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Asset Pricing Models in the Korean Stock Markets: A Review for the Period of 1980~2009

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Abstract

This paper reviews 30 years of empirical research on asset pricing models in the Korean stock markets. The validity of the Capital Asset Pricing Model (CAPM) has been seriously challenged in Korea as in the other countries. The overall empirical results in Korea show, as they do in other countries, that the static CAPM fails to explain for stock returns in Korea. Contrary to the prediction of the CAPM, firm characteristic variables such as firm size, book-to-market, and earnings-to-price ratio have significant explanatory power for average stock returns in the Korean stock markets. Because of these CAPM-anomalous phenomena, various asset pricing models such as the types of Arbitrage Pricing Theory (APT), the Consumption-based Capital Asset Pricing Model (C-CAPM), and the types of the Intertemporal Capital Asset Pricing Model (I-CAPM) have been introduced and tested in the literature. The Fama and French(1993) three-factor model is arguably acceptable in explaining Korean stock returns. This paper also provides some explanations of various testing methodologies used in the literature for asset pricing models and discusses the related econometric issues.

Keywords Asset Pricing Models, CAPM, Arbitrage Pricing Theory, Intertemporal CAPM, Consumption-based CAPM, Korean Stock Markets

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Ⅰ. Introduction

Since the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), and Black (1972) was developed, this model has become a backbone of financial economics. The CAPM provides an easy and simple framework about how to measure risk and the relation between expected return and risk. Almost 45 years after its introduction, the CAPM is still widely used in the field in estimating cost of capital for firms and discount rates for project cash flows and evaluating the performance of managed portfolios, etc. (see the survey results by Graham and Harvey (2001) for the U.S.). Nonetheless, since its introduction, the validity of the CAPM has been seriously challenged in Korea as well as in other countries. In the unconditional model of the traditional Sharpe-Lintner-Black CAPM, expected returns and market betas are assumed constant. However, there is no justification for the idea that expected returns and betas should be constant. Since corporate investment and the financial decisions of a firm could affect investors' expected return of the firm and its systematic risk and since macroeconomic conditions change over time, betas and the market risk premium can be time-varying. In fact, numerous papers empirically show the time-varying behavior of market betas and the market risk premium. In order to capture this time-varying behavior (or non-stationarity) of market betas and the market risk premium, various versions of the conditional CAPM have been suggested in the literature.

The arbitrage pricing theory (APT), formulated by Ross (1976), is considered an alternative pricing model to the CAPM. The APT is less restrictive than the CAPM in that it applies in both single-period and multi-period settings. Further, it does not require that the market portfolio be mean-variance efficient, which is a critical condition for the CAPM. The APT requires an assumption that markets are perfectly competitive and investors' utility functions are monotonically increasing and concave. Although the APT seems more robust compared to the CAPM in many respects, it has two problems. First, the theory provides no clue as to the number of factors. Second, even though the number of factors is known, the daunting task of identifying the risk factors remains. Thus, many researchers attempt to estimate the number of factors and to empirically identify these factors. This paper reviews the various models of the APT suggested in the Korean literature.

One of the assumptions about the CAPM open to criticism is that the CAPM is a static single-period model. That is, all investors have the same holding period and maximize their expected utility of returns over a one-period planning horizon. This means that the trading horizon, the decision horizon, and the planning horizon are all assumed to be equal to each other and to be of the same length for all investors. Critics argue, however, that investors make their investment decisions intertemporally by maximizing their multi-period utility of lifetime consumption, rather than choosing their portfolios according to the Markowitz mean-variance criterion to maximize their single-period utility. Merton (1973) argues that if preferences and future investment opportunity sets are state dependent, investors need an equilibrium model accommodating portfolio selection behavior for intertemporal utility maximization. Merton suggests a multi-period version asset pricing model, called the Intertemporal Capital Asset Pricing Model (I-CAPM).

Rubinstein (1976), Lucas (1978), and Breeden (1979) employ a different approach to obtain investors' equilibrium expected return. These authors assume that investors maximize the expected value of a time-additive and state-independent lifetime utility function. In a situation in which an investor (or a representative agent) has the intertemporal choice problem of maximizing expected utility which depends only on current and future consumption, an asset's risk premium depends on the covariance between the asset's return and the aggregate consumption growth rate. This is the Consumption-based CAPM (C-CAPM). The above two intertemporal models (I-CAPM and C-CAPM) are different from the model for a single-period utility maximizer such as the CAPM.

This paper reviews 30 years of empirical research on the above-mentioned asset pricing models in the Korean stock markets. It provides some explanations of the testing methodologies used in the literature for the asset pricing models. It cites articles published in finance-related journals in Korea after 1990, since most of these articles report results covering the 1980's there are few articles on asset pricing models published prior to 1990. For the non-Korean stock markets (mostly the U.S. markets), I cite only the most important articles. However, I cite these articles only if they are needed to explain the asset pricing models and to review the Korean articles. Thus, I try to minimize the reference list of such articles.

This paper proceeds as follows: Section Ⅱ reviews the literature on the CAPM, both unconditional and conditional, and explains the testing methodologies. Section Ⅲ reviews the literature on the APT models, and Sections Ⅳ and V explain and review the published works on the C-CAPM and I-CAPM, respectively. Section Ⅳ sets forth a discussion and conclusions.

Ⅱ. The Capital Asset Pricing Model (CAPM)

The CAPM implies that the expected return on asset *i*, $E(R_i)$, is a linear function of its systematic risk as represented by β_i. Equation (1) summarizes the CAPM more succinctly:

$$E(R_i) = r_f + [E(R_m) - r_f]\,\beta_i \tag{1}$$

where β_i is the market beta representing systematic risk of asset i, r_f is the riskless rate of return, and $E(R_m)$ is the expected return on the market portfolio. Note that when there is no riskless borrowing and lending, the riskless rate of return is substituted with the expected return on the zero-beta portfolio, which is unrelated to the market portfolio (Black 1972). Each expected return can be interpreted as the appropriate discount rate, cost of capital, or equilibrium rate of return that investors should expect for that amount of systematic risk.

The CAPM is a mathematically perfect model. However, as with all models, many unrealistic assumptions are used in its derivation. This is why the model must be tested against data. The following two sections explain two primary testing methodologies used in the literature: time-series regression and cross-sectional regression (CSR) tests.

1. Time-Series Tests of the CAPM

The ex post form of the CAPM in equation (1) can be represented as

$$R_{it} - r_{ft} = \alpha_i + \beta_i (R_{mt} - r_{ft}) + \epsilon_{it} \quad (2)$$

or

$$r_{it} = \alpha_i + \beta_i r_{mt} + \epsilon_{it} \quad (3)$$

where $r_{it} = R_{it} - r_{ft}$ and $r_{mt} = R_{mt} - r_{ft}$ are returns in excess of the risk-free rate of return r_{ft} on asset i and the market portfolio m, respectively, and ϵ_{it} is the idiosyncratic term with mean zero and variance $\sigma^2_{\epsilon i}$. If the CAPM is valid, the intercept term α_i should be zero for all assets. The Sharpe-Lintner-Black version of the CAPM predicts that the market portfolio is mean-variance efficient. Therefore, the test for the validity of the CAPM is equivalent to the test for the mean-variance efficiency of the market portfolio.[1)]

1) According to Roll (1977), however, this hypothesis cannot be tested since the true market portfolio cannot be

In this circumstance, the only practical empirical test of the CAPM is narrowed to a test of whether a given proxy for the market portfolio is a valid surrogate. That is, to test whether a given market proxy is mean-variance efficient. Therefore, the mean-variance efficiency test for a given market proxy is equivalent to testing the null hypothesis $H_0 : \alpha_i = 0$ for $i = 1, \cdots, N$, where N is the number of test assets.2)

The first extensive study on the mean-variance efficiency of the Korean stock market indexes is conducted by Hwang and Lee (1991). These authors consider four Korean indexes: Korea Composite Stock Price Index (KOSPI), Hankyung-Dow Stock Index, the equally-weighted stock index, and the value-weighted stock index. They also use two sets of test assets: 14 industry portfolios and 20 beta-sorted portfolios. Over the test period from January 1981 through June 1988, they report individual *t*-test statistics of the intercept estimates of the test assets, $\hat{\alpha}_i$, for each of the four market indexes. When KOSPI and Hankyung-Dow Stock Index are used as a proxy for the market portfolio, 12 out of 14 industry portfolios have significantly different intercept estimates from zero. Whenthe equally-weighted and value-weighted stock indexes are used, none of the intercept estimates are significant. Their testing procedure is based on Black, Jensen, and Scholes (1972).

Hwang and Lee's (1991) individual *t*-tests assume that the intercept estimates are independent across test assets. However, insofar as the same explanatory variable is used in estimating the intercept α_i, the independence assumption is not valid. To avoid this problem, Gibbons, Ross, and Shanken (GRS) (1989) suggest a joint test for the null hypothesis $H_0 : \alpha = (\alpha_1,\ \alpha_2, \cdots, \alpha_N)' = 0$.

