財務管理硏究 第十五卷 第二號(1998. 12), 401~419

The Segmentation Hypothesis of International Capital Markets; in the Regional Stock Markets Setting

Sung Hee Ryu* · Sang Keun Lee**

<Abstract>

This paper examines the international arbitrage pricing model (IAPM) in regional equity markets setting. Factor analyses are used to estimate the international common risk factors. And the cross-sectional regression analyses are used to test the validity of regional IAPMs and Chow tests are used to evaluate the integration of regional equity markets. The results of factor analyses show that the number of common factors in each regional group is seven. The cross-sectional regression results lead us not to reject that the IAPMs are regionally valid but Chow test results lead us to reject that regional equity markets are integrated.

Ⅰ. Introduction

Portfolio selection theory of Markowitz(1952) begins at the logic that non-systematic risk can be reduced if a portfolio is composed of the assets with low correlation. The effect of this diversification investment theory can be magnified when it is applied to international investment.[1] This theory, however, constitutes only when it is assumed that international equity markets are integrated, as a result, domestic stocks and international stocks can be analyzed with same risk measurement and risk price. Therefore, whether international equity market is integrated should be verified before discussion of the international asset pricing

---

* Professor in Dept. of Business Administration, Kyonggi Univ.

** Researcher in Institute of Business Research, Sogang Univ.

We appreciate the valuable comments from two anonymous referees.

1) Solnik, Bruno H. (1974), "International Pricing of Risk : An Empirical Investigation of the World Capital Market Structure," *Journal of Finance*, May, pp. 365-378.

models and the effect of international diversification investment.

Most of the previous studies on the international equity markets are based on a segmented market approach. This approach treats the different national equity markets as separated entities, hardly related to each other. Market segmentation is widely accepted as the only possible structure of the international equity market. Different currency areas, separated political organizations and trade barriers have been given as a priori evidence for the segmentation of the international equity markets.[2)]

But recently, many researchers insist that the extent of integration has been grown up since each equity market's worldwide globalization trends.[3)] Most of the previous studies, however, made little contribution to testing the hypothesis on international equity market integration as they had mainly focused on developed countries.[4)] Thus, in this paper, the studies on the integration not only between country markets, but also in each three regional markets (Asian, European, and North American Stock market) are performed. The test of this integration hypothesis might be possible through analyzing the common factors which affect the stock prices of each region, and then through verifying the existence of same risk measurement and risk price with dividing the international equity market by region.

While there is a rich body of theoretical research on international market integration, only a few studies have tried to test this important question empirically.

A first group of empirical tests on the integration has generally adopted an international single index asset pricing model of Sharpe-Lintner-Mossin(1965). These tests have examined whether a purely domestic factor - usually the part of the return on the domestic market portfolio that is orthogonal to the world portfolio - has explanatory power in a regression of stock returns on a world market index. The finding that the domestic factor is often priced is then taken to support market segmentation. The interpretation of this empirical evidence, however, is not so clear-cut because a single index(ICAPM ; international capital asset pricing model) can only be obtained under the restrictive assumptions of either a universal logarithmic utility function[5)] or purchasing

2) Stulz(1981), Errunza and Losq(1985), Eun and Janakiramanan(1986).

3) Campbell and Hamao(1992), Chan, Karolyi(1992).

4) Eun and Senbet(1986), Gultekin, Gultekin, and Penati(1989), Campbell and Hamao(1992).

power parity.[6] Single index models also do not address the question of whether segmentation arises from government policies or from market inefficiency.

A second group of studies have used an international version of the Arbitrage Pricing Model(IAPM). Cho, Eun, and Senbet(1986) and Korajczyk and Viallet(1986) used an IAPM to test the integration of international capital markets. Because the pricing in this model is based on an arbitrage condition of nominal returns, IAPM has the advantage of eluding the problem of purchasing power parity deviations.[7]

Therefore, in this paper, we try to test IAPM in order to examine integration of regional equity markets. Specifically, we address various issues as outline in the following procedure:

(i) Extracting the number of international common risk factors to the each regional equity markets.
(ii) Testing the asset pricing relationship implied by the IAPM ; and
(iii) Examining whether the factor structure and the asset pricing relationship in each regional equity markets are invariant to the numeraire chosen by using the U.S. dollar.

As will be discussed in detail, our test involves the joint hypotheses of the regional equity markets being integrated and the IAPM being valid regionally.

