INTERNATIONAL TRADE AND FINANCE IN THE 1990s

(CONFERENCE PROCEEDINGS)

INTERNATIONAL TRADE AND FINANCE ASSOCIATION

Volume III

MAY 30 - JUNE 2, 1991
MARSEILLE, FRANCE

Khosrow Fatemi
(Editor)

ON THE INTERNATIONAL CO-MOVEMENTS OF CAPITAL MARKETS: EVIDENCE FROM TWO SCANDINAVIAN STOCK MARKETS

Teppo Martikainen
University of Vaasa, Finland

Ilkka Virtanen
University of Vaasa, Finland

Paavo Yli-Olli
University of Vaasa, Finland

ABSTRACT

This paper produces evidence on the co-movements of two Scandinavian stock markets. This is done by using an internationally extended market model for Finnish stocks, where the return of a given Finnish asset is assumed to be dependent on the returns of Finnish and Swedish stock markets. This multi-market model of Finnish securities reveals that several Finnish stocks have significant Swedish risk components. However, it is discovered that these international risk components do not contain incremental information in explaining the cross-sectional variation of expected stock returns with respect to the systematic risk components produced by the Arbitrage Pricing Model (APM). The APM based on pure national stock returns suggests 1-2 priced factors in the Finnish stock market.

I. INTRODUCTION

International asset pricing and portfolio diversification have reached increasing attention in the empirical research of finance. This is because most of the national capital markets have experienced rapid deregulation and integration in recent years. This development has obviously enhanced the efficiency in the international allocation of capital. Numerous studies have investigated relationships between the average returns of different stock markets. In their early paper, Makridakis and Wheelwright (1974) investigated the short-term stability of the relationships between 14 stock market indices reporting that the co-movements of international stock exchanges seem to be random processes. Similar kinds of conclusions have been drawn by Hillard (1979). However, most studies provide results suggesting a higher level of stability and stronger co-movements of international stock markets (see *e.g.*, Ibbotson *et al.*,1982, Philippatos *et al.*, 1983, von

Furstenberg and Jeon, 1989, Meric and Meric, 1989, Grinold *et al.*, 1989, Jeon and von Furstenberg, 1990, and Malkamäki *et al.*, 1991).

In the context of the international CAPM, a typical approach has been to study the sensitivities of individual assets to a world-wide market portfolio. As suggested by Solnik (1977), the efficient way to test for market segmentation and integration would be to specify the type of imperfection which might create it, and to study its specific impact on portfolio optimality and asset pricing. Assuming this specific imperfection be due to inability of a group of investors to trade in a subset of securities as a result of portfolio restrictions imposed by some governments, Errunza and Losq (1985) defined the conditional market risk based on return behaviour of different stock markets. Some empirical evidence of mild segmentation of the world's capital markets was reported. Their results were further extended by Bradfield (1990) for South African markets. He found that a large proportion of shares in the Johannesburg Stock Exchange appeared to be influenced by the movements in the New York Stock Exchange, but only a small proportion of stocks were influenced by the U.K. and Japanese stock markets. In general, the proposed multi-market model seemed to provide useful information about the risk characteristics of individual South African stocks. Hietala (1988) reported relatively low betas for Finnish securities with respect to a world-wide market portfolio. Recently, Martikainen *et al.* (1991) found that Finnish securities have significant Swedish risk components while the association between Finnish and U.S. returns was found to be clearly weaker. A significant part of the cross-sectional variation of the international risk components of the investigated Finnish companies could be appointed to industry differences across the investigated firms.

In addition to the international market models, the usefulness of the international Arbitrage Pricing Model (APM) by Solnik (1983) has also been researched intensively. Cho *et al.* (1986) studied the existence of international common factors in the Arbitrage Pricing Model using inter-battery factor analysis. Their results indicated that the number of common factors between a pair of countries ranged from one to five, depending on the level of their economic integration. Recently, Yli-Olli *et al.* (1990) investigated the common factors in the Finnish and Swedish stock markets. They found that two or three stable factors generating stock returns in these two neighbouring countries could be found. Their results were further extended by Booth *et al.* (1991b). They reported that two of these Scandinavian factors could be regarded as world-wide by nature, being important in the U.S. stock market as well.

