Transaction Costs and the Portfolio Demand for the Ecu: the Case of a Lira Based Investor *

1. Introduction

Some attempts have been made to explain the expansion of the private Ecu in the Euro-currency market and, in particular, in the Euro-banking sector. Two different approaches have been used in these studies, the traditional mean-variance analysis and the theory of international financial innovations.[1] Both approaches treat the Ecu as a currency in its own right, with its own market and interest rate structure. Many studies within the first approach analyze the demand for the Ecu by international investors by focusing on the covariances among alternative asset returns (Hamaui, 1985; Jorion, 1986; Masera, 1987; Jager and de Jong, 1987 and 1988, Steinherr and Girard, 1988; etc.). Other studies seek to evaluate the relative attractiveness of the private Ecu by comparing the performance of its investment with the performance of similar investments in each of the other Euro-currencies treated as a mutually exclusive option *(ECU Newsletter*, various issues; Masera, 1987). In the studies based on the second approach, the Ecu is treated as an international financial innovation which tends to satisfy the increasing demand by the market participants for a less costly mechanism for allocating, diversifying and compensating for exchange rate risks. Pöhl (1985) and Levich (1986) have contributed to this line of argument.

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[1] For the theory and the classification of international financial innovations see Dufey and Giddy, 1981.

In spite of the fact that the authors of most of these studies have recognized the role of transaction costs in explaining the growing importance of the Ecu, none of them have attempted to formalize the basic mechanisms involved. In particular, it has been argued that fixed brokerage fees and other costs, render an optimal portfolio of individual currencies an expensive investment strategy. This is especially important for risk averse international agents, who would like to maintain a desirable return-risk trade off. In order to lower the cost of diversifying into the ten EEC currencies, international investors are thus attracted to direct investments in the Ecu ready-made portfolio.

This kind of analysis may not suffice to explain the increasing use of the Ecu in banking market. It does, however, illustrate the potential of the Ecu for private investors and as an invoicing currency in the commercial market.

The main purpose of this paper is to investigate whether portfolio transaction costs affect the portfolio demand for the Ecu. In particular, this investigation will attempt to study the effects of fixed brokerage fees on the portfolio demand for the Ecu of a potential private investor residing in Italy.[2]

2. Transaction costs and optimal portfolio selection

Most traditional, normative theories of portfolio selection have been based on the assumption that there are no transaction costs in asset or currency markets. This assumption seems to be especially inappropriate for international investments.

Portfolio transaction costs may be classified into two main categories:[3] fixed transaction costs which are independent of the size of trade, and transaction costs which are proportional to the value (and amount) of each transaction.

[2] For the case of a potential private investor residing in Sweden see Chryssanthou, 1989.

[3] See Pogue, 1970; West and Tinic, 1971; Goldsmith, 1976 and Mayshar, 1979, 1981.

For the portfolio as a whole, fixed transaction costs are completely dependent on the number of securities traded or held.[4]

For practical reasons this paper will be limited to the case of fixed transaction costs. The main reason behind this limitation is that proportional transaction costs, reflecting the degree of illiquidity and foreign exchange risk, are quite difficult to identify and correctly measure.

The economic literature on the selection of optimal portfolios with fixed transaction costs has focused on the risk diversification strategy of risk averse investors. By implicitly assuming fixed portfolio transaction costs, Mao (1970) and Jacob (1975) found that it is not economical to invest in all available securities. They showed that both the systematic and residual risk of each security will have to be considered in choosing which of the available assets should be included in the portfolio. Brennan (1975) was the first to explicitly introduce fixed transaction costs in a discrete model of optimal portfolio selection. He added to the models of Mao and Jacob by including an explicit procedure for determining the optimal number of securities in the portfolio. Goldsmith (1976) also attempted to quantify the ways in which fixed transaction costs make the level of an investor's wealth affect the selection of his portfolio. He found that an increase in wealth or decrease in transaction costs increases the optimal number of securities included in a portfolio by lowering the marginal cost of diversification. King and Leape (1984, 1988) found that transaction costs, broadly interpreted to include the "holding cost" in both money and time of monitoring and managing a portfolio, cause the vast majority of households to hold onto only a subset of available assets. They also found that this portfolio behavior

[4] According to Mayshar (1979, 1981), this fixed charge paid by the investor has two components: an objective cost and a subjective, non-pecuniary cost. The objective, fixed transaction cost may include the real resources which have been used in the actual act of trading each asset or currency in the portfolio, for example, communication costs (telephone, telex, post, etc.). The subjective or non-pecuniary cost depends on the degree of obscurity of the market for each asset or currency in the portfolio. It merely involves the cost of gathering information and decision making for each asset or currency. This cost will differ from asset to asset or from currency to currency, according to the degree of difficulty in gaining information about each asset. It will also vary from investor to investor depending upon his ability to gather information and keep track of a given asset or currency. In certain studies the subjective and non-subjective transaction costs have been interpreted as lump-sum costs and have been associated with the imposition of capital controls and other prohibitions between on-shore markets (or between on-shore and off-shore markets).

of households varies over its life cycle, which implies that the number of assets owned may be determined by the interaction between transaction costs and age profile (for wealth). Magill and Konstantinides (1976) have shown that in the presence of transaction costs rational investors will only periodically revise their portfolios. According to them, Merton's (1969) continuous time portfolio selection theory no longer holds where transaction costs are assumed. Finally Mayshar (1979, 1981 and 1983) has studied the effects of fixed transaction costs on equilibrium asset prices. In particular, Mayshar (1979, 1983) has examined the joint discrete and continuous choice of which asset to own and, conditional upon ownership, the optimal asset demand for each asset.

3. Estimating asset returns

In the following two sections Brennan's model will be used to explore the effects of fixed transaction costs on the portfolio demand for Ecus. An analysis will be made of a potential investor residing in Italy who is choosing whether to invest in one or more of the following Euro-currencies, given a risk-free asset: DM, FFR, UKL, HFL, BFR, DKR, IRL, DRH, ECU, USD, YEN, SFR, NOK, and SDR.[5] The period under investigation covers 31 January 1985 - 31 April 1988. In the present study the Italian lira (LIT) has been chosen as the base (*numéraire*) risk-free currency. This choice is grounded on the general recognition that private investors normally calculate their wealth in domestic currency and in terms of what they will consume in their own currency. Thus it is reasonable to consider the domestic currency as a normal unit-of-account of the gains and losses of the domestic private sector's foreign transactions.[6] Following Makin (1978), a domestic currency which is used as a *numéraire* in foreign transactions of the private sector can also be treated as a risk-free asset, since investments in this currency lack exchange rate risks.[7]

The required inputs for our empirical analysis are the beta and residual variances of returns on investments in each of the above interest bearing Euro-currencies. Following the standard procedure, this investigation will be carried out using *ex post* data. Thus, utilizing equation (1) below and regressing the risk premium $R_i - R_f$ of each currency i on an appropriate market risk premium $R_m - R_f$ over the period considered, we obtain estimates of beta and residual variances for each currency.[8]

$$R_i = R_f + b_i (R_m - R_f) + e_i \qquad (1)$$

In this study, the return on investments in foreign currencies is given as the sum of the interest income, a capital gain or loss from exchange rate fluctuations and the resulting cross-product.[9]

Equation (2) below defines the uncovered returns on investments in foreign interest bearing currencies. This equation concerns an investor residing in Italy who invests in a foreign interest bearing currency i and who wants, at the end of the investment period, to convert the yield into his own "domestic" currency, *i.e.*, LIT.

$$R^u_{i,t} = I_{i,t-1} + r_{i,t} \frac{I_{i,t-1} \cdot r_{i,t}}{100} \qquad (2)$$

$I_{i,t-1}$ is the nominal interest rate on currency i. In this study the $I_{i,t-1}$ will be known and fixed at the beginning of the investment period. The term $r_{i,t}$ indicates the percentage capital gain or loss on investment in the foreign currency i. This term is expressed as follows:

$$r_{i,t} = \frac{S^b_{i,t} - S^s_{i,t-1}}{S^s_{i,t-1}} \qquad (3)$$

[5] DM=German mark, FFR=French franc, UKL=Pound sterling, HFL=Dutch guilder, BFR=Belgian franc (fin), DKR=Danish krone, IRL=Irish pound, DRH=Greek drachma, ECU=European Currency Unit, USD=United States dollar, YEN=Japanese yen, SFR=Swiss franc, NOK=Norwegian krone, SDR=Special Drawing Rights.