This paper is organized as follows. Section II briefly reviews the IAPM. Section III discusses the test procedures, methodology and hypotheses to be tested, Section IV presents the empirical results. Section V concludes this paper.

---

5) see Adler and Dumas(1983), for instance.

6) see Grauer, Litzenberger, and Stehle(1976), for instance.

7) CAPM and APM assert that every asset must be compensated only according to its systematic risk. One of the major differences is that, in the CAPM, the systematic risk of an asset is defined to be the covariability of asset with the market portfolio, whereas, in the APM the systematic risks are defined to be the covariability with not only one factor but also possibly with several economic factors. Another difference is that the CAPM requires the economy to be in equilibrium whereas the APM requires only that the economy has no arbitrage opportunities.

II. The International Arbitrage Pricing Model : A Review

Suppose there exist k factors in the world economy which generate the random returns on a set of n international assets in terms of a given numeraire currency, say, the U.S. dollar:

$$\widetilde{R}_i = E(R_i) + b_{i1}\,\widetilde{\theta}_1 + b_{i2}\,\widetilde{\theta}_2 + \cdots + b_{ik}\,\widetilde{\theta}_k + \widetilde{\varepsilon}_i, \quad i=1,2,\cdots,n \tag{1}$$

where $E(R_i)$ is the expected return on the i_{th} asset, $\widetilde{\theta}_j$'s are zero mean international common factors, b_{ij} is the sensitivity of the i_{th} asset to the j_{th} factor, and $\widetilde{\varepsilon}_i$'s are the residual terms of the assets. As usual, it is assumed that $E(\widetilde{\varepsilon}_i \mid \theta_j) = 0$ for I = 1, 2, $\cdots$, n, j=1, 2, $\cdots$, k, n $>$ k and $E(\widetilde{\varepsilon}_i)^2 = \sigma_i^2 < \infty$.

Assuming that investors have homogeneous expectations concerning the k factors generating process of Equation (1), we can derive the IAPM in terms of the U.S. dollar in the usual manner. Suppose that there is a sufficient number of assets so that a portfolio with the following characteristics can be formed :

$$\underline{x}^n \, \underline{1} = 0, \; \underline{x}^n \, \underline{b}_j = 0, \quad j = 1, 2, \cdots, k \tag{2}$$

where $\underline{x}^n$ is an n-dimensional row vector of portfolio weights ; $\underline{1}$ is an n-dimensional vector of ones ; $\underline{b}_j$ is an n-dimensional vector of factor loadings b_{ij}'s. These portfolios entail neither net investment nor systematic risk. Further, the idiosyncratic risk of these portfolios should become negligible as the number of securities grows large. Consequently, in order to preclude arbitrage opportunities, these portfolios must earn zero profits, which in return implies the following relationship.

$$E(R_j) = \lambda_0 + \sum_{l=1}^{k} \lambda_l \, b_{jl} \tag{3}$$

The k weights, $\lambda_1, \cdots, \lambda_k$, can be viewed as risk premia. It is well known in the APM literature that the IAPM of equation (3) holds only as an approximation, particularly in a finite economy, as shown by Ross(1976) and others. In a large economy with infinitely many assets, the model holds as an exact equality under certain conditions[8]

8) see Dybvig and Ross(1985), for instance.

However, the magnitude of mispricing due to the approximation should be mitigated in the international context by the fact that there are more assets in the world economy than in any particular national economy.

Although equation (3) applies to a set of international assets, rather than a set of local assets as in the domestic APM, its structure is identical to the standard APM of Ross(1976).

Ⅲ. Testing Procedures and Hypotheses

In this section, we discuss the sample data used in this study, the testing procedures and the hypotheses to be tested. We shall begin with a discussion of the data, the joint nature of the hypothesis.

1. Data

The Data are described in <Table Ⅰ>. Our total sample consists of 348 stocks representing 5 sectors and 3 different areas, 158 stocks in four Asian countries, 110 stocks in three European countries, and 80 stocks in two North American countries, dollar based weekly returns of which are available for the entire period of January 1994 through December 1996. Data were obtained from International Data Stream.

