter the forward exchange market to eliminate foreign exchange risk, and purchase or sell forward exchange contracts in order to cover their foreign exchange positions. However, if there is a difference between the existing forward exchange rate and the spot rate that is expected to prevail in the future, arbitrageurs will generate excess demand for forward exchange to profit from the difference.

Speculators expect to profit from fluctuations in the foreign exchange rate by holding open positions in foreign exchange.

TABLE A-1.--Regression statistics* for equation: $S_{t+n} = a + bF_{t,n} + u_t$

Country	Time Period	(a) Constant	(b) Slope	R^2	F	s.e.	D.W.	No. of Observations
United Kingdom	8-71-12/78	1.9278 (.2052)	.0024 (.0501)	.9957	84295.0	.0203	1.799	384
France	7/72-5/75	.2280 (.0228)	.0298 (.0828)	.9553	2952.3	.0033	1.910	141
	6/75-12/78	.1939 (.0207)	.1249 (.0833)	.9568	3739.3	.0023	2.166	172
West Germany	1/71-1/75	.4365 (.0430)	-.0417 (.0693)	.9875	15851.9	.0052	1.708	216
	2/75-12/78	.5326 (.0665)	.0169 (.0975)	.9849	11035.2	.0058	2.109	185
Canada	1/71-12/78	.5179 (.2592)	.0213 (.0517)	.9932	56417.7	.0041	1.667	389
Nether-lands	1/72-12/74	.3988 (.0371)	.0010 (.0841)	.9745	5277.1	.0051	1.529	154
	1/75-12/78	.4301 (.0559)	.1305 (.1033)	.9854	11387.7	.0046	1.903	185
Switzer-land	1/71-1/75	.3976 (.0503)	.0130 (.0692)	.9899	19686.7	.0049	1.853	216
	2/75-12/78	.5746 (.0966)	.9835 (.0943)	.9890	15144.8	.0085	1.926	185

*The regression was performed using the Cochrane-Orcutt procedure.

An open position exists when an individual expects to receive or purchase foreign exchange at some future time and uncertainty exists with respect to the domestic currency equivalent of the foreign exchange to be received or purchased. The individual does not eliminate the risk by the sale or the purchase of a forward exchange contract. Hence, the foreign exchange position is "open." The decision by speculators to maintain an open position depends on their expectations on the future spot exchange rate. The speculator plays a key role in the determination of the forward rate and the accuracy with which this rate predicts the future spot rate. The demand by speculators for forward exchange is a function of the difference between the market forward rate and the expected future spot rate. On the one hand, speculators who believe that the forward rate is above the predicted future spot rate will sell the foreign currency forward, thus bidding down the forward rate until it equals the expected future spot rate. On the other hand, those speculators who believe that the forward rate is lower than the expected future spot exchange rate will buy the foreign currency forward, bidding up the forward rate until it reaches the expected future spot rate.

The third group of activities performed in the forward exchange market is that of commercial hedging. Exporters and importers hedge their receipts and payments contracted for a future time by selling and buying forward exchange. An empirical study undertaken by Werner Gaab found that the commercial hedging activities exert no influence on forward exchange rates. Speculation and arbitrage activities are important contributors to the determination of the forward exchange rate. Werner Gaab's (100) findings support those of Kesselman (51), Stoll (70), and Haas (42), who consider only pure interest arbitrage and pure speculation, subsuming commercial hedging activities under these.

A very important factor to the current forward rate equaling the future spot exchange rate is the existence of an infinitely elastic demand by both speculators and arbitrageurs for forward exchange. Many studies have found that arbitrageurs' demand for forward exchange is less than infinitely elastic (67, 74, 71, 9). However, the gap caused by the less than infinitely elastic demand by arbitrageurs is filled by the actions of speculators. The activities of the arbitrageurs and speculators together provide the argument for the forward rate to closely approximate if not equal the expected future spot rate.

APPENDIX B

TIME SERIES FORECASTS--SHORT-TERM INTEREST RATES

TABLE B-1.--Forecasts of the Canadian three-month finance paper rate September 27, 1974 - April 16, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/27/74	91	11.908	12.420	12.410
10/4/74	92	11.800	11.540	11.480
10/11/74	93	11.552	11.750	11.580
10/18/74	94	11.064	11.440	11.390
10/25/74	95	10.730	10.840	10.900
11/1/74	96	10.267	10.580	10.590
11/8/74	97	10.388	10.050	10.140
11/15/74	98	10.241	10.440	10.390
11/22/74	99	9.965	10.170	10.120
11/29/74	100	10.068	9.839	9.846
12/6/74	101	10.539	10.110	10.090
12/13/74	102	10.489	10.750	10.650
12/20/74	103	10.581	10.470	10.410
12/27/74	104	10.318	10.620	10.520
1/3/75	105	10.185	10.200	10.190
1/10/75	106	9.927	10.130	10.110
1/17/75	107	8.498	9.813	9.759
1/24/75	108	8.105	7.822	8.011
1/31/75	109	7.387	7.932	7.868
2/7/75	110	7.342	7.058	7.017
2/13/75	111	7.567	7.322	7.138
2/20/75	112	7.473	7.666	7.507
2/27/75	113	7.279	7.432	7.297
3/5/75	114	7.102	7.194	7.138
3/12/75	115	7.143	7.024	6.968
3/19/75	116	6.988	7.161	7.068
3/26/75	117	6.910	6.920	6.882
4/2/75	118	7.117	6.876	6.839
4/9/75	119	7.328	7.207	7.148
4/16/75	120	7.212	7.421	7.373

$$^{*}z_t - 1.424\, z_{t-1} + .424\, z_{t-2} = a_t$$

$$^{+}y_t - .834\, y_{t-1} = .273\, x_t + \frac{1}{(1 - .278B)}\, a_t$$

where y is the Canadian finance paper rate.

x is the U. S. three-month Treasury bill rate.

TABLE B-2.--Forecasts of the three-month Eurodollar rate
February 2, 1978 - December 8, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Univariate Model**	Transfer Function+
2/03/78	146	7.363	7.270	7.335	7.333
2/10/78	147	7.200	7.378	7.400	7.401
2/17/78	148	7.225	7.161	7.223	7.214
2/24/78	149	7.325	7.231	7.238	7.242
3/03/78	150	7.338	7.349	7.354	7.351
3/10/78	151	7.300	7.341	7.366	7.363
3/17/78	152	7.200	7.291	7.323	7.317
3/24/78	153	7.238	7.176	7.214	7.205
3/31/78	154	7.344	7.247	7.254	7.246
4/07/78	155	7.400	7.368	7.366	7.362
4/14/78	156	7.350	7.413	7.425	7.423
4/21/78	157	7.263	7.338	7.370	7.365
4/28/78	158	7.425	7.242	7.275	7.267
5/05/78	159	7.625	7.463	7.448	7.445
5/12/78	160	7.725	7.673	7.660	7.664
5/19/78	161	1.838	7.749	7.764	7.770
5/26/78	162	7.863	7.866	7.883	7.890
6/02/78	163	8.018	7.869	7.906	7.913
6/09/78	164	8.000	8.053	8.067	8.098
6/16/78	165	8.088	7.996	8.046	8.053
6/23/78	166	8.475	8.109	8.137	8.145
6/30/78	167	8.650	8.511	8.548	8.568
7/07/78	168	8.625	8.695	8.732	8.752
7/14/78	169	8.463	8.619	8.698	7.714
7/21/78	170	8.575	8.422	8.519	8.523
7/28/78	171	8.500	8.603	8.635	8.642
8/04/78	172	8.413	8.482	8.551	8.551
8/11/78	173	8.275	8.391	8.454	8.451
8/18/78	174	8.325	8.241	8.304	8.296
8/25/78	175	8.663	8.337	8.356	8.348
9/01/78	176	8.613	8.747	8.714	8.722
9/08/78	177	8.875	8.601	8.657	8.657
9/15/78	178	8.850	8.938	8.934	8.947
9/22/78	179	9.088	8.844	8.903	8.906
9/29/78	180	9.413	9.144	9.153	8.168

TABLE B-2.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Univariate Model**	Transfer Function+
10/06/78	181	9.575	9.493	9.496	9.521
10/13/78	182	9.738	9.616	9.665	9.691
10/20/78	183	9.913	9.779	9.833	9.861
10/27/78	184	10.313	9.958	10.010	10.040
11/03/78	185	11.975	10.420	10.440	10.460
11/10/78	186	11.438	11.310	11.280	11.320
11/17/78	187	11.700	11.560	11.670	11.710
11/24/78	188	11.275	11.790	11.940	11.950
12/01/78	189	11.663	11.140	11.430	11.470
12/08/78	190	11.563	11.770	11.830	11.890

$^{*}z_t - 1.244\ z_{t-1} + .244\ z_{t-2} = a_t$

$^{**}z_t - 2\ z_{t-2} + z_{t-2} = a_t - .928\ a_{t-1}$

$^{+}y_t = .468\ x_t - .410\ x_{t-1} + a_t - .891\ a_{t-1}$

where: y = Eurodollar rate

x = U. S. three-month Treasury bill rate

TABLE B-3.--Forecasts of West German three-month interbank rate
February 3, 1978 - December 8, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Univariate Model**	Transfer Function+
2/03/78	146	7.967	7.859	7.985	7.994
2/10/78	147	7.764	7.972	8.009	8.007
2/17/78	148	7.645	7.722	7.788	7.785
2/24/78	149	7.802	7.620	7.659	7.649
3/03/78	150	7.915	7.834	7.826	7.825
3/10/78	151	7.876	7.939	7.946	7.944
3/17/78	152	7.688	7.868	7.902	7.898
3/24/78	153	7.570	7.649	7.699	7.689
3/31/78	154	7.724	7.545	7.571	7.560
4/07/78	155	7.903	7.756	7.736	7.730
4/14/78	156	7.847	7.941	7.927	7.927
4/21/78	157	7.624	7.835	7.866	7.862
4/28/78	158	7.758	7.577	7.626	7.616
5/05/78	159	8.126	7.785	7.769	7.763
5/12/78	160	8.274	8.203	8.162	8.166
5/19/78	161	8.405	8.306	8.317	8.323
5/26/78	162	8.374	8.433	8.454	8.460
6/02/78	163	8.444	8.367	8.418	8.425
6/09/78	164	8.384	8.459	8.489	8.478
6/16/78	165	8.651	8.371	8.422	8.427
6/23/78	166	9.014	8.707	8.705	8.714
6/30/78	167	9.220	9.094	9.089	9.108
7/07/78	168	9.140	9.267	9.305	9.326
7/14/78	169	8.941	9.122	9.213	9.230
7/21/78	170	9.093	8.896	8.995	9.002
7/28/78	171	8.927	9.127	9.154	9.163
8/04/78	172	8.860	8.891	8.972	8.973
8/11/78	173	8.974	8.845	8.898	8.897
8/18/78	174	9.250	8.999	9.017	9.017
8/26/78	175	9.267	9.311	9.308	9.316
9/01/78	176	9.075	9.271	9.323	9.328
9/08/78	177	9.325	9.033	9.114	9.111
9/15/78	178	9.489	9.378	9.378	9.385
9/22/78	179	9.847	9.524	9.549	9.555
9/29/78	180	10.310	9.926	9.927	9.947

TABLE B-3.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Univariate Model**	Transfer Function+
10/06/78	181	10.507	10.410	10.410	10.450
10/03/78	182	10.865	10.560	10.620	10.660
10/20/78	183	10.990	10.950	11.000	11.040
10/27/78	184	11.326	11.020	11.120	11.160
11/03/78	185	12.141	11.410	11.480	11.500
11/10/78	186	12.552	12.370	12.360	12.430
11/17/78	187	13.349	12.670	12.800	12.860
11/24/78	188	12.669	13.600	13.690	13.670
12/01/78	189	12.650	12.500	12.860	12.930
12/08/78	190	12.321	12.590	12.780	12.850

$*z_t - 1.213\, z_{t-1} + .213\, z_{t-2} = a_t$

$**z_t - 2\, z_{t-1} + z_{t-2} = a_t$

$+y_t = .408\, x_t - .347\, x_{t-1} + a_t - .916\, a_{t-1}$

where: y = West German three-month interbank rate

x = U. S. three-month Treasury bill rate

TABLE B-4.--Forecasts of the Canadian three-month finance paper rate February 3, 1978 - December 8, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
2/03/78	146	7.276	7.258	7.233
2/10/78	147	7.127	7.276	7.245
2/17/78	148	7.043	7.127	7.146
2/24/78	149	7.036	7.043	7.080
3/03/78	150	7.109	7.036	7.017
3/10/78	151	7.022	7.109	7.078
3/17/78	152	7.017	7.022	6.941
3/24/78	153	6.946	7.017	7.005
3/31/78	154	7.087	6.946	6.915
4/07/78	155	6.978	7.087	7.124
4/14/78	156	7.051	6.978	7.064
4/21/78	157	6.921	7.051	6.996
4/28/78	158	7.569	6.921	6.915
5/05/78	159	7.466	7.569	7.526
5/12/78	160	7.669	7.466	7.552
5/19/78	161	7.847	7.669	7.669
5/26/78	162	7.784	7.847	7.779
6/02/78	163	7.941	7.784	7.927
6/09/78	164	7.852	7.941	8.028
6/16/78	165	7.883	7.852	7.846
6/23/78	166	8.205	7.883	7.877
6/30/78	167	8.355	8.205	8.334
7/07/78	168	8.408	8.355	8.380
7/14/78	169	8.369	8.408	8.525
7/21/78	170	8.402	8.369	8.441
7/28/78	171	8.324	8.402	8.324
8/04/78	172	8.046	8.324	8.228
8/11/78	173	8.162	8.046	7.961
8/18/78	174	8.142	8.162	8.150
8/25/78	175	8.488	8.142	8.443
9/01/78	176	8.358	8.488	8.476
9/08/78	177	8.482	8.358	8.516
9/15/78	178	8.593	8.482	8.543
9/22/78	179	8.869	8.593	8.702
9/29/78	180	9.283	8.869	9.064

TABLE B-4.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/06/78	181	9.357	9.283	9.163
10/13/78	182	9.603	9.357	9.538
10/20/78	183	9.809	9.603	9.546
10/27/78	184	10.220	9.809	9.715
11/03/78	185	10.970	10.220	9.979
11/10/78	186	11.190	10.970	11.690
11/17/78	187	11.510	11.190	11.250
11/24/78	188	11.210	11.510	11.080
12/01/78	189	11.450	11.210	11.480
12/08/78	190	11.470	11.450	11.600

*$z_t - z_{t-1} = a_t$

+$y_t = .300\, x_t + .622\, x_{t-1} + a_t$

where y = Canadian three-month finance paper rate

x = U. S. three-month Treasury bill rate

TABLE B-5.--Forecasts of the United Kingdom three-month interbank rate February 3, 1978 - December 8, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
2/03/78	146	7.014	6.942	6.910
2/10/78	147	6.619	7.014	6.974
2/17/78	148	6.528	6.619	6.643
2/24/78	149	6.762	6.528	6.576
3/03/78	150	6.710	6.762	6.738
3/10/78	151	6.517	6.710	6.670
3/17/78	152	6.502	6.577	6.472
3/24/78	153	6.692	6.502	6.486
3/31/78	154	6.391	6.692	6.652
4/07/78	155	6.535	6.391	6.440
4/14/78	156	6.854	6.535	6.648
4/21/78	157	6.407	6.854	6.780
4/28/78	158	5.275	6.407	6.399
5/05/78	159	5.499	5.265	5.217
5/12/78	160	5.658	5.499	5.615
5/19/78	161	5.908	5.658	5.658
5/26/78	162	6.196	5.908	5.816
6/02/78	163	6.396	6.196	6.386
6/09/78	164	6.294	6.396	6.511
6/16/78	165	5.816	6.294	6.286
6/23/78	166	6.305	5.816	5.808
6/30/78	167	6.663	6.305	6.475
7/07/78	168	7.072	6.663	6.696
7/14/78	169	7.224	7.072	7.228
7/21/78	170	7.168	7.224	7.322
7/28/78	171	7.655	7.168	7.062
8/04/78	172	7.370	7.655	7.529
8/11/78	173	6.459	7.370	7.259
8/18/78	174	6.176	6.459	6.443
8/25/78	175	6.563	6.176	6.591
9/01/78	176	6.534	6.563	6.546
9/08/78	177	6.174	6.534	6.750
9/18/78	178	5.867	6.174	6.253
9/22/78	179	6.147	5.867	6.006
9/29/78	180	5.811	6.147	6.394

TABLE B-5.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/06/78	181	5.935	5.811	5.671
10/13/78	182	6.648	5.935	6.147
10/20/78	183	7.076	6.648	6.579
10/27/78	184	8.178	7.076	6.962
10/03/78	185	9.739	8.178	7.893
11/10/78	186	9.350	9.739	10.510
11/17/78	187	9.564	9.350	9.398
11/24/78	188	9.553	9.564	9.215
12/01/78	189	9.864	9.563	9.777
12/08/78	190	9.497	9.864	9.998

*$z_t - z_{t-1} = a_t$

+$y_t = .871\, x_t + .803\, x_{t-1} + a_t$

where: y = United Kingdom three-month interbank rate

x = U. S. three-month Treasury bill rate.

