ESSAYS ON ECU-DENOMINATED FINANCIAL INSTRUMENTS

By

BASSEM ABOU ZEID

Bachelor of Arts
American University of Beirut
Beirut, Lebanon
1983

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1986

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 1990

ESSAYS ON ECU-DENOMINATED FINANCIAL INSTRUMENTS

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGEMENTS

I wish to express sincere appreciation to Dr. Andreas Savvides for his encouragement and advice throughout my graduate program. His counsel and scholarly skills played a deciding role in the successful completion of this study. Many thanks also go to Dr. Gerald Lage, Dr. Janice Jadlow, and Dr. Lee Adkins for serving on my graduate committee. Their suggestions and support were very helpful throughout the study.

The help of Mr. Tariq Janda in providing programming assistance is sincerely appreciated. Mr. Ahmed Abo-Basha made available to me a number of data sets. A note of appreciation is also extended to Dr. Donald Schlagenhauf of Arizona State University for providing one of the computer programs used in this study.

To the Hariri Foundation I extend sincere thanks. Without their scholarship loan program for furthering the education of Lebanese students my undertaking of graduate studies would not have been possible.

My deepest appreciation is extended to my parents who provided moral encouragement and understanding.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This thesis is composed of two essays. The first essay is an application of dynamic factor analysis to real yields on Eurobonds denominated in the European Currency Unit (ECU). Treating the attractiveness of the ECU Eurobonds as an unobservable variable, the purpose of this application is to derive an attreactiveness index for these Eurobonds and to test the impact of certain variables on their yields and attractiveness. The second essay investigates the interdependence between long-term ECU Eurocurrency interest rates and short-term ECU and Eurodollar interest rates following the Plaza Agreement of September 1985. In Particular, if the Plaza Agreement resulted in a significant shift in exchange rate policy regime for the United States and the member states of the European Monetary System, the nature of the link should differ between the pre- and post-agreement periods.

The thesis is organized as follows: Chapters I, II and III comprise the first essay. Chapter I is a description of the European Monetary System. Chapter II is a literature review concerning the official and private roles of the ECU as well as the operation of the ECU banking market. Chapter III addresses the determinants of yields in the ECU Eurobond market. The chapter also includes a presentation of the econometric model used and the empirical results obtained. Chapter IV represents the second essay of the thesis. It is an investigation of the impact of the Plaza Agreement on the term structure of Eurocurrency interest rates in the United States and the European Monetary

System. Chapter V is a summary of the two essays. The appendix contains a detailed presentation of the EM algorithm which is discussed in chapter III.

The European Monetary System

The European Monetary System (EMS) was formally established on March 13, 1979. Its members included the nine countries which then formed the European Community (EC): Belgium, Denmark, France, West Germany, Ireland, Italy, Luxembourg, the Netherlands and the United Kingdom (Belongia, 1988). Greece became an EMS partner in 1985 after joining the EC. Spain and Portugal joined the EC in 1984. Spain joined the EMS in September 1990 and Portugal may be admitted in the near future.

Membership in the EMS is a two-stage process. The first stage requires each member nation to deposit twenty percent of its gold and gross dollar assets with the European Monetary Cooperation Fund (EMCF) in exchange for an equivalent amount of European Currency Units (ECU's). The second stage of EMS membership requires the EMS countries to participate in a system of fixed but adjustable exchange rates, known as the Exchange Rate Mechanism (ERM) by pegging their currencies to each other and to the ECU (Masera,1987). The purpose of this step is to stabilize nominal bilateral exchange rates at predetermined levels for each bilateral set of rates. The United Kingdom and Greece are not participants in the ERM and, thus, the exchange rates of the U.K. and Greece are not tied to those of other EMS nations (Lomax,1987).

Each member of the ERM has to determine a central exchange rate for its currency, which is determined in currency units per ECU's. Although these central rates are supposed to establish equilibrium exchange values for the currencies, members of the ERM can seek adjustments. This has been done eleven times since the establishment of the EMS. Once the central exchange rates are determined, a grid of bilateral cross exchange rates can be established among the currencies. Members of the ERM are expected to prevent their currencies from exceeding a 2.25 percent margin of either side of these central cross exchange rates, except Spain which has margins of six percent.

If an ERM currency diverges too far from the central cross rates, the country whose currency is appreciating and/or the country whose currency is depreciating must intervene in order to reduce the pressure on the exchange rates (Karamouzis, 1987). The most common form of intervention is known as intramarginal intervention. If, for example, the Deutschemark (DM) is the appreciating currency, it is presumed that the Bundesbank will lend a weaker partner the DMs it needs before the currency reaches the lower margin of its central cross exchange rate against the DM (Jones,1988).

Rogoff (1985) has suggested that increased monetary policy coordination may not have been responsible for the more predictable nominal and real exchange rates between France, Germany, and Italy which coincided with the advent of the EMS. The inference of the author is supported by the fact that the conditional variance of real interest differentials between these countries does not appear to have fallen. Rather, the high onshore-offshore interest differentials for French Franc and Italian Lira assets, and the very slow convergence of intra-EMS inflation rates suggest that capital controls have played a large role in enhancing the stability, and thus the predictability of exchange rates among France, Italy, and Germany. Without capital controls, the weak currencies in the EMS might have undergone continuous depreciation as they come under such speculative 'attacks' by investors that would have rendered intervention by EMS central banks in the foreign exchange markets useless. Thus, without capital controls, the very existence of the EMS is undermined.

Deravi and Metghalchi (1988) compared the volatility of bilateral nominal exchange rates of ERM currencies against the DM. They conclude that bilateral exchange rate variability has been reduced since March 1979. Moreover, it is found that the divergence of interest rates, in the long run and the short, and the rates of growth of the domestic component of the monetary base-both real and nominal -have decreased. Based on the above three inferences, the authors conclude that the EMS has been a success.

Ungerer *et. al.* (1986) point out that the improvement in the convergence of interest rates and monetary policies among EMS countries has not been matched by corresponding progress in the fiscal sector. The authors emphasize widening fiscal deficits which, if not narrowed, may jeopardize the main objective of the EMS, that is, to provide its members with stable exchange rates.

CHAPTER II

LITERATURE REVIEW

The Official ECU

When the EMS was launched, the ECU was assigned four different functions: a) as the denominator (numeraire) for the ERM, b) the basis for the divergence indicator, c) the denominator for the operations in the intervention and credit mechanisms, d) as a reserve instrument and a means of settlement between monetary authorities in the EC. Intervention in the EMS takes place whenever a certain currency is close to exceeding its permitted margin of fluctuations against another currency. Under the intervention mechanism, the central banks are required to make to one another short-term credit facilities to finance the needed interventions regardless of the amounts required. These operations are conducted through the European Monetary Cooperation Fund (EMCF) and are expressed in ECUs (European Documentation, 1987).

Although not designed to supplement their international reserves, the creation of ECUs facilitates the increased use of the reserves of the EMS countries by temporarily transforming a portion of their gold holdings that can be used, when necessary, without sale of the gold. Official ECUs are created by means of revolving three-month swaps of gold and U.S dollars between EMS members and the EMCF (IMF, 1987). EMS participants are required to deposit twenty percent of their gold reserves and twenty percent of their U.S dollar reserves with the EMCF for an equivalent amount of ECUs that is credited to them (European Documentation, 1987). Every three months the swaps are reversed and new amounts are swapped to ensure that they continue to represent at least twenty percent of the gold and U.S dollar reserves of participating central banks, and to bring the amount of ECUs in line with changed valuations of gold and U.S dollars (IMF, 1987). EMS central banks continue to administer the investment of the U.S dollars swapped and to receive interest at U.S dollar rates. The present revolving swap arrangement has led to volatility in the amount of ECUs created. Hence, the possibility of replacing the present swap arrangement with a permanent transfer of reserves to the EMCF is under consideration by the Committee of Central Bank Governors in the EMS (IMF, 1987).

Net users of ECUs pay ECU interest rates on a monthly basis in ECUs. The calculation of the interest rate paid on net ECU credit balances was based on the weighted average of the official discount rates of the member states. However, since July 1, 1985, the interest rate on the ECU has reflected market rates more closely because its calculation is being carried out on the basis of the weighted average of specified short term instruments in the money markets of the EMS countries, weighted according to the relative importance of their respective currencies in the ECU basket. The attractiveness of the ECU as a reserve currency is supposed to increase as the ECU interest rate has come to resemble more closely a market related interest rate. Moreover, as of July1, 1985, EC central banks agreed to relax the rule whereby the amount a debtor central bank could settle in ECUs was limited to fifty percent of the claim being settled. This limit no longer applies if the central bank accepting ECUs is itself a net debtor in ECUs (IMF, 1987).

The official ECU does not adjust continuously to market conditions because it cannot be traded. The interest rate for the official ECU is, however, adjusted monthly so that it can be kept close to market rates of component currencies. This is an incomplete substitute for pricing the official ECU in foreign exchange markets as a technique for allowing the yield on the official ECU to remain competitive.

The Market For Private ECU's

The ECU is a composite currency that is the sum of a fixed amount of each of the currencies of the member countries of the European Monetary System. The quantity of the currency of each country in the ECU reflects that country's relative strength in the E.C. in terms of the rate of growth of its GNP and the demand for its currency in international financial markets in comparison to the other member countries of the EMS. The composition and the proportional weights of the ECU are subject to redefinition every five years and were redefined in September of 1984 and 1989.

In addition to being the official accounting unit of the EMS, the ECU has found a private role in international finance. The currency composition of the private and official forms of the ECU is identical when both are viewed as units of account (Walton, 1988). Table I provides the weights of different currencies comprising the ECU. However, the private and official ECUs are different in the way they are created and used. Official ECU's are created by swap arrangements with the EMCF and are held only by the central banks of the member countries of the EMS and a small number of international monetary institutions such as the Bank for International Settlements (Masera, 1987). The usage of the official ECU is limited to monetary intervention purposes in the ERM. Private ECU's, however, can be created by bundling up the correct amounts of the component currencies (Walton, 1988). Any reference to the ECU in this essay employs the private form only.

TABLE I

COMPOSITION OF THE ECU (SEPTEMBER 1988).

