

## A TEST OF THE MULTI-FACTOR ASSET PRICING MODEL IN KOREA

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*This paper tries to find several macroeconomic factors generating stock market rates of returns and to test whether the macroeconomic factors are priced in order to study the relationship between financial market and the macroeconomy. It is shown that there exist six or seven macroeconomic factors such as bond premium, claims on government of money supply, and etc., and that these factors are priced in Korean stock market.*

### I. INTRODUCTION

As an alternative pricing model to the Capital Asset Pricing Model (hereafter, CAPM), the Arbitrage Pricing Theory (hereafter, APT) has generated considerable theoretical and empirical interest among financial economists.

In recent years, much work on the APT has focused on problems of testing the model and finding macroeconomic factors, by replacing the unknown random factors of the factor analysis with economy-wide macroeconomic variables. McElroy and Burmeister[15] states that the factor analysis approach to testing the APT contains the following economic and econometric problems:

1. If the errors in the APT are not jointly normal, the properties of the estimators for the factor loadings (factor risks) obtained from the factor analysis are unknown.
2. The estimates of the factor loadings are not unique.
3. If the factors are ordered by eigenvalues for two different data sets, there is no guarantee that factor one for the first portfolio will be the same as factor one obtained for the second portfolio.
4. The estimated risk prices as well as their statistical significance are not invariant with respect to the arbitrary partitioning of assets into portfolios.

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5. The factor scores and hence the associated risk prices do not have any straightforward economic interpretation.

The purpose of this paper is to find the macroeconomic factors which generate stock market rates of returns and to study the relationship between them in the Korean stock market. Especially, we prepare a procedure to select factors objectively rather than *ad hoc* and to test whether they are priced.

First, we judge factor number by inter-battery factor analysis and test whether factors are same between two subgroups by five hypotheses. The purpose of this test is not to verify the APT, but to select proper portfolio groups. At this stage, portfolio groups are made using a cluster analysis method. In judging factor number, we consider Akaike Information Criterion in addition to  $\chi^2$ -statistic.

Second, we consider correlation coefficients between factors of selected portfolio groups and innovations of macroeconomic variables to choose macroeconomic factors which can be regarded as most relevant factors. In order to get innovations of macroeconomic variables, we use residuals of the state space model since they are considered to be white noise. Since estimated factor loadings are unique only up to a rotation method, factor scores are obtained by Generalized Least Square method after factor rotation. The Procrustes method is used, as the rotation method.

Third, we test whether the macroeconomic factors are priced by a two-step process which include time-series and cross-section regressions.

In fact, this kind of study which relates macroeconomic factors to stock rates of return originated with studies such as Merton[16], Fama[11], and Gertler and Grinols[12]. In his intertemporal Capital Asset Pricing Model (CAPM), Merton [16] shows that economy-wide state variables affecting investors' earnings opportunities can influence equilibrium security returns. Then Fama[11] and Gertler and Grinols[12] investigate more specifically the relationship between common stock returns and macroeconomic variables, such as inflation, real activity, unemployment and money.

Chen, Roll and Ross[17], Shanken and Weinstein[19], Chan, Chen and Hsieh[6] and McEloy and Burmeister[15] continue this work, by systematically testing whether different macroeconomic variables can explain stock market returns. They study portfolios in order both to make the residual variance small and to make factor risk( $\beta$ ) more stable. More specifically, they analyze portfolios formed on the basis of firm size, to improve the discriminatory power of the cross-sectional regression test.

On the other hand, Sweeney and Warga[21] and Stambaugh[20] use industry portfolios to investigate whether the interest-rate risk for regulated industries is priced in the two factor APT and to examine the sensitivity of the CAPM to different sets of returns.

This paper is organized as follows. Section one contains a general introduction. Section two described the procedure to select macroeconomic factors to test

the APT. Section three contains the main results of our analysis. We presents the cross-sectional regression results of the model. Section four summarizes our findings for the number of factors and the test of the multi-factor asset pricing model.