TABLE B-6.--Forecasts of the Dutch three-month interbank rate
February 3, 1978 - December 8, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
2/03/78	146	7.525	7.310	7.280
2/10/78	147	7.441	7.525	7.488
2/17/78	148	7.266	7.411	7.463
2/24/78	149	7.588	7.266	7.310
3.03/78	150	7.585	7.588	7.566
3/10/78	151	7.609	7.585	7.548
3/17/78	152	7.587	7.609	7.512
3/24/78	153	7.461	7.587	7.572
3/31/78	154	7.533	7.461	7.424
4/07/78	155	7.717	7.533	7.577
4/14/78	156	7.567	7.717	7.821
4/21/78	157	7.287	7.568	7.502
4/28/78	158	7.363	7.287	7.280
5/05/78	159	7.682	7.363	7.311
5/12/78	160	7.869	7.692	7.794
5/19/78	161	8.068	7.869	7.869
5/26/78	162	8.077	8.068	7.987
6/02/78	163	8.255	8.077	8.246
6/09/78	164	8.214	8.255	8.357
6/16/78	165	8.115	8.214	8.207
6/23/78	166	8.622	8.115	8.108
6/30/78	167	8.900	8.622	8.774
7/07/78	168	8.830	8.900	8.929
7/14/78	169	8.811	8.830	8.968
7/21/78	170	9.099	8.811	8.897
7/28/78	171	9.243	9.099	9.005
8/04/78	172	9.431	9.243	9.129
8/11/78	173	8.964	9.431	9.333
8/18/78	174	9.152	8.964	8.950
8/25/78	175	9.274	9.152	9.509
9/01/78	176	9.320	9.274	9.260
9/08/78	177	9.764	9.320	9.498
9/15/78	178	9.735	9.764	9.834
9/22/78	179	10.010	9.735	9.860
9/29/78	180	9.824	10.010	10.230

TABLE B-6.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/06/78	181	9.845	9.824	9.697
10/13/78	182	9.538	9.845	10.040
10/20/78	183	9.895	9.538	9.481
10/27/78	184	10.370	9.895	9.801
11/03/78	185	11.280	10.370	10.120
11/10/78	186	11.810	11.280	12.010
11/17/78	187	12.140	11.810	11.880
11/24/78	188	11.500	12.140	11.640
12/01/78	189	12.090	11.500	11.840
12/08/78	190	12.160	12.090	12.290

*$z_t - z_{t-1} = a_t$

+$y_t = .558\ x_t + .745\ x_{t-1} + a_t$

where: y = Dutch three-month interbank rate

x = U. S. three-month Treasury bill rate

TABLE B-7.--Forecasts of the Swiss three-month interbank rate February 3, 1978 - December 8, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Univariate Model**	Transfer Function+
2/03/78	128	7.184	7.304	7.324	7.295
2/10/78	129	7.315	7.184	7.188	7.171
2/17/78	130	7.248	7.315	7.334	7.312
2/24/78	131	7.328	7.248	7.257	7.235
3/03/78	132	7.483	7.328	7.345	7.325
3/10/78	133	7.300	7.483	7.516	7.497
3/17 78	134	7.415	7.300	7.308	7.307
3/24/78	135	7.285	7.415	7.435	7.432
3/31/78	136	7.400	7.285	7.288	7.294
4/07/78	137	7.500	7.400	7.416	7.413
4/14/78	138	7.445	7.500	7.526	7.510
4/21/78	139	7.221	7.445	7.461	7.456
4/28/78	140	7.240	7.221	7.210	7.214
5/05/78	141	7.658	7.240	7.233	7.240
5/12/78	142	7.848	7.658	6.698	7.681
5/19/78	143	7.934	7.848	7.905	7.885
5/26/78	144	8.045	7.934	7.994	7.983
6/02/78	145	8.223	8.045	8.111	8.082
6/09/78	146	8.163	8.223	8.302	8.263
6/16/78	147	8.226	8.163	8.226	8.194
6/23/78	148	8.604	8.226	8.289	8.261
6/30/78	149	8.794	8.604	8.703	8.654
7/07/78	150	8.809	8.794	8.904	8.855
7/14/78	151	8.662	8.809	8.907	8.852
7/21/78	152	8.836	8.662	8.733	8.676
7/28/78	153	8.718	8.836	8.918	8.876
8/04/78	154	8.599	8.718	8.778	8.755
8/11/78	155	8.285	8.599	8.639	8.633
8/18/78	156	8.403	8.285	8.285	8.293
8/26/78	157	8.757	8.403	8.417	8.383
9/01/78	158	8.678	8.757	8.808	8.772
9/08/78	159	9.454	8.678	8.715	8.666
9/15/78	160	9.476	9.454	9.570	9.518
9/22/78	161	9.906	9.476	9.581	9.524
9/29/78	162	10.109	9.906	10.050	9.980

TABLE B-7.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Univariate Model**	Transfer Function+
10/06/78	163	10.671	10.109	10.260	10.210
10/13/78	164	10.726	10.671	10.870	10.830
10/20/78	165	11.140	10.726	10.910	10.870
10/27/78	166	11.305	11.140	11.350	11.330
11/03/78	167	12.232	11.305	11.510	11.500
11/10/78	168	12.576	12.232	12.540	12.500
11/17/78	169	13.278	12.576	12.890	12.850
11/24/78	170	12.948	13.278	13.660	13.650
12/01/78	171	12.724	12.948	13.210	13.230
12/08/78	172	12.529	12.724	12.930	12.940

*$z_t - z_{t-1} = a_t$

**$z_t - 2z_{t-1} + z_{t-2} = a_t - .884\, a_{t-1}$

+$y_t = .356\, x_t - .404\, x_{t-1} + a_t - .921\, a_{t-1}$

where y = Swiss three-month interbank rate

x = U. S. three-month Treasury bill rate

APPENDIX C

TIME SERIES FORECASTS--LONG-TERM INTEREST RATES

(Three-Month Holding Period Returns)

TABLE C-1.--Forecast of the Canadian long-term government bond yield (Three-month holding-period return) July 14, 1972 - December 29, 1972

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
7/14/72	77	7.320	7.258	7.265
7/21/72	78	7.375	7.320	7.343
7/28/72	79	7.384	7.375	7.387
8/04/72	80	7.327	7.384	7.380
8/11/72	81	7.055	7.327	7.303
8/18/72	82	7.131	7.055	6.964
8/25/72	83	7.162	7.131	7.190
9/01/72	84	7.113	7.162	7.152
9/08/72	85	7.375	7.113	7.086
9/15/72	86	7.330	7.375	7.492
9/22/72	87	7.284	7.330	7.284
9/29/72	88	7.122	7.284	7.287
10/06/72	89	7.122	7.122	7.064
10/13/72	90	6.940	7.122	7.148
10/20/72	91	7.081	6.940	6.864
10/27/72	92	6.900	7.081	7.150
11/03/72	93	6.895	6.900	6.820
11/10/72	94	6.685	6.895	6.916
11/17/72	95	6.747	6.685	6.607
11/24/96	96	6.729	6.747	6.783
12/01/72	97	6.805	6.729	6.707
12/08/72	98	6.938	6.805	6.836
12/15/72	99	7.100	6.938	6.972
12/22/72	100	7.085	7.100	7.142
12/29/72	101	7.195	7.085	7.070

$^{*}z_t - z_{t-1} = a_t$

$^{+}y_t = 1.270\ x_t + a_t + .381\ a_{t-1}$

where y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yields.

TABLE C-2.--Forecasts of the Swiss long-term confederation bond yield (Three-month holding-period return) July 14, 1972 - December 29, 1972

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
7/14/72	77	7.864	6.995	7.013
7/21/72	78	9.504	8.030	8.056
7/28/72	79	9.534	9.943	10.070
8/04/72	80	9.788	9.541	9.625
8/11/72	81	9.616	9.849	9.879
8/18/72	82	9.678	9.575	9.582
8/25/72	83	9.748	9.693	9.689
9/01/72	84	9.548	9.764	9.768
9/08/72	85	9.567	9.501	9.498
9/15/72	86	9.687	9.571	9.558
9/22/72	87	9.401	9.715	9.714
9/29/72	88	9.149	9.334	9.328
10/06/72	89	8.605	9.090	9.066
10/13/72	90	7.797	8.474	8.437
10/20/72	91	7.703	7.590	7.528
10/27/72	92	7.483	7.679	7.628
11/03/72	93	7.503	7.427	7.405
11/10/72	94	7.470	7.508	7.496
11/17/72	95	7.206	7.462	7.462
11/24/72	96	7.027	7.139	7.132
12/01/72	97	6.089	6.982	6.932
12/08/72	98	6.118	5.845	5.801
12/15/72	99	6.078	6.125	6.067
12/22/72	100	6.045	6.068	6.055
12/29/72	101	5.857	6.037	6.030

$$^{*}z_t - 1.225\, z_{t-1} + .225\, z_{t-2} = a_t$$

$$^{+}y_t = .780\, x_t + \frac{(1 - .255B)}{(1 - .526B)}\, a_t$$

where: y = Swiss long-term confederation bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE C-3.--Forecasts of the Canadian long-term government bond yield (Three-month holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	9.811	10.340	10.360
10/18/74	94	9.432	9.584	9.661
10/25/74	95	9.211	9.206	9.243
11/01/74	96	8.846	9.203	9.205
11/08/74	97	8.901	8.544	8.614
11/15/74	98	8.599	8.771	8.755
11/22/74	99	8.701	8.584	8.547
11/29/74	100	8.665	8.773	8.745
12/06/74	101	8.907	8.772	8.659
12/13/74	102	8.741	9.024	8.947
12/20/74	103	8.929	8.762	8.596
12/27/74	104	8.929	9.177	8.998
1/03/75	105	8.781	8.986	9.016
1/10/75	106	8.863	8.730	8.739
1/17/75	107	8.382	9.013	8.954
1/24/75	108	8.475	8.111	8.191
1/21/75	109	8.793	8.562	8.578
2/07/75	110	8.606	8.865	8.818
2/14/75	111	8.491	8.575	8.499
2/21/75	112	8.771	8.397	8.393
2/28/75	113	8.706	8.942	8.824
3/07/75	114	8.572	8.634	8.668
3/14/75	115	8.583	8.581	8.647
3/21/75	116	8.628	8.643	8.708
3/28/75	117	8.734	8.610	8.779
4/04/75	118	8.913	8.935	9.143
4/11/75	119	9.074	8.882	9.026
4/18/75	120	8.957	9.065	9.172
4/25/75	121	8.844	8.987	9.014
5/02/75	122	8.632	8.829	8.908

$$^{*}z_t - 1.364\, z_{t-1} + .364\, z_{t-2} = a_t - .403\, a_{t-11}$$

$$^{+}y_t - .655\, y_{t-1} = .825\, x_t + \frac{(1 - .371B^{11})}{(1 - .242B)}\, a_t$$

where: y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE C-4.--Forecasts of the West German long-term public authority loan rate. (Three-month holding-period returns) January 20, 1978 - November 23, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	10.340	10.070	11.210
1/27/78	143	9.975	10.180	10.300
2/03/78	144	10.060	10.100	10.340
2/10/78	145	9.836	10.080	10.050
2/17/78	146	9.642	9.988	10.220
2/24/78	147	9.803	9.853	10.260
3/03/78	148	9.834	9.833	9.914
3/10/78	149	9.794	9.834	9.719
3/17/78	150	9.487	9.818	9.772
3/24/78	151	9.346	9.689	9.487
3/31/78	152	9.475	9.554	9.385
4/07/78	153	9.643	9.523	10.160
4/14/78	154	9.743	9.570	9.721
4/21/78	155	9.411	9.638	9.839
4/28/78	156	9.579	9.549	9.454
5/05/78	157	9.926	9.561	10.040
5/12/78	158	10.090	9.704	10.120
5/19/78	159	10.330	9.855	10.390
5/26/78	160	10.300	10.040	10.240
6/02/78	161	10.400	10.140	10.510
6/09/78	162	10.400	10.250	10.460
6/16/78	163	10.680	10.310	10.280
6/23/78	164	11.140	10.450	10.670
6/30/78	165	11.370	10.730	11.200
7/07/78	166	11.280	10.990	11.650
7/14/78	167	11.240	11.110	11.470
7/21/78	168	11.480	11.160	11.650
7/28/78	169	11.440	11.290	11.300
8/04/78	170	11.420	11.350	11.370
8/11/78	171	11.450	11.380	10.550
8/18/78	172	11.830	11.410	10.960
8/25/78	173	11.870	11.580	11.840
9/01/78	174	11.650	11.700	11.120
9/08/78	175	11.880	11.680	11.700
9/15/78	176	12.040	11.760	11.470

TABLE C-4.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	12.320	11.880	11.710
9/29/78	178	12.740	12.060	12.730
10/06/78	179	12.750	12.340	12.860
10/13/78	180	13.040	12.520	12.880
10/20/78	181	13.340	12.740	12.730
10/27/78	182	13.750	13.000	13.500
11/03/78	183	14.490	13.330	13.760
11/10/78	184	15.090	13.850	14.690
11/17/78	185	16.060	14.430	14.860
11/24/78	186	15.330	15.230	15.030

*$z_t - z_{t-1} = a_t - .610\ a_{t-1}$

+$y_t + .322\ y_{t-1} = -2.270\ x_t + 5.700\ x_{t-1} + a_t - .549\ a_{t-1}$

where: y = West German long-term public authority loan rate.

x = U. S. 10-year constant maturity bond yield.

TABLE C-5.--Forecasts of the Canadian long-term government bond yield. January 20, 1978 - November 23, 1978 (Three month holding-period return)

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	9.272	9.157	9.249
1/27/78	143	9.241	9.295	9.264
2/03/78	144	9.285	9.236	9.236
2/10/78	145	9.117	9.292	9.288
2/17/78	146	9.061	9.091	9.095
2/24/78	147	9.044	9.052	9.089
3/03/78	148	9.067	9.041	9.033
3/10/78	149	8.989	9.071	9.057
3/17/78	150	8.679	8.977	8.968
3/24/78	151	8.536	8.630	8.596
3/31/78	152	8.637	8.513	8.513
4/07/78	153	8.397	8.653	8.730
4/14/78	154	8.390	8.359	8.325
4/21/78	155	7.929	8.389	8.409
4/28/78	156	8.333	7.857	7.805
5/05/78	157	8.690	8.386	8.473
5/12/78	158	8.835	8.742	8.764
5/19/78	159	8.965	8.857	8.880
5/26/78	160	8.941	8.985	8.983
6/02/78	161	9.038	8.937	8.950
6/09/78	162	8.919	9.052	9.065
6/16/78	163	8.914	8.901	8.875
6/23/78	164	9.325	8.913	8.935
6/30/78	165	9.553	9.386	9.443
7/07/78	166	9.579	9.588	9.621
7/14/78	167	9.400	9.583	9.583
7/21/78	168	9.303	9.372	9.387
7/28/78	169	9.224	9.288	9.272
8/04/78	170	8.793	9.212	9.205
8/11/78	171	8.585	8.724	8.629
8/18/78	172	8.539	8.551	8.545
8/25/78	173	8.717	8.531	8.577
9/01/78	174	8.616	8.746	8.697
9/08/78	175	8.791	8.600	8.604
9/15/78	176	8.827	8.919	8.811

TABLE C.5.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	8.998	8.833	8.816
9/29/78	178	9.143	9.026	9.106
10/06/78	179	9.176	9.167	9.193
10/13/78	180	9.420	9.181	9.186
10/20/78	181	9.548	9.460	9.450
10/27/78	182	9.779	9.569	9.606
11/03/78	183	10.550	9.818	9.848
11/10/78	184	10.430	10.690	10.760
11/17/78	185	10.690	10.410	10.390
11/24/78	186	10.370	10.730	10.700

*$z_t - 1.154\ z_{t-1} + .154\ z_{t-2} = a_t$

+$y_t = .610\ x_t + .592\ x_{t-1} + a_t + .237\ a_{t-1}$

where y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE C-6.--Forecasts of the Dutch long-term government loan rate (Three-month holding-period return) January 20, 1978 - November 24, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	10.090	9.298	9.378
1/27/78	143	9.909	10.530	10.400
2/03/78	144	9.799	9.829	9.847
2/10/78	145	9.486	9.751	9.740
2/17/78	146	9.169	9.349	9.396
2/24/78	147	9.193	9.030	9.079
3/03/78	148	9.093	9.204	9.168
3/10/78	149	8.881	9.049	9.023
3/17/78	150	9.193	8.788	8.804
3/24/78	151	9.515	9.329	9.303
3/31/78	152	9.652	9.656	9.646
4/07/78	153	9.584	9.712	9.818
4/14/78	154	9.233	9.554	9.511
4/21/78	155	9.443	9.079	9.087
4/28/78	156	9.927	9.534	9.503
5/05/78	157	10.100	10.140	10.200
5/12/78	158	10.340	10.170	10.180
5/19/78	159	10.450	10.450	10.460
5/26/78	160	10.660	10.490	10.460
6/02/78	161	10.620	10.760	10.780
6/09/78	162	10.450	10.600	10.600
6/16/78	163	10.720	10.370	10.350
6/23/78	164	11.060	10.840	10.870
6/30/78	165	11.270	11.200	11.230
7/07/78	166	11.410	11.360	11.390
7/14/78	167	11.040	11.470	11.440
7/21/78	168	11.220	10.880	10.910
7/28/78	169	10.880	11.310	11.250
8/04/78	170	10.620	10.730	10.740
8/11/78	171	9.992	10.500	10.400
8/18/78	172	10.060	9.720	9.762
8/25/78	173	10.480	10.090	10.190
9/01/78	174	10.590	10.660	10.520
9/08/78	175	10.800	10.640	10.690
9/15/78	176	11.050	10.890	10.840

TABLE C-6.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	11.320	11.160	11.150
9/29/78	178	10.170	11.440	11.560
10/06/78	179	7.384	9.671	9.702
10/13/78	180	5.235	6.059	6.067
10/20/78	181	6.666	4.130	4.101
10/27/78	182	7.880	7.282	7.319
11/03/78	183	9.091	8.418	8.405
11/10/78	184	10.650	9.642	9.659
11/17/78	185	11.940	11.390	11.330
11/24/78	186	10.530	12.560	12.470

$^*z_t - 1.442\, z_{t-1} + .442\, z_{t-2} = a_t$

$^+y_t = .861\, x_t + .958\, x_{t-1} + \frac{1}{(1 - .413B)}\, a_t$

where: y = Dutch long-term government loan rate

x = U. S. 10-year constant maturity bond yield.

