I have thus reached the end of my sketchy survey of the interplay between politics and economics in the development of, and the debate on, European monetary integration. I do not feel that I should attempt to draw conclusions. Except perhaps one. I am skeptical about the fruitfulness of an explicit interdisciplinary approach. But I am fully convinced that political factors and implications are too often neglected in the economic analysis of some phenomena – just as economic constraints and implications are too often neglected by political scientists and historians. The latter would be advised to monitor closely the current debate on European integration, as an interesting example of a mixture between economic, political, and ideological arguments. As for economists, it is their task to uncover the relevant relationships between variables by means of rigorous models. But their analysis will be all the more useful if they recognize that the quest for "the primitive object" is doomed to failure when the political feedbacks on economic regimes are strong: in such cases there is no economic model good for all seasons and each season will require its appropriate model.

Roma

LUIGI SPAVENTA

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. 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 (Hanslau, 1985; Jorion, 1986; Masera, 1987; Jager and de Jong, 1987 and 1988, Steinharth 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. Pohl (1985) and Levech (1986) have contributed to this line of argument.

* I am indebted to Peter Englund and two anonymous referees for their insightful comments, but any remaining errors are my own. I also wish to thank Jonas Agell, Bengt-Chester Yeander, and Nils Thygesen for their useful comments on earlier drafts.

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* For the theory and the classification of international financial innovations see Dovers and Girard, 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. 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: 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.

According to Mayhew (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 difficulty 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).

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

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...
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 Ecu's. 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, ZKK, IRC, DRH, ECU, USD, YEN, SPR, NOK, and SDR.\footnote{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 Euxus (1981) for a theoretical discussion of the above. Otherwise the nominally risk-free domestic currency can be venturesome.} 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.\footnote{This paper will use an unbiased estimate of the residual variance implied by each regression. With 7 observations and one independent variable this unbiased estimator will be the sum of square residuals implied by each regression divided by T-1.} Following Ma-

\begin{equation}
R_t = R_{it} + h_i (R_{it} - R_{t}) + e_i
\end{equation}

\begin{equation}
R_{it} = I_{it} + r_{it} \frac{I_{it} - r_{it}}{100}
\end{equation}

\begin{equation}
r_{it} = \frac{S_{it} - S_{it-1}}{S_{it-1}}
\end{equation}
The term $S_{i,t}$ 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 $S_{p,t}$ 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 $r_{i,t} \cdot I_{i,t}$ 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.

Risk Premium $(RP)_{i,t} = R_{i,t} - TB_{i,t}$

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, DFR, ECU, USD, YEN, SFR, and SDR are published daily in the Financial Times. 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 Currency 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 may 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:

$$R_{m,t} = \sum_{i=1}^{14} a_i R_{i,t}$$

where "a" is a weight expressing the degree of the stability of each interest bearing risk currency in the market portfolio. 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. 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).

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11 Several other proxies for these weights can be assumed. See Roll and Solnik (1977) for further discussion.

12 The calculated weights for the fourteen risky currencies are as follows:
- DM=0.1533
- FFR=0.0911
- UKL=0.02942
- HFL=0.10739
- BFR=0.11237
- DFR=0.09725
- YEN=0.05819
- SFR=0.03902
- ECU=0.0780
- USD=0.03739
- NOK=0.04724
- SFR=0.06356
- SDR=0.08685

13 With regard to the IRL and the DDK, 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).
### Table 1

<table>
<thead>
<tr>
<th>Currency</th>
<th>Returns on Interest</th>
<th>Capital Gains/Losses</th>
<th>Total/Yield</th>
<th>Risk Premia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>STD</td>
<td>Mean</td>
<td>STD</td>
</tr>
<tr>
<td>DM</td>
<td>1.149</td>
<td>0.707</td>
<td>0.689</td>
<td>1.624</td>
</tr>
<tr>
<td>FFR</td>
<td>2.414</td>
<td>2.074</td>
<td>0.114</td>
<td>2.072</td>
</tr>
<tr>
<td>UKL</td>
<td>2.695</td>
<td>1.335</td>
<td>-0.421</td>
<td>6.032</td>
</tr>
<tr>
<td>HFL</td>
<td>1.411</td>
<td>0.634</td>
<td>0.743</td>
<td>1.714</td>
</tr>
<tr>
<td>BFR</td>
<td>2.082</td>
<td>1.555</td>
<td>0.483</td>
<td>1.618</td>
</tr>
<tr>
<td>DKK</td>
<td>2.406</td>
<td>1.049</td>
<td>0.391</td>
<td>1.770</td>
</tr>
<tr>
<td>IRL</td>
<td>2.970</td>
<td>2.172</td>
<td>-0.455</td>
<td>2.948</td>
</tr>
<tr>
<td>DRH</td>
<td>4.363</td>
<td>3.009</td>
<td>-3.719</td>
<td>4.823</td>
</tr>
<tr>
<td>ECU</td>
<td>2.041</td>
<td>1.188</td>
<td>0.260</td>
<td>1.831</td>
</tr>
<tr>
<td>USD</td>
<td>1.839</td>
<td>1.007</td>
<td>-3.694</td>
<td>4.837</td>
</tr>
<tr>
<td>YEN</td>
<td>1.332</td>
<td>1.772</td>
<td>1.378</td>
<td>3.936</td>
</tr>
<tr>
<td>SFR</td>
<td>1.068</td>
<td>0.736</td>
<td>-0.603</td>
<td>2.956</td>
</tr>
<tr>
<td>NOK</td>
<td>3.459</td>
<td>1.138</td>
<td>-1.289</td>
<td>3.915</td>
</tr>
<tr>
<td>SEK</td>
<td>1.704</td>
<td>0.968</td>
<td>-1.359</td>
<td>2.632</td>
</tr>
<tr>
<td>MARKET</td>
<td>1.973</td>
<td>1.806</td>
<td>-0.847</td>
<td></td>
</tr>
</tbody>
</table>