II. THE PURPOSE AND STRUCTURE OF THE STUDY

This study investigates the level of segmentation of the Finnish stock market to the Swedish stock market using the multi-market model suggested by Errunza and Losq (1985). Due to the rapid deregulation of the Finnish stock market, this is an important task to carry out. In Finland the relative importance of other stock markets in generating the risk characteristics of listed firms may be especially high because of thin trading in the Helsinki Stock Exchange, and because of the considerably increased direct investments of Finnish companies abroad. As an open country which carries on foreign trade to a great extent, Finland is highly dependent on overseas establisment and macroeconomic conditions. On the other hand, the Finnish stock market has generally been regarded as being very different than the major exchanges of the United States, Japan and Western Europe. It is a very small market comprised of generally thinly-traded stocks. This thin trading may lead to significantly biased market-based estimates of systematic risk (see *e.g.*, Berglund *et al.*, 1989). In this context, the use of Swedish data, where the trading is clearly more frequent by nature, might be useful when measuring the systematic risk of Finnish securities. In addition, it has been suggested that efficiency of the Finnish stock market is not especially high (see *e.g.*, Virtanen and Yli-Olli, 1987, and Booth *et al.*, 1991a). This being the case, the return behaviour of the Finnish stock market may be very different from the more developed stock markets.

In addition, it is investigated whether the risk components obtained by the multi-market model contain incremental information with respect to the systematic risk components obtained by the Arbitrage Pricing Model. Chen (1983) discovered that the CAPM based on national systematic risk estimated did not produce incremental information with respect to the APM systematic risk components on the U.S. stock market. His results were strongly supported by Östermark (1989), who used a somewhat similar approach on Finnish and Swedish stock markets. This paper extends these two studies by investigating a two-factor CAPM, where the risk components are produced by market returns of two neighbouring capital markets.

The remainder of the paper is organized as follows. In Section III, the methodology used in this paper is described. Sections IV-VI include the empirical results of the study. In the fourth section, the data are described. A test of the multi-market model is performed in Section V. Section VI includes the comparison of APM and multi-market models. Finally, in Section VII conclusions are drawn, and suggestions for further research are made.

III. METHODOLOGY

The traditional equilibrium model presented in finance literature, the Capital Asset Pricing Model (CAPM), assumes that the expected return of a stock is linearly related to its systematic risk, where the systematic risk of the security is defined to be the covariance of the asset return with the return of the market portfolio divided by the variance of the market portfolio return. Traditionally, betas have been measured using a simple bivariate regression, i.e. Sharpe's (1964) market model.

$$(1) \qquad \underline{R}_i = \alpha_i + \beta_i \underline{R}_m + \underline{\varepsilon}_i \ ,$$

where random variables are denoted by underlining the symbols of the variables. In the above model, $\underline{R}_i$ represents the return of security i, α_i is the intercept term for a security i, β_i is the measure for systematic risk, beta, of a security i, $\underline{R}_m$ is a return of a national stock market index and $\underline{\varepsilon}_i$ is the idiosyncratic risk of security i. Thus, the model assumes that the return of an individual stock is a function of the return of the national stock market. To investigate the Swedish risk components of Finnish securities, a multi-market model in the spirit of Errunza and Losq (1985) is used in this paper. In order to obtain tractable expressions for the risk components of individual assets' Finnish market risk, Swedish market risk, and idiosyncratic risk, the vectors of returns of Finnish and Swedish markets are orthogonalised. In this case, this means removing the effect of a Swedish index from the index describing the behaviour of the Finnish stock market. This can be done by using the following simple bivariate regression:

$$(2) \qquad \underline{R}_m\,(FIN) = \alpha + \beta\, \underline{R}_m\,(SWE) + \underline{\varepsilon} \ ,$$

where $\underline{R}_m$ (SWE) represent the returns of the Swedish market, and $\underline{R}_m$ (FIN) the return of the Finnish market. The residual term $\underline{\varepsilon}$ is the part of the Finnish returns with Swedish returns removed. In the following, let us note the residual term in (2) with $\underline{R}_m$ (FIN-SWE). The multi-market model can now be expressed as

$$(3) \qquad \underline{R}_i = \alpha_i + \beta_{1i}\, \underline{R}_m\,(SWE) + \beta_{2i}\, \underline{R}_m\,(FIN\text{-}SWE) + \underline{\varepsilon}_i \ .$$

In the following, the above model is referred as the Scandinavian market model for Finnish securities. The components of risk for a security i can be obtained considering the expression for the variance of the returns of a security i:

(4) $\quad Var(\underline{R}_i) = \beta_{1i}^2 \, Var(\underline{R}_m(SWE)) + \beta_{2i}^2 \, Var(\underline{R}_m(FIN\text{-}SWE)) + Var(\underline{\varepsilon}_i)$

The multi-market model makes it possible to investigate the level of segmentation across the two Scandinavian stock markets in terms of individual securities. First, assume the Finnish and Swedish markets to be totally integrated. Then, second term in (3), i.e. $\beta_{2i}\,\underline{R}_m$ (FIN-SWE) does not produce significant incremental information with respect to the first term, i.e. $\beta_{1i}\,\underline{R}_m$ (SWE),when the returns of individual assets are investigated. Making an assumption concerning partly segmentation across the two investigated markets, both of the two terms should be significant in the return-generating process of individual assets.

In addition to testing the applicability of the multi-market model, its incremental significance with respect to the asset sensitivities obtained by testing the Arbitrage Pricing Model is investigated in this study. The APM, originally formulated by Ross (1976), predicts that on the perfectly competitive and frictionless stock markets the stock return is a linear function of a certain number, say k, economic factors (see *e.g.*, Roll and Ross, 1980, *pp.* 1076-1082). In order to test the Arbitrage Pricing Theory two main alternative aproaches have been presented. First, one has aimed to estimate the unknown factors and asset sensitivities to these factors simultaneously by factor analysis. Without any theory a decision how many factors to extract from the data has to be made subjectively or by statistical criteria. When we have obtained systematic components of the risk, the risk premia are then estimated using cross-sectional regressions. Secondly, one has tried to specify a priori, on the basis of the theory, the general factors that explain pricing in the stock market (see *e.g.*, Chen *et al.*, 1986, and Martikainen and Yli-Olli, 1990, on Scandinavian data). In this approach, time series regressions are run for each series of stocks (portfolios) to estimate each stock's (portfolio's) sensitivities to macroeconomic variables. Then the risk premia are estimated by running cross-sectional regressions.

In this study the exploratory factor analysis approach is used to estimate APM's unknown factors and asset sensivities to these factors. In the first stage, the following factor analysis model is estimated:

(5) $\quad \underline{R}_i = E(\underline{R}_i) + b_{i1}\,\underline{F}_1 + b_{i2}\underline{F}_2 + \ldots + b_{ik}\underline{F}_k + \underline{e}_i \; ,$

where $E(\underline{R}_i)$, i = 1,2,...n, is the expected return of the stock i, $\underline{F}_j$, j = 1,2,...,k, are unobserved economic factors, b_{ij} is the sensitivity of the security i to the economic factor j, and $\underline{e}_i$ are the idiosyncratic risks of the stocks. Ross (1976) has shown that if the number of stocks is sufficiently large, a linear risk-return relationship between expected returns and asset sensitivities can be written. In this study, this risk-return relationship is tested using the following OLS regression:

$$(6) \qquad E(\underline{R}) = \lambda_0 + \lambda_1\underline{b}_1 + \lambda_2\underline{b}_2 + ... + \lambda_k\underline{b}_k + \underline{\mu}$$

where λ_0 is a constant riskless rate of return (the common return on all zero-beta stocks) λ_j, $j = 1,2,...,k$, represents, in equilibrium, the risk premium for the j^{th} factor.

In the next stage, the part of expected returns unexplained by the APM risk components, i.e. $\underline{\mu}$ is explained by the risk components produced by the Scandinavian market model. Thus, the following cross-sectional regression is finally run:

$$(7) \qquad \underline{\mu} = \gamma_0 + \gamma_1\underline{\beta}_1 + \gamma_2\underline{\beta}_2 + \underline{\mu}',$$

where μ is the residual term from regression (6), i.e. the part of expected returns not explained by the APM systematic risk components, β_1 represents the Swedish risk component of the Scandinavian market model in (3), β_2 is the Finnish risk component of the Scandinavian market model, after first controlling for the average returns of the Swedish stock market. Thus, the main focus in estimating (7) is to discover whether the risk componets produced by the Scandinavian market model offer incremental information content with respect to the APM systematic risk components in explaining the cross-sectional variation of expected stock returns.