TABLE C-7.--Forecasts of the Swiss long-term confederation bond yield (Three-month holding-period return) January 20, 1978 - November 23, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	10.370	9.895	9.903
1/27/78	143	10.170	10.490	10.500
2/03/67	144	10.350	10.120	10.120
2/10/78	145	10.300	10.390	10.400
2/17/78	146	10.370	10.280	10.290
2/24/78	147	10.590	10.380	10.390
3/03/78	148	10.980	10.640	10.650
3/10/78	149	10.800	11.080	11.090
3/17/78	150	10.440	10.760	10.750
3/24/78	151	10.620	10.350	10.340
3/31/78	152	10.640	10.670	10.670
4/07/78	153	10.770	10.650	10.650
4/14/78	154	10.810	10.800	10.800
4/21/78	155	10.510	10.830	10.830
4/28/78	156	10.310	10.440	10.430
5/05/78	157	10.460	10.260	10.260
5/12/78	158	10.410	10.490	10.500
5/19/78	159	10.480	10.400	10.400
5/26/78	160	10.370	10.500	10.500
6/02/78	161	10.370	10.340	10.340
6/09/78	162	10.500	10.370	10.370
6/16/78	163	10.550	10.530	10.530
6/23/78	164	10.700	10.560	10.560
6/30/78	165	10.820	10.740	10.750
7/07/78	166	10.750	10.850	10.850
7/14/78	167	10.640	10.740	10.740
7/21/79	168	10.530	10.610	10.610
7/28/78	169	10.200	10.500	10.490
8/04/78	170	10.430	10.130	10.120
8/11/78	171	11.050	10.480	10.480
8/18/78	172	11.400	11.200	11.210
8/25/78	173	11.800	11.490	11.500
9/01/78	174	11.530	11.900	11.900
9/08/78	175	12.300	11.460	11.450
9/15/78	176	12.450	12.490	12.510

TABLE C-7.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	12.900	12.490	12.490
9/29/78	178	13.180	13.000	13.020
10/06/78	179	13.310	13.250	13.260
10/13/78	180	13.890	13.340	13.350
10/20/78	181	14.400	14.030	14.040
10/27/78	182	14.550	14.540	14.560
11/03/78	183	15.510	14.590	14.600
11/10/78	184	15.840	15.770	15.800
11/17/78	185	16.550	15.930	15.940
11/24/78	186	16.080	16.750	16.760

$$^{*}z_t - 1.269\, z_{t-1} + .269\, z_{t-2} = a_t$$

$$^{+}y_t = -.195\, x_t + \frac{1}{(1 - .289B)}\, a_t$$

where: y = Swiss long-term confederation bond yield

x = U. S. 10-year constant maturity bond yield.

APPENDIX D

TIME SERIES FORECASTS--LONG-TERM INTEREST RATES

(Six-month holding-period return)

TABLE D-1.--Forecasts of the West German long-term public authority loan rate (Six-month holding-period return) July 14, 1972 - December 29, 1972

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
7/14/72	77	13.190	11.460	11.520
7/21/72	78	12.590	13.190	13.220
7/28/72	79	12.430	12.590	12.540
8/04/72	80	12.550	12.430	12.410
8/11/72	81	12.550	12.550	12.560
8/18/72	82	12.790	12.550	12.510
8/25/72	83	12.560	12.790	12.680
9/01/72	84	12.050	12.560	12.540
9/01/72	85	11.840	12.050	11.100
9/15/72	86	11.960	11.840	11.840
9/22/72	87	11.540	11.960	11.950
9/29/72	88	11.490	11.540	11.580
10/06/72	89	11.010	11.490	11.510
10/13/72	90	10.590	11.010	11.000
10/20/72	91	10.200	10.590	10.570
10/27/72	92	10.310	10.200	10.200
11/03/72	93	9.995	10.310	10.350
11/10/72	94	10.110	9.995	10.010
11/17/72	95	10.200	10.110	10.160
11/24/72	96	9.650	10.200	10.250
12/01/72	97	9.693	9.650	9.830
10/08/72	98	10.230	9.693	9.875
12/15/72	99	10.280	10.230	10.340
12/22/72	100	10.820	10.280	10.340
12/29/72	101	10.270	10.820	10.850

*$z_t - z_{t-1} = a_t$

+$y_t - .299\, y_{t-1} = .999\, x_{t-13} + a_t$

where: y = West German long-term public authority loan rate

x = U. S. 10-year constant maturity bond yield.

TABLE D-2.--Forecasts of the Canadian long-term government bond yield
(Six-month holding-period return)
July 14, 1972 - December 29, 1972

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
7/14/77	77	7.325	8.377	7.415
7/21/77	78	7.480	7.325	7.302
7/28/77	79	7.152	7.480	7.522
8/04/77	80	7.089	7.152	7.070
8/11/77	81	7.188	8.089	7.096
8/18/77	82	7.136	7.188	7.211
8/25/77	83	7.098	7.136	7.121
9/01/77	84	7.127	7.098	7.097
9/08/77	85	7.300	7.127	7.143
9/15/77	86	7.218	7.300	7.350
9/22/77	87	7.219	7.218	7.197
9/29/77	88	7.134	7.219	7.227
10/06/77	89	7.045	7.134	7.115
10/13/77	90	6.940	7.045	7.027
10/20/77	91	6.926	6.940	6.916
10/27/77	92	6.740	6.926	6.926
11/03/77	93	6.745	6.740	6.696
11/10/77	94	6.645	6.745	6.750
11/17/77	95	6.662	6.643	6.612
11/24/77	96	6.673	6.662	6.666
12/01/77	97	6.730	6.673	6.673
12/08/77	98	6.902	6.730	6.744
12/15/77	99	6.991	6.902	6.939
12/22/77	100	7.051	6.991	7.006
12/29/77	101	7.083	7.051	7.066

$^*z_t - z_{t-1} = a_t$

$^+y_t = .793\ x_t + a_t + .253\ a_{t-1}$

where: y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE D-3.--Forecasts of the West German long-term public authority loan rate (Six-month holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	12.270	12.830	12.920
10/18/74	94	11.970	12.270	12.160
10/25/74	95	11.370	11.970	11.800
11/01/74	96	11.390	11.370	11.290
11/08/74	97	11.630	11.390	11.340
11/15/74	98	12.280	11.630	11.480
11/22/74	99	12.050	12.280	12.180
11/29/74	100	11.920	12.050	12.020
12/06/74	101	11.580	11.920	11.740
12/13/74	102	11.580	11.580	11.520
12/20/74	103	11.470	11.580	11.070
12/27/74	104	11.770	11.470	11.170
1/03/75	105	11.980	11.770	11.990
1/10/75	106	10.990	11.980	12.000
1/17/75	107	10.380	10.990	10.900
1/24/75	108	9.941	10.380	10.490
1/31/75	109	9.407	9.941	10.060
2/07/75	110	9.365	9.407	9.360
2/14/75	111	9.947	9.565	9.376
2/21/75	112	9.791	9.947	9.970
2/28/75	113	10.160	9.791	9.791
3/07/75	114	10.200	10.160	10.360
3/14/75	115	10.380	10.200	10.320
3/21/75	116	10.270	10.380	10.620
3/28/75	117	10.710	10.270	10.670
4/04/75	118	11.370	10.710	11.130
4/11/75	119	11.550	11.370	11.540
4/18/75	120	11.140	11.550	11.720
4/25/75	121	11.280	11.140	11.120
5/02/75	122	11.030	11.280	11.430

$^{*}z_t - z_{t-1} = a_t$

$^{+}y_t - .234y_{t-1} = 3.410\ x_t + a_t$

where: y = West German long-term public authority loan rate

x = U. S. 10-year constant maturity bond yield.

TABLE D-4.--Forecasts of the Canadian long-term government bond yield (Six-month holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	9.446	9.999	10.040
10/18/74	94	9.268	9.446	9.409
10/25/74	95	9.002	9.268	9.216
11/01/74	96	8.959	9.002	8.979
11/08/74	97	8.876	8.959	8.947
11/15/74	98	8.829	8.876	8.828
11/22/74	99	8.614	8.829	8.799
11/29/74	100	8.761	8.614	8.606
12/08/74	101	8.943	8.761	8.702
12/13/74	102	8.806	8.943	8.928
12/20/74	103	8.893	8.806	8.642
12/27/74	104	8.878	8.893	8.808
1/03/75	105	8.770	8.878	8.966
1/10/75	106	8.468	8.770	8.770
1/17/75	107	8.453	8.468	8.436
1/24/75	108	8.789	8.453	8.491
1/31/75	109	8.733	8.789	8.828
2/07/75	110	8.519	8.733	8.714
2/14/75	111	8.637	8.519	8.454
2/21/75	112	8.662	8.637	8.650
2/28/75	113	8.559	8.662	8.662
3/07/75	114	8.464	8.559	8.629
3/14/75	115	8.549	8.464	8.501
3/21/75	116	8.541	8.549	8.593
3/28/75	117	8.947	8.541	8.673
4/04/75	118	9.07	8.947	9.093
4/11/75	119	9.161	9.017	9.058
4/18/75	120	8.900	9.161	9.214
4/25/75	121	8.761	8.900	8.888
5/02/75	122	8.320	8.766	8.818

$^{*}z_t - z_{t-1} = a_t$

$^{+}y_t = 1.690\ x_t + a_t$

where: y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE D-5.--Forecasts of the United Kingdom 3½ percent war loan yield (Six-month holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	11.370	11.300	11.360
10/18/74	94	11.920	11.570	11.240
10/25/74	95	12.120	11.930	11.490
11/01/74	96	12.270	12.380	12.170
11/08/74	97	11.470	12.180	12.220
11/15/75	98	10.980	11.920	11.850
11/22/75	99	11.050	11.410	11.220
11/29/75	100	10.850	11.330	11.040
12/06/75	101	11.270	10.770	10.720
12/13/75	102	9.655	11.110	10.970
12/20/75	103	9.621	10.480	9.888
12/27/75	104	10.380	9.869	9.458
1/03/75	105	9.402	10.040	10.400
1/10/75	106	8.706	9.542	9.579
1/17/75	107	11.030	9.012	8.834
1/24/75	108	9.406	10.470	10.430
1/31/75	109	9.101	9.942	9.984
2/07/75	110	8.399	8.806	9.019
2/14/75	111	8.029	9.053	8.915
2/21/75	112	8.404	8.327	8.033
2/28/75	113	7.977	7.978	8.167
3/07/75	114	7.053	7.713	8.217
3/14/75	115	6.845	7.623	7.312
3/21/75	116	7.564	7.083	7.072
3/28/75	117	7.905	6.990	7.550
4/04/75	118	8.020	7.237	7.920
4/11/75	119	8.448	8.096	7.986
4/18/75	120	8.769	8.528	8.445
4/25/75	121	8.537	8.515	8.646
5/02/75	122	8.393	8.252	8.759

$^{*}z_t - z_{t-1} = a_t$

$^{+}y_t = 1.240\ x_t + \frac{(1 + .241\ B^4)}{(1 + .372\ B)}\ a_t$

where: y = United Kingdom 3½ percent war loan yield

x = U. S. 10-year constant maturity bond yield.

TABLE D-6.--Forecasts of the French long-term public sector bond yield (Six-month holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	4.957	4.812	4.808
10/18/74	94	5.342	4.842	4.849
10/25/74	95	5.603	5.401	5.315
11/01/74	96	5.488	5.605	5.642
11/08/74	97	3.300	5.377	5.374
11/15/74	98	3.840	3.434	3.400
11/22/74	99	3.960	3.907	3.894
11/29/74	100	2.297	4.123	4.125
12/06/74	101	2.743	2.184	2.153
12/13/74	102	2.133	2.715	2.697
12/20/74	103	-.038	2.034	2.032
12/27/74	104	-.438	-.080	-.135
1/03/75	105	1.689	-.413	-.416
1/10/75	106	4.235	2.131	1.993
1/17/75	107	4.081	4.131	4.201
1/24/75	108	5.697	4.070	4.022
1/31/75	109	5.492	6.156	6.152
2/07/75	110	5.313	5.361	5.364
2/14/75	111	6.697	5.449	5.449
2/21/75	112	6.593	7.189	7.192
2/28/75	113	7.629	6.674	6.675
3/07/75	114	6.944	7.133	7.141
3/14/75	115	7.235	6.457	6.458
3/21/75	116	7.118	7.249	7.253
3/28/75	117	7.679	6.746	6.731
4/04/75	118	7.145	7.806	7.812
4/11/75	119	6.731	7.157	7.161
4/18/75	120	6.734	6.463	6.469
4/25/75	121	7.375	6.847	6.876
5/02/75	122	7.102	7.168	7.185

$*z_t - z_{t-1} = a_t - .217\, a_{t-9}$

$+y_t = .557\, x_{t-4} + a_t$

where: y = French long-term public sector bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE D-7.--Forecasts of the West German long-term public authority loan rate (Six-month holding-period return) January 20, 1978 - November 24, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	10.100	10.440	11.200
1/27/78	143	10.230	10.100	10.140
2/03/78	144	10.230	10.230	10.250
2/10/78	145	9.889	10.230	10.140
2/17/78	146	9.889	10.230	10.140
2/24/78	147	10.390	10.270	10.590
3/03/78	148	10.140	10.390	10.300
3/10/78	149	9.828	10.140	10.040
3/17/78	150	9.702	9.828	10.020
3/24/78	151	9.755	9.702	9.778
2/31/78	152	9.765	9.755	9.750
4/07/78	153	9.870	9.765	10.510
4/14/78	154	9.890	9.870	10.000
4/21/78	155	9.670	9.890	9.956
4/28/78	156	10.270	9.670	9.673
5/05/78	157	10.100	10.270	10.420
5/12/78	158	10.420	10.100	10.410
5/19/78	159	10.540	10.420	10.580
5/26/78	160	10.670	10.540	10.380
6/02/78	161	10.720	10.670	10.680
6/09/78	162	10.720	10.720	10.690
6/16/78	163	11.290	10.720	10.500
6/23/78	164	11.470	11.290	11.020
6/30/78	165	11.620	11.470	11.510
7/07/78	166	11.200	11.620	11.840
7/14/78	167	11.520	11.200	11.490
7/21/78	168	11.520	11.520	11.720
7/28/78	169	11.390	11.520	11.340
8/04/78	170	11.460	11.390	11.340
8/11/78	171	11.510	11.460	10.600
8/18/78	172	11.830	11.510	11.040
8/25/78	173	11.630	11.830	11.950
9/01/78	174	11.840	11.630	11.080
9/08/78	175	11.660	11.890	11.700
9/15/78	176	11.960	11.660	11.470

TABLE D-7.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	12.150	11.960	11.610
9/29/78	178	12.280	12.150	12.590
10/06/78	179	12.530	12.280	12.520
10/13/78	180	12.850	12.530	12.440
10/20/78	181	13.290	12.850	12.340
10/27/78	182	14.110	13.290	13.170
11/03/78	183	14.270	14.110	13.700
11/10/78	184	14.850	14.270	14.390
11/17/78	185	14.830	14.850	14.480
11/24/78	186	14.640	14.830	14.120

*$z_t - z_{t-1} = a_t$

+$y_t = -1.330\ x_t + 6.020\ x_{t-1} - 2.710\ x_{t-2} + a_t - .626\ a_{t-1}$

where: y = West German long-term public authority loan rate

x = U. S. 10-year constant maturity bond yield.

TABLE D-8.--Forecasts of the Canadian long-term government bond yield (Six-month holding-period return) January 20, 1978 - November 24, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	9.161	9.325	9.325
1/27/78	143	9.321	9.161	9.161
2/03/78	144	9.243	9.321	9.321
2/10/78	145	9.121	9.243	9.243
2/17/78	146	9.096	9.121	9.121
2/24/78	147	9.052	9.096	9.096
3/03/78	148	9.019	9.052	9.052
3/10/78	149	8.648	9.019	9.019
3/17/78	150	8.614	8.648	8.648
3/24/78	151	8.691	8.614	8.614
3/31/78	152	8.558	8.691	8.691
4/07/78	153	8.183	8.558	8.558
4/14/78	154	7.675	8.183	8.183
4/21/78	155	8.169	7.675	7.675
4/28/78	156	8.772	8.169	8.169
5/05/78	157	8.830	8.772	8.772
5/12/78	158	8.931	8.830	8.830
5/19/78	159	8.948	8.931	8.931
5/26/78	160	9.214	8.948	8.948
6/02/78	161	9.055	9.214	9.214
6/09/78	162	9.013	9.055	9.055
6/16/78	163	9.176	9.013	9.013
6/23/78	164	9.478	9.176	9.176
6/30/78	165	9.666	9.478	9.478
7/07/78	166	9.404	9.666	9.666
7/14/78	167	9.462	9.404	9.404
7/21/78	168	9.314	9.462	9.462
7/28/78	169	8.907	9.314	9.314
8/04/78	170	8.715	8.907	8.907
8/11/78	171	8.609	8.715	8.715
8/18/78	172	8.812	8.609	8.609
8/25/78	173	8.584	8.812	8.812
9/01/78	174	8.908	8.584	8.584
9/08/78	175	8.706	8.908	8.908
9/15/78	176	9.015	8.706	8.706

TABLE D-8.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	9.234	9.015	9.015
9/29/78	178	9.106	9.234	9.234
10/06/78	179	9.500	9.106	9.106
10/13/78	180	9.594	9.508	9.508
10/20/78	181	9.872	9.594	9.594
10/27/78	182	10.490	9.872	9.872
11/03/78	183	10.630	10.490	10.490
11/10/78	184	10.910	10.630	10.630
11/17/78	185	10.760	10.910	10.910
11/24/78	186	10.790	10.760	10.760

*$z_t - z_{t-1} = a_t$

+$y_t = 1.230\ x_t + a_t$

where: y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE D-9.--Forecasts of the Dutch long-term government loan rate (Six-month holding-period return) January 29, 1978 - November 24, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	10.390	9.926	9.930
1/27/78	143	10.220	10.600	10.490
2/03/78	144	10.200	10.360	10.340
2/10/78	145	9.740	10.090	10.140
2/17/78	146	9.643	9.657	9.679
2/24/78	147	9.702	9.531	9.523
3/03/78	148	9.577	9.698	9.657
3/10/78	149	9.535	9.627	9.619
3/17/78	150	9.769	9.500	9.535
3/24/78	151	9.916	9.742	9.754
3/31/78	152	10.130	9.994	9.984
4/07/78	153	9.810	10.180	10.180
4/14/78	154	9.648	9.850	9.781
4/21/78	155	9.906	9.541	9.554
4/28/78	156	10.430	9.848	9.871
5/05/78	157	10.310	10.540	10.520
5/12/78	158	10.490	10.480	10.400
5/19/78	159	10.320	10.420	10.410
5/26/78	160	10.740	10.330	10.310
6/02/78	161	10.260	10.710	10.720
6/09/78	162	10.530	10.370	10.330
6/16/78	163	10.700	10.410	10.420
6/23/78	164	10.920	10.750	10.760
6/30/78	165	10.900	11.000	10.970
7/07/78	166	10.610	10.940	10.900
7/14/78	167	10.770	10.580	10.550
7/21/78	168	10.390	10.680	10.690
7/28/78	169	10.210	10.440	10.410
8/04/78	170	10.140	10.130	10.150
8/11/78	171	9.637	10.070	10.100
8/18/78	172	10.320	9.639	9.704
8/25/78	173	10.130	10.200	10.250
9/01/78	174	10.410	10.310	10.220
9/08/78	175	10.140	10.390	10.430
9/15/78	176	10.720	19.160	10.170