[6] Two other *numéraire* have been suggested in the economic literature: 1) an arbitrarily chosen currency which is not determined by the purpose of the analysis, that is, a third currency (MAKIN 1974) and 2) an index which is similar in concept to a trade-weighted exchange rate and reflects the impact of exchange rate variations on the purchasing power of a unit of currency (KOURI and BRAGE DE MACEDO 1978, EAKER 1981, GIAVAZZI and GIOVANNINI 1985). For the advantages and disadvantages of the above mentioned *numéraire*, see JAGER and DE JONG (1988).

[7] The validity of this argument presupposes either changes in the prices of import goods will not affect the home country's inflation to exceed its target, or that there will not be an uncertain inflation rate in the home country, see EAKER (1981) for a theoretical discussion of the above. Otherwise the nominally risk-free domestic currency can be venturesome.

[8] In this paper we will use an unbiased estimate of the residual variance implied by each regression. With T observations and one independent variable this unbiased estimator will be the sum of square residuals implied by each regression divided by T−1.

[9] See *ECU Newsletter*, No. 10, September 1984. See also LEVY (1981).

The term $S^s_{i,t-1}$ is the spot rate of currency i in terms of LIT at which a bank will sell to the investor at the beginning of the investment period.

The term $S^b_{i,t}$ is the spot rate of currency i in terms of LIT at which a bank is willing to buy the foreign currency i at the end of the investment period t.

The cross-product $r_{i,t} \cdot I_{i,t-1}$ represents the effects of the exchange rate gain or loss on the interest income.

Given that the investor can borrow at an existing risk-free rate of interest, risk premia on all the above listed currencies can be calculated for each period t, by subtracting from (2) the rate of return on investments in domestic currency, given by the Italian treasury bonds' rate of return. This rate, denoted by TB, will be known and fixed at the beginning of the investment period.

$$\text{Risk Premium } (RP)_{i,t} = R_{i,t} - TB_{t-1} \qquad (4)$$

This study focuses on the Euro-currency deposit market rather than on the market of any other financial instrument, including Euro-bonds. This is due to the fact that data on Euro-currency deposits are more easily available, and that Euro-deposits are available in all the component currencies of the Ecu and in the Ecu itself (see table 1A in Appendix 2). The foreign currency interest rates which will be used in this calculation are the three month Euro-currency deposit rates, the prime bank's bid rates at or near the end of the month.

Data for three-month Euro-currency deposit rates for DM, FFR, UKL, HFL, BFR, DKR, ECU, USD, YEN, SFR, and SDR are published daily in the Financial Times.[10] Data for the Italian treasury bond's rate of return are published in the *IMF Financial Statistics*, line 61a. Data for the spot exchange rates (amounts of LIT per unit of foreign currencies) are available in *Currencies of the World*, edited by the Bundesbank. These exchange rates are the "fixing" rates at the end or nearly at the end of each month.

By using (2) and (3), an investment was simulated which was made on 31 October, 1984 and that is rolled over each three months until April 30, 1988. Following this procedure, a set of percentage rates of returns (at the end of each month) was computed on a three month investment horizon, in each of the above Euro-currencies over the period January 31, 1985 - April 30, 1988. In addition, by using equation (4) quarterly risk premia on all the above fourteen currencies were calculated, for each period t, and over the whole period considered, *i.e* January 31, 1985 - April 30, 1988.

A hypothetical market index can be calculated as the weighted average of the returns on the individual assets that make up the market portfolio. By assuming that the market portfolio consists of the above mentioned fourteen interest bearing Euro-currencies, a market index can be computed for each period t as follows:

$$R_{m,t} = \sum_{i=1}^{14} a_i R_{i,t} \qquad (5)$$

where "a" is a weight expressing the degree of the stability of each interest bearing risk currency in the market portfolio.[11] These weights have been calculated as the ratio of the inverse standard deviation of the respective returns to the inverse standard deviation of returns on all fourteen risky assets.[12] By following the same procedure as in equation (4), quarterly market risk premia were computed for each period t.

Table 1 shows the total percentage of returns on three month investment in foreign interest bearing currencies (averaged over the period 31 January 1985 - 30 April 1988) and their standard deviations. The LIT is the reference currency here. Total returns are broken down into exchange rate gains/losses and interest returns. Total returns are also presented as being in excess of the risk-free rate (Risk Premia).

[10] With regard to the IRL and the DRH, the three month interbank rates at the end of the month were used (published in the *European Economy, Commission of the EC*, Supplement A Series). In the case of NOK the three month interest rates based on forward rates were used (published in the *Economic Bulletin, Norges Bank*).

[11] Several other proxies for these weights can be assumed. See ROLL and SOLNIK (1977) fur further discussion.

[12] The calculated weights for the fourteen risky currencies are as follows: DM=.11333, FFR=.09011, UKL=.02942, HFL=.10709, BFR=.11237, DKR=.09725, IRL=.05819, DRH=.03502, ECU=.09780, USD=.03739, YEN=.04724, SFR=.06356, NOK=.04245, SDR=.06865.

TABLE 1

AVERAGE RETURNS AND RISKS
ON FOREIGN CURRENCY HOLDING ITALIAN INVESTOR'S VIEWPOINT.
THREE MONTH INVESTMENT HORIZON
(31 January 1985 - 30 April 1988)

Currency	Returns on Interest		Capital Gains/Losses		Total/Yield		Risk Premia
	Mean	STD	Mean	STD	Mean	STD	Mean
DM	1.149	0.707	0.688	1.624	1.846	1.725	-0.977
FFR	2.414	2.074	0.114	2.072	2.530	2.151	-0.294
UKL	2.695	1.335	-0.421	6.032	2.266	6.279	-0.557
HFL	1.411	0.634	0.743	1.714	2.166	1.814	-0.658
BFR	2.082	1.555	0.483	1.618	2.576	1.767	-0.248
DKR	2.406	1.049	0.391	1.770	2.808	1.927	-0.056
IRL	2.970	2.172	-0.455	2.948	2.507	3.276	-0.316
DRH	4.363	3.009	-3.719	4.825	0.483	5.098	-2.341
ECU	2.044	1.188	0.260	1.851	2.311	1.990	-0.513
USD	1.859	1.007	-3.694	4.837	-1.902	4.963	-4.726
YEN	1.342	1.172	1.378	3.936	2.738	3.970	-0.085
SFR	1.068	0.736	0.665	2.956	1.742	3.032	-1.082
NOK	3.459	1.138	-1.280	3.915	2.138	4.137	-0.686
SDR	1.784	0.985	-1.339	2.632	0.412	2.681	-2.404
MARKET					1.975	1.806	-0.847
MARKET*							-0.537