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observed. According to Roll (1977), only one potentially testable hypothesis associated with the CAPM is to examine if the true market portfolio is mean-variance efficient. All other hypotheses (such as there being a linear relationship between beta and expected return) can be shown to be redundant, given this main hypothesis.

2) To test the hypothesis, the estimation of parameters in asset pricing equations such as equation (2) or (3) is needed. The parameter estimation can be conducted by ordinary (or generalized) least squares (OLS or GLS), maximum likelihood estimation (MLE), or generalized method of moment (GMM) according to the form of the error term ϵ_{it}.

Assuming the error terms are jointly normally distributed with mean zero and nonsingular covariance matrix Σ, GRS suggest the following test statistic for the null hypothesis:

$$W = \left(\frac{T(T-N-1)}{N(T-2)}\right)\left[\frac{\hat{\alpha}'\hat{\Sigma}_{\epsilon}^{-1}\hat{\alpha}}{(1+\hat{\theta}^2)}\right] \sim F(N,\ T-N-1) \tag{4}$$

where $\hat{\Sigma}_{\epsilon}$ is the unbiased residual covariance matrix, θ is the ratio of average excess return on portfolio *m* to its standard deviation ($= \bar{r}_m / s_m$), which is the Sharpe ratio of the given market proxy portfolio *m*, N is the number of assets, and T is the number of time-series return observations.[3] Hwang and Lee (1991) also employ the above GRS test statistic to test the mean-variance efficiency of the four Korean indexes. These authors conclude that the mean-variance efficiency of KOSPI and Hankyung-Dow Price Index is rejected, while that of the equally-weighted and value-weighted stock indexes is not rejected, which is consistent with their individual *t*-tests results.

Song and Lee (1997) report different results for the mean-variance efficiency of KOSPI from Hwang and Lee (1991). These authors report that all intercept estimates of 13 industry portfolios are insignificant for the test period 1980~1995.[4] Kim, D. (2004) and Kim, D. and Shin (2006) also report test results for the mean-variance efficiency of KOSPI. Kim, D. (2004) presents test results over the period 1987-2002. When 25 size and book-to-market port-

3) When there are K factor portfolios in an asset pricing equation like equation (2), the GRS test statistic of equation (4) can be generalized as follows:

$$W = \left[\frac{T(T-N-K)}{N(T-K-1)}\right]\left[\frac{\hat{\alpha}'\hat{\Sigma}_{\epsilon}^{-1}\hat{\alpha}}{(1+\hat{\theta}^2)}\right] \sim F(N,\ T-N-K),$$

where $\hat{\Sigma}_{\epsilon}$ is the unbiased residual covariance matrix, $\hat{\theta}^2 = \bar{F}'\hat{\Sigma}_F^{-1}\bar{F}$ ($\hat{\theta}$ is the Sharpe ratio), $\bar{F}$ is a $K \times 1$ vector of average returns of the factor portfolios $(= (1/T)\sum_{t=1}^{T} F_t)$, $\hat{\Sigma}_F$ is the covariance matrix of the factor portfolio returns, N is the number of test assets, and T is the number of time-series return observations.

4) They do not report the intercept estimates although they used 25 size and book-to-market portfolios as another set of test assets.

folios are used as test assets, 21 out of 25 intercept estimates are significant, and the GRS test also rejects the mean-variance efficiency of KOSPI. On the contrary, Kim, D. and Shin (2006) report [the test period is 1988. 1 to 2004. 12] that when 10 size portfolios are used as test assets, 2 out of 10 intercept estimates are significant, and the GRS test does not reject the mean-variance efficiency of KOSPI. Even though the test periods are similar, the reason that the opposite test results are obtained is that the CAPM test could be sensitive to the choice of test assets.

Kandel (1984) and Shanken (1985) also suggest a multivariate test for the validity of the Black (1972) zero-beta CAPM, assuming the error terms are normally distributed. By applying their test approach, Koo (1995) conducts the test for the mean-variance efficiency of the Korean market indexes, assuming that the riskless asset does not exist. This author reports that the mean-variance efficiency of KOSPI and Hankyung-Dow Price Index is rejected in that their average returns are even lower than the average return of the global minimum variance portfolio (GMVP). However, the equally-weighted market index has higher average return than that of the GMVP and its mean-variance efficiency is not rejected. Koo's results are consistent with Hwang and Lee (1991).

Several points should be noted. The GRS test is valid when the disturbance terms are jointly normally distributed. Put differently, conditional on returns of a given market index, returns of test assets are jointly normally distributed. Note that the multivariate normality assumption of the disturbance terms drives a multivariate normality of the intercept estimates, $\hat{\alpha}$. However, there is ample evidence that asset returns are not normally distributed in Korea (e.g., see Koo (1998) among others), as well as in other countries. As long as a distributional form of the disturbance terms is known, the parameters can be estimated through maximum likelihood methods. Since maximum likelihood estimates are asymptotically normal, the GRS test statistic follows asymptotically an F-distribution, although the disturbance terms are non-normal. Thus, if the disturbance terms are non-normal, the use of the GRS test is limited when sample size (T) is small. With large sample size, however, the GRS test can be used even when the disturbance terms are non-normal. Like other multivariate tests such as the Hansen-Jagannathan (1997) distance test using the inverse of the covariance matrix, the use of the GRS test is limited as well when the number of test assets (N) is large relative to the time-series sample size (T).

2. Cross-Sectional Regression Tests of the CAPM

The Sharpe-Lintner-Black version of the CAPM also implies that the difference in expected return across assets should be explained solely by the difference in market beta, but other variables, such as firm characteristic variables, should add no explanatory power for expected return. This implication is key in tests of the CAPM, and it leads to the CSR tests.

Unlike the implication of the CAPM, U.S. data shows that stock returns have a regular pattern across variables other than market beta. The most prominent firm characteristic variables that challenge the validity of the CAPM are firm size and book-to-market. Banz (1981) and Reinganum (1981) report that small firms earn considerably higher returns than large firms even after adjusting for beta risk. This phenomenon has since been dubbed "the size effect". This is cited as one of the strongest market anomalies against the CAPM. Stattman (1980), Rosenberg, Reid, and Lanstein (1985), and Fama and French (1992) report that firms with high book-to-market earn considerably higher risk-adjusted returns than firms with lower look-to-market. This phenomenon is also dubbed "the book-to-market effect".

To test the validity of the CAPM and the size and book-to-market effects, the following Fama and MacBeth's (1973) CSR model is estimated at time t:

$$r_{it} = \gamma_{0t} + \gamma_{1t} \hat{\beta}_{it-1} + \gamma_{2t} \ln \mathrm{ME}_{t-1} + \gamma_{3t} \ln \mathrm{BM}_{t-1} + \epsilon_{it} \tag{5}$$

where r_{it} denotes the excess return on asset i in month t, $\hat{\beta}_{it-1}$ is the market beta of asset i estimated from the first-pass market model by using return observations available up to month $t-1$, ME is the market capitalization of asset i (stock price per share times the number of common shares outstanding), and BM is the ratio of book value to market value of common equity. Note that time subscript $t-1$ does not necessarily mean precisely time period $t-1$. Rather, it means the period prior to the estimation time period t. One useful feature of this methodology is that the risk premiums (or gammas) are implicitly allowed to be time varying.

Each month over the test period, the CSR model of equation (5) is estimated. Thus, estimates of the CSR coefficients, $\hat{\gamma}_{0t}$, $\hat{\gamma}_{1t}$, $\hat{\gamma}_{2t}$, and $\hat{\gamma}_{3t}$, are obtained each month. Fama and MacBeth regard the averages of these estimated values ($\bar{\hat{\gamma}}_0$, $\bar{\hat{\gamma}}_1$, $\bar{\hat{\gamma}}_2$, and $\bar{\hat{\gamma}}_3$) as the ultimate estimates of the risk premia, γ_0, γ_1, γ_2, and γ_3, for the corresponding variables. In particular, $\hat{\gamma}_{1t}$ is regarded as the estimate of the market risk premium. The t-statistics for testing the null hypothesis that $\gamma_j = 0$ for j =0, 1, 2, 3 are

$$t\left(\bar{\hat{\gamma}}_j\right) = \frac{\bar{\hat{\gamma}}_j}{S\left(\bar{\hat{\gamma}}_j\right) / \sqrt{T}}, \tag{6}$$

where $S\left(\bar{\hat{\gamma}}_j\right)$ is the standard deviation of the estimated gamma coefficients $\hat{\gamma}_{jt}$, and T is the number of the estimated gamma coefficients. The null hypothesis for the validity of the CAPM is

$$H_0 : \gamma_1 > 0 \text{ and } \gamma_0 = \gamma_2 = \gamma_3 = 0 \quad (7)$$

In particular, of more interest is whether $\gamma_2 = \gamma_3 = 0$, since firm characteristics such as firm size and book-to-market should add no explanatory power for average stock returns when the market beta is in the model.

Most empirical studies in Korea show that market betas are generally insignificant in explaining average stock returns.[5] Several authors show that the market risk premium estimate, $\bar{\hat{\gamma}}_1$, is insignificantly different from zero.[6] Other studies show that it is even negatively significant.[7] One exception is Kim, D. (2004), which shows that market betas have a significant positive explanatory power for average stock returns after adjusting for structural shifts in market betas.