Currency Amount:	Currency
0.71900	German Mark
0.00878	Pound Sterling
1.31000	French Francs
140.00000	Italian Lire
0.25600	Dutch Guilder
3.71000	Belgian Francs
0.14000	Luxembourg Francs
0.21900	Danish Krone
0.00871	Irish Pound
1.15000	Greek Drachmas

(Bank of England Quarterly Bulletin: November 1988)

The ECU has proved to be an attractive currency for transactions purposes in commercial markets. By the end of 1985, it had become the fifth most important Eurocurrency. Corporations in France and Italy are currently the strongest users of the ECU (Lomax, 1987). The growth of the private ECU market is attributed to a number of factors. First, the currency exposure of any member of the EMS is less than the maximum risk when any other individual EMS currency is being used. This is so because the composition of the ECU, as a weighted sum of the individual European currencies, implies that its exchange rate will be less volatile than any individual currency (Lomax, 1987). Second, the interest yield for ECU denominated investments is likely to be less volatile than that of the most volatile national currency, since the ECU interest yield is related to the average in European markets (Lomax, 1987). The stability of the ECU is further enhanced by the commitment of EMS countries to stabilize their bilateral exchange rates. Third, acquiring ECUs entails lower transaction costs to commercial entities than if they were to design their own baskets of currencies. Fourth; the ECU is appealing because, as a currency basket, the U.S. dollar is excluded. Hence, the ECU can be used as an effective hedge against the U.S. dollar (Glick, 1987). Finally; since the ECU is by definition a Eurocurrency, it is free from the restrictive controls of national authorities (Lomax, 1987).

Pozo (1987) examined the reasons for the surprisingly greater acceptance of the ECU over the Special Drawing Right (SDR), especially since the SDR is an older and simpler instrument. The author examined the predictability of the ECU and other monetary assets by comparing the variability of the ECU with the variability of exchange rate movements of other currencies. Pozo assumed that the more predictable (less variable) a currency is, the more useful it is as a unit of account and a means of deferred payment. Also, the average changes in the value of the ECU and other monetary units were examined to check their relative performance as a store of value. The Symmetric Stable Paretian (SSP) distribution was used to describe exchange rate changes. Pozo concluded that the ECU was less variable than other international currencies. Moreover, the stability of the ECU was attributed to a diversification effect, a coordination effect, and a capital controls effect. The diversification effect arises from the fact that the ECU is a currency basket of strong and weak currencies. Increases in appreciating currencies cancel decreases in depreciating currencies and thus the overall variability of the ECU is decreased. The coordination effect has to do with the coordination of economic policies among different countries to attain exchange rate stability. Finally, the capital controls effect refers to the ability of central banks to attain a certain exchange rate by imposing the necessary capital controls.

Jorion (1987) investigated the mean-variance efficiency of the ECU basket to show that investing in the ECU is almost as efficient as tailoring an optimal portfolio consisting of EC currencies. Further, the ECU is superior for diversification purposes if transaction costs are present.

In addition to the stability of the ECU, Aggarwal and Soenen (1988) attribute the dramatic growth of the private use of the ECU to its acceptability by EC institutions. These and certain European governments have actively supported the use of the ECU by private markets. As the official unit of the EC, Europeans have a national interest in the ECU that does not exist for the SDR.

Edison (1987) concluded that the success of the ECU cannot be attributed to any one particular factor. The increasing importance of the ECU can be traced to political and institutional factors in addition to the definition of the ECU as a stable basket which is a weighted average of all the EMS currencies. Edison conducted two experiments: The first experiment focused on the impact of alternative weighting schemes on the currency composition of the ECU and on the dollar value of the ECU. The second experiment analysed West German exchange rate policy assuming its real exchange rate is pegged to a basket other than the ECU. The object of the exercise was to compare the derived optimal basket path with that of the ECU basket path. The first experiment indicated that when there was little exchange rate variability between the currencies that comprise the ECU , the value of the ECU remains invariant to any changes in the shares assigned to the currencies comprising the ECU basket. The second experiment demonstrated that if West Germany decides to peg its currency to a currency basket, the ECU basket would closely approximate the theoretical optimal basket that the DM would be pegged to outside the EMS. Edison concludes that the ECU should survive periods of large dollar depreciation as it has survived large dollar appreciations in the early eighties. What appears to matter for the survival of the ECU is that there be little exchange rate variability between the currencies that comprise the EMS.

Undesirable Features of the ECU

Currently, no single central bank manages the circulation of the ECU. According to Levich (1987), this feature does not appear to be a fatal drawback. Another negative aspect of the ECU has, however, received attention (Levich,1987a).

The ECU is an open rather than a closed basket of currencies. In an open basket, the currencies in the basket and the factors by which they are weighted may change. Agents who wish to use the ECU for hedging specific positions in one or more of the ten component currencies of the ECU will view the open basket concept as an element of risk (Levich,1987b). Indeed, the possibility of a depreciation of the ECU relative to the currencies that comprise the basket after the next recomposition has recently prompted multinationals to issue bonds denominated in ECU. They based their decision on the assumption that they will get funds in a currency that will be weaker when the time comes to pay back what they owe. Those who believe that the ECU will depreciate base their claim on the fact that the 'soft' currencies will dominate the 'hard' currencies in the basket after the Spanish Peseta and the Portugese Escudo are assigned weights in the ECU (Koenig,1989).

The Operation of the ECU Banking Market

Private ECUs are usually created by changing the denomination of assets already in existence. A bank can create a private ECU deposit by accepting currency and recording the value of the deposit in ECUs. The bank will cover its newly created ECU liability by exchanging the currency deposited in a way that establishes an asset of the same value in terms of the ECU. If no true ECU asset is available, the bank will exchange the currency deposited for the ten European currencies in the same proportions as in the ECU basket (a process referred to as 'unbundling'). These assets are usually deposited in the ECU interbank market (Aggarwal and Soenen, 1988).

In the absence of an ECU central bank, a system of "Mutual ECU Settlement Accounts" (MESA) has been developed. This clearing system is centered around the following seven European clearing banks with whom the banks trading in ECUs are likely to have an account: Kredietbank, Brussels; Lloyds Bank, London; Kredietbank, Luxembourg; Credit Lyonais, Paris; Banque Bruxelles Lambert, Brussels; Instituto Bancario San Paolo di Torino, Turin; and Societe Generale de Banque, Brussels (Saunders and Sienkiewicz, 1988).

This system greatly simlifies the settlement of ECU transfers between banks and meant that, for most transactions, it is no longer necessary to break the ECU down into its component parts.

The ECU banking market has been predominantly interbank ever since it came into being. This remains the case, with interbank lending accounting for 77% of international ECU assets as of the end of March 1988. The market is also characterised by a disparity between ECU assets and liabilities, with net assets expanding from ECU 6 billion at end-1985 to ECU 14 billion at end-March 1988. This was primarily due to the increased demand by non-banks for ECU loans (Walton, 1988)

CHAPTER III

THE DETERMINANTS OF YIELDS IN THE ECU EUROBOND MARKET

The ECU Bond Market

The first issue of ECU Eurobonds took place in 1981. From 1981 to 1985, the use of the ECU in international capital markets grew at a rapid pace. By 1985, the ECU was the fifth most important currency for international bond issues, accounting for 4.5 percent of total international fixed and floating rate bond issues. Since 1985, issues of ECU international bonds have slowed down. Nonetheless, ECU Eurobond issues accounted for 5.3 percent of total Eurobond issues for the first nine months of 1988 (The Economist, Dec.10, 1988). For borrowers, ECU Eurobond issues are attractive for several reasons. Since they are Euro-issues, they are free from national restrictions. Also, they provide diversification of liabilities due to the composite nature of the ECU. ECU Eurobond yields, however, are less than those of a weighted basket of Eurocurrency bonds of comparable maturities and credit rating. Investors are willing to accept yields that are less than the weighted average of yields available in individual EMS markets for the benefit of not having to deal with different currencies and markets in order to obtain a basket of Eurocurrency bonds similar to the ECU Eurobond in composition. Exchange rate and interest rate stability have also been cited as major factors contributing to the demand for ECU Eurobonds by investors (Walton, 1988). Investors are able to share in the gains of the West German, French, and U.K. bond markets while reducing the risks of foreign exchange losses (Pitman, 1988). Furthermore, ECU bonds are attractive instruments for investing in "soft" currencies with high yields for which there is no liquid international market, such as the Greek Drachma. Also, the presence of capital controls in France and Italy, which are scheduled to be removed early 1990, makes investment in ECU Eurobonds a convenient method for participating in the Italian Lira and French Franc Eurobond markets that are characterized by high returns (The Economist, Dec.10, 1988).

ECU Eurobonds suffer some drawbacks. As interest rates in Europe converge and currency risks become smaller, some investors may prefer those Eurobonds that offer a slightly lower yield than those on ECU bonds, but which are more liquid and are denominated in a single currency with a home market such as British Pound and Deutsche-mark denominated Eurobonds. Moreover, there may be investors who prefer Eurobonds that offer yields higher than those available for ECU bonds but do not have the interest rate and currency stability that ECU Eurobonds provide. Thus, bonds that outperform the ECU Eurobond (i.e. have a higher yield than the ECU Eurobond) may be viewed as an attractive investment.

The Application of Dynamic Factor Analysis to ECU-denominated Eurobonds

The aim of this chapter is to construct a time series attractiveness index for ECU Eurobonds using the estimation and maximization (EM) algorithm of Watson and Engle (1983). The EM algorithm has been applied by Melvin and Schlagenhauf (1985,1986) to derive country risk indices for France and Mexico. Through the EM algorithm, the impact of the attractiveness index and a measure of capital controls on the yields of ECU Eurobonds will be examined. Finally, several variables influencing the attractiveness of ECU Eurobonds will be investigated. These include the yield on the US Eurodollar and Eurodeutschemark bonds, and the ECU/dollar exchange rate.