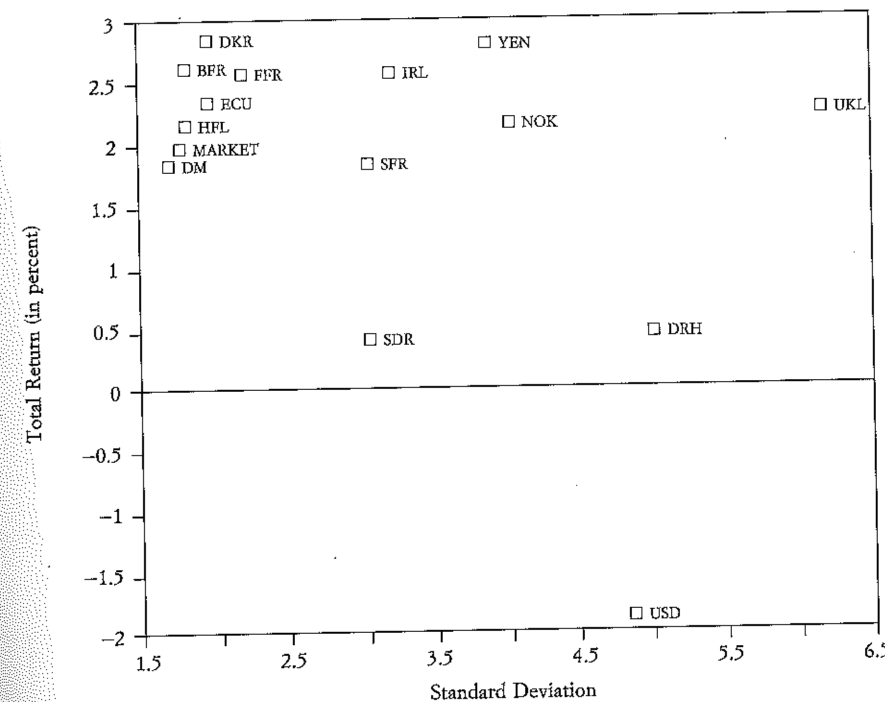
* Denotes that the risk premium for the market has been calculated by assuming a constant risk-free rate 2.5125% (10.05% annually) over the whole period considered.

4. Simulation results

In this section the effects of fixed transaction costs on the demand for Ecus will be investigated by simulating Brennan's model described in section two. In order to estimate the residual variance and the "beta" of each of the interest-bearing currencies under consideration, the three month investment risk premia on the fourteen securities were regressed on the market index risk premium (see the Appendix 2, Table 2A). The computed values of the mean and the variance of the market risk premium were -0.53676 and 3.26362 percent respectively, while the risk-free rate was 2.5125 (10.05% annually). By using equation (5A - see the Appendix 1) each

FIGURE 1

RISK - RETURN RELATIONSHIPS
January 1985 - April 1988



of the above residual variances, implied by regression estimates, were converted into the residual variance of the "standard security". The "standard securities" were then ranked in inverse order of their residual variance. Finally, the minimum residual variances of fourteen well diversified portfolios (RV*) were calculated by using equation (2A).

The resulting order of the underlying assets is given in the first column in Table 2. Column 2 shows how the residual variance RV can be diminished by successively adding new assets in the portfolio. In the first row, the residual variance of a portfolio consisting of one asset, the Ecu, is 0.1909034. In the second row it is shown that by adding the HFL in the portfolio, the residual variance RV decreases to = 0.140751, etc. Column 3 shows how the ratio θ (N) is reduced by adding new assets in the portfolio successively – compare the left hand side of the equation (4A).

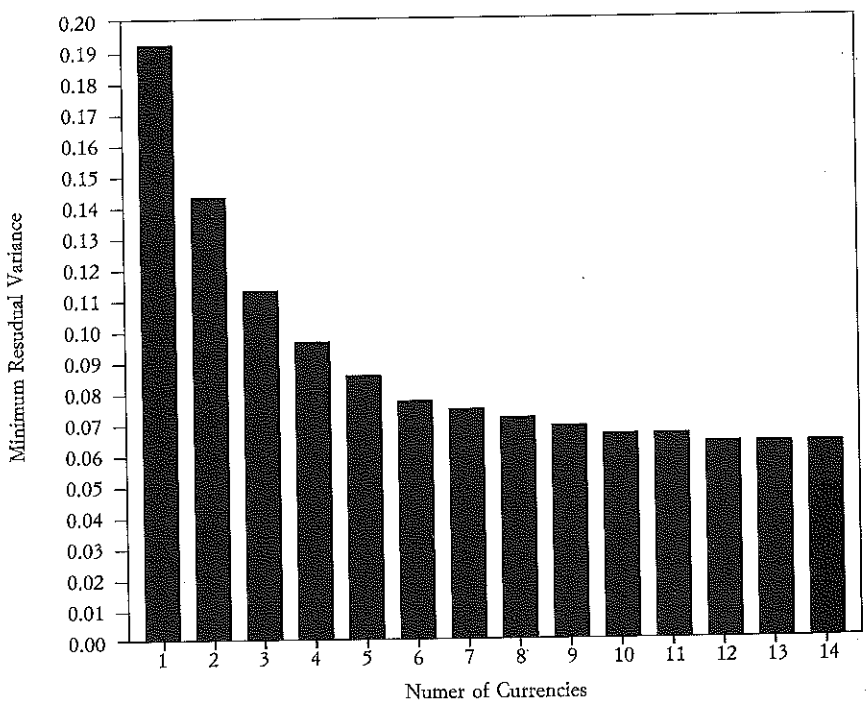
TABLE 2

THE CALCULATION OF MINIMUM RESIDUAL VARIANCES
AND RATIOS θ (N)
(January 1985 - April 1988)

		RV*	θ (N)	"beta" Coefficient	$1/s^{*2}(e_i)$
1	ECU	0.190903	0.003053	1.0809	5.238262
2	HFL	0.140751	0.001709	1.111	1.866448
3	DKR	0.111924	0.001099	1.102	1.829869
4	FFR	0.095375	0.000806	0.995	1.550325
5	BFR	0.084123	0.000631	0.959	1.402343
6	DM	0.076652	0.000526	0.975	1.158616
7	IRL	0.073237	0.000481	1.136	0.608281
8	SFR	0.070364	0.000445	1.223	0.557621
9	UKL	0.068024	0.000416	2.148	0.488813
10	NOK	0.067291	0.000408	1.171	0.160057
11	DRH	0.066627	0.000400	1.283	0.148109
12	SDR	0.066388	0.000397	0.447	0.053996
13	YEN	0.066247	0.000395	0.524	0.032125
14	USD	0.066247	0.000395	0.0092	0.000004

FIGURE 2

THE MINIMUM RESIDUAL VARIANCE OF PORTFOLIO RETURN AS A FUNCTION
OF THE NUMBER OF CURRENCIES IN THE PORTFOLIO



We can now calculate the effects of the fixed transaction costs on the optimal number and kind of currencies in the portfolio. We can also show how this choice is affected by the level of initial wealth and risk aversion.