## II. THE SELECTION OF MACROECONOMIC FACTORS

### 1. The Data

The sample stocks consist of common stocks traded in the Korea Stock Exchange from January 1980 to December 1989. The monthly stock rates of returns were obtained from the Ssangyong Investment & Securities Company data file. These rates of returns were adjusted to reflect the effect of capital increase. In total, we considered 287 stocks and 120 trading months.

We consider as many macroeconomic factors as possible, and thus includes 73 factors in our study. These data are obtained from the Bank of Korea data file and listed in appendix. We use monthly data from January, 1981 to December, 1989. In order to make the factors stationary, we transformed the raw data into increase rates except interest rate on time deposit, interest rate on loans, and risk. Bond premium is the difference between yield of corporate bonds and that of national housing bonds where the latter is the proxy of national bonds. However, we do not consider the term structure of interest rate because of the lack of data in the Korean market.

One of the pitfalls in the study by Roll and Ross [17] is that their methodology has a problem of factor comparability. That is, the estimated factor loadings are unique only up to an orthogonal transformation and thus if one were to carry out separate factor analyses for each group, it would be necessary to verify whether the factors were the same across different groups before making any generalizations over the entire sample. So, Brown and Weinstein[4] attempted to compare the factors from two different groups.

We try to solve this factor comparability problem by using inter-battery factor analysis rather than a traditional factor analysis. Inter-battery factor analysis was first introduced by Tucker[22] and later improved by Browne[5]. Since this analysis allows us to concentrate only on a submatrix, we can employ a larger set of securities than those used by a traditional factor analysis.

In fact, this kind of study originated with Cho[9]. In his paper, "On Testing the Arbitrage Pricing Theory: Inter-Battery Factor Analysis," Cho[9] showed that there are five or six inter-group common factors that generate daily returns for two industry groups of securities. He selected 22 portfolio groups by industry based on the "Standard Industrial Classification"(SIC) code.

Our study differs from that of Cho[9] in three points. First, we make portfolios using the clustering analysis method with average distance rather than traditional industry classification. The homogeneity of each portfolio is needed in using inter-

[Table 1] Portfolio Groups by Clustering Analysis

Group Order	Number of Stocks	Representative Industries
1	26	• Financial Institutions
2	33	• Construction
		• Wholesale & Retail Trade
3	35	• Manufacture of Fabricated Metal Products, Machinery & Equipment
		• Manufacture of Chemical, Petroleum, Coal Rubber & Plastic Product
4	23	• Manufacture of Fabricated Metal Products, Machinery & Equipment
5	31	• Pharmaceutic Industry
		• Manufacture of Foods & Beverage
6	47	• Manufacture of Non-Metalic Mineral Products
7	48	• Financial Institutions
		• Manufacture of Non-Metalic Mineral Products
8	44	• Wholesale & Retail Trade

battery factor analysis, and such a property can be obtained successfully using the clustering analysis method. The portfolio groups formed by this method are summarized in table 1.

Second, there is an improvement over Cho[9] in that we consider the Akaike's Information Criterion (Akaike[2]) as well as the likelihood ratio for the goodness of the test of the model, since the likelihood ratio criterion uses the arbitrary significance level. The number of factors is judged to be six or seven by the likelihood ratio with 0.1 significance level and by the AIC.

Third, Cho[9] performed cross-sectional tests by comparing the risk-free rate and the risk premia between two different groups using the Chow test in order to verify the validity of the APT. These tests, however, can give insight only on the number of economy-wide factors. Accordingly, we use these tests to choose the appropriate portfolios which satisfy all of following hypotheses: first, that the risk-free rate is the same between two groups; second, that the risk premia are the same between two groups; fourth, that the risk-free rate is different from zero while the risk premia are constrained to be the same between two groups; and finally that the risk-free rate is different from zero while the risk premia are allowed to differ between two groups. We selected five out of 28 samples (See table 2).

[Table 2] Selected samples which accept all hypotheses

Selected Samples (Group Group)	# of Samples
1-2, 1-4, 1-5, 2-4, 2-5	5

## 2. Expectations by State Space Model

The risk of an asset is usually quantified by its comovements with the unanticipated changes in state variables. In macroeconomic studies, measures of expectations are usually generated by assuming that agents form their expectations from an autoregressive model (AR model) or an autoregressive model mixed with a moving average (ARMA) model, involving agents' lagged values of those macro-variables. However, here we use a state space model to measure expectations.