TABLE D-9.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	10.180	10.650	10.670
9/29/78	178	8.874	10.340	10.320
10/06/78	179	7.557	8.750	8.714
10/13/78	180	7.524	7.157	7.181
10/20/78	181	9.564	7.212	7.264
10/27/78	182	10.190	9.616	9.607
11/03/78	183	11.430	10.680	10.520
11/10/78	184	11.910	11.570	11.510
11/17/78	185	11.660	12.080	12.020
11/24/78	186	10.560	11.750	11.720

$*z_t - z_{t-1} = a_t + .299\ a_{t-2}$

$+y_t = 1.990\ x_t + a_t + .237\ a_{t-2}$

where: y = Dutch long-term government loan rate

x = U. S. 10-year constant maturity bond yield

TABLE D-10.--Forecasts of the Swiss long-term Confederation Bond Yield (Six-month holding-period return) January 20, 1978 - November 24, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	9.890	10.230	10.230
1/27/78	143	10.130	9.890	9.890
2/03/78	144	10.250	10.130	10.130
2/10/78	145	10.210	10.250	10.250
2/17/78	146	10.410	10.210	10.210
2/24/78	147	11.370	10.410	10.410
3/03/78	148	10.970	11.370	11.370
3/10/78	149	10.400	10.970	10.970
3/17/78	150	10.890	10.400	10.400
3/24/78	151	10.580	10.890	10.890
3/31/78	152	10.820	10.580	10.580
4/07/78	153	11.000	10.820	10.820
4/14/78	154	10.850	11.000	11.000
4/21/78	155	10.240	10.850	10.850
4/28/78	156	10.650	10.240	10.240
5/05/78	157	10.490	10.650	10.650
5/12/78	158	10.560	10.490	10.490
5/19/78	159	10.450	10.560	10.560
5/26/78	160	10.290	10.450	10.450
6/02/78	161	10.650	10.290	10.290
6/09/78	162	10.540	10.650	10.650
6/16/78	163	10.700	10.540	10.540
6/23/78	164	10.770	10.700	10.700
6/30/78	165	10.770	10.770	10.770
7/07/78	166	10.540	10.770	10.770
7/14/78	167	10.760	10.540	10.540
7/21/78	168	10.320	10.760	10.760
7/28/78	169	10.590	10.320	10.320
8/04/78	170	11.100	10.590	10.590
8/11/78	171	11.250	11.100	11.100
8/18/78	172	11.910	11.250	11.250
8.25.78	173	11.190	11.910	11.910
9/01/78	174	11.600	11.190	11.190
9/08/78	175	11.620	11.600	11.600
9/15/78	176	11.830	11.620	11.620

TABLE D-10.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	12.170	11.830	11.830
9/29/78	178	12.160	12.170	12.170
10/06/78	179	12.890	12.160	12.160
10/13/78	180	13.370	12.890	12.890
10/20/78	181	13.710	13.370	13.370
10/29/78	182	14.330	13.710	13.710
11/03/78	183	14.680	14.330	14.330
11/10/78	184	14.930	14.680	14.680
11/17/78	185	14.340	14.930	14.930
11/24/78	186	14.890	14.340	14.340

*$z_t - z_{t-1} = a_t$

+$y_t = .612\, x_t + a_t$

where: y = Swiss long-term confederation bond yield

x = U. S. 10-year constant maturity bond yield.

APPENDIX E

TIME-SERIES FORECASTS--LONG-TERM INTEREST RATES

(ONE-YEAR HOLDING PERIOD RETURN)

TABLE E-1.--Forecast of the West German long-term public authority loan rate (One-year holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	12.150	12.600	12.650
10/18/74	94	11.770	12.150	12.090
10/25/74	95	11.320	11.770	11.690
10/01/74	96	11.300	11.320	11.280
11/08/74	97	11.480	11.300	11.280
11/15/74	98	11.710	11.480	11.410
11/22/74	99	11.310	11.710	11.660
11/29/74	100	11.270	11.310	11.300
12/06/74	101	11.030	11.270	11.190
12/13/74	102	11.090	11.030	11.010
12/20/74	103	11.010	11.090	11.860
12/27/74	104	11.210	11.010	10.880
1/03/75	105	11.330	11.210	11.330
1/10/75	106	10.840	11.330	11.330
1/17/75	107	10.490	10.840	10.790
1/14/75	108	10.150	10.490	10.540
1/31/75	109	9.505	10.150	10.200
2/07/75	110	9.641	9.505	9.477
2/14/75	111	9.762	9.641	9.551
2/21/75	112	9.541	9.762	9.781
2/29/75	113	9.832	9.541	9.541
3/07/75	114	9.853	9.832	9.931
3/14/75	115	10.130	9.853	9.907
3/21/75	116	10.080	10.130	10.200
3/28/75	117	10.500	10.080	10.270
4/04/75	118	10.910	10.500	10.710
4/11/75	119	11.030	10.910	19.970
4/18/75	120	10.730	11.030	11.100
4/25/75	121	10.840	10.730	10.710
5/02/75	122	10.680	10.840	10.910

*$z_t - z_{t-1} = a_t$

+$y_t = 2.550\, x_t + a_t$

where: y = West German long-term public authority loan rate

x = U. S. 10-year constant maturity bond yield.

TABLE E-2.--Forecasts of the Canadian long-term government bond yield (One-year holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	9.435	9.867	9.896
10/18/74	94	9.257	9.435	9.406
10/25/74	95	9.133	9.257	9.216
11/01/74	96	9.003	9.133	9.115
11/08/74	97	8.985	9.003	8.993
11/15/74	98	8.775	8.985	8.947
11/22/74	99	8.646	8.775	8.751
11/29/74	100	8.739	8.646	8.640
12/06/74	101	8.856	8.739	8.692
12/13/74	102	8.784	8.856	8.844
12/20/74	103	8.871	8.784	8.656
12/29/74	104	8.813	8.871	8.805
1/03/75	105	8.672	8.813	8.877
1/10/75	106	8.457	8.672	8.672
1/17/75	107	8.409	8.457	8.432
1/24/75	108	8.443	8.409	8.439
1/31/75	109	8.494	8.443	8.472
2/07/75	110	8.422	8.494	8.479
2/14/75	111	8.442	8.422	8.373
2/21/75	112	8.359	8.442	8.452
2/28/75	113	8.472	8.359	8.359
3/07/75	114	8.388	8.472	8.525
3/14/75	115	8.462	8.388	8.417
3/12/75	116	8.519	8.462	8.495
3/28/75	117	8.893	8.519	8.622
4/04/75	118	8.919	8.893	9.009
4/11/75	119	9.074	8.9o9	8.951
4/18/75	120	8.965	9.074	9.116
4/25/75	121	8.853	8.965	8.956
5/02/75	122	8.723	8.853	8.894

$^{*}z_t - z_{t-1} = a_t$

$^{+}y_t = 1.330\ x_t + a_t$

where: y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield

TABLE E-3.--Forecasts of the French long-term public sector bond yield (One-year holding-period return) October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	5.522	5.431	5.394
10/18/74	94	5.397	5.486	5.522
10/25/74	95	5.703	5.346	5.397
11/01/74	96	5.798	5.681	5.703
11/08/74	97	4.433	5.787	5.798
11/15/74	98	4.981	4.383	4.433
11/22/74	99	5.212	4.950	4.981
11/29/74	100	4.093	5.204	5.212
12/06/74	101	4.429	4.027	4.093
12/13/74	102	3.708	4.413	4.429
12/20/74	103	2.556	3.499	3.708
12/27/74	104	3.266	2.432	2.556
1/03/75	105	3.952	3.395	3.266
1/10/75	106	4.768	3.952	3.952
1/17/75	107	4.957	4.720	4.768
1/24/75	108	5.408	5.015	4.957
1/31/75	109	6.023	5.467	5.408
2/07/75	110	5.844	5.994	6.023
2/14/75	111	6.796	5.748	5.844
2/21/75	112	6.870	6.815	6.796
2/28/75	113	7.585	6.870	6.870
3/07/75	114	6.900	7.696	7.585
3/14/75	115	6.916	6.958	61900
3/21/75	116	6.931	6.916	6.984
3/28/75	117	7.535	6.931	7.137
4/04/75	118	7.002	7.535	7.762
4/11/75	119	6.731	7.002	7.064
4/18/75	120	6.833	6.731	6.808
4/25/75	121	7.606	6.833	6.816
5/02/75	122	7.014	7.606	7.686

$^{*}z_t - z_{t-1} = a_t$

$^{+}y_t = 1.720\, x_t + a_t$

where: y = French long-term public sector bond yield

x = U. S. 10-year constant maturity bond yield.

TABLE E-4.--Forecasts of the Dutch long-term government loan rate
(one-year holding-period return)
October 11, 1974 - May 2, 1975

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
10/11/74	93	10.450	10.700	10.710
10/18/74	94	10.320	10.450	10.430
10/25/74	95	10.050	10.320	10.290
11/01/74	96	9.638	10.050	10.040
11/08/74	97	9.665	9.638	9.632
11/15/74	98	9.642	9.665	9.641
11/22/74	99	9.603	9.642	9.627
11/29/74	100	9.732	9.603	9.599
12/06/74	101	9.821	9.732	9.703
11/13/74	102	9.725	9.821	9.814
12/20/74	103	9.890	9.725	9.644
11/27/74	104	9.861	9.890	9.849
1/03/75	105	10.170	9.861	9.900
1/10/75	106	9.602	10.170	10.170
1/17/75	107	9.162	9.602	9.586
1/24/75	108	9.106	9.162	9.180
1/31/75	109	8.714	9.106	9.124
2/07/75	110	8.454	9.714	8.705
2/14/75	111	8.636	8.454	8.422
2/21/75	112	8.459	8.636	8.642
2/28/75	113	8.495	8.459	8.459
3/07/75	114	8.510	8.495	8.530
3/14/75	115	8.467	8.510	8.529
3/21/75	116	8.615	8.467	8.489
3/28/75	117	8.757	8.615	8.686
4/04/75	118	9.151	8.757	8.832
4/11/75	119	9.489	9.151	9.173
4/18/75	120	9.101	9.489	9.519
4/25/75	121	9.352	9.101	9.094
5/02/75	122	9.015	9.052	9.081

*$z_t - z_{t-1} = a_t$

+$y_t = .824\ x_t + a_t$

where: y = Dutch long-term government loan rate

x = U. S. 10-year constant maturity bond yield

TABLE E-5.--Forecasts of the West German long-term public authority loan rate (One-year holding-period return) January 20, 1978 - November 23, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	10.040	10.320	10.880
1/27/78	143	10.210	10.040	10.500
2/03/78	144	10.230	10.210	10.400
2/10/78	145	10.030	10.230	10.280
2/17/78	146	10.410	10.030	10.310
2/24/78	147	10.490	10.410	10.570
3/03/78	148	10.310	10.490	10.540
3/10/78	149	10.030	10.310	10.350
3/17/78	150	9.723	10.030	10.210
3/24/78	151	9.818	9.723	9.960
3/31/78	152	9.828	9.818	9.853
4-17/78	153	9.912	9.828	10.240
4/14/78	154	9.995	9.912	10.180
4/21/78	155	9.712	9.995	10.150
4/28/78	156	10.040	9.712	9.910
5/05/78	157	10.040	10.040	10.210
5/12/78	158	10.190	10.040	10.340
5/19/78	159	10.250	10.190	10.480
5/26/78	160	10.450	10.250	10.400
6/02/78	161	10.610	10.450	10.530
6/09/78	162	10.680	10.610	10.610
6/16/78	163	11.110	10.680	10.550
6/23/78	164	11.330	11.110	10.830
6/30/78	165	11.320	11.300	11.220
7/07/78	166	11.150	11.320	11.540
7/14/78	167	11.400	11.150	11.490
7/21/78	168	11.360	11.400	11.620
7/28/78	169	11.180	11.360	11.450
8/04/78	170	11.140	11.180	11.300
8/11/78	171	11.190	11.140	10.770
8/18/78	172	11.510	11.190	10.730
8/25/78	173	11.390	11.510	11.240
9/01/78	174	11.740	11.390	11.000
9/08/78	175	11.580	11.740	11.280
9/15/78	176	11.890	11.580	11.280

TABLE E-5.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	12.060	11.890	11.420
9/29/78	178	12.150	12.060	12.050
10/06/78	179	12.320	12.150	12.330
10/13/78	180	12.580	12.320	12.400
10/20/78	181	12.990	12.580	12.360
10/20/78	182	11.813	12.990	12.810
11/03/78	183	13.770	13.810	13.390
11/10/78	184	14.290	13.770	13.910
11/17/78	185	14.240	14.290	14.190
11/24/78	186	14.090	14.240	13.960

*$z_t - z_{t-1} = a_t$

+$y_t = 2.550\ x_t + a_t$

where: y = West German long-term public authority loan rate

x = U. S. 10-year constant maturity bond yield.

TABLE E-6.--Forecasts of the Canadian long-term government bond yield (One-year holding-period return) January 20, 1978 - November 24, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	9.107	9.216	9.216
1/27/78	143	9.212	9.107	9.107
2/03/78	144	9.210	9.212	9.212
2/10/78	145	9.045	9.210	9.210
2/17/78	146	9.009	9.045	9.045
2/24/78	147	8.953	9.009	9.009
3/03/78	148	8.965	8.953	8.953
3/10/78	149	8.583	8.965	8.965
3/17/78	150	8.526	8.583	8.583
3/24/78	151	8.626	8.526	8.526
3/31/78	152	8.427	8.626	8.626
4/07/78	153	8.139	8.427	8.427
4/11/78	154	7.435	8.139	8.139
4/18/78	155	8.114	7.435	7.435
4/25/78	156	8.837	8.114	8.114
5/05/78	157	8.808	8.837	8.837
5/12/78	158	8.866	8.808	8.808
5/19/78	159	8.850	8.866	8.866
5/26/78	160	9.159	8.850	8.850
6/02/78	161	9.044	9.159	9.159
6/09/78	162	8.991	9.044	9.044
6/16/78	163	9.198	8.991	8.991
6/23/78	164	9.325	9.198	9.198
6/30/78	165	9.437	9.325	9.325
7/07/78	166	9.240	9.437	9.437
7/14/78	167	9.341	9.240	9.240
7/21/78	168	9.183	9.341	9.341
7/28/78	169	8.907	9.183	9.183
8/04/78	170	8.606	8.907	8.907
8/11/78	171	8.554	8.606	8.606
8/18/78	172	8.758	8.554	8.554
8/25/78	173	8.529	8.758	8.758
9/01/78	174	8.908	8.529	8.529
9/08/78	175	8.717	8.908	8.908
9/15/78	176	8.949	8.717	8.717

TABLE E-6.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	9.081	8.949	8.949
9/29/78	178	9.117	9.081	9.081
10/06/78	179	9.464	9.117	9.117
10/13/78	180	9.485	9.464	9.464
10/20/78	181	9.894	9.485	9.485
10/29/78	182	10.440	9.894	9.894
11/03/78	183	10.540	10.860	10.860
11/10/78	184	10.540	10.860	10.860
11/17/78	185	10.780	10.540	10.540
11/24/78	186	10.750	10.780	10.780

*$z_t - z_{t-1} = a_t$

+$y_t = 1.100\ x_t + a_t$

where: y = Canadian long-term government bond yield

x = U. S. 10-year constant maturity bond yield

TABLE E-7.--Forecast of the Dutch long-term government loan rate (one-year holding-period return) January 20, 1978 - November 23, 1978

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
1/20/78	142	9.919	9.601	9.601
1/27/78	143	9.879	9.919	9.919
2/03/78	144	8.779	9.879	9.879
2/10/78	145	9.554	9.779	9.779
2/17/78	146	9.429	9.554	9.554
2/24/78	147	9.349	9.429	9.429
3/03/78	148	9.352	9.349	9.349
3/10/78	149	9.300	9.352	9.352
3/17/78	150	9.533	9.300	9.300
3/24/78	151	9.637	9.533	9.533
3/31/78	152	9.768	9.637	9.637
4/07/78	153	9.554	9.768	9.768
4/14/78	154	9.627	9.554	9.554
4/21/78	155	9.725	9.627	9.627
4/28/78	156	10.010	9.725	9.725
5/05/78	157	10.020	10.010	10.010
5/12/78	158	9.994	10.020	10.020
5/19/78	159	9.886	9.994	9.994
5/26/78	160	10.200	9.886	9.886
6/02/78	161	9.967	10.200	10.200
6/09/78	162	10.170	9.967	9.967
6/16/78	163	10.300	10.170	10.171
6/23/78	164	10.490	10.300	10.300
6/30/78	165	10.410	10.490	10.490
7/07/78	166	10.220	10.410	10.410
7/14/78	167	10.460	10.220	10.220
7/21/78	168	10.080	10.460	10.460
7/28/78	169	9.830	10.080	10.080
8/04/78	170	10.030	9.830	9.830
8/11/78	171	9.616	10.030	10.030
8/18/78	172	10.300	9.616	9.618
8/25/78	173	10.150	10.300	10.300
9/01/78	174	10.390	10.150	10.150
9/08/78	175	10.090	10.390	10.390
9/15/78	176	10.560	10.090	10.090

TABLE E-7.--Continued

Date	Forecast Period	Actual Observation	Univariate Model*	Transfer Function+
9/22/78	177	10.250	10.560	10.560
9/29/78	178	9.036	10.250	10.250
10/06/78	179	7.373	9.036	9.036
10/13/78	180	7.752	8.373	7.373
10/20/78	181	10.190	7.752	8.852
10/27/78	182	10.010	10.190	10.170
11/03/78	183	11.180	10.810	10.810
11/10/78	184	11.590	11.180	11.180
11/17/78	185	11.660	11.590	11.590
11/24/78	186	10.690	11.660	11.660

*$z_t - z_{t-1} = a_t$

+$y_t = 1.680\ x_t + a_t$

where: y = Dutch long-term government loan rate

x = U. S. 10-year constant maturity bond yield

APPENDIX F

INTEREST RATE SERIES

TABLE F-1.--United States three-month treasury bill rates: weekly January 29, 1971 - December 8, 1978*