Table 3 below shows the effect of increasing the level of the fixed transaction cost for an investor with initial wealth 500 million LIT and risk aversion coefficient, z, equal to one (A = 2).[13]

We observe from Table 3 that unless fixed transaction costs are trivial, higher transaction costs lead to a smaller number of currencies being held in the optimal portfolio. We also see that diversification no longer occurs when fixed transaction costs (FTC) have reached a level of 31500 LIT per asset. The table also shows that the Ecu is always held when diversification occurs. Thus we can assert that the higher the fixed transaction costs are, the stronger the tendency will be to substitute Ecu for other currencies. If fixed transaction costs are high enough, the Ecu will be the only currency held. This is undoubtedly due to the fact that it has the lowest residual variance of all the currencies in the sample.

TABLE 3

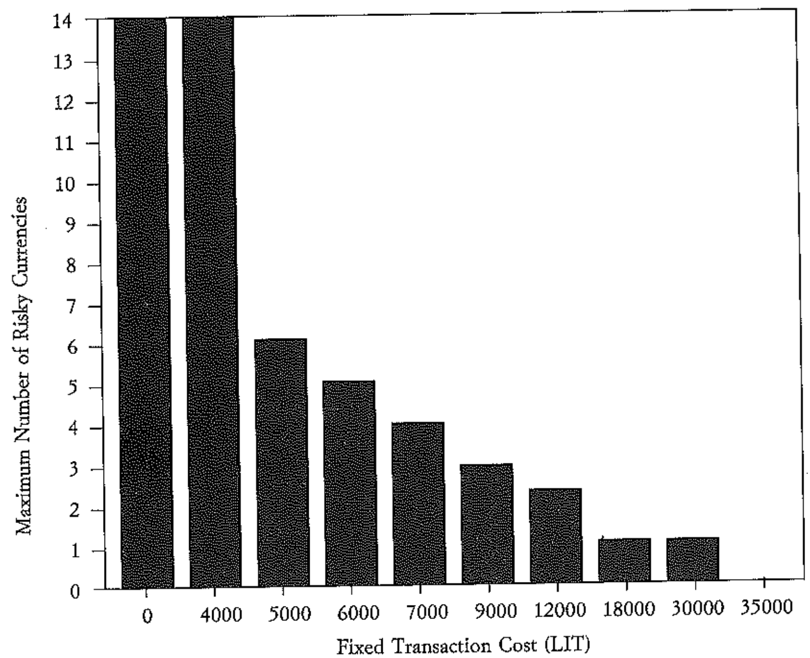
THE MAXIMUM NUMBER AND KINDS OF RISKY CURRENCIES
IN A PORTFOLIO WITH DIFFERENT FIXED TRANSACTION COSTS (FTC)

Fixed Transaction Cost per Currency (LIT)	Maximum Number of Currencies in the Risky Portfolio	Selected Currencies in the Risky Portfolio
0	14	All
4000	14	All
5000	6	ECU HFL DKR FFR BFR DM
6000	5	ECU HFL DKR FFR BFR
7000	4	ECU HFL DKR FFR
9000	3	ECU HFL DKR
12000	2	ECU HFL
18000	1	ECU
31500	0	–

[13] The choice in setting A equal to 2 is based on the estimates in FRIEND and BLUME (1975), who suggested a numerical value of Arrow-Pratt's measure of relative risk aversion of at least 2.

FIGURE 3

FIXED TRANSACTION COSTS AND THE MAXIMUM NUMBER OF RISK CURRENCIES



Given the fixed transaction cost, FTC = 10000 LIT/asset, Tables 4 and 5 below show the effect on the optimal portfolio of increasing the degree of risk aversion and initial wealth.

Table 4 shows that the potential investor, with initial wealth of 500 million LIT, demands fewer risky assets when the level of his risk aversion increases. Moreover, the higher the level of risk aversion, the stronger is the tendency to hold only the Ecu.

Given z = 1, Table 5 shows that an increase in the level of the initial wealth increases the optimal number of risky currencies. When diversification occurs the Ecu is always held since it has the lowest residual variance. Additionally, Table 5 shows that when fixed transaction costs c are high the Ecu will be the only currency held.

TABLE 4

THE MAXIMUM NUMBER AND KINDS OF RISKY CURRENCIES IN A PORTFOLIO FOR VARIOUS LEVELS OF RISK AVERSION

Risk Aversion Coefficient z (z = 0.5 A)	Maximum Number of Currencies in the Risky Portfolio	Selected Currencies in the Risky Portfolio
0.4	14	All
0.5	6	ECU HFL DKR FFR BFR DM
0.6	5	ECU HFL DKR FFR BFR
0.8	4	ECU HFL DKR FFR
1.0	3	ECU HFL DKR
1.2	2	ECU HFL
1.8	1	ECU
3.0	1	ECU
3.2	0	–

TABLE 5

THE MAXIMUM NUMBER AND KINDS OF RISKY CURRENCIES IN A PORTFOLIO FOR VARIOUS LEVELS OF INITIAL WEALTH

Initial Wealth W (in millions LIT)	Maximum Number of Currencies in the Risky Portfolio	Selected Currencies in the Risky Portfolio
100	0	–
200	1	ECU
300	2	ECU HFL
400	2	ECU HFL
500	3	ECU HFL DKR
600	3	ECU HFL DKR
700	4	ECU HFL DKR FFR
800	5	ECU HFL DKR FFR BFR
900	5	ECU HFL DKR FFR BFR
1000	6	ECU HFL DKR FFR BFR DM
1100	8	ECU HFL DKR FFR BFR DM IRL SFR
1200	10	ECU HFL DKR FFR BFR DM IRL SFR UKL NOK
1300	14	All

By employing equation (1A), we can calculate the weights of risky assets included in the optimal portfolio. By substituting the implied residual variance into equation (3A), we then derive the share of the total wealth invested in the risky assets.[14]

The above results are too voluminous to report in full. For practical reasons we have arbitrarily selected the set of optimal portfolios which have been constructed by assuming: z = 1, initial wealth W = 500 million LIT, and transaction costs ranging from 4 thousand to 18 thousand LIT per currency. These results are shown in Table 6 below. One can discern the dominant role of the Ecu in each of the optimal portfolios.

TABLE 6

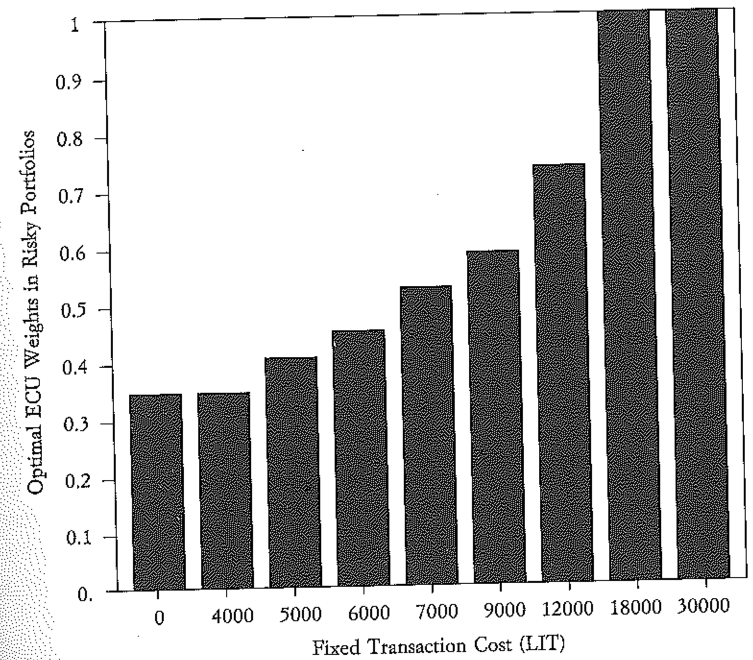
PORTFOLIO COMPOSITIONS FOR VARYING LEVELS OF FIXED TRANSACTION COSTS

FTC/ Currency	4 LIT	5 LIT	6 LIT	7 LIT (in thousands)	9 LIT	12 LIT	18 LIT
ECU	.347022	.401526	.440662	.499600	.586290	.737294	1.0000
HFL	.123647	.143068	.157012	.178012	.208901	.262705	
DKR	.121224	.140264	.153935	.174524	.204807		
FFR	.102705	.118836	.130419	.148622			
BFR	.092901	.107493	.117970				
DM	.076755	.088811					
IRL	.040297						
SFR	.036941						
UKL	.032382						
NOK	.010603						
DRH	.009811						
SDR	.003577						
YEN	.002128						
USD	.000000						
Sum	1	1	1	1	1	1	1
Q	.080017	.077318	.077175	.073525	.071042	.065231	.058904
1-Q	.919982	.922681	.922824	.926474	.928957	.934768	.941095