Since ARMA model belongs to an univariate time series model, it considers only its own past. However, each economic factor may depend on past values of all of the series. The state space model represents the vector time series as a first-order process in terms of the *state vector*. The state vector is a set of linear combinations of past and present values of any of the time series that contains all information useful in predicting future values of any of the time series. That is, the state space model belongs to multivariate time series model, and considers the present and past values of all of the series. So, it is preferable to use state space model in order to measure expectations of macro-variables.

The state space representation of a stationary multivariate time series  $y_t$  of dimension  $p$  is of the form:

$$(1) S_t = AS_{t-1} + G e_t$$

where  $S_t$  is a vector process of dimension  $q$ , whose first  $p$  component  $y_t$  and whose remaining components contain all additional information to forecast future values of  $S_t$ ;  $A$  is an  $q$  by  $q$  transition matrix;  $G$  is an  $q$  by  $p$  input matrix; and  $e_t$  is a sequence of independent  $p$  dimensional random vectors called innovations with common variance matrix and mean zero.

The autocorrelations in the macroeconomic state-variables imply the existence of an errors-in-variables problem that will bias estimates of the factor loadings. So the innovations should be white noise. Since the residuals of state space model are white noise process with mean vector zero, these can be used as innovations.

If we include all these macroeconomic factors, they can lead to multi-collinearity. Additionally, the length of observations is too short in comparison with the number of macroeconomic factors. So we divide these factors into five groups.

Since the factors in the same group should have as small correlations to one another as possible, we group the macroeconomic factors using the clustering analysis method, choosing the factors systematically and forming five groups. To explain it more concretely, the procedure is as follows:

First, we divide the factors into 20 groups using the average linkage method of the clustering analysis. The frequency of each group ranges from 1 to 22. Second, we number the elements of group from one to five serially, and finally, we use these numbers to recognize belonging factors.

### 3. Selection of Macroeconomic Factors by Rotated Factors

Like the solution of a standard factor analysis, that of the inter-battery factor analysis is unique only up to a rotation. The initial loadings are obtained by restricting the factors to be orthogonal and to be arranged in a descending order of importance. These two restrictions are necessary in order to obtain a particular solution. Hence, one can rotate the initial factor loadings to derive a simple and meaningful factor structure.

There are many ways to obtain a simple and meaningful factor structure. However we choose the Procrustes rotation method which is an oblique rotation rather than an orthogonal rotation, because our primary purpose of factor rotation is to find the most relevant macroeconomic factors. If part of the identification conditions are that the factor moment matrix is an identity matrix, then we may obtain a different factor loading matrix from the true one. If the factor loadings are tuned to the target loadings which may represent the true one, however, we may obtain true factor loadings although their factor scales are not orthogonal. Besides, we made the target loadings by clustering the innovations and regressing the stock rates of returns on the averages of clustered innovations.

In detail, the procedure to rotate the factor loadings is as follows: First, we group economic innovations into seven clusters by cluster analysis with average distance, and then obtain averages of within-cluster variables. Each averaged factor is weakly correlated with the others. Second, stock rates of returns are regressed on the averaged factors, and the resulting parameters constitute the target loadings. Third, factor loadings are rotated by the Procrustes constitute the target loadings. Fourth, we come by factor scores of the rotated factor loadings. Since the residual covariance of inter-battery factor model is block diagonal, we should utilize generalized least square regression. The covariance matrix of residuals,

[Table 3] The Frequent Economic Factors

Order	Economic Factors(Innovations)	Frequency
1	Index of Labor Cost Per Unit of Output, Manufacturing(ULABOR)	9(25.7%)
2	Producers Inventory Indexes, Manufacturing(MANINV)	7(20.0%)
3	Producers Shipment Indexes, Manufacturing(MANSHIP)	7(20.0%)
4	Bond Premium(RISK)	6(17.1%)
5	Wholesale Price Index(WPI)	6(17.1%)
6	Export Price Index(EXPI)	6(17.1%)
7	Wholesale and Retail Trade Indexes(WRTRAD)	5(14.3%)
8	Claims on Government(GOVS)	5(14.3%)
9	Deposits at Deposit Monetary Banks, End of(DEPDMBE)	5(14.3%)
10	Yields of Corporate Bonds(YCORB)	5(14.3%)