Contrary to the prediction of the CAPM, firm size and book-to-market have significant explanatory power for average stock returnsin the Korean stock markets. Empirical results in Korea are consistent with those in other countries. Gam (1997), Song (1999), Kim, S. P. and Yoon (1999), Kim, K. Y. and Kim, Y. B. (2001), Kim, D. (2004), and Yun, Ku, Eom, and Hahn (2009) and Paek (2000) report that firm size is negatively significant and book-to-market is positively significant.[8] Some researchers find somewhat weaker evidence for firm size.[9] For example, Kim, S. J. and Kim, J. Y. (2000)

5) Ahn (1999) divides the whole sample into a bull market (when the market excess return is positive) and a bear market (whenthe market excess return is negative) and estimates the beta risk price in each market. He reports that the beta risk estimate ($\hat{\gamma}_{1t}$) is significantly positive in the bull market, while it is significantly negative in the bear market.

6) See Gam (1997), Song (1999), Kim, S. P. and Yoon (1999), Kim, S. J. and Kim, J. Y. (2000), Kim, K. Y. and Kim, Y. B. (2001, 2006), Lee and Kim, Y. B. (2006), Yunet al. (2009), and Jung and Kim, D. (2010).

7) Since the Korea Composite Stock Price Index (KOSPI) began in 1980, I tried to cite more recent works rather than past works as long as the cited works cover the period starting from 1980, although there are many works published before the cited works. For example, Gam (1997), which is the oldest among the cited works, covers the sample period from 1980 to 1995 (its actual testing period starts at 1983 after excluding the estimation period).

8) Sunwoo et al. (1994), also report that firm size is prominent over all months (not necessarily in January) in the Korean stock markets over the period 1980-1992, even after controlling for market betas and other firm characteristics, such as the leverage ratio and price-to-earnings ratio (PER).

9) Hwang (1993) and Kim, K. J. et al. (1994), report that the choice of the market proxy can affect the results of firm size. For example, when the equally-weighted market returns are used instead of the rates of return on the KOSPI (which is the value-weighted index), firm size disappears for the period 1980~1990.

report that when newly listed stocks are added into their sample, firm size becomes insignificant, while book-to-market is robustly positively significant regardless of the addition of the new listings. Kim, K. Y. and Kim, Y. B. (2006) and Lee and Kim, Y. B. (2006) examine whether the explanatory power of market betas, firm size, and book-to-market is sensitive to market conditions. Market betas have a significantly negative relation with average stock returns in down markets, and firm size is negatively significant only when the market is less volatile, but is insignificant in highly volatile markets. These authors also report that book-to-market has a robustly positive relation with average stock returns. Jung and Kim, D. (2010) estimate the CSR model of equation (5) by using the factor loadings on SMB and HML, β_{SMB} and β_{HML}, rather than firm characteristic variables (ln ME and ln BM). These authors find that the risk premiums on β_{SMB} and β_{HML} are both positively significant.

<Table 1> summarizes the results of the CSR tests for market betas, firm size, and book-to-marketfor average stock returns in the Korean stock markets. Overall, the firm size and book-to-market effect are significant in the Korean stock markets.

Another firm characteristic variable that challenges the validity of the CAPM in Korea is Basu's (1983) price-to-earnings ratio (PER). Kim, D. S. and Kim, J. H. (1993), Oh (1994), Sunwoo, Yun, Kang, Kim, Lee, and Oh (1994), and Paek (2000) report a "PER effect" in which firms with lower PER earn higher returns than firms with high PER. Kim, D. S. and Kim, J. H. (1993) examine whether firm size and PER are prominent in Korea after controlling for the effect oneach other, and conclude that, by using CAPM-adjusted (and the market model-adjusted) abnormal returns, the PER effect is significant over the period 1982~1992 even after controlling for firm size, and firm size is also significant after controlling for PER. However, these

〈Table 1〉 Results of Cross-Sectional Regression Tests for Market Betas, Firm Size, and Book-to-Market

Author(s)	Testing period	Market beta (β)	Firm size (ME)	Book-to-market (BM)	Test assets	Variables for Firm size or BM
Jung and Kim, D. (2010)	1995. 3~2008. 6	Insignificant	(+) risk premium	(+) risk premium	25 size/BM portfolios	Factor loadings
Yun et al (2009)	1991. 7~2007. 6 non-financial	(-) significant	(-) significant	(+) insignificant	Individual stocks	Characteristic variable
Kim, K. Y. and Kim, Y. B. (2006) and Lee and Kim, Y. B. (2006)	1990. 1~2002. 12 and 1990. 1~2003. 12	(-) significant only for down markets	(-) significant conditioning on the market condition	(+) insignificant conditioning on the market condition	15 beta portfolios	Characteristic variable
Kim, D. (2004)	1982. 7~2002. 12	(+) significant after adjusting for structural shift	(-) significant	(+) significant	Individual stocks	Characteristic variable
Kim, K. Y. and Kim, Y. B (2001)	1982. 5~1997. 4 non-financial	Insignificant	(-) significant	(+) significant	15 size/beta portfolios	Characteristic variable
Kim, S. J. and Kim, J. Y. (2000)	1992. 1~1997. 12 non-financial	Insignificant	(-) significant, but insignificant with new listings	(+) significant	25 size/BM portfolios	Characteristic variable
Paek (2000)	1985~1996 non-financial	(-) significant	(-) significant	(+) insignificant	Individual stocks	Characteristic variable
Kim, S. P. and Yoon (1999)	1983. 4~1997. 3 non-financial	(+) significant	(-) significant	(+) significant	Individual stocks, 25 size/beta portfolios	Characteristic variable
Song (1999)	1988. 4~1995. 12	n.a.	(-) insignificant	(+) significant	Individual stocks,	Characteristic variable
Gam (1997)	1983. 4~1995. 12	(-) insignificant	(-) insignificant	(+) significant	25 size/BM portfolios	Characteristic variable

effects tend to disappear over the long-term (at least a three-year horizon). By pointing out the bias caused by using the CAPM in computing abnormal returns, Oh (1993) computes abnormal returns by using a multi-factor model with the SUR approach and finds that PER is still significant but that firm size is prominent in January only. Sunwoo et al. (1994) also obtain the similar results with respect to the PER effect even after controlling for the capital structure of the firm.

In addition to the above-mentioned firm characteristic variables, seasonality in stock returns is also a notable variable that challenges the validity of the CAPM. It is well known that seasonality is particularly prominent in January in international stock markets. Many researchers also report the January effect in the Korean stock markets. Kim, K. H. (1991) reports that after adjusting for market beta risk, higher returns are observed in the first three calendar months (January, February, and March) over the period 1981~1989. This phenomenon is especially notable in small firms. However, Yun et al. (1994) report that higher risk-adjusted returns are observed only in January, not in the other calendar months. Their sample period is from 1980 to 1992, which is slightly different from that of Kim, K. H. (1991). Kim, D. and Shin (2006) also report that the January effect is prominent only in January by using more recent stock return data (from 1988 through 2004).

Overall, the empirical studies show that the explanatory power of market betas in the cross-section of stock returns is weak in the Korean stock markets, while firm characteristics such as firm size, book-to-market, and earnings-to-price ratio are significant. However, the results could be subject to many econometric issues in conducting the CSR test. Thus, it would be premature to conclude the rejection of the validity of the CAPM before these issues are resolved. The next section reviews these issues which are related to the test results.

3. Mis-specification Issues in the CSR Tests

3.1 The Errors-in-Variables Problem

The CSR tests performed within the traditional two-pass estimation framework are subject to the errors-in-variables (EIV) problem, since the true beta is unknown and the estimated beta is used instead. That is, in the first-pass, beta estimates are obtained from separate time-series regressions from the market model for each asset, and in the second-pass, these estimated betas are used in CSR's as a regressor. Therefore, the explanatory variable in the CSR is measured with error. The EIV problem is one of the most serious problems in the CSR. The EIV problem induces an underestimation of the price of beta risk (γ_{1t} in equation (5)) and an overestimation of the other CSR coefficients (γ_{2t} and γ_{3t} in equation (5)) associated with such idiosyncratic variables as firm size, book-to-market, and earnings-to-price ratio. The greater the correlation between the estimated beta and the idiosyncratic variable, the more downward bias in the estimate of the price of beta risk and the more upward bias in the estimate of the other CSR coefficients on the idiosyncratic variables (i.e., exaggeration of their explanatory power) [see Miller and Scholes (1972), Litzenberger and Ramaswamy (1979), Shanken (1992), and Kim, D. (1995, 1997)].

There are several approaches to mitigate the EIV problem. The first is to group stocks into portfolios. Since Black et al. (1972) and Fama and MacBeth (1973), it has been a standard practice to construct portfolios as test assets. Portfolios are formed by sorting individual stocks according to some characteristics of the stock, such as market beta from a previous period, firm size, book-to-market, or past returns. Portfolio betas have much smaller estimation errors than individual stock betas and hence, the use of portfolio betas mitigates the EIV problem. The advantage of this approach is simplicity. However, this approach has several disadvantages as well. The most serious is that the test results are sensitive to the portfolio formation method (i.e., how to sort stocks) and the number of portfolios. Another disadvantage of this approach is the potential loss of unique information about individual stocks by grouping them.