[14] By substituting the calculated Q into (5Aa) we can derive the fraction of the total portfolio allocated to the "standard security" i. Having calculated (5Aa) and substituting into (5Ab), we can derive the fraction of the total portfolio allocated to the i, *i.e.*, the actual security. For the equations (5Aa) and (5Ab), see footnote 6 of the Appendix 1.

FIGURE 4

THE SHARE OF THE ECU IN RISKY PORTFOLIOS AS A FUNCTION OF FIXED TRANSACTION COSTS

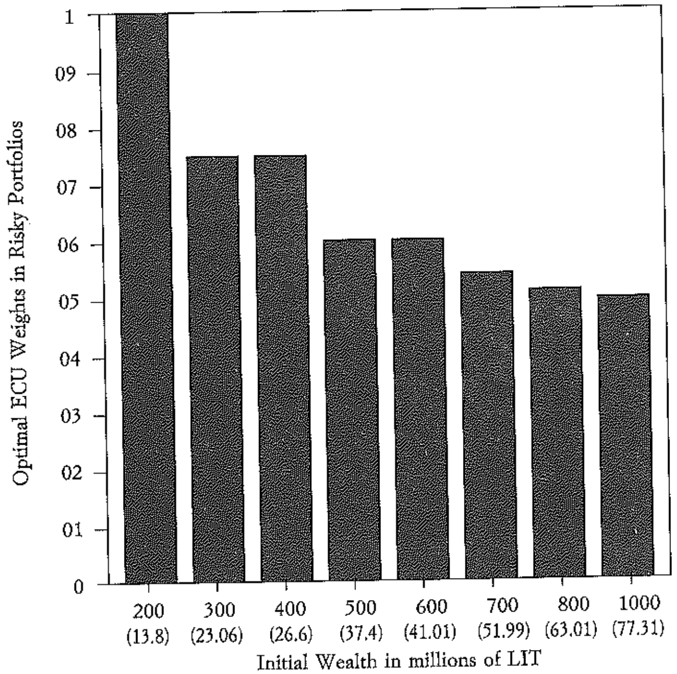


From Table 6 we observe that an increase in the fixed transaction cost implies a shrinking share of the total wealth invested in the risky assets,[15] but also an increasing proportion of the risky portfolio allocated to Ecu. Moreover, we observe that when fixed transaction cost has reached a level of 18 thousand LIT per asset, investments in risky assets have been concentrated in Ecus.

[15] An increase in FTC increases the marginal cost of diversification (the RHS of equation 9), and makes the investor less willing to diversify his risk by investing in a large number of currencies. This implies that the RV*, which corresponds to a high level of FTC, will be larger than the RV* of a portfolio with relatively lower FTC. And according to equation (8), the Q will be lower.

Figure 5

THE OPTIMAL WEIGHTS OF ECU IN THE RISK PORTFOLIOS
WITH VARYING LEVELS OF INITIAL WEALTH



Notice: The entries in parentheses show the amount out of the corresponding initial wealth invested in risky portfolios.

Figure 5 shows that an increase in the level of the initial wealth decreases the proportion of the risky portfolio invested in the Ecu. This is because an increase in wealth increases the optimal number of currencies to include in the portfolio (see Table 5) by lowering the marginal cost of diversification (the LHS of equation 9). Thus the optimal weights of the Ecu in the risky portfolio, calculated by equation (6), will be decreased. Notice however that the size of each currency holding will increase with an increase in wealth. Goldsmith (1976) has shown that the size of each security holding, as well as the number of securities held, increase by the square root of the initial wealth. Likewise, King and Leape (1984) have found a systematic relationship between wealth and portfolio composition.

5. Conclusions

The growing and unexpected importance of the private European Currency Unit (Ecu) in the international financial markets has recently attracted much research interest. This paper has emphasized the role of fixed transaction costs in explaining the portfolio demand for the Ecu. By using an explicit portfolio model incorporating fixed transaction costs, I have tried to formalize the intuitive arguments put forward in earlier literature. After simulating the currency demands for a potential Italian investor, using monthly return data for the period 1985 to 1988, several results stand out.

First, when fixed transaction costs are present, a small scale, risk averse investor who wishes to diversify his risk into assets denominated in foreign currencies (there are presently nine EEC currencies), will substitute Ecu for a considerable part of those currencies. Thus, by investing in the ready made Ecu portfolio the investor will reduce to a considerable extent the transaction costs associated with separate investments in the underlying currencies. It has also been shown that the higher the level of fixed transaction costs, the greater the demand for the Ecu will be.

When transaction costs are eliminated or reduced below an effective level, the Ecu loses a substantial part of its competitive advantage. If one assumes these costs as the outcome of capital controls and exchange restrictions imposed on residents who want to invest-borrow abroad, then the removal of controls on capital and the liberalization of financial services may reduce the role of the private Ecu as a defensive financial innovation.

For large scale investors, however, the amount of fixed transaction costs play a much lesser role. As the influence of fixed transaction costs is a declining function of the size of the investment portfolio, the comparative advantage of the Ecu is smaller for large scale investors, *e.g.*, financial institutions and corporate firms.

It should be stressed that the present analysis is of an explicit partial equilibrium variety. The effects of fixed transaction costs on the demand for the Ecu were examined here under the maintained assumption that these costs did not affect the pattern of equilibrium returns. As shown by Mayshar (1979, 1981, 1983), allowing for the existence of transaction costs will lead to asset pricing relationships which differ fundamentally from those of the standard CAPM. A potentially fruitful extension of the present study is, therefore, to examine the pricing of the Ecu within a general equilibrium framework incorporating various kinds of transaction costs. By considering these costs as the outcome of capital controls and embarked financial services, the question arises as to how the removal of capital controls and the liberalization of financial services will affect the pricing of assets denominated in foreign currencies, including the Ecu. To deal with this issue, a systematic analysis focusing on the effects of freer capital movements upon the changing pattern of transaction costs is required.