In financial markets, the higher the risk associated with a certain bond issue, the greater the yield on bonds (Finnerty and Nunn,1985). Conversely, the lower the risk associated with the bond issue, that is, the more attractive the bond issue is to investors, the smaller the yield. The inverse relationship between the attractiveness of ECU Eurobonds and their yield is captured by specifying the following equation of yield determination:

$$Y_t = \beta_1 + \beta_2 X_t + \beta_3 CC_t + \beta_4 CC_{t-1} + e_t. \qquad <1>$$

Y_t is the real rate of return on ECU Eurobonds at time t, X_t is the value of the ECU Eurobond attractiveness index at t, CC_t is a variable measuring capital controls. Capital controls are measured by the difference between the on and offshore interest rates in Italy. While the EMS members dismantled capital controls throughout the 1980's, Italy (and to a lesser extent France) continued to maintain these. In light of Project 1992, however, the remaining capital controls will be dismantled by the end of 1990. Finally, β_1-β_4 are parameters to be estimated. Our *a priori* hypothesis is that β_2 should be negative. If the attractiveness of the ECU Eurobonds increases, the real rate of return associated with it is expected to shrink. β_1 is an intercept that is included to capture the effects on ECU Eurobonds of the basket recompositions that the ECU periodically undergoes as the strong currencies have to depreciate in order to make room for newly introduced currencies. The coefficient of capital controls is expected to be positive. As the level of capital controls decreases, it is expected to attract capital inflows into Italy. Such inflows have already been reported in the financial press (The Economist, Nov. 4, 1989). As the supply of funds increases, the yields on instruments denominated in Italian Lira will diminish. Consequently, the yield on ECU instruments is expected to decrease since the return on instruments denominated in the Italian currency enter into the composition of ECU instruments of comparable maturities. Hence, a decrease in the level of capital controls in Italy is expected to cause a decrease in the yield on ECU Eurobonds. The less exchange controls there are the narrower is the difference in yields between onshore and offshore financial instruments denominated in the Italian Lira (Jones, 1988). And thus, the differential between the local interest rate and the Eurolira interest rate which is the proxy for the level of exchange controls in Italy.

Since the ECU bond attractiveness index is unobservable, following Melvin and Schlagenhauf (1985, !986), we assume that it evolves over time as follows:

$$X_t = ø X_{t-1} + \infty Z_t + v_t. \qquad \text{<2>}$$

Z_t is a matrix of variables which are hypothesized to determine the attractiveness of ECU Eurobonds. The matrix includes the following variables: the yield on Eurodollar (DOL_t) and Eurodeutschemark bonds (DMB_t), and the ECU/US dollar exchange rate (EX_t). ∞ and ø are parameters to be estimated.

The model of equations <1> - <2> relies on time domain-dynamic factor analysis. According to this methodology, a statistical model is formulated as if the data were available on the attractiveness index, which is an unobservable variable. Then, a joint distribution of the observable variables can be derived. This serves as the likelihood function (L) for estimating the unknown parameters. In addition, this framework generates estimates of the values of the desired unobserved variables in an index form. Details are provided in the Appendix .

The purpose of equation <2> is to identify the variables that determine the attractiveness of ECU Eurobonds over time. The lagged X_t term (X_{t-1}) indicates the possible presence of a significant autoregressive process. It is reasonable to assume that the attractiveness of a financial instrument, such as the ECU Eurobond, is positively autocorrelated as perceptions of the attractiveness associated with a financial instrument change slowly (Melvin & Schlagenhauf, 1986). Hence the lagged X_t term is expected to be positive and significant.

According to Evans (1987), a 'real world' Eurobond trader, the ECU/US dollar exchange rate is not a significant determinant of attractiveness, since ECU bond traders pay little attention to it. In addition, the yield on US Eurodollar bonds of comparable maturities to those denominated in ECUs are not expected to influence ECU bond attractiveness since the two markets are unrelated (Evans, 1987). The yield on Euro-DM bonds, however, is expected to be negatively related to the ECU Eurobond attractiveness variable since ECU Eurobonds are traditionally viewed as an alternative to holding Euro-DM bonds. Therefore, when the yield on the Euro-DM bonds increases, the attractiveness of ECU Eurobonds is expected to diminish (The Economist, April 28, 1990).

Model Estimation and Empirical results

The model of equations <1> and <2> is applied to ECU Eurobonds of two different maturities at the 'long end' of the market. Yield data on a monthly basis for the period November 1984-October 1989 is available from Eurostat a publication of the Statistical Office of the European Communities. One Eurobond is of maturity of five to seven years while the second is an ECU Eurobond with a maturity of more than seven years. The yields are calculated each Wednesday from a sample of fixed interest bonds denominated in ECU and listed on the Luxembourg Stock Exchange. In order to obtain real yields, yields have been deflated by the annual rate of change of a composite index of consumer prices, that includes all the member states of the EC. This index was also obtained from Eurostat. Eurodollar and Euro-DM bonds of comparable maturities are incorporated in the two estimated models. For ECU Eurobonds with a maturity of five to seven years, dollar Eurobonds issued by private corporations with a remaining maturity of four to seven years and Euro-DM bonds issued by private corporations with a remaining maturity of three to seven years are included in the model. As for ECU Eurobonds with a maturity of greater than seven years, Eurodollar and Euro-DM bonds issued by private corporations with a remaining maturity of seven to fifteen years are incorporated in the model. The yields on Eurodollar and Euro-DM bonds are expressed in real terms by deflating the yields by the annual rate of change of the consumer price indices for the US and West Germany, respectively. The yields on these bonds were obtained from OECD Financial Statistics Section1-Part 2 while the consumer price indices were obtained from Eurostat. The ECU/US dollar exchange rate was obtainedfrom ECU-EMS Information published by the Statistical office of the European Communities. The Italian offshore interest rate is the three-month Eurolira deposit rate while the onshore interest rate is the three-month money market interest rate in Italy. Both of these interest rates were obtained from The Economist.

The results from the estimation of the model are shown in the first two columns of Table II. In order to examine whether the two bonds of different maturities behave similarly a test of the equality of coefficients across maturities was performed. l is equal to the value of the likelihood function obtained from the model restricting the two ECU Eurobonds to be equal (93.6424) divided by the product of the values of the likelihood functions obtained from estimating the two ECU Eurobond models separately (42.4194 and 45.3391). The likelihood ratio statistic -2log π for the test that the coefficients in the two estimated models for ECU Eurobonds are jointly equal is 6.04. Based on the chi-squared table the hypothesis of equality of coefficients cannot be rejected at the 0.01 level since he critical value $c^2_{8,.99}$ is 15.51. This suggests that there is no significant difference between the ECU Eurobonds under consideration. Consequently, an additional model is estimated where data on the two ECU Eurobonds are pooled into one sample. As hypothesized, the attractiveness has a significant negative effect on yields on ECU Eurobonds in all three models. Thus, the real rate of return on ECU Eurobonds decreases when attrativeness increases. Italian capital controls exert a positive significant effect on the real returns of ECU Eurobonds.. For ECU Eurobonds with a maturity of five to seven years, CC_t is significant. CC_{t-1} has the statistically significant coefficient in the other two models. Hence, as indicated earlier, the real yield on ECU instruments will decrease as the level of capital controls in Italy diminishes.

TABLE II

ESTIMATED ECU EUROBOND ATTRACTIVENESS MODEL

Real Yield Equation	Maturity 5-7 years	Maturity >7 years	Pooled sample
X	-0.216*	-0.244*	-0.255*
	(-5.985)	(-5.832)	(-8.255)
Constant	1.783	1.550	1.549
	(0.294)	(0.222)	(0.317)
CC_t	0.080*	0.013	0.013
	(2.245)	(0.355)	(0.518)
CC_{t-1}	-0.015	0.084 **	0.083*
	(-0.424)	(2.431)	(3.448)
Attractiveness Equation			
X_{t-1}	0.884*	0.885*	0.887*
	(16.875)	(14.988)	(21.478)
EX_t	0.020	0.378	0.189
	(0.009)	(0.157)	(0.115)
DOL_t	0.378	0.285	0.273
	(1.298)	(1.012)	(1.373)
DMB_t	-0.661*	-0.627*	-0.574*
	(-3.418)	(-3.158)	(-4.287)

(t statistics are in parentheses. Critical values were obtained from the Student-t distribution)

* Significant at the 0.01 level.

** Significant at the 0 05 level

Turning to the attractiveness equation, the lagged variable is positive and significant in all three cases, verifying the presence of a significant autoregressive process. According to Melvin and Schlagenhauf (1986), it is the presence of such a dynamic process in time series data that mandates the use of dynamic factor analysis instead of standard factor analysis.

Both the ECU/dollar exchange rate and the real returns of Eurodollar bonds have no significant impact on the attractiveness of ECU Eurobonds. The coefficient of Euro-DM bonds, on the other hand, is negative and highly significant. These results substantiate the argument that changes in the ECU/dollar exchange rate and developments in the Eurodollar bond market do not impinge on ECU Eurobond yields.

A likelihood ratio statistic ($-2\log \pi 1$) was calculated for the test that the EX_t and DOL_t coefficients are jointly equal to zero. l1 is equal to the value of the likelihood function obtained from the model restricting EX_t and DOL_t to equal zero divided by the likelihood function obtained from the unrestricted model. For ECU Eurobonds with maturities between 5 and 7 years, $-2\log \pi 1$ is 0.19 (38.5961/42.4194). As for ECU Eurobonds with a maturities that exceed 7 years, $-2\log \pi 1$ is 0.18 (41.4261/45.3391). Finally, $-2\log \pi 1$ for the pooled sample is 0.15 (86.8877/93.6424). The degrees of freedom for this test are equal to the number of regressors in the unrestricted model minus the number of regressors in the restricted model, that is, 2 degrees of freedom. The critical value $\chi^2_{2,.99}$ is 9.21. Hence, EX_t and DOL_t are jointly equal to zero in the three estimated models.

A second likelihood ratio statistic ($-2\log \pi 2$) was calculated for the test that the CC_t and CC_{t-1} coefficients are jointly equal to zero. $\pi 2$ is equal to the value of the likelihood function obtained from the model restricting CC_t and CC_{t-1} to equal zero divided by the value of the likelihood function obtained from the unrestricted model. For ECU bonds with maturities between 5 and 7 years, $-2\log \pi 2$ is 0.16 (39.2544/42.4194). As for ECU bonds with maturities that exceed 7 years, $-2\log \pi 2$ is 0.14 (42.3515/45.3391). $-2\log \pi 2$ for the pooled sample is 0.12 (88.2276/93.6424). The number of degrees of freedom for this test is 2. The critical value $\chi^2_{2,.99}$ is 9.21. Thus, CC_t and CC_{t-1} are jointly equal to zero in the three estimated models.