\* There are five portfolio groups selected and each group has seven factors. So there are 35 correlation coefficient for each macroeconomic factor. Frequency 9(25.7%) means nine of correlation coefficients are greater than 20% of the 35 samples.

however, is not known. Thus it is estimated by factor loadings. Finally, we compute the correlations between the rotated factors and innovations of macroeconomic factors. The values of correlations range from 0% to 62.1% in absolute value. In order to choose the relevant macroeconomic factors, we count the numbers that the absolute value of correlation is greater than 20% all through the portfolio groups. The first tenth frequent factors are listed in the table 3.

Since some factors belong to the same clusters in clustering analysis of section 2.3, we choose as the six factors ULABOR, MANINV, RISK, EXPI, YCORB, GOVS. The Korean Composite Stock Price Index, End of (STOPRE) has great correlation coefficient in some portfolio groups and in other rotation methods. Thus we select seven factors including STOPRE. For the six factor model, we exclude GOVS because it is relatively highly correlated with ULABOR.

### III. A TEST OF THE MULTI-FACTOR ASSET PRICING MODEL WITH THE PRESPECIFIED MACROECONOMIC FACTORS

#### 1. The Model

Assuming that linear factor model is valid and that the Arbitrage Pricing Theory(APT) is true,

$$(2)^1 \quad r_t = \mu + \beta_t f_t + e_t$$

and

$$(3) \quad \mu_t = \lambda_{0t} + \beta_t \lambda_t$$

where  $r_t$  is a vector of returns on industry portfolios,  $\mu$  is a vector of expected returns on industry portfolios,  $\beta_t$  is a matrix of factor risks,  $f_t$  is a vector of macroeconomic factors,  $\lambda_{0t}$  is "zero-beta" portfolio rates of return,  $\lambda_t$  is a vector of risk premia, and  $e_t$  is a vector of residuals. Using equations (2) and (3), rates of return can be specified as

$$(4) \quad r_t = \lambda_{0t} + \beta_t \lambda_t + (\beta_t f_t + e_t)$$

This equation (4) can be rewritten as follows:

$$(5) \quad r_t = \lambda_{0t} + \beta_t \lambda_t + \eta_t$$

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<sup>1</sup>As was pointed out by one referee, lagged variables of macrofactors  $f_t$  are very important. However, our paper focuses on the selection of macro factors, not the lagged variables. And explanatory variables are innovations, not the levels, so the autocorrelation problem of  $f_t$  is not serious. Also model specification problem is too general to be specific only in this model.

where  $\eta_t = \beta_t f_t + e_t$

If  $f_t$  were unknown, it would be natural to estimate  $\lambda_t$  by a generalized least squares (GLS) cross-section regression of  $r_t$  on  $\beta_t$ . If the number of securities in the cross section is large,  $\hat{\lambda}_t \approx \lambda_t + f_t$ . Consequently, the standard error of  $\hat{\lambda}_t$  is large; it is difficult to reject the null hypothesis  $\lambda_t = 0$ .

Chen, Roll and Ross[7], Chan, Chen and Hsieh[6] and Shanken and Weinstein[19] handle this problem by looking at the entire series of estimates  $\hat{\lambda}_t$ . They test whether the sample mean of the  $\hat{\lambda}_t$  is significantly different from zero. If so, they say that the factor is "priced." However, they can say little about how  $\hat{\lambda}_t$  depends on  $t$ . Alternatively, McElroy and Burmeister[15] utilized the iterated nonlinear seemingly unrelated regressions (ITNLSUR) methods to get joint estimates of asset sensitivities ( $\beta_s$ ) and their associated risk prices ( $\lambda_s$ ).