<Table 1> Data Description : Sample Stocks of Asian Countries

Nations \ Sectors	Financial	Consumer goods	Capital goods	Wholesale	Public	Total
Korea	10	10	18	9	3	50
Japan	10	10	10	8	10	48
Hong Kong	6	6	6	6	6	30
Singapore	6	6	6	6	6	30

Sample Stocks of European Countries

Nations \ Sectors	Financial	Consumer goods	Capital goods	Wholesale	Public	Total
U.K.	10	10	10	10	10	50
Germany	6	6	6	6	6	30
France	6	6	6	6	6	30

Sample Stocks of North American Countries

Nations \ Sectors	Financial	Consumer goods	Capital goods	Wholesale	Public	Total
U.S.	10	10	10	10	10	50
Canada	6	6	6	6	6	30

2. IAPM and Integration of Regional Equity Markets : Joint Hypotheses

Our test involves a joint hypothesis like any other test of the asset pricing models. In the domestic setting, for example, most of the studies test the joint hypothesis of the market being efficient and the underlying asset pricing model being valid. In an international setting, there is one additional hypothesis, i.e., the markets being integrated. Regional equity markets can be viewed as integrated if each regional assets in various national markets are traded as though their prices are determined in a unified market.

Regional equity markets can be segmented along regional lines due to severe imperfections resulting from discriminatory border taxes, possibilities of expropriation, exchange controls, information gaps. etc. The existence of exchange rate uncertainty per se does not cause segmentation. Indeed, as we saw earlier, the IAPM was developed in an environment characterized by exchange rate fluctuations.

We can not evaluate the extent of regional equity market integration by looking at the number of common factors. A strong single common factor may depict more integration than several weak factors. We can not infer regional equity market integration from factor structure or correlation analysis. We must test if the factors are priced identically across regional equity markets, which should be the case if the IAPM is valid and regional equity markets are integrated. In this sense we try to test a joint hypothesis.

3. Estimating Factor Model

Testing of the IAPM will be carried out in two parts. The first part involves estimation of the systematic risks, i.e., factor loadings for each asset, while the second part involves testing the pricing implications of the IAPM using cross-sectional regression analysis. We adopted the group approach used by Roll and Ross(1980). The analysis proceeds in the following stages:

i) For a regional group of individual assets, a sample product-moment covariance matrix is computed from a time series of returns.

ii) A principal component factor analysis is performed on the covariance matrix. This estimates the number of factors and the matrix of loadings.

iii) The regional individual-asset factor loading estimates from the previous step are used to explain the cross-sectional variation of individual estimated expected returns. The procedure here is similar to a cross-sectional ordinary least squares regression.

iv) Estimates from the cross-sectional model are used to measure the size and statistical significance of risk premia associated with the estimated factors.

4. Hypotheses Testing

Once we obtain estimates of international factor loadings, we can test the basic cross-sectional pricing relationship of the IAPM in equation (3). Cross-sectional regressions are performed to test the significance of the risk-free rate and risk premia and then Chow test same as Brown and Weinstein(1983) was conducted to examine the consistence of risk-free rate and risk premia between in each regional equity market. Specifically, we test the following null hypotheses.

(H1) the risk-free rates are same in each regional equity market.

(H2) the risk premia are same in each regional equity market.

(H3) both the risk-free rates and risk premia are same in each regional market;

$$\begin{aligned} \lambda^{i} &= \lambda^{j}, \lambda_{o}^{i} = \lambda_{o}^{j} \\ \lambda^{k} &= \lambda^{l}, \lambda_{o}^{k} = \lambda_{o}^{l} \\ \lambda^{m} &= \lambda^{n}, \lambda_{o}^{m} = \lambda_{o}^{n} \end{aligned} \tag{4}$$

where λ is risk premia, λ_0 is risk-free rate, i, j are individual stocks in Asian countries ($i \neq j$), k, l are individual stocks in European countries ($k \neq l$), m, n are individual stocks in North American countries.($m \neq n$).

Each of the above hypotheses will be tested using the U.S. dollar as the numeraire currency.

As previously mentioned, our test involves a joint hypothesis that the regional equity market is integrated and that the IAPM is valid regionally. If the IAPM holds regionally, and the regional equity markets are integrated, then none of the above hypothese, H1, H2, and H3, should be rejected.

The Chow test entails comparison of the whole regressed residual sum of squares (ESS_{res}) with the each country regressed residual sum of squares($ESS_{1,2,3,4}$). A given hypothesis is not rejected when the four residual sum of squares are close in value. Furthermore, if df_d and df_n denote the degree of freedom for the regressions, respectively, then

$$F=\frac{[ESS_{res}-(ESS_1+ESS_2+ESS_3+ESS_4)]/df_n}{[ESS_1+ESS_2+ESS_3+ESS_4)]/df_d} \tag{5}$$

has an F-distribution with df_n and df_d degrees of freedom.