* Denotes that the risk premium for the market has been calculated by referring a constant risk-free rate 5.135% (10.60% annually) over the whole period considered.

4. Simulation results

In this section the effects of fixed transaction costs on the demand for Ecu 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 −0.52676 and 3.26362 percent respectively, while the risk-free rate was 2.5125 (10.03% annually). By using equation (3A - see the Appendix 1) each 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 0.140731, 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).
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, γ, equal to one (A = 2).15

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 315.00 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.

15 The choice in setting A equal to 2 is based on the estimates in FERRE and BLUME (1975), who suggested a numerical value of Arrow-Pratt's measure of relative risk aversion of at least 2.
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.
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   | 9 LIT   | 12 LIT  | 18 LIT  |
| ECU                     | .347022 | .401526 | .440662 | .499600 | .586290 | .737294 | 1.0000  |
| FRL                     | .125647 | .140368 | .157012 | .178012 | .208901 | .262705 |
| DLR                     | .121224 | .140264 | .159305 | .174524 | .204807 |         |
| FHR                     | .102705 | .118836 | .130419 | .148622 |         |         |
| BFR                     | .092301 | .107493 | .117970 |         |         |         |
| DM                      | .076735 | .088811 |         |         |         |         |
| IEL                     | .06297 |    .06297 |         |         |         |         |
| SFR                     | .04041 |         |         |         |         |         |
| UKL                     | .03238 |         |         |         |         |         |
| NOK                     | .01603 |         |         |         |         |         |
| DEM                     | .009811|         |         |         |         |         |
| SDR                     | .00177 |         |         |         |         |         |
| YEN                     | .00128 |         |         |         |         |         |
| USD                     | .00000 |         |         |         |         |         |
| Sum                     | 1       | 1       | 1       | 1       | 1       | 1       |         |

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 Ecu.

\(^{14}\) By substituting the calculated \( Q \) into (3Aa) we can derive the fraction of the total portfolio allocated to the "standard security" \( L \). Having calculated (3Aa) and substituting into (3Ab), we can derive the fraction of the total portfolio allocated to the, i.e., the actual security. For the equations (3Aa) and (3Ab), see footnote 6 of the Appendix 1.

\(^{15}\) An increase in FTC increases the marginal cost of diversification (the RHS of equation 30), 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 (38), the \( Q \) will be lower.
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 embedded 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 free capital movements upon the changing pattern of transaction costs is required.

Nikos Chryssanthou

APPENDIX I

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 (1-Q) fraction in a 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 ≥ 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 CAMP, b, and \sigma^2(e_i) are the estimated "beta" coefficients of the systematic risk, and the residual variance respectively for each risky asset. 2 The investor maximizes his utility, given by \sum_{i=1}^{N} (E(R_i) - z \sigma^2(R_i)) the joint utility of the unsystematic risk of his portfolio where \sigma^2(R_i) is the expected portfolio return, \sigma^2(R_i) 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

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 AAGZL (1960).

\[ X^*_i = \left(1/\sigma^2(e_i) \right) \left\{ \frac{1}{\sum_{j=1}^{N} \left( \frac{1}{\sigma^2(e_j)} \right) } \right\} \]

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

\[ Q^* = \sqrt{\frac{z}{RV^*(N)y(N)}} \]

\[ \frac{RV^*(N)y(N)}{\sigma^2(\mu) + RV^*(N)^2} = \frac{4z(1+z)}{[E(R_\mu) - R]^2} \]

where \sigma^2(\mu) = (1/z^2) \sigma^2(e_i)