An alternative approach is to directly tackle the EIV problem.[10] Inferences of the two-pass methodology are based on the *t*-statistics of equation (6). Shanken (1992) provides an EIV-bias correction for the standard error of the estimate of the price of beta risk, and suggests an EIV-bias corrected t-statistic. On the other hand, Kim (1995, 1997) provides a direct EIV-bias correction for the estimate of the price of beta risk. In particular, the Kim correction is useful when individual stocks are used as test assets, since it can be directly applied to obtain the EIV-bias-corrected estimate of the price of beta risk itself. It appears that there are no significant articles that thoroughly examine the explanatory power of market betas in Korean stock markets that directly tackle the EIV bias.[11]

3.2 Non-Normal Distributions of Stock Returns

Multivariate tests of the mean-variance efficiency for a given market proxy based on the GRS statistic of equation (4) are valid only when the disturbance terms are jointly normally distributed. In the Fama and MacBeth (1973) CSR tests, the disturbance terms are assumed to be serially independent and homoskedastistic (in the OLS estimation). Thus, if the disturbance terms are non-normal, serially correlated, and heteroskedastistic, the estimation results from the previously-described methods may be biased and mislead the test

10) Gibbons (1982) suggests an iterative one-step Gauss-Newton method to estimate betas and argues that his method can avoid the EIV problem. As Shanken (1992) points out, however, the advantage of Gibbons's approach is apparently lost in linearizing the constraint that isvalid under the CAPM, and thus, the Gibbons estimates are still subject to the EIV bias.

11) Han (1994) employs a reverse regression approach to control the EIV problem. From the reverse regression estimation, Han obtains the results that the firm size effect disappeared in Korean stock markets.

results. For this circumstance, Hansen (1982) and Hansen and Singleton (1982) suggest a generalized method of moment (GMM) method. One of the advantages of the GMM method is that the distributional forms of asset returns and the error terms are not assumed, and it accommodatesempirical irregularities that are found in actual return data.

Jung and Kim, H. C. (1992) conduct a GMM test over the period 1977~1991 for the mean-variance efficiency of KOSPI by using 10 size portfolios and 10 industry portfolios, each a set of test assets. They report that the mean-variance efficiency of KOSPI is not rejected under the assumption of constant expected returns, but is rejected when expected returns are assumed to be time-varying.[12] Koo (1998) also conducts a GMM test by assuming non-normality of asset returns, but obtains results similar to those obtained by assuming normality of asset returns in his 1995 study (Koo; 1995). That is, the mean-variance efficiency of KOSPI and Hankyung-Dow Price Index is rejected, while the efficiencyof the equally-weighted market index is not rejected. It could be argued, based on the (GRS and GMM) tests, that the equally-weighted market index is more mean-variance efficient than the other Korean market indexes.

3.3 Mis-specification in Estimating Market Betas

The CAPM is an ex ante model. Therefore, ex antemarket betas should be used in cross-sectional tests of the CAPM. It is not possible, however, to know ax ante market betas. Instead, a proxy for the ex ante market beta is used. Since the use of the mis-estimated proxy of the ex ante market beta could mislead the CSR tests, mis-specification of the market beta can be a serious issue in the CSR test.

12) Lee and Nam (1992) estimate market betas through a GMM method, assuming that the error terms are serially correlated and their variance is auto-regressive conditional heteroskedastistic (ARCH). However, these authors do not perform tests for the mean-variance efficiency of the Korean market indexes.

The most popular proxy for the ex ante market beta is the beta estimate obtained from the market model using historical return observations (i.e., ex post market beta estimates). The implicit assumption behind estimating market betas is that market betas are stationary over time. Market betas are estimated using an arbitrarily chosen length of estimation period such as a five-year period, assuming that market betas are stationary over that period. However, most empirical studies do not support this assumption. In particular, the stationarity of the market beta over relatively long periods has been severely questioned in many empirical studies. Moreover, the capital structure theory shows that the levered firm's market beta is a function of the debt-equity ratio in a simple setting. Since the debt-equity ratio changes irregularly over time, the stationarity assumption of the market beta is hardly acceptable theoretically as well.

Sim et al. (1989) investigate the extent of beta nonstationarity over the period 1977~1986 and conclude that the stationarity of the market beta is not acceptable. They also investigate three different lengths of the estimation periods of 24, 36, and 48 months and conclude that 48 months may be the best estimation period among the three in that the nonstationarity of the market beta is the least severe. Kim, D. (2004) directly estimates the structural shift time points of the market beta of individual Korean firms by assuming that the market beta over the period between two beta shift points is stationary. He uses the market betas estimated over this stationary period in the CSR tests and finds that the explanatory power of market betas for average stock returns becomes significant. Kho and Yeh (2005) employ thestochastic beta model of Ang and Chen (2003) and Jostova and Philipov (2005) in which the market beta is assumed to change at every time point. They show that the beta estimates obtained from the stochastic betamodel have stronger cross-sectional explanatory power for average stock returns than the other beta estimates.[13)]

Another approach to estimating ax ante market betas is to relate the market beta of a firm to macroeconomic variables. In other words, if the systematic risk changes over time, this approach attempts to determine which macroeconomic variables underlie the non-stationarity of the market beta and to identify a relationship between the market beta and the macroeconomic variables. Lee and Shin (1991) examine the relation between market betas and macroeconomic variables over the period 1975~1989. They find that the real growth rates of GNP and money supply, unexpected inflation rate, interest rate, the government fiscal deficit, and business cycle affect the market betas of Korean firms. In particular, the sign of each of the macroeconomic variables on the market beta depends on the magnitude of the market beta and the business cycle.[14)] Kang, Choi, and Lee (1996) relate rates of return on portfolios (10 firm size and 9 industry portfolio) to the following macroeconomic variables: three-year corporate bond yield, the term spread (three-year corporate bond yield minus call rate), rate of return on KOSPI, lagged growth rate of industrial production, growth rate of money supply, and the ratio of imports to exports. They find that among those variables, the term spread and the ratio of imports to exports significantly affect the market betas of the portfolio, but the extent of association differs by industry and firm size.

A similar approach to estimate ax ante market betas is to relate the market beta of a firm to the firm's fundamental variables which are mostly accounting variables. Lee et al. (1992) and Park (1993, 1999) show that the beta estimate containing firm accounting information has better predictive power for future risk of the firm than the historical beta estimate. Park (1993) argues that

13) Han (1994) employs a reverse regression method to decrease the estimation error of the beta. He finds that the beta estimates from this method are able to explain the firm size effect in Korean markets.

14) Koo and Shin (1990) employs a similar approach and derive results similar to Lee and Shin (1991).

firm size is the most prominent determinant of market beta among the firm fundamental variables considered.

The above approach of relating market betas to macroeconomic or fundamental variables is a conditional approach. In other words, market betas are represented as a linear combination of these variables, and thus, market betas are conditioned on the information contained in the given variables. Since macroeconomic or fundamental variables change over time, this approach in fact allows market betas to be time-varying. Rather than conditioning on macroeconomic or fundamental variables to capture the time-variation of market betas, their time-varying behavior can be directly (unconditionally) modeled. Ryu and Lee (2009) assume a first-order autoregressive process [AR(1)] to model the time-varying behavior of the market beta. After accommodating this unconditional time-varying behavior of market betas, they find that firm size becomes insignificant, while book-to-market is still significant.

3.4 Return Measurement Intervals

Another issue in the CSR test is the arbitrary choice of the return measurement interval in estimating market betas. The CAPM assumes that all investors are single-period expected-utility-of-terminal-wealth maximizers. There is no particular restriction on the length of the holding period (investment horizon) as long as it is the same for all investors. That is, the CAPM implicitly assumes that asset betas are invariant to the investment horizon. In empirical tests, the investment horizon is arbitrarily selected, since the "true" investment horizon is unknown. In reality, however, betas are sensitive to the investment horizon. The covariance of an asset's (buy-and-hold) return with the market return and the variance of the market return do not change proportionately according to the investment horizon (see Levhari and Levy 1977, and Handa, Kothari, and Wasley 1989). Kim, D. H. (1996) empirically shows that the beta estimates are sensitive to the length of the return measurement interval and the extent of the sensitivity differs according to the magnitude of the beta and firm size in Korea. That is, for firms with small market capitalization and low beta (with large market capitalization and high beta), the beta estimate tends to increase (decrease) with the return measurement interval.