IV. THE DATA

Monthly stock returns from the Helsinki Stock Exhange for January 1980 to December 1986 are used in this study. These individual asset returns are collected from a data base originally introduced by Berglund, Wahlroos and Grandell (1983). Our sample consists of 28 firms that have had their ordinary shares listed for the entire research period. The price indices used in the study are closing values for each month. The prices are corrected for splits, new issues etc. assuming that dividends are reinvested with zero transaction cost. The returns for each month are determined as first differences of the natural logarithms of these price indices. The market index in use for the Helsinki Stock Exchange is the value-weighted market index collected from the same data base. For Swedish returns, a market index published by a Swedish journal, Affarsvärlden, is in use.

V. A TEST OF THE SCANDINAVIAN MARKET MODEL ON FINNISH SECURITIES

To obtain some preliminary evidence on the relationships of the returns on the investigated stock markets, the following time-series OLS regressions (8) and (9) between the market returns are first run:

(8) $R_{mt}\,(FIN) = \alpha + \beta R_{mt}\,(SWE) + \varepsilon_t$

(9) $R_{mt}\,(FIN) = \alpha + \beta R_{mt-1}\,(SWE) + \varepsilon_t$

Table I presents the results of these regression analyses. The two markets seem to be positively related to each other. The strongest relationship between the two markets is found in model (8), i.e. between the Finnish and Swedish stock markets when the returns are measured from the same month.

Table I. Regression analysis estimates of market returns. (t-values in parentheses)

Model	Constant	Coefficients	R^2	F	
(8)	0.0156 (3.530)***	0.2250 (2.864)**	0.0919	8.200**	N=83
(9)	0.0167 (3.667)***	0.1852 (2.304)*	0.0622	5.307*	N=82

*significant at 0.05 level **significant at 0.01 level *** significant at 0.001 level

To produce evidence on the appropriateness of the so-called multi-market model in Finland, a market-model extented to the Swedish stock market is tested next. The non-diversifiable risk components of this model are presented in Table II. The results on that table are based on model (10):

(10) $R_{it} = \alpha_i + \beta_{1i} R_{mt}\,(SWE) + \beta_{2i} R_{mt}\,(FIN\text{-}SWE) + \varepsilon_{it}$,

where R_m (SWE) represents the returns of the Swedish stock market, and R_{mt} (FIN-SWE) the return of the Finnish market orthogonalised with respect to the returns of the

Swedish market, i.e. the residual term from the regression R_{mt} (FIN) = $\alpha + \beta R_{mt}$ (SWE) $+ \varepsilon_t$. Typically, when estimating betas, portfolios have been preferred to single securities. In this study, however, time-series of single securitues are used, due to the small number of listed securities in the Helsinki Stock Exchange.

Table II. Results of the Scandinavian market model and traditional national market model (1) for Finnish stocks.

Systematic risk measures obtained by
$\beta_{1i}{}^2$ Var ($\underline{R}_m$ (SWE)) and
$\beta_{2i}{}^2$ Var ($\underline{R}_m$ (FIN-SWE))

Firm	Sweden	Finland	Total	Traditional Market Model
Effoa	0.0011	0.0504	0.0515	0.0415**
Kesko	0.0674**	0.2081***	0.2755	0.2636***
Ford	0.0043	0.1137**	0.1180	0.0909***
Stockmann	0.0648*	0.1501***	0.2149	0.1992***
Talouskauppa	0.0036	0.0650*	0.0686	0.0682***
Tamro	0.0614*	0.0206	0.0819	0.0449**
Enso	0.0130	0.0614*	0.0743	0.0732***
Fiskars	0.0020	0.1768***	0.1787	0.1499***
Huhtamäki	0.0625**	0.3697***	0.4322	0.4293***
Instru	0.0352+	0.2208***	0.2560	0.2547***
Kajaani	0.0790**	0.1992***	0.2783	0.2607***
Kemi	0.0042	0.0625*	0.0667	0.0666***
Kymi	0.0145	0.3031***	0.3176	0.3149***
Lassila	0.0209	0.0689*	0.0898	0.0864***
Lohja	0.0363*	0.4707***	0.5070	0.5063***
Nokia	0.0688**	0.4218***	0.4906	0.4878***
Otava	0.0016	0.0169	0.0184	0.0125
Partek	0.0656**	0.3346***	0.4002	0.3955***
Rauma	0.0203	0.3322***	0.3525	0.3510***
Rosenlew	0.0040	0.0809***	0.0849	0.0843***
Schauman	0.0270(-)	0.0653*	0.0923	0.0375*
Serla	0.0011	0.1791***	0.1802	0.1707***
Sokeri	0.0152+	0.2277***	0.2549	0.2547***
Trikoo	0.0116	0.0550*	0.0667	0.0657***
Tamfelt	0.0049	0.0965**	0.1014	0.1007***
Tampella	0.0190	0.0487*	0.0677	0.0635***
Wärtsilä	0.1102***	0.3078***	0.4180	0.3961***
Yhtyneet	0.0927***	0.3159***	0.4086	0.3943***

underlying betas

+ significant at 0.10 level *significant at 0.05 level ** significant at 0.01 level *** significant at 0.001 level