			4220	4090	3700	3600	3410
3340	3300	3520	3390	3640	3820	4000	3860
4040	3920	3940	4380	4400	4260	4600	4970
4820	5220	5420	5350	5440	5430	5280	5220
4780	4730	4500	4600	4850	4770	4670	4540
4440	4460	4370	4160	4190	4140	4400	4310
4100	4120	4040	3760				
3690	3230	3300	3460	3400	3160	3060	3180
3470	3560	3940	3770	3870	3820	3820	3640
3580	3600	3620	3780	3840	3810	3880	3860
3970	3870	4080	4070	3910	3960	3770	3860
3910	4180	4550	4710	4710	4630	4610	4690
4760	4790	4740	4750	4750	4740	4840	4870
5000	5000	5150	5110				
5160	5190	5360	5670	5680	5570	5430	5620
5850	5870	6060	6350	6280	6510	6220	6110
6280	6260	5970	6190	6630	6910	7060	7160
7290	7280	7980	7680	8030	8170	8380	8770
8950	8780	8620	8760	9020	8550	7120	7480
7140	7190	7020	7360	8200	8300	7780	7520
7680	7480	7300	7570				
7520	7670	7900	8010	7510	6930	7040	7040
7350	7710	7830	8100	8450	8490	8520	8160
8020	8770	8700	7960	8140	8130	7950	8200
7990	7300	7750	7390	7720	7420	7670	8840
8760	9310	9590	9360	9060	7830	7070	6790
7340	7720	7550	7980	7620	7180	7410	7600
7470	7120	6810	6980				
7060	6540	6650	6170	5770	5450	5700	5300
5620	5530	5410	5490	5520	5640	5700	5340
5690	5500	5470	4940	5160	5210	5240	4950
5360	5820	6020	6100	6070	6340	6200	6410
6450	6460	6550	6390	6420	6450	6350	6530
6270	6100	5730	5560	5530	5360	5470	5550
5560	5640	5450	5270	5200			
5080	4850	4790	4710	4960	4830	4920	4870
5200	4970	5000	4860	4970	4930	4790	4690
4850	4860	5140	5310	5460	5570	5440	5400
5330	5370	5400	5150	5230	5170	5190	5170
5150	5100	5090	5100	5110	5030	5070	5070
4900	4840	4880	4850	4920	4810	4630	4410
4440	4330	4280	4370				
4470	4570	4630	4710	4760	4620	4620	4700
4640	4630	4620	4540	4570	4580	4570	4500
4450	4690	5040	4980	5060	5040	5060	5020
5020	4970	5120	5160	5230	5250	5330	5460
5600	5550	5560	5600	5870	5870	5860	6130
6360	6140	6100	6220	6150	6090	6050	6040
6100	6050	6000	6190				
6160	6680	6500	6460	6410	6440	6500	6470
6420	6290	6270	6220	6280	6420	6330	6320
6250	6390	6390	6280	6510	6650	6640	6630
6840	6880	7070	7190	7060	6900	6760	6740
7240	7220	7480	7580	7760	8080	7890	8180
8090	7940	7540	8850	8990	8020	8630	8980
8890							

*411 observations, in three decimal places.

TABLE F-2.--Three-month Eurodollar rates: Weekly, January 29, 1971 - December 8, 1978*

6440	6138	5814	5590	5814	5758	5397	5290	5214	5036	5062	5036
5274	5638	6083	5838	6026	6412	7364	7052	6862	7705	7312	7164
6988	6800	6627	6414	6262	6452	6828	7526	8627	8522	9127	8752
8088	8214	8212	7302	6802	6552	6155	5970	5955	6052	6676	6657
6600	6464	6182	6313								
5412	5564	5532	5114	4978	5088	5036	5015	4950	4675	5314	5426
5688	5480	5485	5186	5088	5014	4928	4878	4774	4747	4776	4788
4862	5752	5327	5450	5702	5602	5597	5376	5500	5500	5440	5485
5467	5338	5302	5940	6050	5970	6000	5926	5778	5812	5702	5705
6124	6065	5964	6107								
5875	5888	6064	6152	6576	6940	7080	7547	8180	8810	8402	8264
8592	8576	8112	7900	8083	8212	8252	8547	8516	8652	8688	8752
8776	8914	9262	9762	9976	11088	11350	11502	11426	11312		
11514	11548	11452	11426	10798	10376	10690	10038	9580	9266		
9390	9576	9800	10426	10478	10714	11490	10813				
10500	9374	9574	9490	9088	8788	8326	8364	8478	8662	8788	9302
9812	9838	10100	10438	10640	11450	11525	11738	11788	11828		
11863	11625	11900	12688	13413	13800	14013	12863	13313	13600		
13188	13513	13906	13734	12975	12175	11600	12038	11638	11038		
10650	10213	10000	9888	10000	10288	10813	10213	10188	9969		
10229	9725	8663	8088	8013	7250	7100	7488	7338	7350	6813	6595
6838	6980	7438	7013	6788	6925	6688	6500	5988	5984	6013	5850
5773	6288	6838	7363	7113	7163	7063	6975	7238	7163	7500	7225
7188	7438	7500	7725	7950	7250	6713	6638	6763	6638	6763	6850
6925	6600	6563	6350	5896							
5703	5425	5513	5475	5288	5475	5550	5575	5663	5638	5575	5525
5425	5438	5363	5313	5388	5500	5625	5975	6350	6578	6350	6188
6138	6038	5950	5763	5750	5763	5700	5788	5675	5625	5531	5538
5575	5450	5575	5605	5463	5350	5488	5363	5313	5413	5200	5175
4950	4950	5013	5094								
5031	5038	5225	5175	5238	5063	5013	5063	5150	5088	5100	5088
5238	5175	5271	5088	5138	5338	5663	5800	5975	6000	5875	5675
5800	5800	5763	5771	5750	5775	6113	6175	6463	6363	6297	6263
6488	6588	6775	6975	7188	7300	7050	7138	7225	7088	7013	6975
6988	7113	7000	7328								
7250	7263	7425	7300	7363	7200	7225	7325	7338	7300	7200	7238
7344	7400	7350	7263	7425	7625	7725	7838	7863	8016	8000	8088
8475	8650	8625	8463	8575	8500	8413	8275	8325	8663	8613	8875
8850	9088	9413	9575	9738	9913	10313	11075	11438	11700	11275	
11663	11563										

*411 observations, in three decimal places.

TABLE F-3.--West German three-month interbank rates (adjusted): Weekly, January 29, 1971 - December 8, 1978*

6196	6588	6498	6410	6113	5791	5663	6501	6639	5962	6364	5897	6887	6901	7087	8308
8017	7624	9526	8701	7074	7123	6835	7674	7837	7969	8332	8849	9327	10005	11535	
12705	11817	11047	10265	9452	9054	9024	8916	8325	8306	8024	7883	8437	8241	7850	
8208	8341	8621													
7549	7498	6888	6361	6108	6939	6212	6263	6960	6768	7483	7240	7196	6866	6876	7097
6718	6617	6307	6229	6136	5906	6017	6089	6331	7139	8109	9053	9895	9347	9675	9460
9368	9535	9311	9250	9113	9104	8898	10271	9877	9845	9445	9539	10139	10116	9599	
9138	9934	10590	10901	10627											
10157	10064	10504	10367	10649	13194	15762	16247	16460	18528	17584	19098	18451			
17336	16323	15591	16737	17244	18249	19688	19624	19389	18065	17696	16727	15827			
18272	17809	18357	16691	18642	19160	19004	17813	18457	17939	18023	17867	18849			
18815	19217	18999	18293	16709	14670	15271	16701	12787	11658	11982	12384	11520			
11007	9079	10553	11340	9844	10082	8873	8679	8405	8537	8163	8749	9984	11223	11385	
11729	12255	11885	11874	12048	11994	11434	12062	12166	12199	12719	13612	14339			
14535	13267	13334	14273	14449	14399	14279	14596	13594	12846	12159	12064	11890			
11038	10828	10287	10366	10667	10254	10417	11186	10573	10521	10455					
10646	10179	9129	8467	8190	7544	7247	7625	7293	7704	7162	6995	6997	7072	7771	
7406	7137	7328	7229	6881	6185	6216	6296	6136	6093	6401	7077	7813	7869	7671	7737
7727	8016	7704	7902	8061	7865	7929	7896	8093	8426	7947	7074	6793	6814	6787	6869
6979	6999	6760	6844	6641	6847										
6194	5772	5789	5616	5712	5897	5909	5896	5889	5845	6113	6046	5980	5956	5722	5786
5748	5870	5959	6249	6534	6696	6445	6337	6311	6214	6176	5974	5837	5826	5869	6010
5903	5879	5705	5835	5910	5623	5593	6023	5719	5392	5630	5557	5593	5674	5388	5277
4625	4878	5119	4969												
5176	5180	5373	5207	5306	5248	5142	5156	5281	5302	5278	5214	5406	5431	5489	5388
5440	5632	6101	6400	6423	6537	6416	6151	6224	6300	6316	6226	6310	6209	6412	6543
6826	6743	6616	6631	6845	6930	7202	7441	7673	7735	7346	7542	7491	7460	7184	7292
7299	7593	7913	8314												
8350	8137	8330	7942	7967	7764	7645	7802	7915	7876	7688	7570	7724	7903	7847	7624
7758	8126	8274	8405	8374	8444	8384	8651	9014	9220	9140	8941	9093	8927	8860	8974
9250	9267	9075	9325	9489	9847	10306	10507	10865	10990	11326	12141	12552	13349		
12669	12608	12321													

*411 observations, in three decimal places.