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APPENDIX 1

Brennan (1975) assumes that an investor places a Q fraction of his initial wealth denoted by W, in N available risky assets and the remaining net of transaction costs in the risk-free asset. Transaction costs are defined as $c = FTC/W$, where FTC is a fixed amount which the investor is obliged to pay his bank each time he buys or sells any risky asset. i is independent of the amount bought or sold, and it is assumed to be the same for each asset. X_i is the fraction of Q which is invested in the risky asset i, where $X_i \geq 0$ and $\sum_{i=1}^{N} X_i = 1$. It is also assumed that asset returns are generated by the diagonal model of Sharpe and that assets are priced according to CAPM.[1] Thus, given an *ex post* form CAPM b_i and $\sigma^2(e_i)$ are the estimated "beta" coefficients or the systematic risk, and the residual variance respectively for each risky asset.[2] The investor maximizes his utility, given by $U = E(R_p) - z\,V(R_p)$, conditional upon the minimization of the unsystematic risk of his portfolio where $E(R_p)$ is the expected portfolio return, $V(R_p)$ the portfolio variance which can be broken down into systematic and unsystematic or residual risk (variance), and z a risk aversion coefficient.[3] Brennan obtained the first order conditions of the above minimization/maximization problems and derived the optimal number of assets in the risky portfolio taking into account the presence of transaction costs. Formally, his solutions can be restated as follows:

$$X_i^* = [1/\sigma^{*2}(e_i)] \Big/ \sum_{i=1}^{N} \left[\frac{1}{1/\sigma^{*2}(e_i)}\right] \tag{1A}$$

$$RV^*(N) = \frac{1}{\sum_{i=1}^{N}\left[\frac{1}{\sigma^{*2}(e_i)}\right]} \tag{2A}$$

$$Q^* = \sqrt{\frac{c(1+R_f)}{z\,RV^{*2}(N)y(N)}} \tag{3A}$$

$$\frac{RV^{2*}(N)\,y(N)}{[\sigma^2(m) + RV^*(N)]^2} = \frac{4\,z\,c\,(1+R_f)}{[E(R_m) - R_f]^2} \tag{4A}$$

$$\text{where}^4 \quad \sigma^{*2}(e_i) = (1/b_i^2)\,\sigma^2(e_i) \tag{5A}$$

$\sigma^2(m)$ constitutes the variance of the market index, $[E(R_m)\text{-}R_f]$ the market premium, R_f the return on a risk-free asset, $RV^*(N)$ the minimum residual variance of a N asset portfolio, and $RV^{2*}(N)y(N)$ is the effect on RV^* of increasing the number of assets in the portfolio when N varies continuously.[5]

Equation (1A) shows the optimal values of X which minimizes the residual variance $RV^*(N)$ of the N assets portfolio. Equation (2A) shows a trade-off between the minimum residual variance of a well diversified portfolio and the number of its constituent assets. It also shows that the minimum RV of a well diversified portfolio is dependent upon the size of the residual variance of each asset in the portfolio and on the way in which these assets are introduced into this portfolio. If assets are arranged according to the increasing order of their residual variance:

$$\sigma^{*2}(e_1) < \sigma^{*2}(e_2) < \sigma^{*2}(e_3) \ldots < \sigma^{*2}(e_N)$$

[1] It is assumed that for each asset there is a large number of investors, so that security expected returns derived by CAPM are not distorted by fixed transaction costs.

[2] Initially and for the sake of simplicity, in this model Brennan has assumed that all risky assets have the same systematic risk and that their "beta" coefficients are equal to one. He relaxed this assumption later, by introducing the "standard security" model. See footnote 4.

[3] z is equal to 0.5 A, where A is a constant parameter greater than 0 and equivalent to the Arrow-Pratt measure of relative risk aversion. For the derivation, see AGELL (1986).

[4] Equation (5A) shows the residual variance of Brennan's so-called "standard security". By introducing the "standard security", Brennan modified his initial model to one where all assets differ not only in terms of residual variance, but also in terms of their systematic risk.

[5] $$dRV^*(N)\,/\,dN = \frac{-1}{\left[\int_0^N y(t)dt\right]^2}\,y(N) = -RV^{2*}(N)\,y(N)$$

We can see the effect on the minimum residual variance of increasing the number of assets in the portfolio. Equation (3A) shows the optimal fraction of the initial wealth which is invested in N risky assets.

The right hand side of equation (4A) is a coefficient which deters the representative investor from further diversification, provided that $c>0$ and $z>0$. This can be interpreted as the marginal cost of diversification. The left hand side of the above equation indicates (in terms of a percentage of the total portfolio variance) the effect on the RV* of adding new assets in the portfolio. This can be interpreted as the marginal benefit of diversification. We denote this ratio as $\theta(N)$. In the presence of fixed transaction costs the optimal number of assets N in the portfolio is determined when $\theta(N)$ is equal to the right hand side of equation (4A), or when the marginal cost is equal to the marginal benefit of diversification. Equation (4A) shows a trade-off between the benefits of adding a risky asset in the portfolio (*i.e.*, the reduction of the portfolio residual variance) and the cost of this additional transaction, which is positively dependent upon the levels of risk aversion and FTC, and negatively upon the amount of initial wealth. The acquisition of a risky asset in the portfolio will, therefore, be justified if the size of the reduction of the portfolio residual variance exceeds some critical minimum given by the right hand side of equation (4A). It becomes clear that the higher this critical minimum the lower will be the maximum number of assets in the portfolio of this particular investor.

Within this framework, equation (4A) is first solved for the optimal number of assets in the portfolio, given the estimate on the right hand side of equation (4A). Then the total portfolio share Q invested in risky assets is calculated by substitution of N in equation (3A). The weights of the "standard assets" in the optimal risk asset portfolio, X_i^*, are derived from equation (1A), given that (5A) is calculated for each risky asset i.[6]

N.C.

[6] The fraction of the total portfolio allocated to the standard security i is equal to:

$$w_i^* = X_i^* Q^* \quad 5A(a)$$

and the fraction of the total portfolio allocated to the underlying actual asset is then given as:

$$w_i = w_i^* / b_i = (X_i^* Q^*)/b_i \quad 5A(b)$$

APPENDIX 2

Table 1A

EUROMARKET AVAILABILITY IN COMPONENT CURRENCIES OF CERTAIN ECU-DENOMINATED FINANCIAL INSTRUMENTS

ECU Financial Instruments	DM	FFR	UKL	HFL	ITL	BFR	DKR	IRL	DRH
Eurodeposits:									
o/n, s/n, 1w, 1, 2, 3, 6, 12 months	yes	yes	yes	yes	yes	yes	yes	yes	yes
Facilities:									
1. Commercial paper	no	dom	yes	dom	dom	no	no	no	no
2. CD	yes	yes	yes	yes	yes	yes	yes	no	no
3. Note Issuance facilities	no	no	no	no	no	no	no	no	no
4. Multiple option facilities	yes	yes	yes	yes	yes	yes	no	no	
5. Medium-Term notes	no	no	yes	no	no	no	no	no	no
Bond Issues:									
1. Fixed rate	yes	yes	yes	yes	yes	yes	yes	no	no
2. Variable rate	yes	yes	yes	yes	yes	yes	yes	no	no
3. Zero coupon	yes	no	yes	no	no	no	yes	no	no
4. Equity warrant	yes	yes	yes	yes	no	no	no	no	no
5. Convertible	yes	yes	yes	yes	dom	no	no	no	no
Bank Loans:									
1. Revolving standby credits	yes	yes	yes	yes	yes	yes	yes	no	no
2. Term loans	yes	yes	yes	yes	yes	yes	yes	no	no
Futures and Options	yes	yes	yes	yes	opt	opt	yes	opt	no

DOM = Available through domestic market facilities.
OPT = Options only.
Sources: London-based banks and Tommaso Padoa-Schioppa (1987).