(-) negative

The first column in Table II presents the systematic risk components of securities (in percentage of the total risk associated with the variability of the returns of a security in question) appointed to the Swedish market index. It can be seen that for 12 securities the estimated beta coefficient for Swedish markets has been statistically significantly different from zero. Only in one case, i.e. in the context of Schauman, the beta has been negative. Thus, the results clearly support the segmentation hypothesis of Finnish and Swedish security markets. Swedish risk components seem to be important in the return generating process of Finnish stocks.

The second column in Table II contains information about the part of total risk associated with the general return of the Finnish market after first controlling for the behaviour of the Swedish stock market. All of the estimated betas have expected positive signs, and almost all of them are statistically different from zero. These results give support to the so-called mild segmentation hypothesis. There seems to exist significant incremental information in Finnish market returns after removing the part associated with Swedish market returns.

VI. A COMPARISON OF APM AND SCANDINAVIAN MARKET MODEL

In this section the empirical results of the APM and multi-market model are compared. Especially, the incremental significance of the risk components produced by the multi-market model are compared to those of the APM. The next step in the empirical analysis is to test the APM is to use factor analysis procedure to identify the number of factors affecting equilibrium returns. In earlier studies, this procedure has typically been very problematic because it has been shown that the number of factors discovered depends for example on the size of the groups of securities one deals with. The estimation of factors can be carried out by different factor analytic methods. In this study, the initial factor extraction is carried out by the principal component method based on the covariance matrices of monthly stock returns, and thereafter a varimax rotation is applied.

In this study, two-, three-, and four-factor solutions were first derived for Finnish returns. The selection of these factor solutions was based on earlier findings by Yli-Olli *et al.* (1990), and Booth *et al.* (1991b) indicating that there does not obviously exist more than four common factors in the Finnish stock market. The cumulative proportions of total variance explained (of the unrotated factor patterns) are presented in Table III.

Table III. Cumulative proportions of total variance explained.

FACTOR1	FACTOR2	FACTOR3	FACTOR4
0.239	0.334	0.404	0.470

The figures of cumulative proportions in Table III reveal that the first factor accounts 23.9 per cent of the total variation of Finnish security returns during the research period, while 47 per cent of this variation can be explained by the first four factors appearing in the descending order of variance explained by the factors. The results are about of the same order as those reported by Yli-Olli *et al.* (1990). The slightly higher cumulative proportions of total variance reported by Yli-Olli *et al.* may be due to longer estimation period used in this paper. The following step involves examining the effect of factor loadings, i.e. systematic risk components of the APM, on equilibrium returns. In cross-sections the dependent variable is the monthly mean return and the independent variables are factor loadings from factor analysis. The risk-free rate of return is not restricted but estimated from the stock returns, assuming the intercept term to represent this return. The OLS regression coefficients are the estimated risk premia. In factor analysis there is no absolute meaning to the signs of the parameters or the scaling of the factors, and then also the signs of regression coefficients are arbitrary. Therefore, only the statistical significance of regression coefficients is relevant instead of their numerical values. The results of the cross-sectional test of the APM are presented in Table IV.

The results in Table IV support 1-2 priced factors in the APM in the Finnish stock market. However, the R-squares and F-values of the regressions are low indicating that a significant proportion of the cross-sectional variation of expected returns cannot be explained by the risk compinents of the APM.