The ECU Eurobond Attractiveness Index

Figures1 and 2 depict the estimated attractiveness indices for the two ECU Eurobonds under consideration, while figure 3 charts the attractiveness index for the sample of observations that comprise the two Eurobonds over the 1984-1989 period. The three indices display an almost identical path over time. These indices are the estimated unobservable X factors in the models and can be considered to be the maximum likelihood estimates based on the data and the estimated parameters of the models (Melvin & Schlagenhauf, 1986). The index is relatively stable from November 1984 till August 1986. Late 1986 is a period of decreased attractiveness followed by a briefly increasing index until May 1987. The ECU bond market went through a period of weakness in late 1986 because of the fall in the price of oil, and the depreciation of the British pound against the other European currencies. The depreciation of the British pound by fifteen percent against the DM in the second half of 1986 led to the depreciation of the ECU against the other European currencies. This meant that non-British Pound holders of ECU Eurobonds suffered an exchange loss during that period. According to Lomax (1989), another problem for ECU Eurobonds in late 1986

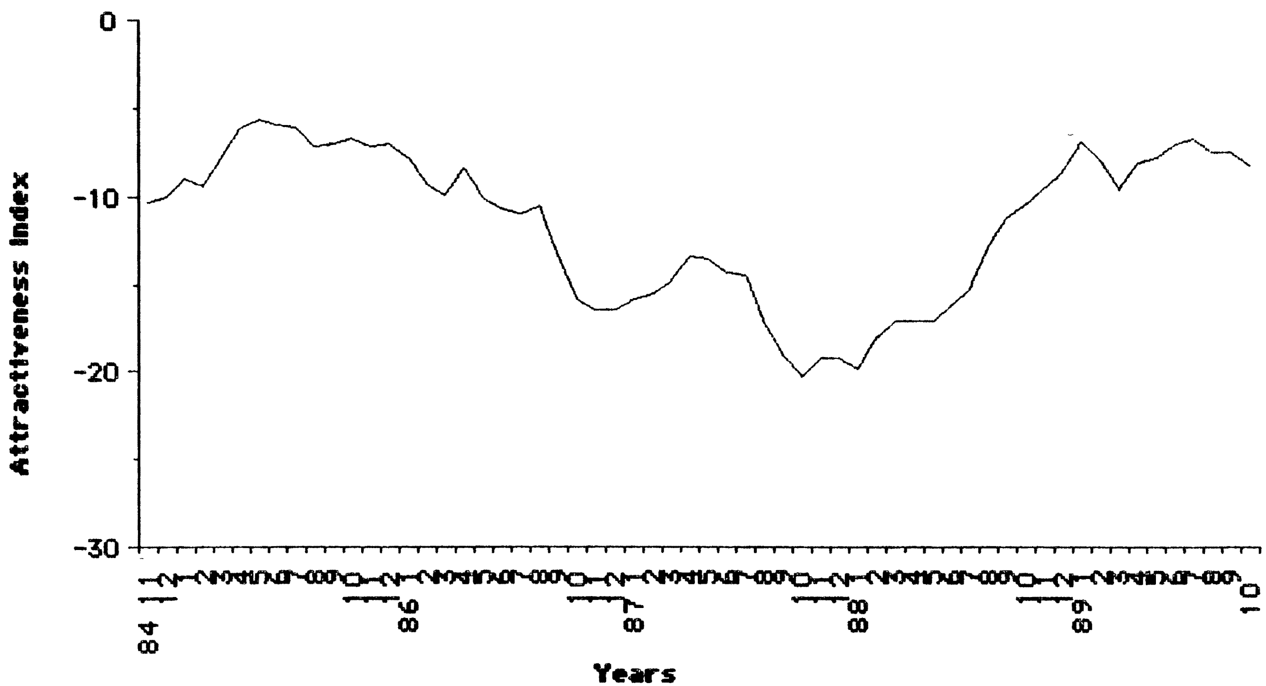

Figure1. Attractiveness Index for ECU Eurobonds with Maturity of 5-7 Years

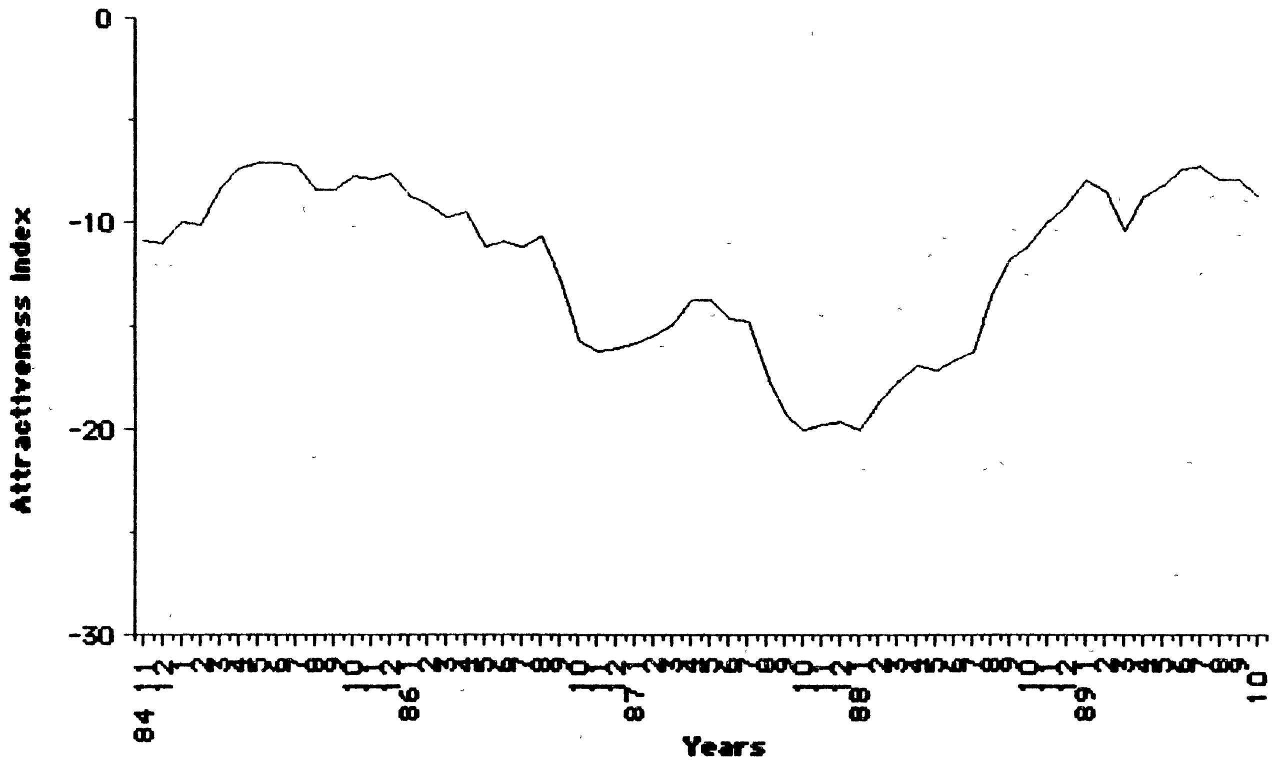

Figure2. Attractiveness Index for ECU Eurobonds with Maturity Greater than 7 Years

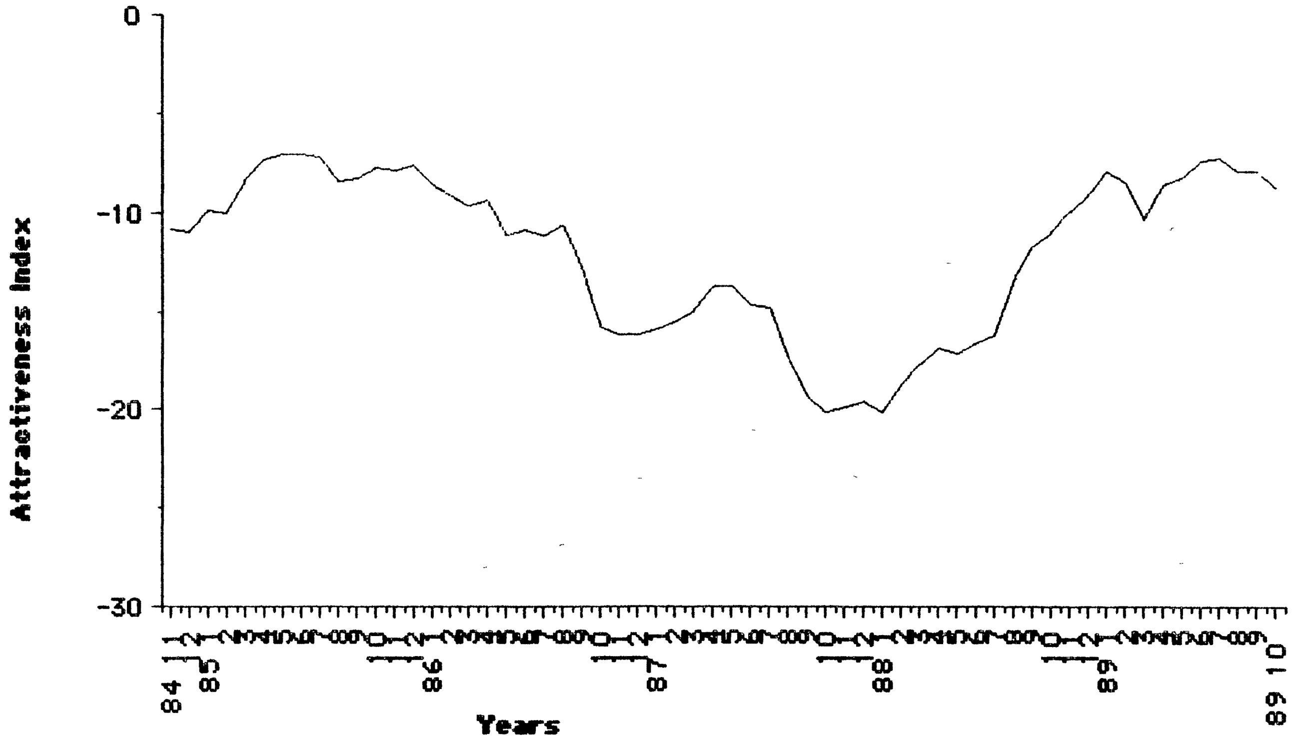

Figure 3. Attractiveness Index for Both Maturities

was the reduced interest premium compared with DM Eurobonds, making them relatively less attractive.