We resolve this problem in a superior way. For each  $t$ , we use ordinary least squares (OLS) to estimate the second-step cross-section regression as follows. That is, since we assumed that macro-factors ( $f_t$ ) are known, we perform the second-step OLS regression using the equation (6):

$$(6) \quad r_t = \beta_t f_t = \lambda_0 + \beta_t \lambda_t + e_t$$

If the number of securities in the cross-section is large,  $\hat{\lambda}_t \approx \lambda_t$ ;  $\hat{\lambda}_t$  measures  $\lambda_t$  very accurately.

More specifically, we first regress each of stock returns on the macroeconomic variables in the first five years to estimate the factor risks ( $\beta_t$ ) which are called betas. Then we perform the cross-sectional regressions of the differences between the stock returns and their factor risks multiplied by the factors themselves on the stocks multiple betas which are estimated in the first step. This second-step regression is performed in the first month of the sixth year.

These procedures are repeated with the intervals overlapped for period, March, 1981 through December 1989 month by month. The reason why the starting period is March, 1981 is that the total intervals are diminished in stabilizing the time series when we obtained innovations.

From this model of the equation (6),  $\text{Var}(\hat{\lambda}) \approx 0$  if the number of securities is large, since the  $e_t$  are uncorrelated across securities. Therefore, this way of estimation should get a very accurate estimate of true  $\lambda$ . On the contrary, like the model of equation (5), the previous means of estimation of  $\lambda$  gives an inaccurate estimate of true  $\lambda$  since  $\text{Var}(\hat{\lambda}) \approx \text{Var}(\bar{f})$ , which is large.

And since  $\mu = \lambda_0 + \beta \lambda$  by the APT, expected values of OLS estimated risk premia,  $E(\hat{\lambda})$ , will be



$$\begin{aligned}
 (7) \quad E(\hat{\lambda}) &= \frac{\text{Cov}(\mu + e, \beta)}{\text{Var}(\beta)} \\
 &= \frac{\text{Cov}(\lambda_0 + \beta\lambda + e, \beta)}{\text{Var}(\beta)} \\
 &= \lambda
 \end{aligned}$$

Therefore estimated risk premia,  $\hat{\lambda}$ , will be unbiased. That is, the estimated  $\hat{\lambda}_t$  by our model is  $\lambda_t$ , whereas the  $\hat{\lambda}_t$  is  $\lambda_t + f_t$  by the model of Chen, Roll and Ross[7], Chan, Chen and Hsieh[6] and Shanken and Weinstein[19], if the number of securities is large. In this sense, our model has more information than the previous model. Therefore, we can estimate risk premia more accurately.

## 2. The Results

We chose as the seven macroeconomic factors ULABOR, MANINV, RISK, EXPI, GOVS, YCORB, STOPRE. In order to obtain innovations, we use the state space model. Individual stock returns can be specified as a linear factor model as follows:

$$\begin{aligned}
 (8) \quad r = &\alpha + \beta_{\text{ULABOR}} \text{ULABOR} + \beta_{\text{MANINV}} \text{MANINV} \\
 &+ \beta_{\text{RISK}} \text{RISK} + \beta_{\text{EXPI}} \text{EXPI} + \beta_{\text{GOVS}} \text{GOVS} \\
 &+ \beta_{\text{YCORB}} \text{YCORB} + \beta_{\text{STOPRE}} \text{STOPRE} + \varepsilon
 \end{aligned}$$

We refer to each beta as the “factor risk” on the economic state-variable. The intercept  $\alpha$  is the expected rate of return. And  $\varepsilon$  is an idiosyncratic error term. The seven economic variables refer to the innovations, not the levels.