The literature shows, in general, that the explanatory power of market betas in the cross-section of stock returns is weak in Korean stock markets. Most CSR tests are based on a return measurement interval of one month. It would be necessary, therefore, to re-examine the explanatory power of market betas in various return measurement intervals.[15)]

4. Conditional Versions of the CAPM and GMM Tests

The Sharpe-Lintner-Mossin or Black CAPM is the static or the unconditional model. Tests of the unconditional version of the CAPM by Black et al. (1972), Fama and MacBeth (1973), Gibbons (1982), Stambaugh (1982), and Shanken (1985) are conducted by assuming that expected returns are constant and that asset betas are stationary over a fixed period of time. Thus, in the CSR tests, unconditional expected returns are regressed on unconditional betas. However, there is no reason to believe that expected returns and betas should be constant. Corporate investment and the financial decisions of a firm could affect investors' expected return of the firm and its systematic risk. Numerous papers show that betas change over time. According to changes inmacro-economic conditions, the market risk premium is also affected. In this context, it would be rational to allow expected returns and betas to be time-varying. Furthermore, a number of papers suggest that the inability of the uncondi-

15) Lee (2007) examines a continuous-time version of the CAPM by using returns measured over various intervals. Jo and Lee (2004) suggest a beta estimation method of considering the frequency of trades by using the Wavelet transform technique.

tional version of the CAPM to explain firm size, book-to-market (or value premium), the momentum phenomenon, and other market anomalies could be due to afailure to accommodate non-stationarity or time-variation of expected returns and market betas.

One convenient way to model the time-variation of expected returns and betas is to model them conditioned on some information set. If the information set changes over time, expected returns and betas also change since their values are conditioned on this information set. Let I_{t-1} be the information set available at time $t-1$. Then, the conditional version of the CAPM is stated as

$$E(r_{it} \mid I_{t-1}) = \beta_{it}(I_{t-1})\ E(r_{mt} \mid I_{t-1}) \tag{8}$$

where

$$\beta_{it}(I_{t-1}) = \frac{\mathrm{Cov}(r_{it},\ r_{mt} \mid I_{t-1})}{\mathrm{Var}(r_{mt} \mid I_{t-1})} \tag{9}$$

Since the true information set, I_{t-1}, is unavailable, expected returns and betas are conditioned on the observed information set, Z_{t-1}. We decompose the return on asset i and the market into their forecastable and unforecastable components as follows:

$$r_{it} = E(r_{it} \mid Z_{t-1}) + u_{it}, \qquad i = 1, 2, \cdots, N \tag{10}$$

$$r_{mt} = E(r_{mt} \mid Z_{t-1}) + u_{mt} \tag{11}$$

where u_{it} and u_{mt} are the forecast errors with mean zero and are orthogonal to the information set Z_{t-1}.

There are many ways to formulate a test of the conditional CAPM of equation (8), according to the assumption on the right-hand side terms of equations

(10) and (11). The first way is to use the instrumental variables to estimate the forecastable parts of equations (10) and (11). That is,

$$E(r_{it} \mid Z_{t-1}) = Z_{t-1}\,\delta_i, \qquad i = 1, 2, \cdots, N \tag{12}$$

$$E(r_{mt} \mid Z_{t-1}) = Z_{t-1}\,\delta_m \tag{13}$$

where Z_{t-1} is the vector of the l instrumental variables and δ_i (δ_m) is the $l \times 1$ coefficient vector for asset i (the market).[16] Thus, the unforecastable parts are denoted, respectively,

$$u_{it} = r_{it} - Z_{t-1}\,\delta_i, \qquad i = 1, 2, \cdots, N \tag{14}$$

$$u_{mt} = r_{mt} - Z_{t-1}\,\delta_m \tag{15}$$

We first consider a simpler version of the conditional CAPM of equation (8) by assuming that the reward-to-variance ratio of the market portfolio is constant. This implies that, for $i = 1, 2, \cdots, N$,

$$\begin{aligned} E(r_{it} \mid Z_{t-1}) &= \lambda \operatorname{Cov}(r_{it}, r_{mt} \mid Z_{t-1}) \\ &= \lambda E\{[r_{it} - E(r_{it} \mid Z_{t-1})][r_{mt} - E(r_{mt} \mid Z_{t-1})]\} \end{aligned} \tag{16}$$

where $\lambda = E(r_{mt} \mid I_{t-1})/\operatorname{Var}(r_{mt} \mid I_{t-1})$ is the reward-to-variance ratio of the market portfolio. We define a disturbance term from equation (16) as

$$\begin{aligned} e_{it} &= r_{it} - \lambda[r_{it} - E(r_{it} \mid Z_{t-1})][r_{mt} - E(r_{mt} \mid Z_{t-1})] \\ &= r_{it} - \lambda(r_{it} - Z_{t-1}\,\delta_i)(r_{mt} - Z_{t-1}\,\delta_m) \end{aligned} \tag{17}$$

The conditional mean of the three disturbance terms, $E(u_{it} \mid Z_{t-1})$, E

16) Here we assume that asset returns and the instrumental variables are jointly distributed and that their joint distribution falls into the class of spherically invariant distributions.

$(u_{mt} \mid Z_{t-1})$, and $E(e_{it} \mid Z_{t-1})$, are zero. In other words, these three disturbance terms are orthogonal to the predetermined instrumental variables, Z_{t-1}. Thus, we have the orthogonality condition $g = \mathrm{vec}(\epsilon' \mathrm{Z})$, where ε is a vector of all stacked disturbance terms. Parameters δ_i, δ_m, and λ are estimated by minimizing the quadratic form, $g' Wg$, where W is a symmetric weighting matrix that is defined as the metric to make the orthogonality condition g as close to zero as possible. This estimation is usually conducted through the Hansen (1982) generalized method of moments (GMM) method. Rather than assume the constant reward-to-variance ratio of the market portfolio, we can assume the time-varying reward-to-variance ratio as in equation (8). In this case, a disturbance term different from equation (17) is defined.[17) One advantage of this instrumental variables approach is that the EIV problem can be mitigated and the assumption on the distribution of the disturbance terms is not needed only the intertemporal independence of the disturbance terms is needed. However, the critical disadvantage of this approach is that the choice of instrumental variables is arbitrary and test results could be sensitive to their selection. Another disadvantage of this approach is that it cannot be applied when the number of test assets is large.

Nam and Lee (1995) conduct a GMM test for the conditional CAPM by choosing the constant, the difference between the corporate bond yield, and the bank deposit interest rate as instrumental variables. By using 10 size portfolios as test assets, these authors find that the conditional covariances, expected returns, and reward-to-variance ratio of the market portfolio are time-varying and they report a rejection of the conditional version of the CAPM. Cho (1996) chooses the constant, the January dummy, and the corporate bond yield as instrumental variables in the GMM tests and uses eight industry portfolios as test assets for the period from April 1980 to March 1995. Cho concludes

17) See Harvey (1989) for more details.

that the conditional CAPM explains well the returns of the test assets, which is opposite to the conclusions of Nam and Lee (1995).

The second way to formulate a test of the conditional CAPM of equation (8) is to model the time-series behavior of the disturbance terms of equations (10) and (11). The most commonly assumed model of such time-series behavior is the auto-regressive conditional heteroskedasticity (ARCH) model. Specific ARCH-type models are assumed for the conditional variance of each disturbance term and the conditional covariance between u_{it} and u_{mt}. Differently from the instrumental variables approach, this approach assumes the conditional variance (or covariance) as a function of past conditional variances (or covariances). By using ARCH-type models to formulate the conditional CAPM, Cho and Lee (1998) findthat the risk premium is time-varying but statistically insignificant and that the conditional CAPM also does not explain well the stock returns although their conditional version of the CAPM performs better than does the unconditional CAPM. Chang (1998) obtains similar results. This author finds that market risk premium estimates are insignificant and that the validity of the conditional version of the CAPM is rejected.

The third way to formulate a test of the conditional CAPM is the Jagannathan and Wang (1996) approach. According to these authors' arguments, the conditional expected return for each asset *i* at time *t* is linearly related to its conditional beta at time *t*-1. That is,

$$E(R_{it} \mid I_{t-1}) = \gamma_{0t-1} + \gamma_{1t-1}\,\beta_{1t-1} \tag{18}$$

where $\beta_{1t-1} = \mathrm{Cov}(R_{it},\, R_{mt} \mid I_{t-1})/\mathrm{Var}(r_{mt} \mid I_{t-1})$ is the conditional beta, γ_{0t-1} is the conditional expected return on the zero-beta portfolio, and γ_{1t-1} is the conditional market risk premium. By taking the unconditional expectations on both sides of equation (18), the unconditional CAPM is obtained:

$$E(R_{it} = \gamma_0 + \gamma_1 \overline{\beta}_i + \mathrm{Cov}(\gamma_{1t-1}, \beta_{1t-1}) \tag{19}$$

where $\gamma_0 = \mathrm{E}(\gamma_{0\mathrm{t}-1})$ and $\gamma_1 = \mathrm{E}(\gamma_{1\mathrm{t}-1})$ are the corresponding unconditional expected returns, and $\overline{\beta}_i = \mathrm{E}(\beta_{1t-1})$ is the unconditional beta of asset *i*. If the covariance between the conditional beta of asset i and the conditional market risk premium, $\mathrm{Cov}(\gamma_{1t-1}, \beta_{1t-1})$, is zero, equation (19) becomes the static CAPM. Jagannathan and Wang (1996) argue, however, that the conditional betas and the expected market risk premium are time-varying and they are correlated. They also argue that the unconditional expected return is not a linear function of the unconditional beta alone, since the last term in equation (19) is not zero in general.