The Autumn of 1986 marked the discovery of the ECU Eurobond market by Japanese investors (Cohen, 1987). Having suffered exchange losses of their own, and with the yield on ECU Eurobonds becoming more attractive, Japanese investors found an ideal financial instrument in the ECU. This demand for ECU Eurobonds by Japanese investors accounts for the rise in the attractiveness index from the end of 1986 till May 1987. However, over the summer of 1987, with international tension rising in the Persian Gulf, most investors, especially the Japanese, shifted their holdings to domestic financial markets and government bonds (Cohen, 1987). The ECU Eurobond attractiveness index declines from June 1987 till the end of that year.

In the first nine months of 1988, increased demand for ECU Eurobonds brought yields down to eight percent from nearly ten percent in September of 1987. That surge in ECU activity marks the beginning of continuous growth in the volume of ECU Eurobonds issued for the rest of the period of this study. This is mirrored by a rise in the attractiveness index that is not followed by any reversals for that same period. The appeal of ECU Eurobonds since the beginning of 1988 can be attributed to three factors.

First, the market has acquired increased depth. A greater number of quality issuers has entered the market. Before 1988, the market was dominated by issues from EEC official borrowers such as the European Investment Bank and the European Coal and Steel Community. In 1988, ECU Eurobond issues by the French government, Italy's state railway, GMAC, Toyota, and IBM contributed to the diversity of quality borrowers in the ECU market.

Second, the swap markets played a part in promoting activity in the ECU bond market. The benefit for those engaged in swapping ECU assets comes from arbitrage opportunities created by Italy's domestic ECU bonds. Swaps are mostly executed from fixed rate ECU assets into floating rate dollar assets. Swaps take place as follows: Banks based in countries with dual tax agreements with Italy can pick a 12.5 percent tax benefit when the Italian treasury auctions five-year ECU denominated certificates (CTE's). Commercial banks, then, buy these tax bearing government bonds at a discount. Instead of holding the bonds to maturity, banks "swap out" of ECU into dollar assets, picking up several basis points over Libor in the process, which includes the 12.5 percent tax refund paid in accordance with the dual tax agreement (Keller, 1990).

Third, ECU yields have risen. Japanese investors have been lured back into the market by high yields on ECU bonds, which, by the last quarter of1989, compared favourably with its traditional alternative, the Deutschemark Eurobond (The Economist, April 28, 1990).

Summary

A dynamic factor analysis model has been utilized to estimate attractiveness indices for ECU Eurobonds of two distinct maturities in a smooth index form. The model utilizes the real yield on ECU Eurobonds as the measured variable containing information on the attractiveness of ECU Eurobonds. It is demonstrated that ECU Eurobond attractiveness is negatively ralated to the real returns on Euro-DM bonds. This result confirms empirically the often cited, but as yet untested, observation in the financial press that Euro-DM bonds are traditional alternatives to ECU Eurobonds.

CHAPTER IV

DID THE PLAZA AGREEMENT MATTER? EVIDENCE FROM US-EMS EUROCURRENCY INTEREST RATES

Introduction

In September 1985, the Finance Ministers and central bank governors of France, West Germany, Japan, the U.K and the USA (the Group of Five) met in New York and struck an accord that became known as the Plaza Agreement. The Group of Five (G5) expressed their commitment to undertake coordinated intervention in the foreign exchange markets. According to the Plaza communique [cited in Fraser (1987)] ". . . in view of the present and prospective changes in fundamentals, some further orderly appreciation of the main non-dollar currencies against the dollar is desirable. They [G5] stand ready to cooperate more closely to encourage this when to do so would be helpful."

While general discussions of the Plaza Agreement abound [e.g., Funumachi (1988) and Feldstein (1989)], little empirical work on the impact of the Plaza Agreement has appeared in the literature. Klein, Mizrach, and Murphy (1989) found that the Plaza Agreement marked the beginning of a fundamental shift in the exchange rate policy regime for the United States, West Germany, and Japan. Using a simple two-country model of the open economy, the authors found a strong relationship between exchange rates and news about the trade balance during the period after the Plaza Agreement, but found no relationship at all during the period preceding the Agreement.

This chapter fills a gap in the empirical literature. It considers whether the agreement represented a fundamental shift in exchange-rate policy regime for the US and the countries of the European Monetary System (EMS). In particular, it tests whether, by altering investors' perceptions, the agreement resulted in significantly transforming the link between short-term Eurodollar interest rates and long-term EMS Eurorates. In what follows, long-term EMS Eurorates will be proxied by the interest rate on long-term Eurobonds denominated in the European Currency Unit (ECU). At this juncture, a short note on the ECU and ECU-denominated Eurobonds is in order.

The European Currency Unit (ECU) came into existence in 1979 in connection with the formation of the EMS. Its purpose was to give the member countries of the EMS a monetary unit which could be used as a vehicle to promote monetary integration. The ECU is a composite currency which contains specified amounts of the currencies of the member states of the European Community (EC). The weight of each currency in the basket is based on each country's share in EC gross national product and trade and is reviewed every five years.

The ECU has proved to be an attractive instruments in private financial markets. In terms of the volume of transactions denominated in a particular currency, it ranked fifth in 1985, according to Masera (1987). The ECU represents a 'bundling' of positions in the component currencies. Thus, an ECU Eurobond is equivalent to a basket of Eurobonds denominated in the component currencies. Therefore, it offers investors substantial savings in transaction costs (Levich, 1987). More importantly, the success of the ECU has been attributed to its stability in terms of its component currencies.

The next section of the chapter presents the framework which links short-term interest rates in the domestic region (US) and long-term rates in the foreign

(EMS). In what follows, the long-term interest rate in the EMS will be proxied by the interest rate on long-term ECU-denominated Eurobonds. The long-term ECU Eurobond rate is, in turn, the return on bonds denominated in a currency basket which includes all the currencies of the EMS. ECU Eurobond rates are available in the Eurostat publication ECU-EMS Information. These rates are the unweighted arithmetic averages of weekly yields of these bonds. The weekly yields are calculated each Wednesday from a sample of fixed interest bonds, denominated in ECU and listed on the Luxembourg Stock Exchange. Short-term interest rates are those on three month Eurocurrency deposit rates. Those for ECU deposit rates were obtained from ECU-EMS Information and those for Eurodollar deposit rates from the OECD Financial Statistics: Section 1-Part2. The link is examined within the framework of the term structure of Eurocurrency interest rates. The reason for focusing on interest rates in the EMS rather than individual-country interest rates is that the Plaza Agreement provided, *inter alia* , for joint coordination between the major participants in the EMS and the US. In contrast to individual-country interest rates, use of EMS interest rates, which contain information across various participants in the Agreement, exploits the joint nature of the Agreement. The model highlights the role played by exchange rate expectations in linking interest rates between the two regions. In particular, if the Agreement provided for a significant shift in exchange-rate policy regime, the nature of the link should be significantly altered. The following section of the chapter presents the empirical results from the testing this hypothesis. The final section offers some concluding remarks.

The Interdependence Between ECU and Eurodollar Interest Rates

Bisignano (1983) studied the impact of exchange rate intervention using domestic interest rates in the US, West Germany and Canada. The author concluded that, following the October 1979 change of monetary policy control procedures by the Federal Reserve, the Federal Republic of Germany found that its financial markets were more linked to US financial markets than before. This linkage emerged because of strong expectations that the Bundes Bank would not allow long-run currency depreciation of the DM against the US dollar. Consequently, expected future short-term interest rates in Germany were strongly influenced by changes in short-term interest rates in the US. Such a linkage depends on the expectations theory of the term structure and the assumption of international interest rate parity. The same linkage was evident in the case of Canada and the US in spite of the fact that a long term depreciation of the Canadian dollar was expected after October 1979. Bisignano's results suggest that, despite a 'weak' currency, the exchange rate objectives of the Bank of Canada were as strong as those of Germany.

Following Bisignano, Krol (1986) examined the interdependence of the term structure of Eurocurrency interest rates focusing on short-term Eurodollar interest rates and long-term Euromark and Swiss Eurofranc interest rates. The linkage between long term interest rates in one region's offshore financial market and short term interest rates in the other offshore market was arrived at by combining a rational expectations model of the term structure of interest rates with the concept of international interest rate parity.

Cumby and Mishkin (1986) demonstrated thet *ex ante* real interest rates in several European countries, Canada, and the United States had been considerably higher since 1980 than during the 1970's. The authors also found a significant positive correlation between real interest rate movements in the US and those in seven other industrialized countries. While significantly positive, the degree of international linkage in real rates was less than complete, leaving open the posssibility that European monetary policy could influence domestic economic activity. The evidence presented by Cumby and Mishkin also points to significant independence in real rate movements in the countries under study.

The expectations hypothesis of the term structure of interest rates states that agents arbitrage bonds of varying maturities. The result of this is an "equilibrium" in which the return on a long term bond equals the average of the return on a certain short term bond and the expected returns on future short term bonds over the same holding period. That is, bonds of like characteristics but of different maturities, are good substitutes for each other. Thus, their average expected return over a given time horizon are approximately equal (Bisignano, 1982).

The term structure relationship between Eurocurrency rates can be represented by the following simple linear rational expectations model:

$$R_t \approx g + 1/n\, E_t\,(r_t + r_{t+1} + \ldots\ldots\ldots\ldots + r_{t+i}) \qquad <3>$$

$$R_t \approx g + n^{-1}(r_t + \Sigma\, E_t r_{t+i}) \qquad <4>$$

R_t and r_{t+i} ($i>0$) represent the long and short term Eurocurrency intrerest rates, respectively. $E_t r_{t+i}$ is the expected value of the short term Eurocurrency interest rate in period t+i, formed rationally in period t using all current information. The information set contains all the information needed for forecasting r_{t+i}. g is a term premium which reflects investors' risk aversion and is assumed to be constant over time (Krol, 1986).

The international-interest rate parity is an arbitrage relationship that holds for two assets of identical maturity but different currency of denomination. For the two returns to be equivalent in equilibrium, the compounded yield differential between the two securities should equal the expected change in the exchange rate (Bisignano, 1982).