For the six macroeconomic factors, the linear factor model is as follows:

$$\begin{aligned}
 (9) \quad r = &\alpha + \beta_{\text{ULABOR}} \text{ULABOR} + \beta_{\text{MANINV}} \text{MANINV} \\
 &+ \beta_{\text{RISK}} \text{RISK} + \beta_{\text{EXPI}} \text{EXPI} + \beta_{\text{YCORB}} \text{YCORB} \\
 &+ \beta_{\text{STOPRE}} \text{STOPRE} + \varepsilon
 \end{aligned}$$

Since the bias occurring from the nonzero expected values of estimated risk premia of economic factors is eliminated, we can compare the results month by month, March, 1986 through December, 1989. In table 4, all seven factors, ULABOR, MANINV, RISK, EXPI, GOVS, YCORB and STOPRE are “priced” in the sense that of the 46 values of risk premia, the percentages which are significant at the 90 percent level (about 65.2%, 58.7%, 65.2%, 60.9%, 73.9%, 60.9%, 67.4% for ULABOR, MANINV, RISK, EXPI, GOVS, YCORB and STOPRE respectively.) exceed the 10 percent that would occur by chance alone. In table 5, all six factors are “priced,” too. About 65.2%, 60.9%, 63.1%, 63.1%, 63.1%, 60.9% of ULABOR, MANINV, RISK, EXPI, YCORB and STOPRE respectively are significant at the 90 percent level. (See table 4 and 5).

[Table 4.] Result of Seven Factor Model

	ULABOR	MANINV	RISK	EXPI	GOVS	YCORB	STOPRE	F	R-SQUARE
Mean	-0.002	0.006	-0.154	-0.002	0.636	-0.008	-0.018	24.64	0.343
	3.055	2.502	3.328	3.073	4.185	3.583	3.492	-	-
Priced Percent	65.2	58.7	65.2	60.9	73.9	60.9	67.4	-	-

\*The first row shows the averages of coefficients from the cross-sectional regression and second row shows the averages of absolute value of t-statistics.

[Table 5] Results of Six Factor Model

	ULABOR	MANINV	RISK	EXPI	YCORB	STOPRE	F	R-SQUARE
MEAN*	-0.003	0.003	-0.184	-0.002	-0.009	-0.019	23.35	0.291
	2.834	2.757	3.382	3.197	3.577	3.711	-	-
Priced Percent	65.2	60.9	63.1	63.1	63.1	60.9	-	-

\*The first row shows the averages of coefficients from the cross-sectional regression and the second row shows the averages of absolute value of t-statistics.

Furthermore, all of pricing factors are significant based on the F statistics although it is not presented in the tables. If we consider R-squares, recent months tend to have higher values. Especially, more than half months in 1989 had R-square values that were greater than 40%. This implies that the stocks become more sensitive to macroeconomic factors as time passes.

In a study of the United states market, Cheong[8] used term structure variable(UTS), risk premium(URP), forecasting errors of inflation(INFL), forecasting errors of industrial production(INPD), S&P500 Index Variable(S&P500) as macroeconomic factors. Cheong[8] showed that 44%, 35%, 38%, 29%, and 31% of UTS, URP, INFL, INDP and S&P500 respectively are significant at the 90 percent level. Any priced percentage in the U.S. market is not greater than that in Korean market. This implies that stocks in Korean market are more related to the macroeconomic factors than in the U.S. market. The reason seems to be that pricing of stocks in the Korean stock market is not as efficient as in the U.S. stock market<sup>2</sup>.

#### IV. CONCLUSIONS

In this paper, we try to find macroeconomic factors generating stock market rates of returns and to test whether the macroeconomic factors are priced in order

<sup>2</sup>Of course, the economic system of U.S is different from that of Korea in many respects such a economic structure, government policy and etc. So the difference should be considered when we judge the efficiency of the market as was pointed out by one referee. However, the quantification of those qualitative variables is so difficult that only rates of return data are generally used for the judgement.

to study the relationship between financial market and the macroeconomy in Korea.

We select six and seven macroeconomic factors in section two. In order to choose these factors, we utilize inter-battery factor analysis, clustering analysis and the state space model.

First, using the method of the inter-battery factor analysis, an alternative to standard factor analysis, we find that the number of common factors is six or seven. Portfolios are formed by the clustering analysis method since the stocks within groups need to be homogeneous. In judging factor numbers, we also use the Akaike's Information Criterion(AIC) as an subsidiary criterion to avoid the arbitrariness of the significance level. We also test whether the factors are same between two subgroups by five hypotheses. We try it in order to select portfolios which fit with the purpose of our study, not to test validity of APT. We selected five of the 28 samples to choose the relevant macroeconomic factors.