Ⅳ. Empirical Results

In this section, the factor analysis is conducted to estimate the regional common factors. Then, cross-sectional regressions are performed in order to investigate the validity of the IAPM. Finally, Chow tests are performed to evaluate the integration of regional equity markets. First, we need to analysis the correlation between returns of two countries in each region.

1. Results of Correlation Analysis

We summarize the results of correlation analysis for Asian stock returns, European stock returns, and North American stock returns in <Table 2>.

In Asian area, the correlation coefficient between Japan and Singapore is 0.27 and between Hong Kong and Singapore is 0.38. These results show that the movement of stock returns between these countries are statistically significant. The correlation coefficients between U.K. and Germany, between U.K. and France, and between Germany and France are 0.30, 0.46, and 0.41 respectively. This result reveals that the correlation coefficients between European countries are also statistically important. The correlation coefficient, however, between U.S. and Canada in North American stock markets is not significant.

<Table 2> Correlation Matrix of Stock Returns

Asian Area

	Korea	Japan	Hong Kong
Korea	1		
Japan	0.04	1	
HongKong	-0.02	0.00	1
Singapore	0.06	0.27**	0.38 **

European Area

	U.K.	Germany	
U.K.	1		
Germany	0.30***	1	
France	0.46***	0.41***	1

North American Area

	U.S.
U.S	1
Canada	0.09

significant at 5%, * significant at 1%

2. Regional Common Factors

All samples of each region were used to extract common risk factors by using factor analysis. To be specific, one of three regions was combined with four countries in Asia, three countries in Europe, and two countries in North America and factor analysis was executed three times totally. Generally, number of common factors are determined by eigen values of factors which are greater than one.

In this test, however, scree plot was used to select common factors and factor loading matrix since eigen value approach produced too many factors.[9] This procedure allows us to generate the optimal common factors and test the validity of the IAPM across all region groups of securities. Results of the factor analyses which are obtained using scree plot show that there exist seven common factors in each regional equity market.

9) We obtained over 10 common factors when we used eigen value approach. Many obtained factors might give us problem to execute cross-sectional regression such as multicollinearity and a lot of computation cost.

3. Tests of the Regional IAPM ; Cross-Sectional Regression Analysis Results

We investigate the validity of the IAPM by cross-sectional regression. To conduct these tests, we regressed average and quarterly returns of each stocks as dependent variables into factor loadings of each area as independent variables. If there are statistically significant common factors, pricing factors, in each regression equation, IAPM of the regional equity market could be valid.

We summarize results of cross-sectional regression analyses as dependent variable with average rate of return to test the significance of t-statistics each regional capital market in <Table 3> and results of cross-sectional regression analyses as dependent variable with quarterly rate of return to test the significance of t-statistics each regional capital market in <Table 4>.

(1) Results of Cross-Sectional Regression Analyses as Dependent Variable with Average Rate of Return

The result of cross-sectional regression analysis as dependent variable with average rate of return in Asian equity market is presented in <Table 3a).

<Table 3a> Cross-Sectional OLS in Asian Equity Market

	Intercept	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	R^2
Whole	0.0034*** (5.68)	-0.0032** (-2.42)	-0.01*** (-6.99)	-0.0017 (-1.17)	-0.0043*** (-3.15)	-0.001 (-0.71)	-0.0044*** (-2.82)	0.001 (0.57)	0.3
Korea	0.0077*** (7.01)	0.0088** (2.13)	-0.014*** (-9.17)	-0.0087*** (-4.18)	-0.0038 (-1.29)	-0.004 (-0.8)	0.0027 (0.61)	0.001 (0.48)	0.7
Japan	-0.0002 (-0.2)	0.0026 (1.32)	-0.0063* (-1.87)	-0.0048 (-1.12)	-0.0017* (-1.55)	-0.0016 (-0.45)	-0.0046 (-1.41)	0.003* (1.55)	0.24
HongKong	0.0055*** (2.63)	-0.0074 (-0.36)	-0.022 (-1.37)	-0.0051 (-0.35)	0.037** (2.04)	-0.0045 (-1.12)	-0.0007 (-0.05)	-0.0026 (-0.24)	0.33
Singapore	0.002 (0.96)	-0.0027 (-0.33)	-0.002 (-0.23)	0.005 (0.67)	-0.0008 (-0.11)	0.0011 (0.16)	-0.0031 (-0.72)	-0.0019 (-0.3)	0.07

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
t-statistics are presented in parentheses.