The international interest-rate parity condition can be represented as:

$$\frac{1+R}{1+R^*} = n^{-1}[(E_t s_{t+n} - s_t) + ø] \qquad \text{<5>}$$

R and R* are the market yields on domestic and foreign Eurobonds, respectively. s_t represents the exchange rate defined in units of home currency per unit of foreign currency. f equals the exchange rate premium which is assumed to be constant over time (Krol, 1986). Taking logs and using the approximation ln(1+R)=R

$$R_t - R_t^* = n^{-1} [(E_t e_{t+n} - e_t) + ø] \qquad \text{<6>}$$

e_t represents the natural logarithm of the exchange rate and $E_t e_{t+n}$ equals the expected value of the exchange rate in period t+n rationally formed in period t using all current information. It is assumed that the information set contains both domestic government policy rules and any exchange rate policy rules (Krol, 1986). The relationship between the foreign long term Eurocurrency interest rate R_t^* and short term home Eurocurrency interest rates r_{t+i} is established by solving <5> for R_t, substituting in <4> and solving for R^*_t.

$$R_t \approx n\text{-}1 [(E_t e_{t+n} - e_t) + ø]+R_t^*$$

$$g + n^{-1}(r_t + \Sigma E_t r_{t+i}) \approx n^{-1}[(E_t e_{t+n} - e_t) + ø]+ R_t^*$$

$$Rt^* \approx g + n^{-1} [r_t + \Sigma E_t r_{t+i} - (E_t e_{t+n} - e_t) - ø$$

$$E_t(e_{t+n}) - e_t = E_t[(e_{t+1} - e_t) + (e_{t+2} - e_{t+1}) \ldots\ldots\ldots +$$

$$(e_{t+n} - e_{t+n-1})]$$

$$E_t(e_{t+n}) - e_t = E_t(\Delta e_t + \Delta e_{t+1} + \ldots\ldots\ldots + \Delta e_{t+n})$$

$$R^*_t \approx g + n^{-1}[(r_t - E_t \Delta e_t) + \Sigma E_t(r_{t+i} - \Delta e_{t+i}) - ø]. \qquad \text{<7>}$$

Here Δe_{t+i} equals the change in the exchange rate from period t+i-1 to t+i. It can be observed from <7> that the level of the foreign country's long term Eurocurrency interest rates is influenced by the average of current and expected levels of the home- country's short term Eurocurrency interest rates and the expected change in the exchange rate in each individual time period. Any change in policy rules would have an impact on the term structure equation of the foreign region.

$$R^*_t \approx g + n^{-1}[\, r_t + \sum_{i=1}^{n} E_t r_{t+i} - \sum_{i=0}^{n} \Delta e_{t+i} - ø] \qquad \text{<8>}$$

where R^*_t is the market yield on foreign (ECU) Eurobonds and r_t is the short-term Eurocurrency interest rate in the home region (US). n is a given time period over which bonds of different maturities are held. $E_t r_{t+i}$ is the expected value of the short-term Eurocurrency interest rate in period t+i, formed rationally in period t using all current information and Δ is the change operator. Both the term premium (g) and the exchange rate premium (ø) are assumed constant over time, as in Krol (1986).

The equation demonstrates that the foreign (ECU) long-term Eurocurrency interest rate is influenced by the average of current and expected levels of the home (US) short-term Eurocurrency interest rates and the expected change in the exchange rate in each time period.

The critical point in establishing the link between short-term US and long -term ECU interest rates is the potential for joint action on the part of central banks and its effect on exchange rate expectations. In this chapter we examine the impact of central bank intervention in the member states of the EMS, *vis á vis* the dollar, for the period January 1984-February 1989. The period is chosen because yields on all ECU Eurobonds are available beginning in January 1984.

The period prior to the Plaza Agreement of September 1985 was characterized by a lack of coordination of exchange rate policy between the US and the member countries of the EMS. Between 1979 and 1985, the currencies of the major participating countries in the EMS depreciated against the US dollar. During those years, realignment of central rates, intervention in the currency markets, and other short term monetary measures were unsuccessfully implemented by the major members of the EMS in order to alleviate market pressure on their currencies (Fraser, 1987). Thus no clear cut policy influence on exchange rate expectations is evident during this period and therefore short-term Eurodollar interest rates are expected to influence significantly the long-term ECU rate.

The Plaza agreement expressed official commitment to coordinated intervention in the currency markets. Therefore, if the Plaza Agreement provided a significant change in exchange rate policy regime and clear direction to investors' expectations, then the exchange rate terms in <8> are expected to dominate, and therefore no significant impact of US short-term

Eurodollar rates should be detected. If investors perceive that short-term Eurocurrency interest rates are moving against a backdrop of exchange rate coordination, interest rate developments within the EMS are expected to be dominant, while short-term interest rate developments in the US are expected to be inconsequential to their decision-making process. In order to capture the effect of the shift from uncoordinated to coordinated exchange rate policy on the term structure equation a comparison of the period prior to the Plaza Agreement with that following the Agreement is undertaken. It is expected that in the first period, a significant relationship will exist between short-term Eurodollar rates and long-term ECU interest rates. With the presence of coordinated exchange rate policy in the second period, it is expected that short-term Eurodollar interest rates will not be significant while short-term ECU rates will influence the long-term rate significantly.

Empirical Results

The hypothesis advanced in the previous section can be tested by estimating the following equation:

$$\Delta R^*_t = \beta o + \beta_1 \Delta r^*_t + \beta_2 \Delta r_t + \mu_t \qquad \text{<9>}$$

where r^*_t is the foreign short-term interest rate (ECU) and μ_t is a stochastic disturbance term. All other terms were previously defined. The equation is estimated with long-term interest rate data for three maturities: less than five years, 5-7 years and greater than 7. Short-term rates are three-month Eurodollar and ECU deposit rates sampled monthly. The estimating period is January 1984 to February 1989.

The estimating equation is expressed in difference form in the relevant variables because of the suggestion in the literature [see, for example, Nelson and Plosser (1982)] of the presence of a unit root in most macroeconomic variables. In order to confirm the presence of a unit root in both short-term ECU and US interest rates and the long-term ECU rates an augmented Dickey-Fuller test was conducted. The augmented Dickey-Fuller test [see Dickey and Fuller (1981)] involves estimating the following equation:

$$\Delta y_t = \alpha + a1t + a2y_{t-1} + a3\Delta y_{t-1} + w_t \qquad \text{<10>}$$

where y_t refers to short-term Eurodollar and ECU rates and long-term ECU rates and t represents a time trend. The relevant statistics T_t were -0.9886 and -2.1273 for the US and ECU short-term respectively and -1.27, -1.32 and -1.48 for the three long-term bond rates. Based on the critical value from table 8.5.2 of Fuller (1976), the hypothesis of a unit root cannot be rejected at the 0.05 level in all cases. The Box-Ljung statistic indicates that the residuals in all tests were white noise.

Since the short-term rates are three-month rates sampled monthly, the variance-covariance matrix from ordinary least squares (OLS) is not consistent. Hansen and Hodrick (1980) provide the consistent variance-covariance matrix. In this chapter the Cumby, Huizinga and Obstfeld (1983) two-step two-stage least squares (2S2SLS) method is employed which provides estimates similar to those of Hansen and Hodrick but are more general because they allow for heteroskedasticity of the residuals. This method was also used by Cumby and Mishkin (1988) in their study of the link between European and US real interest rates.

The 2S2SLS estimates of <9> are

$$(X'Z\hat{\Omega}^{-1}Z'X)^{-1}X'Z\hat{\Omega}^{-1}Z'y \qquad \text{<11>}$$

where X is the matrix of regressors, Z is a matrix of instruments, y is the dependent variable and Ω is given by

$$(1/T)\sum_{k=-L}^{L}\sum_{t=1}^{T} Z'_t\hat{\mu}_t\hat{\mu}_{t-k}Z_{t-k} \qquad \text{<12>}$$

where L is the order of the moving average (MA) process and T is the number of observations. Cumby and Mishkin show that for three month rates sampled monthly the MA process is of the second order.

Table III presents the results from the application of 2S2SLS to equation <9>.The instruments used are current and one-lag values of the three-month Eurocurrency deposit rates on the Pound Sterling, Deutsche-mark, and French franc; current and one-lag values of three-month US treasury bill rates; the regressor variables lagged once; and a time trend. Eurocurrency deposit rates were obtained from <u>OECD Financial Statistics: Section 1-Part 2</u>. US treasury bill rates were obtained from the <u>Federal Reserve Bulletin</u>.

While the Plaza Agreement took place in September 1985, the results presented in Table III partition the sample between February and March 1986. In accordance with Klein, Mizrach and Murphy (1989), the sample is partitioned on the basis of a moving sample Chow test. The test involves computing an F-ratio statistic as:

$$[(\mu'_T\mu_T - (\mu'_1\mu_1 + \mu'_2\mu_2))/k] \,/\, [(\mu'_1\mu_1 + \mu'_2\mu_2)/(n_1+n_2-2k)] \qquad \text{<13>}$$

TABLE III

TESTS FOR THE INTERDEPENDENCE OF THE TERM STRUCTURE OF EUROCURRENCY RATES

Maturity(years)	bo	b_1	b_2	R^2	F(df)
Less than 5	-0.035	0.028	0.308*	0.343	5.49**
Jan84-Feb86	(-1.112)	(0.255)	(4.116)		(2,21)
Less than 5	0.011	0.539*	-0.129	0.383	10.23*
Mar86-Feb89	(0.469)	(4.507)	(-0.678)		(2,33)
Greater than 5	-0.045*	0.034	0.313*	0.532	11.96*
Jan84-Feb86	(-3.017)	(0.466)	(7.841)		(2,21)
Greater than 5	-0.011	0.447*	0.122	0.534	18.13*
Mar86-Feb89	(-0.319)	(2.848)	(0.629)		(2,33)
Greater than 7	-0.050*	-0.003	0.302*	0.584	14.72*
Jan84-Feb86	(-5.235)	(-0.060)	(7.015)		(2,21)
Greater than 7	-0.005	0.412*	0.001	0.411	11.52*
Mar86-Feb89	(-0.156)	(3.022)	(0.006)		(2,33)

The t-statistic is in parentheses and it is based on the standard errors from the 2S2SLS procedure of Cumby, Huizinga and Obstfeld (1983).

*Significant at the 0.01 level.
**Significant at the 0 05 level

Where $\mu'_T\mu_T$ is the sum of squared residuals over the whole period. $\mu'_1\mu_1$ is the sum of squared residuals over the sub-period January 84-February 86 and $\mu'_2\mu_2$ is the sum of squares residuals over the sub-period March 86-February 89. n_1 and n_2 are the number of observations in the first and second sub-periods, respectively. k is the number of parameters.