Table IV. Regression analysis estimates.

dependent variable: average monthly return for security
independent variables: factor loadings (k=2-4)

(t-values in parantheses)

		Coefficients of					
No of factors	Constant	Fact1	Fact2	Fact3	Fact4	R-square	F
2	0.0160 (2.878)**	0.0069 (0.724)	0.0153 (1.870)+	-	-	0.126	1.808
3	0.0161 (2.933)**	0.0051 (0.581)	0.0173 (2.179)*	0.0033 (0.472)	-	0.185	1.816
4	0.0153 (2.119)*	0.0153 (1.863)+	0.0062 (0.685)	0.0173 (2.089)*	0.0038 (0.530)	0.217	1.590

+ significant at 0.10 level *significant at 0.05 level ** significant at 0.01 level *** significant at 0.001 level

Finally, in order to discover whether the risk componets of the Scandinavian multi-market model offer incremental information with respects to the above estimated APM risk components, the part of expected returns unexplained by the APM risk components, i.e. the residual term of the cross-sectional regressions shown in Table IV is explained by the risk components produced by the Scandinavian market model. The results of this incremental information content analysis are reported in Table V.

The results in Table V are clear. The international risk components of the Scandinavian market model do not offer incremental information with respect to the APM risk components when explaining the cross-sectional variation of expected returns in the Finnish stock market. This can be seen from the statistically insignificant t-values of the regression coefficients, and from the low R-squares and F-values of the models.

Table V. Regression analysis estimates.

dependent variable: residual term of the cross-sectional APM
independent variables: Sacndinavian market model risk components

(t-values in parantheses)

		Coefficients of			
No of factors in the APM	Constant	$\beta_{1i}R_m$(FIN-SWE)	$\beta_{2i}R_m$(SWE)	R-square	F
2	-0.0016 (-0.391)	0.0036 (0.624)	-0.0065 (-0.673)	0.022	0.275
3	-0.0007 (-0.188)	0.0030 (0.540)	-0.0086 (-0.921)	0.033	0.426
4	-0.0010 (-0.263)	0.0025 (0.457)	-0.0051 (-0.545)	0.013	0.168

+ significant at 0.10 level *significant at 0.05 level ** significant at 0.01 level *** significant at 0.001 level

VII. SUMMARY AND FURTHER RESEARCH

This study focused on the level of segmentation of the Finnish stock markets to Swedish and US stock markets. This was carried out by exploiting an internationally extended market model for Finnish stocks, and the APM originally developed by Ross (1976). The multi-market model of Finnish securities revealed that several Finnish stocks have significant Swedish risk components. The results supported the mild-segmentation hypothesis of the two investgated Scandinavian stock markets.

When analysing the incremental information of the Scandinavian market model risk components with respect to the APM, in explaining the cross-sectional variation of expected returns, the multi-market model parameters did not produce incremental information content. In this context, this paper extends the earlier work by Chen (1983) and Östermark (1989) who discovered that traditional market model betas did not offer incremental information with respect to the systematic risk components of the Arbitrage Pricing Model.

In the context of further research, the results obtained here should be reconsidered in other stock markets as well. This is because of the recent deregulation and integration of the world's capital markets. In addition, the effects of certain macroeconomic changes, such as inflation, demand for money, industrial production, and interest rates, should be considered in terms of the time-series variation of the systematic risk components of the multi-market model. Finally, the level of firm-specific characteristics, such as profitability, financial leverage, operating leverage and growth, should be investigated with respect to the cross-sectional variation of the systematic risk components of the multi-market model. This is because these four components can be regarded as theoretical determinants of systematic risk (see *e.g.*, Martikainen, 1992, and the literature cited there).

REFERENCES

Berglund, T., Wahlroos, B. and Grandell, L., "The KOP and UNITAS indexes for the Helsinki Stock Exchange in the light of value weighted index", Finnish Journal of Business Economics, Vol 32, No 1, 1983, 30-41 (in Swedish).

Berglund, T., Liljeblom, E. and Löflund, A., "Estimating betas on daily data for a small security market", Journal of Banking and Finance, Vol 13, No 1, 1989, 41-64.

Booth, G.G., Hatem, J., Virtanen, I. and Yli-Olli, P., "Stochastic modeling of security returns. Evidence from the Helsinki Stock Exchange", European Journal of Operational Research, 1991a, (Forthcoming).

Booth, G.G., Martikainen, T., Virtanen, I. and Yli-Olli, P., "On the common factors in the Arbitrage Pricing Model. International evidence from U.S. and Scandinavian stock markets", Paper presented to the Joint International Meeting of TIMS XXX - SOBRAPO XXIII, Rio de Janeiro, Brazil, 15.-17.7. 1991.

Bradfield, D.J., "An extented market model for non-USA markets", Paper presented at the 12th Triennal Conference on Operations Research. IFORS, Athens, Greece 25.-29.6.1990.