According to the t-test, intercept, factor 1, 2, 4, and 6 were very significant for pricing in the whole market. In Korean market, intercept, factor 1, 2, and 3, in Japanese market, factor 2, 4 and 7, and in Hong Kong market, intercept and factor 4 were statistically significant for pricing. But no factors are important for pricing in Singapore equity market. Therefore we came to the conclusion that the IAPM in Asian stock markets was valid.

<Table 3b> shows the result of cross-sectional regression analysis as dependent variable with average rate of return in European equity market.

<Table 3b> Cross-Sectional OLS in European Equity Market

	Intercept	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	R^2
Whole	0.0018 (1.38)	0.0025 (1.03)	-0.0004 (-0.17)	-0.00019 (-0.07)	-0.0023 (-0.97)	-0.002 (-0.81)	-0.0018 (-0.61)	0.0068** (2.34)	0.10
U.K.	0.0102*** (6.37)	-0.011*** (-3.64)	-0.009*** (-3.86)	-0.0023 (-0.44)	-0.01** (-2.33)	0.0025 (0.83)	0.0049* (1.6)	0.00001 (0.01)	0.50
Germany	-0.0041 (-1.35)	0.011 (0.87)	-0.008 (-0.72)	0.01* (1.48)	0.001 (0.08)	-0.0028 (-0.32)	-0.0017 (-0.16)	0.017** (2.21)	0.33
France	0.00011 (0.04)	0.0033 (0.4)	0.0024 (0.21)	0.0058 (0.95)	0.00031 (0.06)	-0.0039 (-0.74)	-0.0039 (-0.59)	0.0017 (0.25)	0.16

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
t-statistics are presented in parentheses.

Factor 7 was statistically important for pricing at the whole market in European equity market. In U.K. market, intercept, factor 1, 2, 4, and 6 and in German market, factor 3 and 7 were significant for pricing. In French market, however, there was not any significant factor. It led us not to reject the validity of the IAPM in European stock markets.

The result of cross-sectional regression analysis as dependent variable with average rate of return in North American equity market is presented in <Table 3c>. The intercept, factor 2, and 5 were statistically significant for pricing at the whole market in North American equity market. Factor 1, 3, and 7 in U.S. market and all factors except factor 1 including intercept were statistically significant for pricing in Canadian equity market. This result revealed that the IAPM was valid in North American equity market.

<Table 3c> Cross-Sectional OLS in North American Equity Market

	Intercept	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	R^2
Whole	0.0046*** (3.02)	0.0035 (1.45)	-0.0051** (-2.21)	-0.0033 (-1.14)	-0.0011 (-0.33)	-0.008*** (-2.46)	0.0015 (0.48)	0.0034 (1.27)	0.18
U.S.	0.0012 (092)	0.0057*** (3.58)	-0.0014 (-0.87)	0.0043* (1.82)	0.0024 (1.21)	-0.00035 (-0.15)	-0.0033 (-1.41)	0.0037* (1.45)	0.46
Canada	0.018*** (4.79)	0.01 (1.54)	0.026* (1.78)	-0.03*** (-3.84)	-0.016* (-1.85)	-0.02** (-2.65)	0.012* (1.71)	-0.01** (-2.07)	0.81

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
t-statistics are presented in parentheses.

(2) Results of Cross-Sectional Regression Analyses as Dependent Variable with Quarterly Rate of Return

The result of cross-sectional regression analysis as dependent variable with quarterly rate of return in Asian equity market is presented in <Table 4a>.

<Table 4a> Cross-Sectional OLS in Asian Equity Markets

	Intercept	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	R^2
Whole	0.002 (0.58)	0.0018 (0.30)	-0.03*** (-4.40)	0.007 (1.12)	-0.011* (-1.69)	-0.005 (-0.77)	-0.0002 (-0.03)	-0.02** (-2.11)	0.02
Korea	0.0016 (0.21)	0.0039 (0.13)	-0.0038 (-0.34)	0.024* (1.60)	0.019 (0.90)	0.065* (1.80)	-0.016 (-0.50)	0.035** (2.33)	0.03
Japan	-0.002 (-0.41)	0.015 (1.25)	-0.006 (-0.30)	0.013 (0.53)	-0.0008 (-0.13)	0.023 (1.07)	-0.069*** (-3.54)	0.015* (1.45)	0.04
Hong Kong	0.0073 (0.64)	0.037 (0.34)	0.062 (0.71)	-0.003 (-0.03)	-0.0023 (-0.02)	0.014 (0.66)	-0.135** (-1.84)	-0.0075 (-0.13)	0.02
Singapore	0.005 (0.74)	0.018 (0.71)	-0.025 (-0.93)	0.026 (1.14)	0.032* (1.41)	-0.024 (-1.16)	-0.042*** (-3.08)	0.007 (0.36)	0.06

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
t-statistics are presented in parentheses.