The partition point is chosen where the F-ratio statistic reaches a maximum. The values of the F-ratio statistic for different partition dates are shown in Table IV. The F-ratio is largest at the February 86/March 86 point for ECU Eurobonds with maturities greater than 5 and greater than 7 years while it is largest at the January 86/February 86 breaking point for ECU Eurobonds with a maturity of less than 5 years. For purposes of uniformity, the February 86/March 86 breaking point is adopted for all three ECU Eurobonds. All the calculated F-values are significant at the 0.01 level.

The partition represents a lag of five months from the actual agreement. The same conclusion was reached by Klein, Mizrach and Murphy (1989 p.11) who argue that this " is consistent with the view that a change in the policy regime requires some time to become credible to market participants." As a test of the sensitivity of the results, the actual date of the Agreement (September/October 1985) was used as the partition date. The results obtained are virtually identical to those in Table III.

Table III reveals that, as hypothesized, prior to the Agreement, the contemporaneous change in the Eurodollar short-term rate has a significant (0.01 level) impact on the long-term ECU interest rate. Following the Agreement, the contemporaneous change in the US short term Eurocurrency rate is insignificant at conventional levels of significance. Thus, contemporaneous changes in the short term Eurodollar rate are no longer part of the investors' information set. Hence, the term structure relationship fails to

TABLE IV

MOVING SAMPLE CHOW TESTS

Partition Point	ECUL5*	ECU5-7**	ECUG7***
Sep. 85	2.367	2.989	2.335
Oct. 85	2.132	2.590	2.225
Nov. 85	2.132	2.577	2.208
Dec. 85	2.942	2.706	2.240
Jan. 86	3.161	2.973	2.740
Feb. 86	2.742	3.264	3.410
Mar. 86	2.310	2.526	2.896

* ECUL5 are ECU bonds with a maturity of less than 5 years.
** ECU5-7 are ECU bonds with a maturity between 5 to 7 years.
*** ECUG7 are ECU bonds with a maturity greater than 7 years.

The moving sample Chow test involves computing an F-ratio statistic as:

$$[(\mu'_T\mu_T - (\mu'_1\mu_1 + \mu'_2\mu_2))/k] / [(\mu'_1\mu_1 + \mu'_2\mu_2)/(n_1+n_2-2k)]$$

hold. Moreover, contemporaneous changes in ECU short-term rates are now a significant determinant (0.01 level) of the long-term ECU rate. In summary, in the presence of exchange rate coordination, changes in the US short term rate are no longer significant, whereas changes in short-term ECU rates become the important determinant of long term ECU rates.

Summary

This chapter investigates the interdependence of the term structure of Eurocurrency interest rates for the ECU and the US dollar for the period. The results affirm that the Plaza Agreement represents a significant change in policy regime. After this meeting, pressure on the currencies of the major members of the EMS was substantially reduced, and investors became convinced that member countries of the EMS and the US were serious about coordinating their exchange rate policies.

CHAPTER V

SUMMARY AND CONCLUSIONS

A dynamic factor analysis model has been utilized in the first essay to estimate attractiveness indices for ECU Eurobonds of two distinct maturities. A test for the equality of coefficients across maturities revealed no significant difference in the behaviour of the two bonds. Thus, an additional model was estimated utilizing a pooled sample of both ECU Eurobonds.

The models utilized the real yield on ECU Eurobonds as the measured variable containing information on the attractiveness of ECU Eurobonds. Holding constant the effect of actual capital controls, an equation is specified relating the real returns on ECU Eurobonds to the attractiveness of these Eurobonds. A second equation described the determinants of ECU Eurobond attractiveness and permitted hypothesis tests of the relationship between these variables and ECU Eurobond attractiveness.

Aside from a significant autocorrelation effect, ECU Eurobond attractiveness is negatively ralated to the real returns on Euro-DM bonds. This result confirms empirically the often cited, but as yet untested, observation in the financial press that Euro-DM bonds are traditional alternatives to ECU Eurobonds. Moreover, it was demonstrated that, as hypothsized, the ECU/US$ exchange rate and developments in the Eurodollar bond market do not impinge on the attractiveness of ECU Eurobonds.

The attractiveness index evolves over time in a manner consistent with a number of financial and political events which have exerted a significant bearing on the ECU Eurobond market. Such events include the depreciation of the British Pound in the last quarter of 1986, the intensification of military conflict in the Persian Gulf area in the summer of 1987, and the marked increase in the yields on ECU Eurobonds in 1989.

The second essay investigated the interdependence of the term structure of Eurocurrency interest rates for the ECU and the US dollar for the period January 1984-February 1989. The relationship between long-term offshore interest rates in the EMS and short-term offshore interest rates in the US was examined by combining a simple rational expectations model of the term structure of interest rates with the concept of international interest parity. Partitioning the data reveals that the linkage between the two interest rates does not hold after the Plaza Agreement. The results affirm that the Plaza Agreement represents a significant change in policy regime because the term structure of Eurocurrency interest rates for the the US and the EMS does not hold for the post-Plaza Agreement sub-period. After this meeting, pressure on the currencies of the major members of the EMS was substantially reduced, and investors became convinced that member countries of the EMS and the US were serious about coordinating their exchange rate policies. By examining ECU Eurobond rates this chapter captures the impact of coordinated exchange rate policy by the EMS countries on the term structure of ECU-US dollar Eurocurrency rates. On the other hand, individual exchange rate policies of the EMS members, which can be captured by examining their respective Eurocurrency markets, tend to reflect considerations other than those pertinent to the EMS. Moreover, by subdividing the period into pre and post Plaza periods, the results capture the impact of coordination of exchange rate policies on long-term ECU Eurobond rates.

BIBLIOGRAPHY

Adam, N. (1988). "The Growing 'Will' to make EMS Work", International Management, 43(1), 26-28.

Aggarwal, R. and Soenen, L. A. (1988). "Private Use of Official Currency Cocktails: The relative Success of the ECU and the SDR", Banca Nazionale del Lavoro Quarterly Review, 61(4), 425-440.

Allen, P. R. (1987). "Discussion", in R. Levich and A. Sommariva (Eds.), The ECU Market (pp. 210-213). Massachusetts: Lexington Books.

Becketti, S. and and Hakkio, C. (1987). How Real is the 'Real Exchange rate? Research Working Paper 87-04, Research Division, Federal Reserve Bank of Kansas City.

Belongia, M. T. (1988). "Prospects for International Policy Coordination: Some Lessons from the EMS", Federal Reserve Bank of St. Louis Review, 70,19-29.

Bisignano, J. (1983). "Monetary Policy Regimes and International Term Structures of Interest Rates", Federal Reserve Bank of San Francisco Economic Review, Fall Issue, 7-26.

Bofinger, P. (1986). "Private ECUs: Unhappy Triad", Intereconomics, 21(3), 224-231.

Cohen, E. (1987). "Acts of the Apostles", The Banker, 137(9),113-119.

Cumby, R., Huizinga, J., and Obstfeld M. (1983). "Two-Step Two-Stage Least Squares Estimation in Models with Rational Expectations", Journal of Econometrics, 21, 333-355.

Cumby, R. and Mishkin, F. (1986). "The International Linkage of Real Interest Rates: The European-US Connection," Journal of International Money and Finance, 5, 5-23.

Deravi, M. K. and Metghalchi, M. (1988). "The European Monetary System: A Note", Journal of Banking and Finance, 12(3), 505-512.

Dickey, D. and W. Fuller, W. (1981). "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", Econometrica, 49(4), 1057-1072.

Edison, H. J. (1987) "Is the ECU an Optimal Currency Basket?" In R. Levich and A. Sommariva (Eds.), The ECU Market (pp. 191-209). Massachusetts: Lexington Books.

European Documentation (1987). The ECU 5, Luxembourg: Office for Official Publications of the European Communities.

Evans, R. (1987). "The Secondary Market in Ecu Bonds". In R. Levich (Ed.), ECU (pp. 57-68). London: Euromoney Publications.

Feldstein, M. (1989). "The Case Against Trying to Stabilize the Dollar", American Economic Review Papers and Proceedings, 79(2), 36-40.

Fels, J. (1987) "The European Monetary System 1979-1987: Why Has It Worked?" Intereconomics, 22(6), 216-222.

Finnerty, J. and Nunn, K. (1985). "The Determinants of Yield Spreads on U.S. and Eurobonds," Management International Review,1985/2 25 23-33.

Fraser, R. (1987). The World Financial System, Essex, Longman.

Fuller, W. (1976). Introduction to Statistical Time Series, New York, John Wiley and Sons.

Funabashi, Y. (1988). Managing the Dollar: From the Plaza to the Louvre, Washington: Institute for International Economics.

Glick, R. (1987). "ECU, Who?", Federal Reserve Bank of San Francisco Weekly Letter 1, 1-3.

"The Good Europeans". (1990). The Economist, April 28, 311(4), 85.

Grabbe, O. (1986). International Financial Markets New York: Elsevier.

Graupe, D. (1984). Time Series Analysis, Identification and adaptive filtering. Port Malabar: Robert E. Krieger Publishing Company.

Guitian, M., Russo, M., and Tullio, G. (1988). Policy Coordination in the European Monetary System, Occasional Paper No. 61, Washington D.C. International Monetary Fund.

Hansen, L. and Hodrick, R. (1980). "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis", Journal of Political Economy, 88(5), 829-853.

Harvey, A.C. (1982). Time Series Models New York: Halsted Press.

International Financial Statistics, Washington, D. C. International Monetary Fund, different issues.

International Monetary Fund, (1987). "The Role of the SDR in the International Monetary System, "Occasional Paper No. 51, Washington, D. C., International Monetary Fund.

Jager, H. and De Jong, E. (1988). "The Private Ecu's Potential Impact on Global and European Exchange Rate Stability", Banca Nazionale Del Lavoro Quarterly Review , 41(1), 33-59.

Jones, C. (1988). "EMS+1992=?," The Banker, 138(6), 43-49.

Jorion, P. (1987). "The ECU and Efficient Portfolio Choice." In R. Levich and A. Sommariva (Eds.), The ECU Market (pp.119-139). Massachusetts: Lexington Books.

Karamouzis, N. (1987). "Lessons from the European Monetary System," Federal Reserve Bank of Cleveland Economic Commentary, 8.

Keller, P. (1989). "The Market Approaches Critical Mass", Euromoney, 1, 67-72.

Keller, P. (1990). "The Pursuit of the ECU", Euromoney, 1, 77-82.

Klein, M., B. Mizrach and R. G. Murphy, 1989, Managing the Dollar: Has the Plaza Agreement Mattered? Working Paper No.185, Department of Economics, Boston College.