Under certain circumstances, the unconditional expected return of equation (19) becomes

$$E(R_{it}) = c_0 + c_m \beta_i + c_{\mathrm{prem}}\, \beta_{\mathrm{i}}^{\mathrm{prem}} \tag{20}$$

where $\beta_i = \mathrm{Cov}(R_{it}, R_{mt})/\mathrm{Var}(R_{mt})$ and $\beta_{\mathrm{i}}^{\mathrm{prem}} = \mathrm{Cov}(R_{it}, \gamma_{1t-1})/\mathrm{Var}(\gamma_{1t-1})$, and c_m and c_{prem} are coefficients. To measure the prem-beta, $\beta_{\mathrm{i}}^{\mathrm{prem}}$, the conditional market risk premium (γ_{1t-1}) should be given. Jagannathan and Wang (1996) choose the default yield spread between Baa- and Aaa-rated bonds for (γ_{1t-1}). These authors use the sum of the value-weighted market index and human capital as a proxy for the true market portfolio, which is not observable. Thus, the return on the true market portfolio, R_{mt}, can be represented as

$$R_{mt} = \phi_0 + \phi_{vw}\, R_t^{vw} + \phi_{labor}\, R_t^{labor} \tag{21}$$

where R_t^{vw} is the return on the value-weighted market index and R_t^{labor}

is the growth rate in per capita labor income which is used to measure the return on human capital. Finally, the unconditional expected return of equation (20) can be represented as

$$E(R_{it}) = c_0 + c_m \beta_i^{vw} + c_{prem}\,\beta_i^{prem} + c_{labor}\,\beta_i^{labor} \tag{22}$$

Kook and Hahn (1999) perform the cross-sectional tests based on equation (22) and the GMM tests over the period 1984~1995. They report that the unconditional standard CAPM is also invalid and that the conditional CAPM performs better than the static CAPM. In particular, the human capital beta, β_i^{labor}, is statistically significant in explaining stock returns. However, they also report that firm size is still significant regardless of inclusion of human capital betas.

Ⅲ. Arbitrage Pricing Theory (APT)

As described in the previous section, the validity of the CAPM has been seriously challenged in Korea as well as in the other countries. Thus, its acceptance in academia as the premier asset pricing paradigm is less than universal, although it rather tends to be widely accepted in industry (see Graham and Harvey (2001)). The APT, formulated by Ross (1976), is considered as an alternative pricing model, together with the Breeden (1979) consumption-based CAPM and the Merton (1973) intertemporal CAPM.

The APT begins by assuming that asset returns are governed by a linear return-generating process similar to the multiple-index models. In particular, any asset *i* is assumed to have returns that are generated by the following process:

$$r_{it} = \alpha_i + \beta_{i1}\, r_{p_2,\, t} + \beta_{i2} r_{p_2,\, t} + \cdots + \beta_{iK} r_{pK,\, t} + \epsilon_{it} \tag{23}$$

where α_i is a constant for asset i, β_{ik} is the factor loading of asset i on the k-th factor $(k = 1, \cdots, K)$, $r_{p_k, t}$ denotes the return on the k-th factor portfolio, and ϵ_{it} is the mean-zero random error term for asset i that representsresidual or idiosyncratic risk. The error term satisfies the following conditions: $\mathrm{E}(\epsilon_{\mathrm{it}}\, \epsilon_{\mathrm{jt}}) = 0$ for $i \neq j$ and $E(\epsilon_{it}\, r_{p_k,\, t}) = 0$. Taking the expected value of equation (23) yields

$$E(r_i) = \alpha_i + \beta_{i1}\, E(r_{p_1, t}) + \beta_{i2} E(r_{p_2,\, t}) + \cdots + \beta_{iK}\, E(r_{p_K,\, t}) \tag{24}$$

Subtracting equation (24) from equation (23) and rearranging results in

$$r_{it} = E(r_i) + \beta_{i1}\, f_{1t} + \beta_{i2} f_{2t} + \cdots + \beta_{iK}\, f_{Kt} + \epsilon_{it} \tag{25}$$

where $f_{kt} = r_{p_k,\, t} - E(r_{p_k,\, t})$ is a mean-zero common factor. Under no arbitrage conditions, the expected return on asset i is represented as a linear combination of the factor loadings;

$$E(r_i) r_f + \lambda_1 \beta_{i1} + \lambda_2 \beta_{i2} + \cdots + \lambda_K \beta_{iK} \tag{26}$$

where λ_k is the risk premium of the k-th risk factor which is measured by $E(r_{p_k,\, t}) - r_f$. Here, $E(r_{p_k,\, t})$ is the expected return on a portfolio that has unit sensitivity to the k-th factor and no sensitivity to all other factors.

The APT is less restrictive than the CAPM in that it applies in both the single-period and multi-period settings. Furthermore, the APT is based on fewer and more realistic assumptions. It requires only that markets are perfectly competitive and investors' utility functions are monotonically increasing and concave (i.e., only risk aversion is required). The CAPM assumptions of quadratic utility functions and/or normally distributed returns are not necessary in deriving the APT. The CAPM (to be valid) requires that the market portfolio be mean-variance efficient, while the APT requires nothing special from the market portfolio. However, although the APT seems more robust than the CAPM in many aspects, it has two critical problems. First, the theory contains no clue about the number of factors. Second, even if the number of factors is known, the task of identifying the risk factors is daunting.

There are roughly three approaches in empirical studies that test the APT pricing equation (26).

1. APT Tests by Identifying Both Factors and Factor Loadings

As in Roll and Ross (1980), the first approach is to test the APT pricing equation (26) without specifically identifying the factors. Rather, both the factor loading β's and the factor scores of each factor in equation (25) are simultaneously estimated at a given number of factors K by using the factor analysis or principal component analysis in which only the covariance matrix of test assets' returns is needed. By applying a searching method, the optimal number of factors is determined according to some criterion. The estimated factor loading β's are used as regressors in CSR tests.

By using factor analysis, Lee et al. (1984) report that there might be four common factors in the Korean stock markets over the period from January 1977 to August 1983. These authors also report that only one or two factor loadings among the four explain significantly the cross-section of average stock returns. Lee (1994) also employs factor analysis to find the number of significant factors. Lee argues that two or three factors are significant and that the most plausible macroeconomic variables for these factors are returns on KOSPI, industrial production, unemployment rate, and an index of firm size. Cho (1998) teststhe APT pricing equation in a dynamic setting by assuming that risk premia and factor loadings (or betas) are time varying. Time-varying factor loadings are estimated under the assumption that the variances of asset returns and factor returns follow an ARCH process. Cho confirms that the variances show conditional heteroskedastisticity. He extracts four factors from the covariance matrix of 17 industry portfolios' returns by using factor analysis. He later replaces the first factor with the equally-weighted market returns since their correlation coefficient is almost perfect; it is 99.45%.[18] By using the GMM estimation method, Cho reports that three among the four risk premia estimates are all significant. In particular, the risk premium of the first factor (i.e., the market return) is highly significant. By using the 11 industry portfolio returns from January 1980 to June 1997, Koo (1999) argues that the determination of the priced factors in Korea maybe meaningless, since the test results are similar and the validity of the APT pricing equation is not rejected in any number of assumed factors (2, 4, and 10 factors are assumed). Based on the above results, there may be at least two to three common factors in the Korean stock markets.

2. APT Tests by Identifying Factors from Macroeconomic Variables

The second approach of the APT test is to first identify the factors by relating macroeconomic variables to common factors. Chen, Roll, and Ross (1986) is most representative in this approach. After identifying the relevant factors, the typical testing procedure of the APT pricing equation is the Fama and MacBeth two-pass methodology. In the first-pass, betas are estimated by regressing returns of test assets on the identified macroeconomic variables, and, in the second-pass, risk premia are estimated in CSR's of excess returns of test assets on the estimated betas.

18) There is almost no ambiguity in other countries' literature as well that the first factor from factor analysis or principal component analysis represents the return on the market portfolio.

Gam (1991) chooses six macroeconomic variables and conducts CSR tests by using the estimated betas of the six variables. He finds that three among the six betas significantly explain the cross-section of average stock returns. After estimating seven factors through factor analysis, Jung (1991) relates 73 available macroeconomic variables to the seven factors. By examining the correlation coefficients between each of the seven factor scores and each of the 73 macroeconomic variables, Jung identifies returns on KOSPI, unit labor cost, money supply, exporting price index, inventory index of manufacturing products, corporate bond yields, and corporate bond yield spread as the relevant factors in Korea. Jung also argues that the chosen seven factors are significantly priced in Korea. Further, Ji (1992) similarly investigates which variables are priced in Korea. This author reports that five macroeconomic variables are relevant: changes in foreign exchange rates, changes in industrial production, changes in unexpected risk premium, changes in money supply, and oil price changes. Since the macroeconomic variables are not factor portfolios, factor models containing macroeconomic variables cannot be used as pricing equations. In other words, the intercept α in equation (23) does not indicate pricing error.