Factor 2, 4, and 7 at the whole market in Asian equity market were statistically important. In Korean market, factor 3, 5, and 7, in Japanese market, factor 6 and 7, in Hong Kong market, factor 6, and in Singapore market, factor 4 and factor 6 were statistically significant for pricing. This result led us not to reject the validity of IAPM in Asian market. It is exactly same when we regressed with average rate of return as dependent variable.

<Table 4b> presents the result of cross-sectional regression analysis as dependent variable with Quarterly rate of return in European equity market.

<Table 4b> Cross-Sectional OLS in European Equity Market

	Intercept	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	R^2
Whole	-0.0016 (-0.49)	0.022^{***} (3.61)	-0.011^{**} (-1.95)	0.003 (0.43)	0.0035 (0.59)	-0.012^{*} (-0.81)	0.0038 (0.51)	0.019^{***} (2.56)	0.02
U.K.	-0.015^{**} (-2.23)	-0.016^{*} (-0.58)	-0.026^{***} (-3.20)	0.0038 (0.21)	-0.014 (-0.92)	-0.0052 (-0.48)	0.015 (1.40)	-0.001 (-0.10)	0.03
Germany	-0.0041 (-1.35)	0.011 (0.87)	-0.067^{***} (-2.83)	0.056^{***} (3.67)	-0.06^{**} (-2.21)	0.029 (1.51)	-0.016 (-0.70)	0.055^{***} (3.28)	0.10
France	-0.012 (-1.35)	0.019 (0.72)	-0.025 (-0.69)	0.028^{*} (1.95)	0.0068 (0.45)	-0.024^{*} (-1.49)	0.017 (0.82)	0.022 (1.04)	0.04

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
t-statistics are presented in parentheses.

According to the result, factor 1, 2, 5, and 7 were statistically significant for pricing at the whole market in European stock market. In U.K. market, intercept, factor 1, and 2, in German market, factor 2, 3, 4, and 7, and in French market, factor 3 and 5 were significant for pricing. Therefore, the hypothesis that IAPM was valid in European market could not be rejected.

The result of cross-sectional regression analysis as dependent variable with quarterly rate of return in North American equity market is presented in <Table 4c>. Only factor 7 was statistically significant common factors for pricing at the whole market in North American equity market. In U.S. market, factor 1, 4, and 6 and in Canadian market, factor 3 and 5 were important common factors for pricing. This result led us not to reject the validity of the IAPM in North American stock markets.

<Table 4c> Cross-Sectional OLS in North American Equity Market

	Intercept	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	R^2
Whole	-0.0029 (-0.70)	0.0075 (1.14)	0.0015 (0.25)	0.0055 (0.70)	-0.0024 (-0.27)	-0.0077 (-1.03)	-0.0089 (-1.04)	-0.01* (-1.47)	0.01
U.S.	-0.007 (-1.10)	0.016** (2.02)	0.0041 (0.53)	-0.0007 (-0.06)	0.021** (2.13)	0.0035 (0.31)	0.017* (1.52)	0.0024 (0.20)	0.02
Canada	0.033 (1.22)	0.055 (1.14)	0.014 (0.13)	-0.083* (-1.54)	0.0058 (0.09)	-0.08* (-1.65)	0.0049 (0.09)	0.03 (0.89)	0.05

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
t-statistics are presented in parentheses.

4. Evaluation of the Integration of Regional Equity Markets

We summarize Chow test results for the consistence of risk premia each regional equity market in <Table 5>. The null hypotheses of Chow test are (H1), (H2), and (H3) in equation (4). The F-values for Chow test are computed by equation (5). Thus, we could test the hypotheses to compare F-values for the Chow test with F-statistic.