TABLE F-4.--Canadian three-month finance paper rates (adjusted): weekly, January 29, 1971 - December 8, 1978*

```
4597 4597 4785 7653 3982 3923 3635 3850 3928 3653 4158 4474 4570 4834 4715 5257
5218 5213 5295 5241 5194 5656 5431 5579 6156 6158 5856 5684 6300 6290 5947 5988
5986 6053 6040 5964 5764 5844 5372 5172 5073 4726 4990 5022 5043 4867 4917 5061
4871
5200 4671 4324 4158 4088 4075 3940 3999 4294 3805 4462 4545 4681 4757 4650 4870
4703 4576 4656 4457 4241 4267 4349 4515 4236 5000 4723 4812 5055 5269 5076 4849
4822 5172 4944 5334 5338 5313 5271 5290 5418 5388 5298 5214 5345 5376 5368 5372
5355 5416 5500 5608
5776 5839 6031 6309 6446 6715 6887 7118 7113 7255 7387 7512 7652 7615 7534 7505
7647 7760 7762 7619 7956 7970 7956 8147 8525 8640 8760 9244 9495 10059 10570
10252 11070 11129 11161 11258 11071 10917 10577 10388 10011 9237 8969 8540 8863
9115 9255 9529 9522 9504 9246 9412
9221 8979 8958 9135 8872 8646 8275 8187 8151 8349 8613 8854 9215 9588 9861
10192 10482 10620 10989 10939 11472 11575 11606 11301 11542 12259 12816 13821
13649 13365 13133 13297 13090 13277 13791 13710 13363 12699 11908 11800 11552
11064 10730 10267 10388 10241 9965 10068 10539 10489 10581 10318
10185 9927 8498 8105 7387 7342 7567 7473 7279 7102 7143 6988 6910 7117 7328 7212
6909 6899 6509 7296 6072 5982 6031 5925 5857 5801 6503 7147 6939 7168 7306 6955
7374 7127 7283 7173 7403 7415 7316 7236 7483 6782 6624 6422 6363 6213 6360 6283
6208 6366 6247 6364 6190
5482 4963 5254 5302 5140 5031 5160 4980 5120 5021 4780 4563 4933 4886 4919 4802
4985 5163 5459 5904 6358 6251 6073 5998 5867 5556 5470 5247 5300 5324 5037 5188
5424 5044 5326 5219 5175 4970 5101 5221 5115 4982 5037 4931 4945 5107 4794 4306
4593 4425 4540 5048
4806 4851 5087 5107 5083 5013 4868 4682 4727 4729 4811 4552 4754 4767 4780 4810
4939 5186 5440 5678 6198 5907 5738 5578 5676 5651 5679 5784 5706 5649 5933 6010
6278 6090 6052 6151 6391 6590 6605 6774 6808 6898 6897 6920 6870 6959 6803 6754
6928 7177 7001 7059
7138 7193 7369 7258 7276 7127 7043 7036 7109 7022 7017 6946 7087 6978 7051 6921
7569 7466 7669 7847 7784 7941 7852 7883 8205 8355 8408 8369 8402 8324 8046 8162
8142 8488 8358 8482 8593 8869 9283 9357 9603 9809 10221 10967 11190 11510 11205
11449 11470
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*411 observations, in three decimal places.

TABLE F-5.--United Kingdom three-month interbank rates (adjusted): Weekly, August 31, 1973 - December 8, 1978*

9078	9237	8010	7271	7770	8369	8926	8772	8489	8245	8072	7670	8055	8758	9120	8933
7434	7802														
8272	6629	7061	6214	4820	2175	2805	4345	4563	2945	3682	4258	5820	5824	5941	4857
5359	7411	7580	8738	9108	9642	9527	9060	7773	8431	10467	11162	11525	11334	11626	
11379	10737	9563	9859	10089	10075	9209	8770	8138	8151	7906	8336	7707	7016	6286	
6563	6581	7474	7333	5468	4319										
4347	2904	4301	6346	6000	5418	4803	4606	5991	4053	3921	4223	4101	4276	4303	4015
3885	3491	3197	2982	3574	4755	4525	4693	4780	5307	5726	6802	6490	6323	6440	5750
6207	6601	7105	6831	6642	6865	6776	6733	6886	6494	5911	5873	6019	6001	6049	5871
6103	5943	5806	5442	5373											
5318	4846	4731	4314	4013	4655	4765	4687	4894	4336	2698	2751	3797	3402	2884	3418
3640	3865	3784	4256	5053	4993	4944	3517	3208	2220	2937	2648	2794	3206	2998	2740
2630	2676	2574	1354	1936	2626	1806	0518	0021	-1422	-1457	-2154	2728	3209	2465	2406
2179	2280	2827	2214												
2555	3002	3738	4492	3730	2810	1461	2264	2494	2418	3296	3013	3967	4443	4369	3710
4126	4503	4517	5197	4071	2304	3001	3072	3453	4007	4124	3503	3038	3862	5196	5135
5295	5406	5307	5383	6160	5908	6135	6677	7158	7238	6822	6859	6717	7038	6365	6848
6642	7027	6945	7230												
7059	6913	7018	6942	7014	6619	6528	6762	6710	6577	6502	6692	6391	6535	6854	6407
5275	5499	5658	5908	6196	6396	6294	5816	6305	6663	7072	7224	7168	7655	7370	6459
6176	6563	6534	6174	5867	6147	5811	5935	6648	7076	8178	9739	9350	9564	9553	9864
9497															

*266 observations, in three decimal places.

TABLE F-6.--French three-month interbank rates (adjusted): weekly, April 25, 1975 - December 8, 1978*

															4472
4912	4721	5465	5256	5506	4902	3848	3451	3296	3762	3063	2305	1038	3256	4393	5480
5929	7078	7064	6913	6685	6923	6922	6816	6954	6397	6225	6365	6453	6414	6486	6103
6270	6256	5989	5901												
5552	5283	5052	3196	3469	2865	2277	2756	2834	0715	-5771	-1461	0779	-0260	-0464	0386
1399	2651	2744	3043	3884	4008	3074	3384	3785	3824	4171	1732	0935	2357	3058	3985
4014	3630	3779	4007	3902	3968	3402	3157	3071	2846	3279	2758	2455	2889	2901	2972
2839	2841	2629	2470												
2052	2351	2637	2451	2882	3350	3707	3228	3289	3313	3382	3753	3955	4239	4261	4223
4388	3989	3694	4009	4254	4145	4214	4289	4620	4908	4601	3898	2837	2629	2226	2779
3461	3902	4142	3921	4175	4889	5395	6097	5939	6045	5456	5104	4669	3050	3523	2599
2338	3067	3094	2664												
2852	3855	3757	3316	3150	1715	2240	3486	4148	3503	5312	6477	6339	6870	6582	6738
6335	6084	6138	6604	6706	6603	5968	5456	5622	6654	6309	6387	6294	6520	6732	6449
6815	6757	7116	7366	7849	8144	7761	7126	7554	7570	8084	9457	9011	10474	9553	
9767	8744														

*190 observations, in three decimal places.

TABLE F-7.--Dutch three-month interbank rates (adjusted): weekly, April 25, 1975 - December 8, 1978*

															6797
6787	6600	6275	6023	5859	5987	5755	5660	6299	6870	7227	7116	6940	7266	7099	7345
7195	7358	7280	7084	7408	7747	7845	8332	7796	7012	6741	6815	6706	6989	6953	6864
6648	6658	6354	6212												
5729	5415	5353	5452	5151	5695	5557	5501	5599	5681	5653	5451	5368	5294	5354	5216
5306	5634	5625	5990	6303	6610	6094	6147	6132	5895	5542	5444	5337	5357	5103	4889
4590	3201	3887	4336	4442	3906	4490	4719	4448	4343	4805	4862	4999	4942	4894	4889
4811	4560	4446	4701												
4889	4817	5035	4988	5018	4723	4847	4932	5160	4954	4956	4872	5035	5030	4870	4723
5026	5066	5626	5715	5896	5870	5718	5486	5657	5662	5544	5582	5864	5931	6247	6163
6483	6326	6244	6136	6315	6473	6803	6930	7028	7289	6949	7236	7334	7173	6988	7086
7177	7055	7286	7522												
7342	7408	7748	7310	7525	7441	7266	7588	7585	7609	7587	7461	7533	7717	7568	7287
7363	7692	7869	8068	8077	8255	8214	8115	8622	8900	8830	8811	9099	9243	9431	8964
9152	9274	9320	9764	9735	10011	9824	9845	9538	9895	10365	11281	11806	12136		
11498	12086	12157													

*190 observations, in three decimal places.

TABLE F-8.--Swiss three-month interbank rates (adjusted): weekly, August 29, 1975 - December 8, 1978*

7691	7310	7244	7635	7745	7789	8134	7327	6745	6549	6647	6720	6738	6739	6917	6618
6523	6222	5830													
5575	5392	5290	5362	5272	5312	5398	5486	5692	5730	5598	5603	5405	5409	5340	5437
5342	5631	5582	6094	6314	6615	6401	6171	6449	6098	6135	6112	5677	5577	5781	5875
5884	5676	5540	5690	5750	5464	5265	5613	5434	5407	5421	5523	5279	5454	5079	5038
5118	4865	4928	4840												
4787	5055	5248	4978	5183	5099	4928	4911	5322	4900	5044	5077	5207	5157	5172	5039
5123	5295	5662	5733	5922	5987	5981	5725	5743	5932	5878	5908	5585	5840	6229	6292
6497	6547	6359	6288	6412	6629	6914	7093	7389	7606	7211	7398	7337	7269	7136	7113
7244	7251	7518	7291												
7317	7034	7371	7304	7184	7315	7248	7328	7483	7300	7415	7285	7400	7500	7445	7221
7240	7658	7848	7934	8045	8223	8163	8226	8604	8794	8809	8662	8836	8718	8599	8285
8408	8757	8678	9454	9476	9906	10109	10671	10726	11140	11305	12232	12576	13278		
12948	12724	12529													

*172 observations, in three decimal places.

TABLE F-9.--United States ten-year constant maturity bond yield: weekly, January 29, 1971 - November 24, 1978*

6530	6460	6270	6130	6080	6100	6080	6110	6150	6070	5820	5610
5420	5550	5610	5770	5980	6030	6240	6360	6570	6410	6262	6428
6660	6598	6678	6672	6612	6748	6890	6876	6822	6354	6392	6222
6100	6164	6174	6066	5976	5880	5922	5895	5740	5784	5768	5900
5916	5918	5936	5988								
5912	5866	5948	6036	6084	6110	6080	6065	6034	6020	6080	6094
6112	6172	6212	6222	6172	6162	6182	6140	6052	6065	6116	6100
6092	6130	6132	6118	6100	6104	6142	6146	6184	6224	6382	6508
6550	6574	6582	6532	6488	6484	6432	6372	6292	6248	6258	6286
6310	6348	6396	6402								
6420	6430	6460	6500	6570	6640	6620	6650	6650	6670	6720	6760
6710	6700	6640	6640	6680	6750	6810	6850	6910	6940	6920	6860
6880	6930	7020	7050	7090	7240	7480	7540	7410	7330	7260	7130
7190	7090	6950	6890	6770	6800	6750	6720	6760	6760	6710	6700
6720	6690	6710	6870								
6940	6980	6990	7010	7010	6940	6930	6960	7010	7080	7120	7280
7380	7470	7480	7460	7580	7640	7660	7550	7540	7510	7510	7490
7530	7620	7680	7820	7880	7770	7900	7990	8040	8050	8140	8110
8070	8070	7940	7990	7940	7870	7840	7824	7760	7720	7710	7630
7610	7370	7240	7370								
7370	7320	7380	7440	7410	7310	7330	7330	7440	7500	7570	7800
8050	8120	8210	8190	8280	8280	8090	8040	8000	8060	7970	7710
7790	7950	8010	8020	8020	8090	8170	8400	8420	8450	8450	8300
8470	8520	8370	8440	8260	8130	8030	7960	7930	7970	8140	8140
8120	8190	7970	7830								
7750	7690	7700	7770	7810	7840	7850	7790	7710	7830	7760	7750
7660	7660	7570	7490	7520	7620	7740	7930	7950	7960	7920	7880
7840	7810	7860	7820	7780	7860	7860	7830	7820	7750	7270	7670
7650	7600	7540	7550	7440	7340	7380	7460	7400	7450	7240	7120
6960	6880	6890	6850	6830							
6920	7240	7290	7360	7400	7350	7350	7470	7460	7490	7450	7450
7450	7450	7320	7310	7400	7460	7500	7460	7410	7380	7350	7240
7250	7220	7330	7310	7320	7350	7430	7450	7440	7340	7340	7310
7350	7360	7400	7430	7550	7550	7570	7650	7600	7550	7540	7560
7620	7660	7730	7790								
7830	8010	7980	7980	7960	8000	8080	8080	8040	8030	8000	7980
8120	8140	8150	8120	8210	8280	8350	8350	8390	8410	8380	8410
8490	8590	8620	8680	8650	8630	8460	8390	8480	8370	8380	8340
8310	8460	8550	8580	8540	8620	8690	8820	8860	8770	8780	8850

*409 observations, in three decimal places.

TABLE F-10.--West German long-term public authority loan rate adjusted: weekly, January 29, 1971 - November 23, 1978* (Three-month holding-period return)

6344	6756	6735	6816	6677	6243	5938	6797	6935	7083
7741	7623	8497	8592	8852	10144	9920	9550	11508	10397
8824	8525	8193	8414	8568	8691	8985	9587	10181	10823
12124	13418	12421	11572	10746	10032	9124	9175	8915	8687
8860	9177	9208	9635	9437	9349	9475	9396	10216	9750
9762	9193	8584	8439	8814	8632	8808	9523	9272	10065
10232	10294	9838	9814	10140	9737	9480	9432	9573	9592
9355	9124	9465	9881	10768	11535	12467	13499	12946	13004
12880	12786	12807	12309	12054	11787	11809	11470	11836	11018
10942	10650	10682	10413	10431	9984	9522	9903	10478	10707
10749	10717	11036	11125	11114	11294	13893	16206	16854	17145
18883	17702	19097	18450	17639	15022	13362	14054	14187	14853
15856	15957	16658	14332	13452	12687	12245	13727	13748	14027
12605	12587	13936	13990	13628	14135	13242	13394	13237	14553
14542	14334	14033	13385	11927	9871	10815	10311	9163	8258
8567	9052	8223	8065	6099	8213	8954	7802	8015	7768
8263	8411	8522	7860	8122	9202	10567	11263	12133	13312
13103	13415	14047	14055	13192	13290	13644	13804	14230	14828
16079	16219	14926	14963	15672	15682	15632	15520	15825	14954
14228	13470	13353	12961	12172	11878	11404	11561	11996	12186
11940	12247	11662	11619	11796	11976	12083	10872	10020	9608
9017	9616	10150	10078	10260	10202	10280	10409	10694	11835
11536	10847	10845	10780	10308	9388	9495	9735	9685	9608
9841	10404	11534	11655	11429	11538	11731	12636	12593	12601
12572	12367	12618	12595	12584	12930	12430	11676	11328	11501
11346	11324	11356	11346	11045	11047	10820	11050	10442	9986
9983	9877	9874	10102	10127	10000	9913	9774	10094	9983
9956	10097	9834	9921	9998	10216	10243	10615	10886	11029
10661	10394	10324	10076	10169	9916	9628	9563	9587	9640
9562	9425	9255	9295	9373	8977	8885	9123	8805	8512
8595	8523	8481	8351	7996	7850	7142	7308	7585	7356
7445	7399	7645	7660	7720	7671	7554	7588	7573	7514
7419	7224	7238	7266	7177	7041	7072	7268	7826	8202
8288	8441	8364	8096	8145	8227	8151	7988	8085	8003
8088	8253	8520	8414	8296	8342	8517	8625	8860	9018
9359	9380	9027	9256	9173	9173	8904	8909	8853	9287
9815	10325	10473	10152	10338	9975	10063	9836	9642	9803
9834	9794	9487	9346	9475	9643	9743	9411	9579	9926
10091	10330	10298	10400	10403	10675	11139	11369	11277	11241
11479	11436	11421	11454	11834	11871	11653	11877	12035	12315
12741	12752	13040	13340	13749	14494	15088	16058	15333	

*409 observations, in three decimal places.

TABLE F-11.--Canadian long-term government bond yield adjusted: weekly, January 29, 1971 - November 23, 1978* (Three-month holding-period return)

5042	5260	5428	5454	5475	5476	5908	6396	6706	6447
6514	6696	6985	7336	7429	8033	8114	8116	8210	7834
8225	8561	8229	8161	8365	8377	8530	8766	8722	8745
7757	7768	7766	7743	7586	7407	7245	6858	6333	6202
6154	6329	6535	6567	6561	6587	6638	6681	6762	6881
6671	6541	6554	6400	6331	5789	5565	5714	5167	5729
6083	6199	6445	6335	6208	5740	5760	5811	5609	5173
5181	5549	5928	6541	7114	7258	7320	7375	7384	7327
7055	7131	7162	7113	7375	7330	7284	7122	7122	6940
7081	6900	6895	6685	6747	6729	6805	6938	7100	7085
7195	7615	7659	7891	8216	8407	8641	8846	9112	9194
9463	9649	9709	9748	9839	9373	9111	9239	9197	9067
9063	9326	9206	9202	9252	9428	9442	9508	9671	9683
10166	10785	10559	11003	10836	10668	10560	10353	10050	9529
9281	8918	8132	7589	7145	7441	7705	7762	8162	8021
8018	7715	7633	7435	7197	7550	7632	7771	7735	7487
7388	7393	7593	7972	8192	9602	9035	8798	8645	8448
8567	8311	8613	8871	8982	9391	9326	9873	10701	11443
12045	11774	11317	11210	11323	11108	11343	11821	11631	11245
10765	10417	10211	9811	9432	9211	8846	8901	8599	8701
8665	8907	8741	8929	8929	8781	8863	8382	8475	8793
8606	8491	8771	8706	8572	8583	8628	8734	8913	9074
8957	8844	8632	7884	8467	7286	7425	7547	7342	7351
7710	8065	8537	8557	8661	8939	8511	8334	8104	8088
8000	7994	8173	8148	8191	8098	7415	6917	6940	6817
6523	6617	6579	6198	6405	6387	6301	6342	5531	5073
5364	5364	5327	5251	5309	5288	5312	4925	4546	4163
4091	4195	4356	4391	4664	4856	5112	5619	6062	5887
5739	5799	5620	5435	5316	5126	5121	5270	5017	4976
5020	4890	4859	4903	4881	4820	4918	4954	4828	4756
4907	4753	4633	4833	4741	4603	4737	4598	4510	5200
5020	5200	5368	5344	5447	5537	5616	5674	5778	5652
5793	5836	6074	6083	5948	6008	6133	6278	6665	7061
7514	7533	7336	7059	7215	7224	7190	7183	7144	7052
7275	7322	7484	7284	7132	7167	7459	7821	8138	8329
8409	8348	8291	8254	8209	8299	8181	8226	8282	8625
8675	8829	8913	9124	9272	9241	9285	9117	9061	9044
9067	8989	8679	8536	8637	8397	8390	7929	8333	8690
8835	8965	8941	9038	8919	8914	9325	9553	9579	9400
9303	9224	8793	8585	8539	8717	8616	8791	8827	8998
9143	9176	9420	9548	9779	10548	10433	10689	10368	

*409 observations, in three decimal places.

TABLE F-12.--United Kingdom government 3½% war loan yield adjusted: weekly, January 29, 1971 - November 23, 1978* (Three-month holding-period return)

6203	6378	6292	5438	5310	5639	5205	5533	5672	6062
5963	6451	6403	6783	7271	8117	8088	8069	8588	8193
8287	8325	8401	8484	8564	8543	8496	8667	8940	9195
9397	10281	10763	10333	10760	11394	10599	10600	10324	9076
8488	9062	9258	9658	10446	11270	11435	10418	10032	9410
9555	9302	8650	8194	8056	7977	7844	8093	8043	8528
8923	8973	8686	8974	8728	8597	8708	8621	8845	8851
8775	9077	9111	6521	3288	5933	6157	6147	5466	5866
5564	6363	7319	6820	6688	6704	6750	6354	6764	6942
6980	6995	6440	6555	6410	6511	6533	6615	6324	5930
5853	6069	6103	5864	5872	7433	5595	5978	5776	6020
7034	5852	6223	6761	7212	7399	7755	8006	7874	7865
8244	8276	8428	8573	8686	8701	8754	8712	7577	8886
9488	7365	7944	5789	5910	6153	6732	6064	5755	6173
6607	7239	7110	7136	6760	7037	6829	5794	5817	6379
5537	4251	4383	4968	3775	4539	3828	2196	1106	744
2866	3578	1570	2402	2890	5306	4634	5659	5287	6875
7924	7902	9105	9715	10467	10626	11263	10205	10655	12049
12952	13047	12907	13271	13255	13900	12571	12890	12778	12973
12292	11920	11765	12080	11673	13128	13087	11859	11401	11331
10921	11575	11931	8946	8912	9082	6983	8617	9503	9203
8524	7608	7834	9486	6520	6462	6591	7632	7820	8767
8673	9095	8462	7620	7262	7801	9295	9031	9457	9324
10031	10192	11093	10581	10413	9744	9389	9360	9883	10324