Chen N-F., "Some empirical tests of the theory of arbitrage pricing", Journal of Finance, Vol 38, No 5, 1983, 1393-1414.

Chen N-F., Roll, R. and Ross, S.A., "Economic forces and the stock market", Journal of Business, Vol 59, No 3, 1986, 383-403.

Cho, D. C., Eun, C.S. and Senbet, L.W., "International arbitrage pricing theory: an empirical investigation", Journal of Finance, Vol 41, No 2, 1986, 313-329.

Errunza, V. and Losq, E., "International asset pricing under mild segmentation: theory and test", Journal of Finance, Vol 40, No 1, 1985, 105-124.

von Furstenberg, G.M. and Jeon, B.N., "International stock price movements: links and messages", Brookings Papers on Economic Activity, No 1, 1989, 125-179.

Grinold, R., Rudd, A. and Stefek, D., "Global factors: fact or fiction", Journal of Portfolio Management, Fall 1989, 79-88.

Hietala. P.T., "Super premiums in the Finnish stock market", Finnish Economic Papers, Vol 1, No 2, 1988, 148-171.

Hillard, J.E., "The relationship between equity indices on world exchanges", Journal of Finance, Vol 34, No 1, 1979, 103-114.

Ibbotson, R.C., Carr, R. C. and Robinson, A.W., "International equity and bond returns", Financial Analyst Journal, Vol 38, 1982, 61-83.

Jeon, B.N. and von Furstenberg, G.M., "Growing international co-movements in stock price indexes", Quarterly Review of Economics and Business, Vol 30, No 3, 1990, 15-30.

Makridakis, S.G. and Wheelwright, S.C., "An analysis of the inter-relationships among the world stock exchanges", Journal of Business Finance and Accounting, Vol 1, No 1, 1974, 195-215.

Malkamäki, M.J., Martikainen, T. and Perttunen, J., "On the riskiness of the world's stock markets", European Journal of Operational Research, 1991, (Forthcoming).

Martikainen, T. and Yli-Olli, P, "A test of the Arbitrage Pricing Model using accounting information", Economics Letters, Vol 34, No 1, 1990, 55-59.

Martikainen, T., Virtanen, I. and Yli-Olli, P., "Further evidence on international asset pricing. On the level of segmentation of the Finnish stock market to Swedish and U.S. stock markets", Paper presented to the Joint International Meeting of TIMS XXX - SOBRAPO XXIII, Rio de Janeiro, Brazil 15.-17.7. 1991.

Martikainen, T., "Stock returns and classification pattern of firm-specific financial variables. Empirical evidence with Finnish data", Journal of Business Finance and Accounting, 1992, (Forthcoming).

Meric, I. and Meric, G., "Potential gains from international portfolio diversification and inter-temporal stability and seasonality in international stock market relationships", Journal of Banking and Finance, Vol 13, No 4-5, 1989, 627-640.

Philippatos, G.C., Christofi, A. and Christofi, P., "The inter-temporal stability of international stock market relationships: another view", Financial Management, Winter 1989, 63-69.

Roll, R. and Ross, S.H., "An empirical investigation of the arbitrage pricing theory", Journal of Finance, Vol 35, No 5, 1989, 1073-1103.

Ross, S.H., "The arbitrage pricing theory of capital asset pricing", Journal of Economic Theory, Vol 13, No 1, 1976, 341-360.

Sharpe, W.F., "Capital asset prices: A theory of market equilibrium under conditions of risk", Journal of Finance, Vol 19, No 5, 1964, 425-442.

Solnik, B., "Testing international asset pricing. Some pessimistic views", Journal of Finance, Vol 32, 1977, 503-512.

Solnik, B., "International arbitrage pricing theory", Journal of Finance, Vol 38, No 2, 1983, 449-457.

Solnik, B, International Investments, Addison Wesley, Reading, MA, 1983.

Virtanen, I. and Yli-Olli, P., "Predicting stock returns in a thin security market", OMEGA International Journal of Management Science, Vol 15, No 2, 1987, 145-155.

Yli-Olli, P., Virtanen I. and Martikainen, T., "Common factors in the Arbitrage Pricing Model in two Scandinavian countries", OMEGA International Journal of Management Science, Vol 18, No 6, 1990, 615-624.

Östermark, R., "Arbitrage pricing models for two Scandinavian stock exchanges", OMEGA International Journal of Management Science, Vol 17, No 5, 1989, 437-447.