Second, factor loadings are rotated by the oblique Procrustes rotation and factor scales are obtained by generalized least square(GLS) regression. We use such an oblique method so that we may obtain true factor loadings if the factor loadings are tuned to the target loadings which may represent the true one. The GLS regression is used in obtaining factor scales because the residual covariance of inter-battery factor model is block diagonal.

Third, we get innovations of macroeconomic factors by using the state space model. The state space model belongs to multivariate time series model, and considers present and past values of all of the series while ARMA is univariate model and considers only its own past. We try to include as many macroeconomic factors as possible in our study.

Finally, we compute the correlations between the rotated factors and innovations of macroeconomic factors. The values of correlations range from 0% to 62.1% in absolute value. In order to choose the relevant macroeconomic factors, we count the numbers that the absolute value of correlation is greater than 20% all through the portfolio groups. We choose ULABOR, MANINV, RISK, EXPI, GOVS, YCORB and STOPRE as the seven factors, but we excluded GOVS from the six factors.

In section three, we test whether the factors are priced. The results are that all of the six and seven factors are priced and that the stock returns are explained better by those factors in recent months if we consider the R square. The percent value of priced factors are greater in the Korean stock market than in the U.S. market. We can say that the results can be explained as follows: First, the stocks become more sensitive to macroeconomic factors as the time passes in Korean stock market. Second, stocks are more related with the macroeconomic factors in Korean market than in the U.S. market. The reason seems to be that pricing in the Korean stock market is not as efficient as in the U.S. stock market.

In future work, we hope that we can compare the result of other rotation methods. By Varimax method, for example, other economic factors can be selected

and the result can be compared with our work.

## APPENDIX

### Macroeconomic Factors

Fields	Macroeconomic Factors
Money & Banking	Bank Notes & Coins Issued(End of, Averages) Reserve Money(End of) M1(End of, Averages) M2(End of, Averages) M3(End of) Money Supply by Sector: Domestic Credit Claims on Government Claims on Private Sector Foreign Sector Foreign Asset Foreign Liability Other Sector Deposits at Deposit Monetary Banks(End of, Averages) Time & Savings Deposits at Deposit Monetary Banks(End of) Demand Deposits at Deposit Monetary Banks(End of) Deposits at Bank of Korea(End of, Averages) Loans of Deposit Monetary Banks(End of, Averages) Interest Rate on Time Deposits at National-Wide Commercial Banks Yields of Corporate Bonds Yields of Dishonored Bills Ratio of Dishonored Bills Turnover Ratio of Demand Deposits, National-Wide Commercial Banks
Industry	Industrial Production Indexes(All Items, Capital Asset, Manufacturing) Producers Shipment Indexes(All Items, Manufacturing) Producers Inventory Indexes(All Items, Manufacturing) Manufacturing Production Capacity Index Manufacturing Operation Ratio Index Permits Authorized for Building Construction Domestic Construction Orders Received Machinery Orders

Fields	Macroeconomic Factors
Employment & Wages	Wholesale and Retail Trade Indexes
	Manufacturing Inventory Index
	Employed(Total, Manufacturing)
	Wages(Total, Manufacturing)
	Accession Rate, Manufacturing
	Index of Labor Cost per Unit of Output, Manufacturing
	Index of Workers, Manufacturing
Prices	Monthly Hours Worked of Production Workers, Manufacturing
	Wholesale Price Index
	Consumer Price Index
	Export Price Index
	Import Price Index
Foreign trade & Exchange	Exports
	Imports
	Exchange Rates of Won to U.S. Dollar
	Exchange Rates of Won to Yen
	Letters of Credit Arrival
	Current Balance
	Trade Balance
	Invisible Trade
	Unrequited Transfers
Business Indicators	Leading Composite Index of Business Indicators
	Coincident Composite Index of Business Indicators
	Lagging Composite Index of Business Indicators
Securities	Korean Composite Stock Price Index(End of, Averages)
	Average PER
	Dividend Yield Ratio
Bond Premium	Differences Between Yield of Corporate Bonds and that of
	National Housing Bond

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