\sigma^2(\mu) constitutes the variance of the market index, [E(R_\mu)-R] the market premium, R, the return on a risk-free asset, RV^*(N) the minimum residual variance of a N asset portfolio, and RV^*(N)y(N) is the effect on RV^* of increasing the number of assets in the portfolio when N varies continuously.2

Equation (1A) shows the optimal values of X which minimize 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:

\[ \sigma^2(e_1) \leq \sigma^2(e_2) \leq \sigma^2(e_3) \leq \cdots \leq \sigma^2(e_N) \]

\[ z = \frac{\partial RV^*(N)}{\partial N} = \sum_{i=1}^{N} \frac{-1}{y(N)} \frac{y(N) - RV^*(N)y(N)}{[y(N) - RV^*(N)y(N)]^2} \]

\[ \int_{0}^{t} y(\mu) d\mu \]

1 Equation (3A) 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.
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 determines 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 ratio of adding new assets in the portfolio. This can be interpreted as the marginal benefit of diversification. We denote this ratio as $0(N)$. In the presence of fixed transaction costs the optimal number of assets $N$ in the portfolio is determined when $0(N)$ 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 to 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 (3A) is calculated for each risky asset $i$.

$$N.C.$$
THE RESULTS OF THE REGRESSION:

\[ R_i - R_s = \beta_1 (R_m - R_s) + \epsilon \]

where \( R_i - R_s \) is the risk premium of the asset \( i \) and \( R_m - R_s \) is the risk premium of the market

<table>
<thead>
<tr>
<th>Asset denominated in:</th>
<th>( \beta_1 )</th>
<th>( R^2 )</th>
<th>( \text{SE}^\beta )</th>
<th>( t_{11} )</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>0.9730</td>
<td>0.701</td>
<td>51.178</td>
<td>1.7605***</td>
<td></td>
</tr>
<tr>
<td>EUR</td>
<td>0.9948</td>
<td>0.849</td>
<td>24.266</td>
<td>1.5534***</td>
<td></td>
</tr>
<tr>
<td>UKL</td>
<td>2.1488</td>
<td>0.765</td>
<td>358.681</td>
<td>1.4888***</td>
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</tr>
<tr>
<td>DEK</td>
<td>1.1060</td>
<td>0.785</td>
<td>25.130</td>
<td>1.6316***</td>
<td></td>
</tr>
<tr>
<td>BFR</td>
<td>0.9589</td>
<td>0.773</td>
<td>24.521</td>
<td>2.4361****</td>
<td></td>
</tr>
<tr>
<td>DKR</td>
<td>1.1025</td>
<td>0.823</td>
<td>23.241</td>
<td>2.2060***</td>
<td></td>
</tr>
<tr>
<td>IRL</td>
<td>1.1360</td>
<td>0.796</td>
<td>80.618</td>
<td>1.5113***</td>
<td></td>
</tr>
<tr>
<td>DRH</td>
<td>1.2831</td>
<td>0.605</td>
<td>422.331</td>
<td>1.5355***</td>
<td></td>
</tr>
<tr>
<td>ECD</td>
<td>0.0059</td>
<td>0.941</td>
<td>8.475</td>
<td>1.6991***</td>
<td></td>
</tr>
<tr>
<td>USD</td>
<td>0.0602</td>
<td>0.216</td>
<td>726.426</td>
<td>2.3027****</td>
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<tr>
<td>YEN</td>
<td>0.5241</td>
<td>0.439</td>
<td>324.780</td>
<td>1.8685**</td>
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<tr>
<td>SFR</td>
<td>1.3233</td>
<td>0.689</td>
<td>101.928</td>
<td>1.4532***</td>
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</tr>
<tr>
<td>NOK</td>
<td>1.1708</td>
<td>0.541</td>
<td>325.553</td>
<td>1.9906***</td>
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<tr>
<td>SDR</td>
<td>0.4474</td>
<td>0.505</td>
<td>140.615</td>
<td>2.3874***</td>
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</tr>
</tbody>
</table>

Note: Initially all frontier equations had values for Dado-Watson statistic indicating positive autocorrelation. Using the Cochrane-Orcutt method three re-estimates were conducted. Thus for all the above equations the hypothesis of no autocorrelation had not to be rejected for significance criticals of 0.0 and the 2.5%.  
* Indicates that the convergence has achieved after one interaction.  
** Two interactions 
*** Three interactions, etc.  
* Indicates that \( \beta \) is insignificant at the 5% probability level.
ECU - DENOMINATED EUROBONDS
(8% breakdown by issuer category: 1988)

Private Sector Companies
Public Sector Companies
Financial Institutions
Governments

Source: ECU Newsletter

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