9999	10022	10144	10146	10363	10327	9645	8879	8731	9054
9213	9347	9216	9524	9536	9595	8634	8788	8272	7856
7847	7148	7572	8837	9240	9384	9643	9307	7827	7907
8993	8482	7814	8466	7151	6850	6954	7465	7951	7454
7283	6088	5766	4473	5323	5016	5129	5632	5418	5310
5201	5444	5210	4283	4306	4257	3800	2780	1108	-1200
-1266	-2597	2904	3346	2554	2318	2133	2344	2745	1996
1939	2023	2170	3510	3847	3606	2648	3744	4801	3655
4687	4962	5863	7206	7385	7045	7453	8203	8286	9150
8409	6350	7066	7349	7859	8431	8703	7968	7557	8220
9814	10097	9702	10172	9900	9336	10124	10129	9825	10857
12246	12505	11836	12202	11690	12215	11682	10165	9560	10092
9872	10063	10288	10470	10547	10616	10576	9816	9619	9661
9684	9398	9648	10037	9979	9983	10813	9355	8039	7653
7228	7757	7921	8773	8156	7090	7990	8446	8721	8685
8523	8640	8812	8154	8181	8587	8702	8233	8010	8265
7903	7692	8286	8012	9044	10673	9851	9421	9261	

*409 observations, in three decimal places.

TABLE F-13.--French long-term public sector bond yield adjusted: weekly, January 29, 1971 - November 23, 1978* (three-month holding-period return)

7125	7114	7026	6917	6796	6635	6490	6669	6660	6959
7249	7427	7454	7491	7408	8965	7921	8084	8251	7741
7553	7674	7344	7234	8106	8418	8543	9295	11811	13951
13834	15656	15483	14928	16484	16788	13602	11910	11538	12243
13086	12761	12834	12581	12975	17605	19253	14486	8281	8687
8789	8777	8317	8177	8125	8073	8063	8200	8082	8805
8759	8768	8454	8498	8368	8212	7947	7422	7251	7424
7456	7725	8172	8400	8858	8557	8815	9062	8865	8866
8596	8659	8665	8753	8667	8878	8835	8485	8602	8311
7950	7670	7316	7121	6827	6461	6469	6235	5960	6020
6016	5929	6186	6540	6778	7243	7483	7394	8017	8636
9166	9451	10657	10506	10018	9464	9114	9188	9500	9480
9714	9712	9717	9890	9690	9711	9985	9411	9540	10425
11638	11616	11684	11917	11745	11963	11971	11939	11367	7679
7656	8416	7975	7491	6489	7050	7611	7917	8131	8052
8243	8000	8179	7672	5759	6986	2779	1260	1699	1639
1277	947	-1599	-908	-125	597	1685	1702	948	2424
3742	6777	7359	7095	7280	6248	6218	6315	5982	2711
5677	6605	5851	5188	4507	5847	5854	5828	5006	5067
5199	4981	4835	5285	5489	5883	5605	4415	4458	3971
3286	-647	-790	-1622	-2448	-52	2116	3939	4229	5558
5780	5768	6840	7402	7303	6918	6953	7313	7330	6477
5839	6407	6847	6711	7747	7778	8057	7509	6590	6084
6013	6442	5503	4653	3604	5770	7085	8251	8683	9943
10045	9906	9432	9783	9855	9854	9842	9280	9261	9375
9313	9357	9492	9156	9317	9385	9382	9322	8981	8909
8814	6565	6711	5541	4230	4908	5011	2746	-3906	625
2963	1969	1761	2638	3544	4901	4937	5267	5910	5832
5062	5356	5905	5992	6209	3722	2329	3417	4019	4687
4247	4348	4666	4933	4794	4826	4147	3903	3685	2673
3204	2432	2672	3289	3227	3134	2908	2959	2903	2615
2431	2834	3067	3021	3514	4089	4531	3730	3805	4067
4026	4389	4750	5318	5540	5547	6026	5705	5478	5767
6016	5829	5966	6111	6472	6868	6510	5964	4913	4779
4329	4836	5578	6104	6515	6282	6582	7126	7762	8422
8196	8368	7727	7230	6339	4501	4928	3816	3199	3184
4003	3687	4039	5391	5288	4875	4788	2638	2721	3803
4425	3891	5769	7887	8299	9027	8788	9031	8578	8170
8304	8766	8988	9097	8487	7905	7977	8955	8643	9001
8963	9239	9544	9207	9531	9431	9810	10066	10419	10767
10366	9694	10121	10220	10762	12253	11785	13431	12472	

*409 observations, in three decimal places.

TABLE F-14.--Dutch long-term government loan rates adjusted: weekly, January 29, 1971 - November 23, 1978* (Three-month holding-period return)

7397	7745	7823	7623	7393	7276	7334	7649	7877	8269
8869	10033	8975	8102	8405	10071	9728	9391	10226	9540
9315	8926	9250	9128	9308	9707	9869	9813	10150	10001
11159	11639	11075	10943	11015	10448	9173	8624	8093	7450
7612	7499	7965	8167	8352	8412	8333	8305	8302	7561
7811	7577	7272	6903	6988	7298	7669	8010	7965	9698
10109	10612	10212	10236	10013	9656	9883	9405	9425	9359
9480	8804	9156	9506	10590	10621	11177	12135	11582	11863
11697	11400	11312	11176	10897	10290	9929	9729	10151	10053
10136	9522	9041	8291	8535	8293	8482	8692	8736	8674
8495	8385	8585	8672	8724	9163	10212	11239	11411	12394
15208	14673	14994	15392	15621	14064	13252	12502	12088	11379
12027	12034	11826	11746	12054	11825	11444	9391	9387	10361
10318	10055	10421	10026	9811	9441	9329	8939	8949	8690
7938	7356	7646	7001	7229	7268	8265	8405	8729	7639
4496	4589	4531	5589	3575	5909	5817	6582	5363	6162
6947	6600	7617	7904	8494	9386	9323	9441	9573	9849
10139	10421	11012	11030	11243	10709	10293	10946	11889	11622
12089	11431	10815	11877	12296	11976	12125	12586	12541	12544
11536	11382	12034	11697	11108	10595	10085	9910	10464	10870
11176	11310	10563	10877	11019	10984	10310	9318	8744	8965
7884	8209	8651	8170	7926	7988	7916	8484	8490	9252
9270	9050	9440	9216	9873	9814	9938	9802	9854	10352
10989	10952	11373	11402	11358	11590	11552	11607	11621	11515
11498	11464	11762	11998	11330	11198	10561	9874	9342	9332
9070	9347	9324	9147	8708	8615	8152	8221	7982	7614
7660	7941	8200	9176	9656	9786	9985	9805	10121	9884
9578	9261	9402	9650	9483	9514	9725	10554	10133	9425
8568	8840	8363	6955	6067	6029	5881	5687	4660	3408
-8	-1638	-1757	-207	2044	1964	1718	1659	2491	3079
4342	4259	4404	4676	4874	5437	5502	5540	5700	5988
6035	6406	6658	6370	6167	6048	6363	6571	7046	6639
6709	6732	6767	6737	6629	7282	8052	8506	9810	9902
10258	10297	10093	10127	10197	9775	9835	9774	9811	9650
10164	9596	9931	9529	9234	8992	8870	8999	9437	9650
9935	9811	9446	9924	9818	8340	8845	8396	8050	7808
7843	8336	8691	9112	10093	9909	9799	9486	9169	9193
9093	8881	9193	9515	9652	9584	9233	9443	9927	10096
10344	10446	10663	10619	10449	10724	11057	11267	11408	11037
11224	10879	10617	9992	10063	10479	10588	10796	11053	11324
10165	7384	5235	6666	7880	9091	10654	11938	10533	

*409 observations, in three decimal places.

TABLE F-15.--Swiss long-term confederation bond yield adjusted: weekly, January 29, 1971 - November 23, 1978* (Three-month holding-period return)

		7294	7293	7470	7315	7076	6783	7392	7445
7553	8095	8311	8356	8551	8808	8706	9447	8745	10169
9293	8526	8433	8215	8294	8544	8664	8600	9130	9346
10149	10076	11940	11328	10572	10108	10176	9539	9507	8472
8868	8984	9052	9072	9473	9538	9063	9329	9263	9202
9470	9630	9149	8917	8825	8998	8820	8900	9995	9544
10044	10117	10368	10025	10024	10083	9758	9355	9200	9285
9396	9299	9051	9113	9515	11046	10146	11463	13193	12590
12430	12549	12550	12788	12561	12054	11838	11959	11538	11494
11008	10592	10202	10314	9995	10113	10197	9650	9693	10229
10280	10818	10268	10699	10845	11077	11207	12575	14584	14608
14273	15736	15594	16126	16427	16688	15219	13871	13236	13874
14195	15028	14970	15148	14914	14006	12714	12789	13031	13238
13281	12388	12651	13954	13936	13444	13758	13512	13207	13107
13880	13384	13007	13150	13085	11662	9964	10525	10467	8705
8793	8902	9512	8739	9013	7649	8347	9081	7882	8635
8247	8515	8771	8488	8294	8346	9427	10007	11078	11722
11655	12174	12549	13116	13350	12840	12845	13068	12980	13487
12999	14970	15348	14062	14226	14358	14513	14808	14556	14995
14485	14130	13386	12866	12832	12271	11971	11371	11391	11627
12281	12053	11923	11578	11576	11466	11769	11984	10990	10378
9941	9407	9565	9947	9791	10158	10201	10383	10271	10709
11374	11548	11143	11281	11034	10914	10022	10081	10277	10280
10128	9933	10449	11068	11001	11456	11563	11584	12374	12309
12136	12437	12382	12642	12826	12502	13086	12511	11937	11474
11701	11430	11422	11595	11555	11341	11287	11266	11256	11137
10247	10179	10050	10104	10302	10188	10408	10347	10311	10324
10378	10379	10227	10169	9976	9996	10114	10281	10698	11092
11152	10830	10549	10343	10201	10255	9978	9836	9589	9706
9706	9601	956	9144	9361	9295	9231	8819	8768	8893
8647	8607	8659	8690	8504	8303	7874	7687	7477	7827
7761	7764	7556	7816	7864	8011	8118	7947	7920	7907
7879	7796	7695	7704	7575	7570	7196	7198	7251	7750
8313	8557	8390	8494	8345	8210	8401	8242	8074	8309
8228	8399	8268	8606	8533	8374	8385	8405	8553	8860
8913	9431	9727	9093	9198	9504	9335	9124	8891	8997
9420	10042	10362	10605	9950	10437	10100	10226	10226	9889
10269	10385	10143	9828	9702	9755	9765	9870	9890	9670
10270	10101	10417	10543	10669	10722	10722	11291	11471	11619
11196	11523	11522	11393	11457	11511	11829	11627	11893	11659
11957	12147	12275	12529	12847	13293	14110	14269	14854	14834
14643									

*409 observations, in three decimal places.

TABLE F-16.--West German long-term public authority loan rates adjusted: weekly, January 29, 1971 - November 23, 1978* (Six-month holding-period return)

5471	5330	5240	5065	5143	5545	5775	5616	6363	6561
7365	7442	7708	7986	8280	8238	8601	8347	8605	7794
7137	7175	7064	7431	7513	7387	7168	7651	9535	11313
11020	12275	12070	11465	11315	11873	11294	10954	10319	9816
9819	9985	10285	10300	9932	9208	8958	8286	8813	9225
9545	9360	9159	9285	9193	9145	9251	9319	9179	9505
9742	9857	8471	8607	8250	8707	8210	8022	8113	7690
7170	6874	6839	6912	7413	7072	7864	9504	9534	9788
9616	9678	9748	9548	9567	9687	9401	9149	8605	7797
7703	7483	7503	7470	7206	7027	6089	6118	6078	6045
5857	5853	6152	5979	6229	6465	7690	7542	7346	8407
9300	9768	9819	9851	10396	10293	10187	10371	10364	10615
11256	11738	11981	11890	11304	10791	11171	11768	10893	10554
12242	12037	10838	11131	11410	12217	11975	11851	11466	11343
10756	11049	10906	10589	9452	8744	8794	8159	6694	7121
6167	4772	4684	5146	3581	3547	3050	4358	4781	4401
4745	5206	5036	4259	4837	4804	7055	7813	8302	9749
9742	9997	9809	10331	9737	9522	9127	9112	9163	8977
8944	9037	8502	8914	9586	10234	10523	10147	13551	9588
9258	9049	8992	8994	8932	8652	8162	8570	8729	9199
8992	8244	8200	7770	7625	7927	8231	8486	8177	8449
8635	8809	9157	9844	9579	8922	9017	9156	9072	9092
9375	9488	9273	9231	9052	8834	8756	9125	9094	9000
9198	9521	9541	9859	9409	9316	9265	9924	10685	11556
11465	11296	11185	11237	10784	10795	10470	10225	9975	9928
9912	9686	9524	9257	9194	9182	9181	8999	9080	9551
9612	9788	9778	9814	9655	9478	9482	9374	9351	9389
9421	9511	9563	9675	9624	9822	9799	10194	10308	10365
10178	10489	10928	10687	10523	10249	10096	9716	9625	9934
9991	9823	9546	9454	9448	9152	8919	8300	8520	8617
8480	8199	7806	7824	7335	7257	7447	7472	7464	7565
8534	8132	8226	7987	7933	7777	7609	7200	6754	6440
6171	5723	6141	6245	6465	6869	6459	6136	5495	6084
6211	6403	6403	6408	6476	6754	7068	6989	6841	7223
7780	7972	8338	8374	8162	8165	8153	8110	8548	8613
8845	9385	9235	9335	9320	9091	8483	8359	8598	8790
9141	9601	10019	9921	10373	10173	10349	10297	10367	10588
10979	10802	10444	10624	10641	10765	10814	10513	10307	10456
10410	10481	10369	10372	10502	10545	10702	10819	10753	10636
10525	10204	10430	11046	11400	11797	11528	12303	12454	12896
13178	13312	13889	14403	14549	15510	15841	16546	16079	

*409 observations, in three decimal points.

TABLE F-17.--Canadian long-term government bond yield adjusted: weekly, January 29, 1971-November 23, 1978* (Six-month holding-period return)

		5307	5515	5624	5579	5733	5728	6349	6720
6421	6438	6421	6408	6811	6849	7195	7377	7412	7543
7574	7163	7636	7811	7592	7739	7892	7848	8125	8223
8331	8080	7509	7489	7543	7430	7357	7164	6917	6602
6316	6308	6270	6290	6542	6648	6561	6510	6510	6477
6703	6722	6565	6571	6503	6267	6233	5785	5778	5706
5753	6267	6427	6516	6706	6739	6446	6170	6212	6162
5926	5666	5550	6051	6472	7082	7230	7377	7325	7480
7152	7089	7188	7136	7098	7127	7300	7218	7219	7134
7045	6940	6926	6740	6745	6643	6662	6673	6730	6902
6991	7051	7083	7465	7595	7902	8026	8347	8382	8444
8582	9061	9081	9261	9220	9564	9433	8778	8961	8914
8793	8599	8998	8906	8646	8793	8860	9018	9065	9309
9300	9724	10013	10001	10236	10020	10053	9997	9814	9889
9629	8883	8768	8100	7520	6922	7126	7527	7776	7624
7898	7952	7669	7526	7332	7139	7408	7416	7554	7599
7502	7354	7352	7535	7791	7991	8246	9585	8399	8561
8273	8537	8613	8559	8732	8871	8942	9205	9265	10039
10456	10889	11241	11114	10819	11110	10985	10854	11223	11399
11158	10883	10357	10097	9999	9446	9268	9002	8959	8876
8829	8614	8761	8943	8806	8893	8878	8770	8468	8453
8789	8733	8519	8637	8662	8559	8464	8549	8541	8947
9017	9161	8900	8766	8320	8477	7831	7903	8025	7939
7753	7919	8226	8525	8597	8596	8724	8683	8675	8446
8531	8099	8143	8235	8549	8282	8650	7944	7493	7310
7329	6885	6124	7343	7092	6883	7003	6781	6958	6533
5734	5916	6037	6186	5827	5995	5990	5784	5947	5345
5061	4487	4806	4724	4926	5100	5206	5809	6081	6815
6707	6348	6356	6412	5996	5992	5534	5599	5677	5465
5332	5343	5433	5219	5331	5385	5202	5257	5317	5208
5189	5320	5337	5326	5265	5762	5283	5158	4785	5109
5085	5280	5491	5894	5945	5893	6042	6076	6072	6252
6126	6199	6280	6425	6468	6433	6174	6267	6411	6768
7287	7779	7769	7551	7366	7414	7482	7360	7317	7360
7275	7536	7361	7557	7460	7234	7234	7455	7672	8079
8240	8355	8536	8353	8265	8426	8328	8305	8231	8348
8610	8716	8955	8965	8786	9325	9161	9321	9243	9121
9096	9052	9019	8648	8614	8691	8558	8183	7675	8169
8772	8830	8931	8948	9214	9055	9013	9176	9478	9666
9404	9462	9314	8907	8715	8609	8812	8584	8908	8706
9015	9234	9106	9508	9594	9872	10487	10633	10905	10755
10789									

*409 observations, in three decimal places.

TABLE F-18.--United Kingdom long-term 3½% war loan yield adjusted: weekly, August 28, 1971 - November 24, 1978* (Six-month holding-period returns)

		9506	9987	9763	9804	11297	9692	9872	9748
8646	8011	8787	8910	8993	9652	9817	9435	10166	9314
8883	9019	9223	8590	8136	8188	8090	8122	8082	8053
8434	8599	8892	8696	8856	8852	8437	8499	8497	8517
8786	8794	8805	8786	7995	2000	6348	7103	6320	6335
6213	6032	6454	7003	6953	6673	6745	6568	6340	6626
6996	6982	7240	7162	6981	6558	6851	6590	6714	6571
6145	6066	6025	6140	6030	5960	6045	5896	6548	5920
6292	6611	6275	6436	6659	7147	7221	7595	7764	7742
7737	8013	8112	8229	8298	8526	8646	8635	8344	7894
8168	8371	6935	7563	6881	6944	6743	7026	7134	6727
6978	6958	7195	7030	6929	6737	6983	7072	5965	5467
5836	5945	4426	5052	5310	4839	5249	5007	4296	3672
2833	3855	4734	3050	4045	3789	4593	5101	5419	5952
6188	7722	7041	8637	8054	9422	9235	9615	9502	8725
10882	10512	11614	11236	11721	11918	11864	11491	11883	12451
12308	11956	11307	10802	11696	11365	11922	12124	12270	11474
10977	11048	10846	11268	9655	9621	10379	9402	8706	11026
9406	9101	8399	8028	8404	7977	7053	6845	7564	7905
8020	8448	8769	8537	8393	7778	7861	9222	8730	9118
8945	9290	9880	10521	10871	10001	9777	9304	9592	9838
10298	10465	10254	10486	10310	10212	10393	9953	9880	9161
9670	9823	9815	9632	9737	10009	9857	9317	9280	9395
8700	8389	8230	7751	8790	8751	9346	9482	9106	8838
8210	9271	8780	7933	8731	7659	7832	7285	7595	7544
7812	7815	7588	7137	6426	6219	5846	5800	6108	6189
5776	5437	5716	5503	5021	4323	4588	4277	2613	2511
906	1583	167	2600	3808	4401	3540	3782	3427	4044
3236	3314	3636	3781	4813	5273	5116	3784	4146	4851
5446	4736	5073	5706	6756	7134	6601	7484	7495	8044
8618	8483	7631	6922	7225	7347	7509	7966	7738	7136
7799	9105	9924	10362	9651	9759	9746	10018	10270	10118
9724	11074	12252	11616	11530	11478	11377	11115	10661	9608
10131	9802	9923	10030	10398	10635	10457	10479	10006	10128
9559	9469	9266	9336	9861	9589	9737	9629	10353	8325
7908	7462	6799	7630	8235	8277	7335	8022	8541	8600
8835	8667	8510	8836	9006	8403	8705	8620	8791	8289
8541	7760	7764	7739	8104	8462	10160	9625	9517	9330
9571									

*379 observations, in three decimal places.

TABLE F-19.--French long-term public sector bond yield adjusted: weekly, January 5, 1973 - November 24, 1978* (Six-month holding-period returns)

			6115	6440	6611	7075	7559	7786	7221
8369	9082	9278	8998	9560	9742	9296	9121	9020	9387
9266	9319	9339	9566	9651	9540	9509	9561	9256	9294
9704	10965	11265	10903	11414	11075	11108	11311	11286	11164
6464	7628	7719	8121	7586	6512	6959	7408	7727	7744
7756	7976	7882	7692	7456	6497	5845	5168	1989	2408
2792	1282	1450	-1497	-507	154	678	1919	2746	948
1643	2791	5869	7392	7129	6854	6128	5839	6325	5315
5594	4728	6038	6035	5373	4867	5111	5654	5553	5437
6056	5073	4764	4157	4861	4957	5342	5603	5488	3300
3840	3960	2297	2743	2133	-38	-438	1689	4235	4081
5697	5492	5313	6697	6593	7629	6944	7235	7118	7679
7145	6731	6734	7375	7102	7183	8325	8534	8591	7681
7428	7087	6917	6312	6345	4466	6578	6525	8104	8400
10008	9742	10078	9574	9663	9939	10404	9692	9219	9229