TABLE 2A

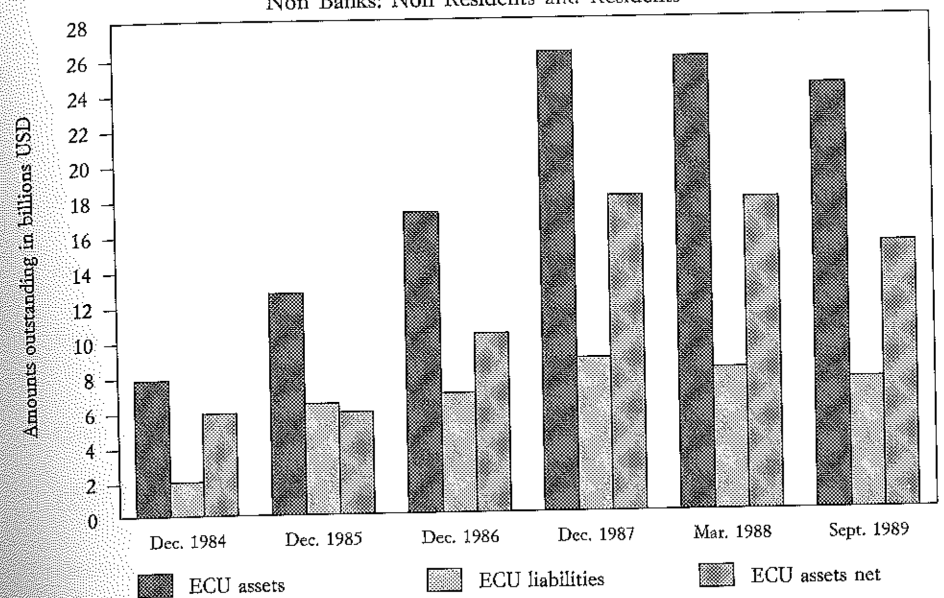
THE RESULTS OF THE REGRESSION:
$R_i - R_f = b_i\,[R_m - R_f] + e_i$ where $R_i - R_f$ is the risk premium of the asset i and $R_m - R_f$ is the risk premium of the market

Asset denominated in:		b_i	R^2	$\sum_{T=1}^{39} e_i^2$	DW
DM		0.9750	0.701	31.178	1.7603****
	t-Stat	(9.217)			
FFR		0.9948	0.849	24.266	1.5534***
	t-Stat	(10.999)			
UKL		2.1484	0.765	358.681	1.4888***
	t-Stat	(6.064)			
HFL		1.1106	0.785	25.130	1.6516*****
	t-Stat	(11.719)			
BFR		0.9589	0.773	24.921	2.4381*****
	t-Stat	(10.174)			
DKR		1.1025	0.823	25.241	2.2060*****
	t-Stat	(12.079)			
IRL		1.1360	0.796	80.618	1.5113***
	t-Stat	(6.851)			
DRH		1.2831	0.605	422.331	1.5555**
	t-Stat	(3.344)			
ECU		1.0809	0.941	8.475	1.6991***
	t-Stat	(20.224)			
USD		0.0092	0.216	726.426	2.3027******
	t-Stat	(0.018)+			
YEN		0.5241	0.439	324.780	1.8483*
	t-Stat	(1.564)+			
SFR		1.2233	0.689	101.928	1.4532***
	t-Stat	(6.276)			
NOK		1.1708	0.541	325.553	1.9906***
	t-Stat	(3.525)			
SDR		0.4474	0.505	140.615	2.3874****
	t-Stat	(2.029)			

Note: Initially all fourteen equations had values for Durbin-Watson statistic indicating positive autocorrelation. By using the Cochrane-Orcutt method these values were corrected. Thus for all the above equations the hypothesis of no autoregression had not to be rejected for significance points of dl and du: 2.5%.
* Indicates that the convergence has achieved after one interaction.
** Two interactions.
*** Three interations, etc.
\+ Indicates that b is insignificant at the 5% probability level.

FIGURE 1A

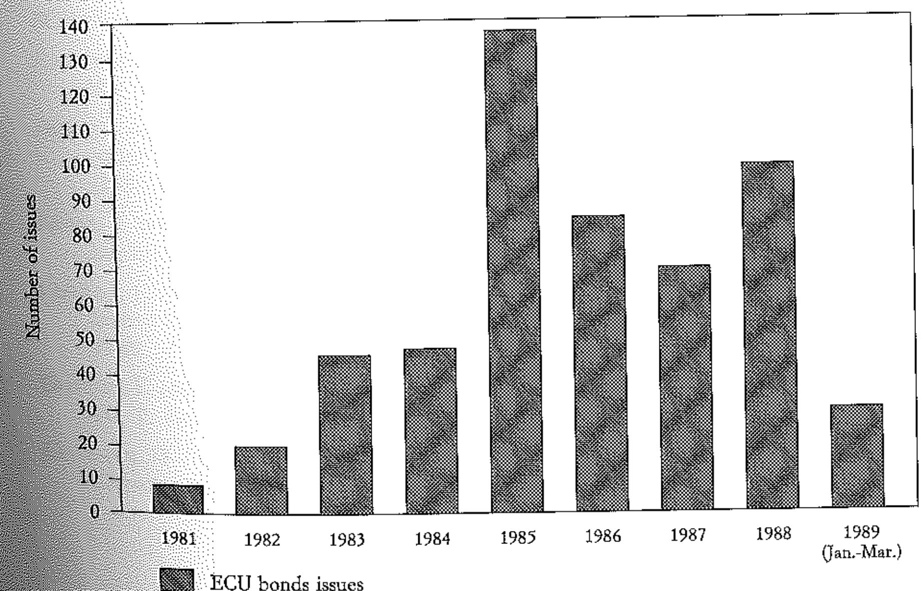
WORLD TOTAL ECU BANKING MARKET
Assets and Liabilities of Banks *vis-à-vis*
Non Banks: Non Residents and Residents



Source: ECU *Newsletter.*

Figure 2A

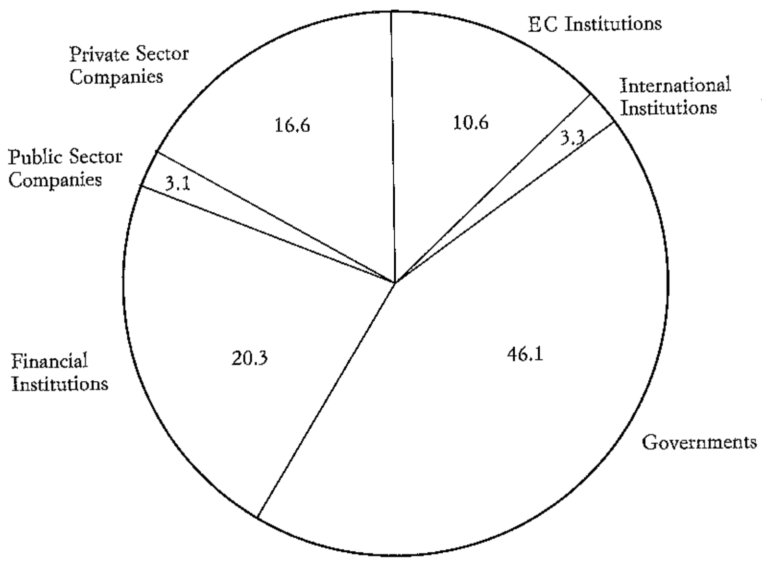
WORLD TOTAL ECU BONDS
Number of Issues



Source: ECU *Newsletter.*

FIGURE 3A

ECU - DENOMINATED EUROBONDS
(% breakdown by issuer category: 1988)



Source: ECU *Newsletter.*

REFERENCES

AGELL, J. "The Effects of Capital Taxation. An Equilibrium Asset Market Approach", *Acta Univ. Ups., Studia Oeconomica Upsaliensia* 9, Uppsala 1986.