3. APT Tests through Constructing Factor Mimicking Portfolios

The third approach of the APT test is to construct factor portfolios and include them in factor models such as equation (23). Unlike the second approach, the intercept α can be used as a measure of pricing error. Factor portfolios are usually estimated by constructing arbitrage portfolios by taking a long position in high risk-high return assets and a short position in low risk-low return assets. Fama and French (1993) is most representative of this approach. The literature shows that there are several market phenomena (so called *anomalies*) that the CAPM fails to explain. The most prominent such phenomena in international markets are firm size, book-to-market, momentum, liquidity, information quality, and information asymmetry. It is conjectured, therefore, that there might be systematic risks associated with these characteristics that market betas do not capture. In other words, since only the market portfolio may be insufficient to diversify away idiosyncratic risk, investors may need other portfolio(s) to hedge risks associated with these characteristics. This portfolio should be a well-diversified factor portfolio, and its returns should track innovations in the particular source of risk associated with the characteristic.

The most popular model in this approach is the three-factor model by Fama and French (1993). The three factors are the market portfolioand the factor portfolios associated with firm size and book-to-market, SMB and HML, respectively. Gam (1997) conducts time-series testsof the three-factor model over the period 1983~1995 by using 25 portfolios sorted by firm size and book-to-market as test assets. This author reports that the three-factor model explains well time-series variations of the test assets in thatall 25 intercept estimates are insignificant. Song and Lee (1997), Kim, S-J, and Kim, J-Y (2000), and Yun et al. (2009) also report similar results for Korea.[19] The above test results support the Fama and French (1993) three-factor model in Korea.

It is noteworthy, however, that the above test results may be naturally expected, since most tests employ the test assets from which the factors are generated. It is not surprising that these self-generated factors explain well returns of the same test assets. Kim, D. and Shin (2006) use a different set of test assets to test the performance of the three-factor model. Unlike the previous results, they report that the performance of the three-factor model is unsatisfactory. Three of the ten intercept estimates of 10 size-sorted portfo-

19) Song and Lee (1997) and Yun et al. (2009) argue that the explanatory power of HML is weak relatively to SMB.

lios are significantly different from zero. Chae and Yang (2008) use individual stocks to examine the explanatory ability of the following three asset pricing models: the CAPM, the Fama and French three-factor model, and the Carhart (1997) four-factor model. These authorsregress cross-sectionally the pricing errors produced from an asset pricing model on several idiosyncratic variables. The pricing error is defined as the difference between the expected return from an asset pricing model and the realized return. They find that the pricing errors from all three modelsare significantly related with transaction costs, investors' irrationality, and even firm size and book-to-market. Their resultsindicate that all three models fail to explain the cross-section of stock returns in Korea. Therefore, test results could be sensitive to the formation method of test assets and even the number of test portfolios. Further, the current literature in Korea shows that the reported average returns of the three factor portfolios are quite different depending on the sample period.[20] They are sometimes quite different even when the sample period does not differ much. Based on my observations of the literature on Korea, the test results may also be sensitive to the choice of the sample period.

Aside from therisk factors associated with firm size and book-to-market (i.e., SMB and HML), other risk factors are suggested. One risk factor that has recently drawn much interest in the literature is liquidity (or illiquidity). The literature suggests various measures (or proxies) for liquidity. Kwon and Park (1997) employ Roll's (1984) and George, Kaul, and Nimalendran's (1991)

20) For example, Song and Lee (1997) report that the average monthly returns of the market portfolio, SMB, and HML are 0.11%, 0.64%, and 0.93%, respectively, over the period 1980-1995; Kim, D. and Shin (2006) report that they are 0.693%, 0.191%, and 1.065%, respectively, over the period 1988-2004; Yun et al. (2009), report that they are 0.26%, 0.99%, and 0.87%, respectively, over the period July 1991-June 2007; Kim, S-H, (2009) reports that they are -0.22% (after subtracting the risk-free return), 0.47%, and 0.68%, respectively, over the period January 1988-October 2007; and Jung and Kim, D. (2010) report that they are 0.41%, 1.11%, and 1.38%, respectively, over the period March 1995-December 2008. Overall, the average return of HML is relatively high in any period, which indicates that the value premium is strong in Korea relatively to the growth premium. The above-mentioned papers also report quite different correlation coefficients between SMB and HML. Kim, D. and Shin (2006), Yun et al. (2009), Kim, S-H (2009), and Jung and Kim (2010) report that the correlation coefficients between SMB and HML are -0.164, 0.641, 0.09, and 0.278, respectively.

liquidity costs as a measure of liquidity. In the CSR over the period 1986~1994, Kwon and Park find that the CSR coefficient estimate on the liquidity variable is positively significant even after adjusting for firm size and market betas. They argue that the liquidity risk premium is significant in Korea. Park and Eom (2008) also obtain similar results over amore recent period (1996~2006) in the CSR tests with controlling for market betas, firm size, book-to-market, and past returns. These authors also report that a significant liquidity risk premium is found in stocks traded on Korea Stock Exchange (KSE), but not found in stocks on Korean Securities Dealers Automated Quotations (KOSDAQ).[21)] Yun et al. (2009) argue that a three-factor model including the market factor, SMB, and a liquidity factor better explains stock returns than the Fama and French three-factor model. Their liquidity factor is a mimicking portfolio of liquidity proxied by turnover ratio. By employing the Amihud (2002) illiquidity measure, Choe and Yang (2009) also report results supporting the role of liquidity; stocks with higher average illiquidity earn higher average returns. However, Nam, Park, and Eom (2005) report the irrelevance of liquidity in stock returns. Rather than using asset pricing models to examine the role of liquidity in Korea, these authors use principal component analysis to extract two common factors, one from liquidity data and the other from stock returns. They find that there is no significant relation between these two common factors, and conclude that the commonality of liquidity does not explain the commonality of stock returns.

Many other risk factors, such as foreign currency risk, earnings information uncertainty risk, and risk associated with information asymmetry and information quality, have also been considered in the literature. Kwon and Park (1999) examine whether foreign currency risk is priced in Korea. They report

21) Park and Eom (2008) also report that in the time series tests, all of the intercept estimates (or Jensen's alpha) are insignificant only in the one-factor model with the liquidity factor, but not in the other multi-factor models although the liquidity factor is included.

that foreign currency risk is not priced over the whole period from 1983~1996, but is weakly priced over the subsample period 1990~1996. By using the GMM method, Yu (2002) tests whether there exists a risk premium associated with foreign currency risk through a conditional asset pricing model and concludes that the risk premium exists in Korea.[22)]

Kim, D. and Shin (2006) suggest a two-factor model containing the market factor and a risk factor associated with earnings information uncertainty, and argue that this two-factor model performs well in explaining firm size and the January effect. Choe and Yang (2007) examine whether information asymmetry affects systematically stock returns in Korea. They use three measures of information asymmetry; Glosten and Harris's (1998), Hasbrouck's (1991), and Easley, Hvidkjaer, and O'Hara's (2002) PIN (probability of informed trading). In particular, PIN has drawn much interest in the literature as a measure of information asymmetry. They report that the measures of Glosten and Harris (1998) and Hasbrouck (1991) support a positive relation between information asymmetry risk and stock returns, while PIN does not support the positive relation. They conclude that information asymmetry is a determinant of stock returns however, PIN is not useful as a measure of information asymmetry in Korea. Park and Eom (2008) also report that PIN is not useful, but that Duarte and Young's (2007) adjusted PIN is useful. An, Kim, J., and Kim, D. (2010) also examine whether information quality (or earnings quality) is priced in Korea. By using accruals qualityas a measure of information quality, they find that accruals quality is not priced. Note that accruals quality is priced in the U.S. markets (see Kim and Qi (2010)).

22) Yu (2000) reports that Korean firms are significantly exposed to a USD risk after the liberalization of capital flows in 1992. After controlling for Japanese yen and other macroeconomic variables, however, the USD risk exposure became insignificant.

Ⅳ. The Consumption-Based Capital Asset Pricing Model (C-CAPM)

By introducing the consumption beta, equation (27) can be rewritten as

$$E(r_{t+1}) = r_f + \lambda\beta_{c,\,t+1} \tag{28}$$

where $\lambda = \gamma\,\mathrm{Var}(g_{c,\,t+1})$ is the market price of consumption risk, and $\beta_{c,\,t+1} = \mathrm{Cov}(r_{t+1},\ g_{c,\,t+1})/\mathrm{Var}(g_{c,\,t+1})$ is the consumption beta. This is the Consumption-based CAPM (C-CAPM).[23)]

The intuition of the C-CAPM is that if an investor holds assets, he can sell some of the assets to finance consumption when his current income is low. Thus, an individual asset is more desirable if its return is expected to be high when consumption is low (since more can be invested). However, if its return is expected to be high when consumption is high (since less can be invested), the asset is less desirable and more risky, and thus, the investor demands a higher risk premium to hold it.