<Table 5> Chow Tests for Risk Premia Consistence of Regional Equity Markets

Regional Equity Markets		F-Value for Chow-test	F-Statistic
with Average Rate of Return	Asian	4.17***	$F_{0.95}(8,120)$ = 2.02, $F_{0.99}(8,120)$ = 2.66
	European	5.22***	$F_{0.95}(8,79)$ = 2.02, $F_{0.99}(8,79)$ = 2.66
	North American	13.54***	$F_{0.95}(8,55)$ = 2.10, $F_{0.99}(8,55)$ = 2.82
with Quarterly Rate of Return	Asian	50.46***	$F_{0.95}(8,1836)$ =1.94, $F_{0.99}(8,1836)$ = 2.51
	European	5.25***	$F_{0.95}(1,219)$ = 1.94, $F_{0.99}(8,1219)$ = 2.51
	North American	61.01***	$F_{0.95}(8,926)$ = 1.94, $F_{0.99}(8,926)$ = 2.51

*Significant at the 10% level, **Significant at 5%, ***Significant at 1%
degree of freedoms are presented in parentheses.

According to the result of Chow test with average rate of return, the F-value in Asian equity market was 4.17. This result implies that null hypotheses are rejected at 5% significance level and risk premia of Asian equity markets are not consistent. It means that Asian stock markets are segmented. Since the F-value in European market was 5.22, we could reject null hypotheses at 5% significance level. This result showed that European stock markets were not integrated. And F-value in North American equity market was 13.54. It led us to reject the hypothesis that North American markets were integrated.

According to the result of Chow test with quarterly rate of return, the F-value in Asian equity market was 50.46. We could reject null hypothesis at 5% level of significance and Asian stock markets were segmented. And the F-value in European market was 5.25. We could also reject null hypotheses at 5% significance level. This result revealed that European stock markets were segmented. F-value in North American equity market was 61.01. It led us to reject the hypothesis that North American markets were integrated. It also showed that North American stock markets were segmented.

In conclusion, three regional capital markets are segmented as result of Chow tests with average rate of return and with quarterly rate of return.

V. Conclusions

The effect of diversification investment theory can be magnified when it is applied to international investment. This logic, however, constitutes only when it is assumed that international equity markets are integrated, as a result, domestic stocks and international stocks can be analyzed with same risk measurement and risk price. Therefore, whether international equity market is integrated should be verified before discussion of the international asset pricing models and the effect of international diversification investment. This paper examined the integration of three regional stock markets.

As for the empirical analysis examined integration of the international stock markets in each regional market, IAPMs in Asian, European, and North American stock markets were valid according to the cross-sectional regression analyses.

Next, we examined the consistence of risk premia regional stock markets in which

IAPMs were valid. According to Chow test, F-values for Chow tests in Asian, European, and North American stock markets were greater than F-statistic . It meant that we could reject the hypotheses that three regional equity markets were integrated. Therefore, we concluded that Asian, European, and North American stock markets were segmented respectively.

Market segmentation is widely accepted as the only possible structure of the international equity market. Different currency areas, separated political organizations and trade barriers have been given as a priori evidence for the segmentation of the international equity markets. It might lead us to reject the integration of each regional stock market.

The results of this paper have significant implications in terms of international diversification investment effect and establishment of international asset pricing model in international financial theory, and in practice, for international stock investment and international listings on the foreign stock markets by the financial staff in multinational companies and by individual investors.

In the segmented stock market, we can not discuss the effect of international diversification investment but we should consider in terms of the international capital budgeting, when we try international investment. Thus, in three regional stock markets, when individual invetors and companies try tó invest regionally, they cannot expect the effect of international diversification investment and they should try to invest in terms of Capital budgeting.

References

Alexander, G., C., Cheol S. Eun, and S. Janakiramanan. "Asset Pricing and Dual Listing on Foreign Capital Markets : A Note," *Journal of Finance*, 1987, Vol 42, pp. 151-158.

Asprem, Mads (1989), "Stock Prices, Asset Portfolio and Macroeconomic Variables in Ten European Countries, *Journal of Banking and Finance, Vol* 13, pp. 589-612.

Bekaert, G., and C. Harvey. "Time-Varying World Market Integration," *Journal of Finance, 1995, Vol* 50, pp. 403-444.

Brown and M. Weinstein. "A New Approach to Testing Asset Pricing Models: The Bilinear Paradigm," *Journal of Finance*, 1983, pp. 711-743.