AGMON, T. and BARNEA, A. "Transaction Costs and Marketability Services in the Eurocurrency Money Market", *Journal of Monetary Economics* 3, 1977, pp. 359-366.

ALLEN, P.R. "Birth of a New Euro-Currency: The ECU", *Occasional Papers* No. 20, New York, Group of Thirty, 1985.

ALLEN, W. "A Note on Uncertainty, Transaction Costs and Interest Parity", *Journal of Monetary Economics* 3, 1977, pp. 367-373.

BRENNAN, J.M. "The Optimal Number of Securities in a Risky Portfolio When There are Fixed Costs of Transacting: Theory and Some Empirical Results", *Journal of Financial and Quantitative Analysis,* September 1975.

CHRYSSANTHOU, N. "The Portfolio Demand for the ECU: A Transaction Cost Approach", *Economic Studies,* Department of Economics, Uppsala University, 1989: 1.

CLINTON, K. "Transaction Costs and the Covered Interest Arbitrage: Theory and Evidence", *Journal of Political Economy,* vol. 96, No. 2, 1988, pp. 358-370.

DEMSETZ, H. "The Cost of Transacting", *Quarterly Journal of Economics,* February 1968, pp. 33-55.

DUFEY, G. and GIDDY, J. "Innovation in the International Financial Market", *Journal of International Business Studies,* Fall 1981.

EAKER, R.M. "The Numeraire Problem and Foreign Exchange Risk", *Journal of Finance,* 1981, pp. 414-426.

ECU Newsletter, Istituto Bancario San Paolo di Torino, various issues.

EUROPEAN INVESTMENT BANK, "The Private Life of the ECU", *EIB-Information* No. 40, May 1985, pp. 7-10.

FRENKEL, A.J. and LEVICH, M.R. "Transaction Costs and Interest Arbitrage: Tranquil versus Turbulent Periods", *Journal of Political Economy,* Vol. 85, 1977, pp. 1209-1226.

FRIEND, I. and BLUME, M. "The Asset Structure of Individual Portfolios and some Implications for Utility Functions", *Journal of Finance* 30, 1975, pp. 585-603.

GIAVAZZI, F. and GIOVANNINI, A. "Asymmetries in Europe: The Dollar and the EMS", in ISTITUTO BANCARIO SAN PAOLO DI TORINO, *Europe and the Dollar,* Torino 1985, pp. 77-92.

GIAVAZZI, F. and GIOVANNINI, A. "The EMS and the Dollar" *Economic Policy,* Cambridge No. 2, April 1986.

GLASSMAN, D. "Exchange Rate Risk and Volatility: Evidence from Bid-Ask Spreads", Department of Economics, University of British Columbia 1984.

GOLDSMITH, D. "Transaction Costs and the Theory of Portfolio Selection", *Journal of Finance,* Vol. XXXI, No. 4, September 1976.

HAMAUI, R. "The ECU and Efficient Portfolio Choice", *Ricerche,* January 1985, Banca Commerciale Italiana.

JACOB, N. "A limited-Diversification Portfolio Selection Model for the Small Investors", *Journal of Finance,* December 1975.

JAGER, H. and DE JONG, E. "The Exchange-Rate Mechanism of the EMS and the ECU as a Reserve Asset", *European Economic Review* 31, 1987, pp. 1071-1091.

JAGER, H. and DE JONG, E. "The Private ECU's Potential Impact on Global and European Exchange Rate Stability", in this *Review,* No. 164, March 1988, pp. 33-57.

JORION, P. "The ECU and Efficient Portfolio Choice", paper presented at a conference on the "ECU Market: Current Developments and Future Prospects", New York University, January 30-31, 1986.

KING, M.A. and LEAPE, J. "Wealth and Portfolio Composition: Theory and Evidence", *NBER Working Paper Series,* No. 1468, September 1984.

KING, M.A. and LEAPE, J. "Asset Accumulation, and the Life-Cycle", *Discussion Paper* No. 0014, LSE Financial Market Group, London 1988.

KOURI, P.J.K. and DE MACEDO, B. "Exchange Rates and the International Adjustment Process", *Brooking Papers on Economic Activity* 1, 1978.

LEVICH, R. "Developing the "ECU Markets: Prospectives on Financial Innovations", paper presented at a conference on the "ECU Market: Current Development and Future Prospects", New York University, January 30-31, 1986.

LEVY, H. "Optimal Portfolio of Foreign Currencies with Borrowing and Lending", *Journal of Money, Credit and Banking,* Vol. 13, No. 3, August 1981.

MAGILL, M.J.P. and CONSTANTINIDES, G.M. "Portfolio Selection with Transaction Costs", *Journal of Economic Theory,* 13, Oct. 1976, pp. 245-263.

MAKIN, J.H. "Equilibrium Interest on Special Drawing Rights", *Southern Economic Journal* 41, 1974, pp. 171-181.

MAKIN, J.H. "Portfolio Theory and the Problem of Foreign Exchange Risk", *Journal of Finance,* May 1978.

MAO, J. "Essentials of Portfolio Diversification Strategy", *Journal of Finance,* December 1970.

MASERA, R.S. "An Increasing role for the ECU: A Character in Search of a Script", *Essays in International Finance,* No. 167, Princeton, N.J., Princeton University, International Finance Section, June 1987.

MAYSHAR, J. "Transaction Costs in a Model of Capital Market Equilibrium", *Journal of Political Economy,* 1979, Vol. 87, No. 4, pp. 673-700.

MAYSHAR, J. "Transaction Costs and the Pricing of Assets", *Journal of Finance,* vol. XXXVI, No. 3, June 1981, pp. 583-597.

MAYSHAR, J. "On Divergence of Opinions and Imperfections in the Capital Market", *American Economic Review,* Vol. 73, No. 1 1983, pp. 114-128.

MERTON, R.C. "Lifetime Portfolio Selection under Uncertainty: The continuous-time case", *Review of Economics and Statistics* LI, Aug. 1969, pp. 239-246.

OVERTURF, S.F. "Transactions charges, and the Market for Foreign Exchange Services", *Economic Inquiry,* Vol. XX, April 1982, pp. 291-301.

PADOA-SCHIOPPA, T. "The ECU's Coming of Age", Contribution to the "Liber Amicorum" in honour of Johannes Wittevens *The Quest for National and Global Stability,* July 1987.

POGUE, A.G. "An Extension of the Markowitz Portfolio Selection Model to Include Variable Transaction Costs, Short Sales Leverage Policies and Taxes", *Journal of Finance,* Vol. XXV, No. 5, December 1970, pp. 1005-1016.

PÖHL, K.O. "The European Monetary System: Consolidation and Evolution", Speech by the President of the Deutsche Bundesbank at the French Association of Banks, Paris, July 1985.

ROLL, R. and SOLNIK, B. "A Pure Foreign Exchange Asset Pricing Model", *Journal of International Economics* 7, 1977, pp. 161-179.

STEINHERR, A. and GIRARD, J. "ECU Financial Markets: Recent Evolution and Perspectives", Paper prepared for the conference "Jubilee Robert Triffin: Evolution of the International and Regional Monetary Systems", Brussels, 8-9 December 1988.

WEST, R. and TINIC, S.M. *The Economics of the Stock Market,* New York: Praeger, 1971.