9358	9317	9170	9377	9189	9169	9258	9238	9217	8862
8882	8821	7317	7141	6736	4394	5282	4994	5444	759
1187	2963	3566	2327	2923	3371	5001	4762	5456	5731
6031	5403	5333	5888	6154	6067	5427	2764	4022	4219
4569	4091	4695	4739	4761	4574	4708	4025	3327	3767
2845	3498	2923	3063	3314	3153	3404	3125	3183	3063
2881	2582	2683	3119	3129	3450	4013	4454	3337	4012
4113	4076	4327	4486	5078	4764	5255	6280	5636	5881
5706	6242	6131	6031	6233	6437	7091	6872	6205	5141
5174	4886	5103	5669	5494	6024	5700	5935	6424	6905
7884	7626	8130	7737	6894	6282	4840	5234	4840	3556
4456	3245	3488	3764	4463	5198	4816	5033	2602	3546
5357	5465	5472	4977	8023	7595	9033	8376	8954	8382
8415	7907	8793	8344	9202	8666	8308	8150	8559	8641
8841	8792	8824	9151	8885	9222	8936	9546	9667	9367
10443	9979	9250	9940	10000	10108	11253	11221	11860	12212
12417									

*308 observations, in three decimal places.

TABLE F-20.--Dutch long-term government loan rate adjusted: weekly, January 5, 1973 - November 23, 1978* (Six-month holding-period returns)

			8474	8300	8520	8735	9574	10787	10223
11016	13251	12889	13390	13710	13870	13185	13228	11841	11498
10655	11390	11794	11458	11536	11502	11105	10810	10029	9627
10118	9622	9481	9690	10410	9846	9707	9636	9208	9469
9027	8690	8312	8529	7620	8008	7436	7432	8227	8321
7926	5368	5812	5375	6124	5635	6390	5958	5608	5553
6129	6746	6639	7458	7808	7832	8859	8920	9035	9765
9179	10177	9658	10520	10940	10796	10666	10044	10179	10800
11308	11545	10747	10231	11275	11485	11311	11444	11921	11853
12057	11738	11288	11439	11453	10953	10636	10389	9867	9894
10295	10244	10602	10636	10549	10662	10742	10845	9798	9325
9345	8605	8324	8592	8438	8365	8488	8369	8583	8779
9356	9857	9317	9451	9360	10313	9806	9655	9658	9444
9487	9789	10248	10411	10449	10190	10818	10432	10741	10929
10846	11222	11205	11283	11787	11257	11472	10782	10389	10005
9816	9661	9689	9753	9737	9518	9206	9139	8916	8775
8224	8175	8276	8330	9028	9702	9685	9896	10137	10000
9896	9794	9510	9154	9379	9289	9151	9463	10140	10613
9642	8666	9113	8160	7538	7258	7055	6248	5822	5573
4767	2468	2392	845	3089	3166	2959	4414	3174	4480
4120	5096	5259	5300	5331	5035	5917	5975	5907	6573
6117	6269	6404	6699	6770	6547	6507	6483	6798	7364
7143	6962	6956	7227	7036	7036	7332	7578	8063	9061
8975	9446	9350	9135	9146	9111	8586	8789	8898	8717
8760	9121	8790	9263	9053	8986	8707	8302	8748	8991
9227	9557	10244	9402	9412	9486	8077	8722	8929	8163
8028	7851	8228	9023	9034	9965	10390	10221	10197	9704
9643	9702	9577	9535	9769	9916	10132	9810	9648	9906
10433	10314	10485	10324	10736	10256	10533	10704	10918	10898
10609	10769	10390	10207	10135	9637	10319	10125	10414	10135
10720	10181	8874	7557	7524	9564	10193	11430	11913	11660
10561									

*309 observations, in three decimal places.

TABLE F-21.--Swiss long-term confederation bond yield adjusted: Weekly, January 29, 1971 - November 23, 1978* (Six-month holding-period return)

6218	6875	6587	6478	7057	7132	6552	7698	7705	7942
7826	8164	8396	8427	8363	8657	9141	9310	9699	9552
10217	10575	10059	9500	9953	9753	10132	9585	10354	10532
9573	8695	9127	9718	9749	9991	9334	9746	9207	8975
9090	9154	8350	7704	7839	7614	7268	7594	7360	7224
5460	6309	5183	5876	5142	5731	5741	5271	5328	5790
5962	5784	5891	5837	7218	7334	7594	7916	7980	8242
8443	8446	8436	8673	8320	8301	8301	8269	8299	8245
8170	8106	8384	8771	9114	9056	9206	9045	8744	8751
8849	8805	8775	8755	8361	8445	8511	8863	8910	8358
8424	8200	7748	7813	7898	8267	8116	7964	8240	8107
8215	8312	8505	8151	8088	8178	8507	8560	8686	8815
8847	8910	8921	8742	8806	8735	8811	8646	8648	8746
8791	8886	8843	8887	8984	9231	9669	10043	10512	10100
10099	10003	10192	10215	10024	9919	9728	9845	9539	9444
9593	9456	9382	9308	9266	9067	9328	9226	9126	8815
8941	9121	9237	8984	8943	9028	8987	9082	9030	9114
9187	9166	9281	9439	9492	9818	9934	10049	9797	10039
10249	10186	9913	9597	9587	9503	9335	9388	9482	9398
9284	9105	9074	9022	8760	8518	8499	8300	8311	8166
7885	7760	7667	7155	7302	7364	7384	7406	7583	8391
7826	7899	8097	7962	8035	7484	7172	6985	6662	6652
6423	6496	6704	6933	6549	6382	6067	6295	6326	6643
6622	6810	6759	6976	7153	7062	7013	6992	7377	7398
7524	7722	7639	7743	7681	7691	7879	8326	8461	9094
8835	8762	9073	8949	8616	8388	8523	8886	8886	9042
8242	9135	9663	9330	9661	9609	9545	9875	11063	10660
9919	10591	10268	10661	10722	10514	9965	10183	10152	10079
10102	10050	10453	10287	10493	10607	10461	10441	10585	10368
10337	11670	11370	11834	11213	11470	11593	11686	12078	11892
12383	13402	13120	13789	14117	14157	13519	13662		

*409 observations, in three decimal places.

TABLE F-22.--West German long-term public authority loan rates adjusted: weekly, January 5, 1973 - November 23, 1978* (One-year holding-period return)

10351	10465	10632	10805	11479	12673	12362	12385	13447	13228
13770	14122	14404	14121	13240	12713	13166	13508	14351	14043
14154	14518	13775	12911	12547	12360	12391	12786	12179	12277
13074	12945	12565	12639	12559	12440	12362	12871	12429	12282
12393	12393	11487	10424	10558	10807	9657	9362	9351	9698
9200	9331	8416	8884	9301	8792	9019	8828	8965	8992
8985	8792	8932	9592	10150	10824	11158	11103	11324	11555
12021	11989	11822	11893	11995	11895	12247	12234	13331	13820
12789	12809	12996	13305	13679	13295	13634	13356	13422	12888
12689	12600	12149	11771	11315	11302	11483	11707	11314	11274
11029	11094	11005	11209	11326	10837	10488	10148	9505	9641
9762	9541	9832	9853	10133	10075	10503	10907	11026	10731
10837	10676	10784	10152	10189	10309	10204	10128	10041	10222
10635	10796	10752	10849	10891	11595	11584	11465	11603	11765
11819	12025	11895	12122	11807	11461	11192	11419	11181	11020
11150	11241	11059	11027	10984	10963	10877	10301	10200	10072
10104	10226	10220	10354	10293	10203	10249	10184	10196	10227
10222	10116	10082	10146	10227	10536	10704	10850	10635	10549
10375	10201	10060	9956	9804	9589	9630	9630	9493	9397
9004	9177	9166	9069	8744	8747	8861	8625	8553	8606
8550	8461	8271	7981	7827	7788	8042	7911	7946	7759
7869	7992	8097	8268	8226	8155	8196	8083	8053	8026
8002	7883	7868	7567	7527	7580	7846	8313	8408	8368
8441	8366	8210	8327	8200	8117	8235	8228	8399	8384
8564	8491	8374	8416	8427	8596	8807	8913	9452	9780
9294	9251	9557	9377	9272	9028	9018	9325	10106	10330
10415	9950	10321	10037	10205	10226	10026	10406	10491	10312
10028	9723	9818	9828	9912	9995	9712	10038	10038	10185
10248	10448	10606	10680	11112	11302	11323	11154	11396	11363
11181	11139	11193	11511	11394	11744	11575	11893	12063	12148
12317	12582	12985	13813	13770	14292	14239	14091		

*308 observations, in three decimal places.

TABLE F-23.--Canadian long-term government bond yield adjusted: weekly, January 5, 1973 - November 23, 1978* (One-year holding-period return)

7251	7284	7484	7586	7779	7857	7898	8003	8224	8244
8295	8362	8555	8564	8231	8338	8345	8310	8212	8342
8475	8193	8265	8311	8393	8418	8554	8524	8744	8904
8966	9169	9049	9191	9243	9006	9134	8896	8452	8392
7939	7542	7095	7277	7484	7689	7398	7446	7629	7519
7493	7342	7257	7386	7395	7554	7588	7546	7397	7374
7492	7683	7776	7987	9280	8399	8431	8305	8603	8591
8570	8569	8664	8724	8932	9025	9525	9777	10055	10363
10291	10096	10298	10294	10207	10422	10542	10445	10367	10093
9889	9867	9435	9257	9133	9003	8985	8775	8646	8739
8856	8784	8871	8813	8672	8457	8409	8443	8494	8422
8442	8359	8472	8388	8462	8519	8893	8919	9074	8965
8853	8723	8739	8266	8240	8264	8298	8155	8180	8455
8644	8619	8662	8844	8957	8971	8785	8761	8372	8516
8389	8725	8436	8892	8295	7833	7802	7832	7333	7359
7869	7530	7376	7562	7241	7352	6927	6402	6583	6650
7147	6713	6673	6744	6581	6582	5958	5970	5418	5670
5708	5801	6029	6092	6585	6836	7449	7122	6862	6968
7035	6630	6485	6223	6310	6431	6165	5912	6022	6034
5689	5865	6105	5922	5879	5874	5765	5734	5843	5860
5817	5843	6264	5773	5713	5231	5446	5595	5660	5838
6209	6184	6208	6444	6499	6561	6643	6452	6515	6595
6687	6631	6662	6414	6517	6618	6953	7516	7942	7921
7758	7584	7523	7504	7415	7350	7426	7361	7536	7372
7579	7471	7245	7202	7401	7640	8101	8338	8366	8449
8244	8113	8328	8241	8163	8177	8294	8534	8662	8792
8889	8786	9216	9107	9212	9210	9045	9009	8953	8965
8583	8526	8626	8427	8139	7435	8114	8837	8808	8866
8850	9159	9044	8991	9198	9325	9437	9240	9341	9183
8907	8606	8554	8758	8529	8908	8717	8949	9081	9117
9464	9485	9894	10443	10863	10543	10776	10745		

*308 observations, in three decimal places.

TABLE F-24.--United Kingdom government 3½% war loan yield adjusted: weekly, January 5, 1973 - November 23, 1978* (One-year holding-period return)

6623	6502	6410	6506	6522	7009	6633	6952	7095	6815
6954	7089	7312	7320	7485	7676	7753	7682	7935	8134
8273	8342	8404	8558	8558	8454	7927	8080	8327	7623
7896	7616	7756	7511	7394	7502	7263	7357	7159	7195
7052	6963	6704	6838	6939	6156	5702	6139	6373	5346
5883	6028	5772	6104	5785	5688	5417	5068	5683	6403
5395	6070	5858	6267	6925	6940	7233	7389	8387	7862
8683	8270	9092	9088	9706	9868	8771	10547	10294	10946
10708	11043	11205	11036	11538	11235	11698	11513	11381	11008
10802	11557	11388	11760	12228	12422	11626	11480	11668	11278
11619	10772	10453	11132	10390	9546	10886	9497	9516	8928
8452	8692	8332	7404	7208	7621	7950	7952	8493	8712
8767	8715	8260	8309	9188	8902	9152	9129	9393	9731
10373	10620	10001	9937	9555	9832	9895	10321	10556	10334
10566	10504	10440	10702	10572	10558	9918	10232	10316	10320
10228	10253	10572	10409	10030	9853	9853	9280	9035	8820
8293	9061	9227	9562	9698	9390	9373	9328	9795	9476
8833	9221	8560	8343	7818	7991	7930	8233	8225	8168
7774	7325	7173	6835	6801	6972	7009	6697	6416	6433
6279	5990	5433	5700	5319	4415	4486	3216	3447	2635
4701	5337	5572	4904	5228	4973	5210	4638	4646	4622
4662	5498	6147	5981	5146	5399	5935	6480	5590	5857
6177	6890	7067	6780	7350	7316	7686	8105	8160	7889
7494	7718	7796	7868	8180	8165	7608	8002	8768	9711
10093	9417	9626	9568	9730	9983	9875	9439	10415	11227
10824	10717	10718	10499	10368	10209	9442	9593	9561	9659
9800	10080	10295	10117	10172	10160	10150	9504	9524	9321
9270	9982	9347	9637	9507	10186	8845	7908	7606	6899
7597	7978	8121	7703	8234	8798	8768	8835	8667	8555
8925	9073	8659	8805	8776	8948	8545	8663	8183	8221
8174	8473	8574	9870	9759	9652	9386	9593		

*308 observations, in three decimal places.

TABLE F-25.--French long-term public sector bond yield adjusted: weekly, January 5, 1973 - April 25, 1975; March 26, 1976 - November 24, 1978* (One-year holding-period return)

6331	6624	6806	7086	7473	7916	7264	7643	8161	8497
8565	8986	9157	8971	8872	8944	8974	9038	9070	9067
9316	9184	9301	9325	9332	9343	9229	9279	9821	10317
9997	10290	10082	10224	10274	10489	10246	7851	8136	8101
8121	7717	6818	7244	7506	7606	7591	7549	7878	7882
7889	7653	7134	6229	5883	4067	4952	5173	4482	4691
2540	3021	3088	3436	4026	4192	3055	3629	4357	6200
7337	7185	6899	6504	6049	6701	5958	5705	5795	6627
5935	4852	5233	5998	6253	6251	6136	5467	5606	5508
5267	5394	5522	5397	5703	5798	4433	4981	5212	4093
4429	3708	2556	3266	3952	4768	4957	5408	6023	5844
6796	6870	7585	6900	6916	6931	7535	7002	6731	6833
7606									
								5327	5943
5100	5388	5473	5925	5796	6127	6413	6603	6085	6059
6086	6253	6232	5328	5273	5376	5519	5605	5040	5632
5721	5632	5490	5569	4621	4476	4750	3950	4316	4361
3727	4200	4315	4290	4121	4179	4004	3434	3523	3458
3728	3737	4057	4444	4619	3890	4177	4499	4242	4714
4818	4967	5418	5310	5948	5692	5725	5651	5909	5809
5865	5966	6049	6603	6540	5828	4919	4753	4498	4671
4905	4741	5149	4990	5226	5760	6195	7175	6973	7643
7305	6994	6326	5704	6309	5594	4575	5155	3729	4542
4496	4940	5408	5193	4767	4666	4468	5946	6276	6371
6442	7457	7428	8479	7612	8146	7973	8216	7653	8174
7791	8561	8103	7999	7841	8206	8299	8212	8351	8328
8721	8488	8715	8363	9116	9734	8949	9817	9265	8964
9423	9528	9425	9789	10363	10826	11002	11010		

*262 observations, in three decimal places.

TABLE F-26.--Dutch long-term government loan rates adjusted: weekly, January 5, 1973 - November 24, 1978* (One-year holding-period return)

8345	8322	8466	8617	8878	9471	9271	9551	10923	10439
10831	11726	11823	11678	11603	10730	10430	10153	10514	10907
10826	10967	11073	10868	10648	9803	9303	10053	9999	9460
9528	10214	9814	9794	9864	9435	9436	9199	8992	8690
8691	7825	8180	7565	7518	8162	8127	8034	5977	7039
6480	6948	6976	6618	6859	6325	6336	6640	7203	7150
7458	7677	7962	8653	8920	9068	9612	9147	9696	9330
10092	10260	10137	10085	9639	9654	9925	10343	10678	10308
10165	10417	10649	10640	10651	10833	10724	10970	10883	10544
10574	10697	10449	10318	10050	9638	9665	9642	9603	9732
9821	9725	9890	9861	10170	9602	9162	9106	8714	8454
8636	8459	8495	8510	8467	8615	8757	9151	9489	9101
9052	9015	10184	9288	9160	9271	9004	8875	9165	9461
9496	9684	9543	9867	9570	9770	9905	10081	10306	10237
10423	10862	10580	10740	10384	10131	10005	9977	9779	9624
9667	9619	9432	9185	9117	8884	9033	8601	8518	8501
8619	8857	9328	9193	9350	9579	9423	9404	9483	9392
9100	9207	9139	9119	9291	9818	10137	9437	8839	9081
8334	8017	7879	7860	7412	7009	7022	6260	4669	4702
3427	4952	5137	4952	6346	5402	6192	5537	5920	6050
6035	5936	5878	6468	6492	6284	6821	6461	6559	6640
6968	7093	6956	6808	6924	7121	7472	7304	7177	7171
7356	7229	7229	7332	7524	7773	8247	8257	8418	8557
8429	8482	8575	8039	8147	8159	8085	8160	8331	8150
8474	8380	8367	8056	7875	8363	8584	8862	9118	9825
9145	9123	9174	8098	8410	8670	8087	7921	7754	8099
8658	8787	9601	9919	9879	9779	9554	9429	9349	9352
9300	9533	9637	9768	9554	9627	9725	10006	10015	9994
9886	10201	9967	10169	10298	10491	10406	10223	10458	10078
9830	10027	9616	10297	10147	10393	10092	10559	10245	9036
7373	7752	10190	10809	11182	11590	11660	10691		

*308 observations, in three decimal places.

TABLE F-27.--Swiss long-term confederation bond yield adjusted: weekly, January 5, 1973 - November 23, 1978* (One-year holding-period return)

		5896	5970	5741	5751	6120	6068	5794	6326
6462	6884	6926	7446	7510	7689	6943	7353	7309	7658
7141	6794	6857	6865	6834	7128	7107	6980	7034	7864
9077	9488	9973	9848	9439	10281	10071	9819	10291	9871
9063	9473	9389	9735	9672	9054	8142	7879	7278	7719
8076	8749	8036	8855	8929	8824	8406	8689	8804	8951
9181	9317	9631	8384	8635	7848	8362	8140	7803	7782
7835	7205	6986	6586	6805	7824	6856	7739	9262	8864
8791	8864	9179	9179	9609	9504	9473	9116	8937	8622
7551	7686	7413	7297	7232	7126	6967	6363	6247	6335
6308	6026	6162	6039	6695	6451	6404	7573	7711	6657
8506	7778	8342	8721	8932	9448	9301	9185	9511	9963
9953	10543	10606	11270	11386	10090	9606	10585	10712	11017
10238	11333	11355	10216	9339	10151	11186	10710	10107	10106
10413	9767	9514	9545	9715	8149	7662	7935	7572	6929
7424	7020	6745	4269	6438	4535	5621	4142	5071	5284
4824	4465	5278	5311	5015	5559	5377	7218	7463	7884
8463	8591	9155	9216	9315	9252	9467	8545	8719	8730
8526	8685	8556	8352	8288	8867	9307	9393	9346	9625
9303	8648	8719	8817	8741	8646	8659	8114	8263	8393
8863	9113	8529	8478	7975	7502	7598	7930	8514	8255
8231	8646	8374	8535	8814	8910	8333	8162	8285	8784
8752	9007	9178	9071	9134	9092	8881	8892	8948	8971
8668	8893	9012	9121	9376	9184	9058	9069	9688	10062
10670	11202	10864	10788	10587	10745	10852	10512	10396	10068
10142	9846	9698	9953	9594	9604	9531	9436	9151	9444
9332	9348	9110	9131	9500	9563	9395	9185	9365	9313
9429	9219	9376	9355	9429	9555	9607	9618	9923	10281
10291	9902	10533	10691	10680	10302	9892	9661	9556	9156
9388	9535	9503	9158	8948	9021	8917	8655	8518	8467
8426	8458	8219	7937	7917	7688	7072	7479	7364	7426
7353	7636	8622	8138	8055	8149	7827	7983	7380	6933
6725	6215	6049	5862	6049	6361	6756	6133	5863	5567
5899	6003	6382	6309	6622	6497	6766	7049	6989	6992
6992	7482	7555	7753	7899	7691	7920	7754	7764	8097
8471	8731	9240	9001	8969	9239	9105	8751	8284	8658
9063	9042	9363	8429	9695	10234	9890	10128	10252	10208
10413	11374	10971	10396	10891	10579	10817	11001	10845	10244
10648	10493	10555	10454	10288	10649	10535	10700	10772	10772
10544	10760	10316	10585	11102	11246	11906	11192	11604	11624
11830	12171	12160	12889	13371	13708	14325	14684	14929	14343
14888									

*308 observations, in three decimal places.

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