Koenig, P. (1989). "Basket Case Faces Bumpy Ride," Euromoney, 3, 58.

Krol, R. (1986). "The Interdependence of the Term Structure of Eurocurrency Interest Rates," Journal of International Money and Finance, 5(1), 245-253.

Levich, R. and Sommavira A. (1987). "Introduction and Overview". In R. Levich and A. Sommariva (Eds.), The ECU Market (pp. 1-6). Massachusetts: Lexington Books.

Levich, R. (1987a). "Development of the ECU markets: Perspectives on Financial Innovation". In R. Levich and A. Sommariva (Eds.), The ECU Market (pp. 103-116). Massachusetts: Lexington Books.

Levich, R. (1987b). "The Ecu: Introduction and Overview". In R. Levich (Ed.), ECU (pp. 7-24). London: Euromoney Publications.

Lomax, D. (1987). "The Evolution of the ECU Market: A Private Sector View". In R. Levich and A. Sommariva (Eds.), The ECU Market (pp. 9-28). Massachusetts: Lexington Books.

Lomax, D. (1989). "The ECU as an Investment Currency". In P. De Grauwe and T. Peeters (Eds.), The ECU and European Monetary Integration (pp. 119-138). London: The Macmillan Press.

Mahajan, A. and Fraser, D. (1986). "Dollar Eurobond and U.S. Bond Pricing", Journal of International Business Studies, 17(3), 21-36.

Masera, R. (1987). An Increasing Role for the ECU: A Character in Search of a Script, Essays in International Finance No.167, Princeton, N.J., Princton University, International Finance Section.

Masera, R. (1987). "An Increasing role for the ECU: A charater in Search of a Script". In R. Levich and A. Sommariva (Eds.), The ECU Market (pp. 33-67). Massachusetts: Lexington Books.

Melvin, M. and Schlagenhauf, D. (1985). "A Country Risk Index: Econometric Formulation and an Application to Mexico", Economic Inquiry, 23(4), 601-619.

Melvin, M. and Schlagenhauf, D. (1986). "Risk in International lending: A Dynamic Factor Analysis Applied to France and Mexico", Journal of International Money and Finance, 5(1), 31-48.

Micossi, S. (1985). "The Intervention and Financing Mechanisms of the EMS and the Role of the ECU," Banca Nazionale Del Lavoro Quarterly Review, 38(4), 327-345.

"More Nonsense About Monetary Union". (1988). The Economist, November 19, 309(11), 77.

Nelson, C. and C. Plosser, C.(1982), "Trends and Random Walks in Macroeconomic Time Series", Journal of Monetary Economics, 10, 139-162.

Pitman, J. (1988). "Japan Gets a Taste for the ECU," Euromoney, 5, 149-151.

Plaut, S. (1988). "The Eurobond Market- Its Use and Misuse", Federal Reserve Bank of San Francisco Weekly Letter, 6, 1-3.

Pozo, S. (1987). "The ECU as International Money" , Journal of International Money and Finance, 6(1), 195-206.

"Premature Entry?" (1989). The Economist, November 4, 313(11), 100.

Roggoff, K. (1985). "Can Exchange Rate Predictability be Achieved Without Monetary Convergence?: Evidence from the EMS," European Economic Review, 28(1), 93-115.

Sarcinelli, M. (1986). "The EMS and the International Monetary System: Toward Greater Stability", Banca Nazionale Del Lavoro Quarterly Review, 39(1), 57-83.

Saunders, A. and Sienkiewicz, S. (1988). "The Hedging Performance of ECU Futures Contracts," The Journal of Futures Markets, 8(3), 335-353.

"Second-Best ECUs". (1988). The Economist, December 10, 309(12), 85.

Ungerer, H., Evans, O., Mayer, T., and Young, P. (1986). The European Monetary System: Recent Developments, Occasional Paper No. 48, Washington D.C. International Monetary Fund.

Walton, R. (1988). "ECU Financial Activity", Bank of England Quarterly Bulletin, 4, 509-519.

Watson, M.W. and Engle, R. F. (1983). "Alternative Algorithms for the Estimation of Dynamic Factor MIMIC and Varying Coefficient Regression Models," Journal of Econometrics, 25(4), 385-400.

APPENDIX

THE DYMIMIC MODEL

The economic model of chapter III is specified in state-space form so that the EM algorithm can be applied. The state-space form allows maximum likelihood estimates to be extracted from the Kalman filter recursive algorithm.

There are two vector equations in a state-space model and it has the following general form:

$$\underset{jx1}{X_t} = \underset{jxj}{\o} \underset{jx1}{X_{t-1}} + \underset{jxk}{\partial} \underset{kx1}{Z1t} + \underset{jx1}{v_t}. \qquad \text{<A1>}$$

$$\underset{px1}{Y_t} = \underset{pxj}{\mu} \underset{jx1}{X_t} + \underset{pxk}{\beta} \underset{kx1}{Z2t} + \underset{px1}{e_t}. \qquad \text{<A2>}$$

$$\begin{pmatrix} v_t \\ e_t \end{pmatrix} \approx N\begin{bmatrix} 0, & Q_t & 0 \\ & 0 & R_t \end{bmatrix} \qquad \text{<A3>}$$

In most applications the covariance matrices are constant over time so that their time subscript can be suppressed (Watson and Engle, 1983).

Thus,

$$\begin{pmatrix} v_t \\ e_t \end{pmatrix} \approx N\begin{bmatrix} 0, & Q & 0 \\ & 0 & R \end{bmatrix} \qquad \text{<A4>}$$

where X_t is a jx1 state vector of unobserved variables. Y_t is a vector of measurements (also called indicator variables). They provide noisy information about the behaviour of the state variable X_t (Beckett and Hakkio, 1987).

Z1 is a kx1 vector of observable exogenous and lagged dependent variables; Z2 is a kx1 vector of observable and lagged dependent variables; v_t is a jx1 vector of serially uncorrelated random errors; e_t is a px1 vector of of disturbances which is serially uncorrelated and is independent of v_t ; and ø, ∂, μ and ß are coefficient matrices. Equation <A1> is known as the transition equation and describes the evolution of the unobserved variables. Equation <A2> is the measurement equation. It describes the relationship between the unobserved variables and the measured Y variables (Melvin and Schlagenhauf, 1985).

In many instances, the parameters are known in advance and the only issue is the estimation of the state vector. In this case, however, the parameters are estimated. This particular form of the model is referred to as a DYMIMIC (Dynamic Multiple Indicator Multiple Cause) model by Engle and Watson (1981).

According to Harvey (1982), the log likelihood for equations A1-A3 is

$$L(O)= \text{constant} - 1/2\ \Sigma(\log|H_t + f'_t H_t^{-1} f_t). \qquad \text{<A5>}$$

where f_t is the innovation in y_t. f_t is known as an 'innovation' due to the fact that it includes no past information on Y_t but only a new element not present in the past (Graupe, 1984).

Formally:

$$f_t = Y_t - Y_{t|t-1}. \qquad \text{<A6>}$$

H_t is the variance of f_t and 0 is the vector of unknown parameters. f_t and H_t are calculated with the Kalman filter. To maximize the log likelihood function, a derivative free procedure consisting of an estimation step and a maximization step is employed. The two steps of the EM algorithm are iterated to convergence. Using specified starting values for the first iteration, the estimation step constructs the estimate of the missing observation conditional on the observed data and the parameters.

Let $Y_t = (y_t, y_{t-1}, ... Z1_t, Z1_{t-1}, ... Z2_t, Z2_{t-1} ....)$ <A7>

$X_{t|t-i} = E(X_t|Y_{t-i})$ <A8>

$y_{t|t-i} = E(y_t||Y_{t-i})$ <A9>

$P_{t|t-i} = Var(X_t \,|y_{t-i})$ <A10>

The Kalman filter is a recursive method for calculating $E(X_t|Y_t)$ using the following equations:

$X_{t|t-1} = \o X_{t-1|t-1} + \partial Z1_t$ <A11>

$P_{t|t-1} = \o P_{t-1|t-1} \o' + Q$ <A12>

$Y_{t|t-1} = \infty X_{t|t-1} + \beta Z2_t$ <A13>

$H_t = \infty P_{t|t-1} \infty' + R$ <A14>

$X_{t|t} = X_{t|t-1} + P_{t|t-1} \infty' H_t^{-1} (Y_t - Y_{t|t-1})$ <A15>

$P_{t|t} = P_{t|t-1} - P_{t|t-1} \infty' H_t^{-1} \infty P_{t|t-1}$ <A16>

Equations A11 to A16 generate the means and covariance matrix of the joint distribution of $(Y_t \; X_t)$ conditional on Y_t. These values can then be substituted into (A15) and (A16) to find $X_{t|t}$ and $P_{t|t}$. Following Melvin and Schlagenhauf (1985) the algorithm will be started using a vague prior. A value of zero will be assigned to $X_{0|0}$ and 1000 for $P_{0|0}$. The Kalman filter generates minimum mean square error estimates of X_t using the data up through $t(X_{t|T})$.

$$X_{t|T}=X_{t|t}+ A(X_{t+1|T}- X_{t+1|t}) \quad \text{<A17>}$$

$$A_t=P_{t|t}ø'P_{t+1|t} \quad \text{<A18>}$$

$$P_{t|T}=P_{t|t}+ A_t[P_{t+1|t}- P_{t+1|t}]A'_t \quad \text{<A19>}$$

The second step of the EM algorithm - the maximization step calculates MLEs of the parameters conditional on the observed and newly created data (Watson and Engle, 1983).

The EM algorithm was kindly provided by Dr. Donald Schlagenhauf at Arizona State University.

VITA

Bassem Abou Zeid

Candidate for the Degree of

Doctor of Philosophy

Thesis: ESSAYS ON ECU-DENOMINATED FINANCIAL INSTRUMENTS

Major Field: Economics

Biographical:

Personal Data: Born in Beirut, Lebanon, August 3, 1961, the son of Mohammed S. and Nadia Abou Zeid.

Education: Graduated from International College, Beirut, Lebanon, in June 1980; received Bachelor of Arts Degree in Economics from the American University of Beirut in June, 1983; received Master of Science Degree in Economics from Oklahoma State University in May, 1986; completed requirements for the Doctor of Philosophy Degree at Oklahoma State University in December, 1990.

Memberships: American Economic Association; Southern Economic Association.