Campbell, J. Y., and Hamao, Y. "Predictable Stock Returns in the U.S. and Japan : A Study of Long-Term Capital Market Integration," *Journal of Finance*, 1992, Vol 47, pp. 43-70.

Cho, D., C. Eun, and L. Senbet. "International Arbitrage Pricing Theory : An Empirical Investigation," *Journal of Finance*, 1986, pp. 313-329.

Dhrymes, Pheobus, J., Irwin Friend, and N. Bulent Gultekin. "A Critical Reexamination of the Empirical Evidence on the APT," *Journal of Finance,* 1984, Vol 39, pp. 323-346.

Dybvig, P., and S. Ross. "Yes, the APT is Testable," *Journal of Finance*, 1985, pp.1173-1188.

Engle, R. and R. Susmel. "Common Volatility in International Equity Markets, *Journal of Business and Economic Statistics, 1993, Vol* 11, pp. 167-176.

Errunza, Vihang and Etienne Losq. "International Asset Pricing Under Mild Segmentation : Theory and Test," *Journal of Finance*, 1985, pp. 105-124.

Eun, Cheol S., and Bruce G. Resnick. "Estimating the Correlation Structure of International Share Prices," *Journal of Finance*, 1984, pp.1311-1324.

Grauer, Robert R., and Nils H. Hakansson. "Gain from International Diversification : 1968-85 Returns on Portfolios of Stocks and Bonds," *Journal of Finance*, 1987, pp. 721-741.

Gultekin, Mustafa N., N. Bulent Gultefkin, and Alessandro Penati. "Capital Controls and

International Capital Market Segmentation : The Evidence from the Japanese and American Stock Markets," *Journal of Finance*, 1989, pp. 849-870.

Hamao, Y. "An Empirical Examination of the APT : Using Japanese Data," *International Journal of Theory and Policy, 1988.*

Jacquillat, Bertrand, and Bruno H. Solnik. "Multinationals are Poor Tools for Diversification," *Journal of Portfolio Management*, 1978, pp. 4-23.

Jorion, and Eduardo Schwartz. "Integration vs. Segmentation in the Canadian Stock Market," *Journal of Finance,* 1986, Vol 41, pp. 603-613.

Karajczyk, R. and Viallet. "An Empirical Investigation of International Asset Pricing," *Review of Financial Studies,* 1989, Vol 2, pp. 553-585.

Karolyi, G. and M. Stulz. "Why Do Markets Move Together? An Investigation of U.S.-Japan Stock Return Comovements, *Journal of Finance, 1996, Vol* 3, pp. 951-986.

Lee, W. Y., and K. S. Sachdeva. "The Role of the Multinational Firm in the Integration of Segmented Capital Markets," *Journal of Finance*, 1977, pp. 479-492.

Longin, F. and B. Solnik. " Is the Correlation in International Equity Returns Constant : 1970-1990, *Journal of International Money and Finance, 1995, Vol* 14, pp.3-26.

Roll, R . "A Critique of the Asset Pricing Theory's Tests ; Part 1. On Past and Potential Testability of the Theory," *Journal of Financial Economics*, 1977, Vol 4, pp. 129-176.

———— . "Industrial Structure and the Comparative Behavior of International Stock Market Indices, *Journal of Finance, 1992, Vol* 47, pp. 3-42.

————, and Stephen Ross . "An Empirical Investigation of the APT," *Journal of Finance, 1980,* Vol 35, pp. 1073-1103.

Solnik, Bruno H. "International Pricing of Risk : An Empirical Investigation of the World Capital Market Structure," *Journal of Finance*, 1974, pp. 365-378.

————. "Testing International Asset Pricing : Some Pessimistic Views," *Journal of Finance,* 1977, Vol 32, pp. 503-511.

————. "International APT," *Journal of Finance*, 1983, Vol 38, pp. 449-457.

———— . "Pricing Capital Assets in an International Setting : An Introduction," *Journal of International Business Studies,* 1984, pp. 55-73.

Stulz, Rene M. "A Model of International Asset Pricing," *Journal of Financial Economics,* 1987, Vol 9, pp. 383-406.

Theodossiou, Panayiotis, and Unro Lee. "Mean and Volatility Spillovers Across Major National Stock Markets : Further Empirical Evidence," *Journal of Financial Research,* 1983, Vol 16, pp. 337-351.

Wheatley, Simon. "Some Tests of International Equity Integration," *Journal of Financial Economics*, 1987, Vol 21, pp. 177-212.