Empirical results on the validity of the C-CAPM in Korea are similar to those in the U.S. That is, the C-CAPM performs poorly empirically. By using 11 industry portfolios and the maximum likelihood estimation under the non-linear C-CAPM constraints, Koo (1992, 1993) tests whether there is a linear relation between stock returns and consumption betas and reports that the linearity is rejected over the sample period 1980~1990.[24)] Choi and Baik

23) The formulation of the C-CAPM can be generalized. If the utility is a function of an uncertain amount of total (market-wide) wealth instead of consumption, the C-CAPM of equation (28) becomes the standard CAPM, since the consumption growth rate is equivalent to the rate of return on the market portfolio. Cochrane (1991) also derives the production-based CAPM (P-CAPM) by using producers and production functions in the place of consumers and utility functions thatare used in deriving the consumption-based CAPM. The marginal rate of substitution of consumption is substituted as the marginal rate of transformation of capital. According to the reports from Koo (1993), Nam and Lee (1995), and Nam, Choi, and Kim (2003), the P-CAPM performs better in Korea than does the C-CAPM.

24) By using the same way, Koo (1992) reports that the linearity of the CAPM is valid over some subperiods.

(1992) conduct a test for the validity of the C-CAPM over the period 1980~1990 through the Fama-MacBeth two-pass methodologyby using 27 industry portfolios. They report that (contemporaneous) consumption betas fail to explain the cross-section of average stock returns. By using a time-series analysis, they also report that stock returns are related more to changes in future consumption than changes in current or past consumption. Thus, Lee, Park, and Cho (1998) use forecasted future consumption betas (obtained from regressing returns at time t on the growth rate in consumption at time $t+k$, $k=1$, 2, 3, and 4) rather than contemporaneous consumption betas. However, they report that future consumption betas also fail to explain the cross-section of average stock returns in Korea.

V. Intertemporal Capital Asset Pricing Model

Merton (1973) derives a version of the CAPM by assuming that trading in assets takes place continuously over time and that investors maximize their expected utility at each time for lifetime consumption. Merton argues that when there is stochastic variation in investment opportunities, there will be risk arising from unfavorable shifts in the investment opportunity set. Thus, this risk is associated with innovations in the state variables that describe the investment opportunities. One of the state variables that is directly observable is the interest rate. Under this circumstance, Merton argues that investors need another portfolio to hedge against this risk, in addition to the market portfolio. Investors will hold portfolios chosen from three funds: the risk-free asset, the market portfolio (m), and a hedge portfolio (N) whose return is perfectly negatively correlated with the stochastic risk-free rate of return. The first and second funds provide the service to investors of an instantaneously efficient risk-return frontier. The third fund (N) allows investors to hedge against risk caused by unfavorable intertemporal shifts in the efficient frontier (the investment opportunity set). All investors'optimal portfolios can be represented as a linear combination of the three mutual funds (portfolios). In this case, the equilibrium returns will satisfy

$$E(r_i) = r_f + [E(r_m) - r_f]\,\beta_i^{(m)} + [E(r_N) - r_f]\,\beta_i^{(N)} \tag{29}$$

where

$$\beta_i^{(m)} = \frac{\beta_{im} - \beta_{iN}\,\beta_{Nm}}{1 - \rho_{Nm}^2}, \quad \beta_i^{(N)} = \frac{\beta_{iN} - \beta_{im}\,\beta_{Nm}}{1 - \rho_{Nm}^2}, \quad \beta_{jk} = \frac{\mathrm{Cov}(r_j,\ r_k)}{\mathrm{Var}(r_k^2)}$$

This is the intertemporal capital asset pricing model (I-CAPM).

If there are S sources of uncertainty ("state variables") in the opportunity set rather than just the risk-free rate, these sources of uncertainty can influence the magnitude of the risk-return parameters of the assets and cause the investment opportunity set to shift intertemporally. In this case, investors need S hedging portfolios and Merton's two-factor I-CAPM can be extended to $(S+1)$ factor I-CAPM.[25)]

It is difficult to construct factor portfolios (or hedging portfolios) tracking innovations in state variables. The firstapproach to construct factor portfolios is the economic tracking portfolio approach introduced by Lamont (2001). In this approach, economic tracking portfolios are designed to capture unexpected returns that are maximally correlated with unexpected components (or innovations) of a target macroeconomic variable. Future GDP growth (Vassalou; 2003), future labor income growth (Kim, Kim, and Min; 2010), and future money supply growth (Jung and Kim; 2010) are examples of such

25) Richard (1979) suggests the growth rate in the money supply, prices of industrial goods, disposable income, and wage rates as the state variables whose innovations are sources of uncertainty.

target macroeconomic variables. The second approach is to construct zero-investment portfolios by using firm characteristics such as Fama and French's (1993) SMB and HML and to attribute these factors to state variables that cause changes in investment opportunity sets. Fama and French (1992) state "examining relations between SMB and HML and economic variables that measure variations in business conditions might help expose the nature of the economic risks captured by size and book-to-market equity." In this approach, it would be ambiguous to empirically differentiate the I-CAPM from the APT-motivated models. The third approach is to determine macroeconomic factors that are most plausible to change investment opportunity sets. Campbell (1996) selects five state variables and suggests a five-factor model containing the market portfolio return, dividend yield, relative bill rate, yield spread, and real labor income growth rate.[26)]

Most empirical research on the I-CAPM in Korea is quite recent. Son, Kim, and Yoon (2009), Kim, B. J. and Cho (2010), and Jung and Kim, D. (2010) compare the performance of pricing ability of several asset pricing models including the CAPM, several APT-motivated models, and the I-CAPM models such as the Campbell model. Their common model comparisons are conducted through the stochastic discount factor (SDF) approach by implementing the GMM method. Here, the SDF approach is briefly introduced.

In the circumstance in which the distributional form of the disturbance terms are unknown (or un-assumed), Hansen (1982) and Hansen and Singleton (1982) suggest a GMM method. It is well known that when there is no arbitrage, there exists a positive stochastic discount factor (SDF) (or pricing kernel) m_t such that

$$E(m_t R_t) = 1_N \tag{30}$$

26) The relative bill rate (RTB) is the difference between the 1-month Treasury bill rate and its 1-year backward moving average.

where R_t is a $(N \times 1)$ vector of gross returns; 1_N is an $(N \times 1)$ vector of ones; and N is the number of test assets. Since all asset pricing models under consideration are linear factor pricing models, the pricing kernel can be represented as a linear combination of the factors. That is,

$$m_t = b_0 + b_1{}' f_t \tag{31}$$

where f_t is a $(K \times 1)$ vector of factors; b_0 is an intercept; and b_1 is a $(K \times 1)$ coefficient vector. b_0 and b_1 are called the SDF loadings.

If the SDF m_t correctly prices the N portfolios (i.e., the test assets), the pricing error vector, $g(\theta)$, of the N portfolios should be zero. The pricing error vector is defined as

$$g(\theta) = E(m_t R_t) - 1_N \tag{32}$$

where $\theta = (b_0,\ b_1{}')$ is the set of parameters to be estimated. However, if m_t is misspecified, the pricing errors $g(\theta)$ are nonzero. When one of the factors (or a factor portfolio) in a factor model is not given but, rather, must be estimated, there occur orthogonality conditions. In this case, the or thogonality conditions are stacked in equation (32). The parameters are chosen to minimize the quadratic form

$$J_T = g(\theta)' W_g(\theta) \tag{33}$$

where W is an $(N \times N)$ weighting matrix. In order to compare the performance of the pricing ability of the models, $E[RR']^{-1}$, which is the inverse of the second moments of asset returns, is used for the weighting matrix.[27)]

27) The asymptotically optimal weighing matrix is adopted to compute Hansen's *J*-statistic of equation (33) on the overidentifying restrictions of the models. In this case, it is well known that the *J*-statistic is asymptotically χ^2

The advantage of using this weighting matrix is that it is invariant across competing asset pricing models. The Hansen-Jagannathan (1997) distance (HJ distance) is defined as

$$\text{HJ distancd} = \left[\underset{\theta}{\text{Min}}\, g(\theta)'\ W\ g(\theta) \right]^{1/2}$$

where $W = E[RR']^{-1}$. The HJ-distance can be interpreted as the maximum pricing error for the set of assets mis-priced by the model (Campbell and Cochrane, 2000). The disadvantage of using this weighting matrix is that the distribution of the HJ distance is difficult to find.

According to Cochrane (1996), the risk premia, λ, can be estimated in the SDF approach as follows

$$\lambda = -\, r_f\, Cov(f,\, f')\, b_1 \tag{35}$$

where r_f is the riskless return. If the SDF factor loading, b_1, is time-varying and its time-varying behavior is conditioned on instrumental variables, Z_{t-1}, then it can be represented as $b_1 = c_0 + c_1 + c_1\, Z_{t-1}$. In this case, the model becomes a conditional model, and the parameters to be estimated are $\theta = (b_0,\ c_0,\ c_1{}')$. Of course, if c_1 is assumed to be zero, it is an unconditional model.

By using the SDF approach, Son, Kim, and Yoon (2009) compare four models over the period April 1991 through February 2009 by using 16 size-BM portfolios as test assets CAPM, the Fama and French three-factor model, the Fama and Frenchthree-factor model plus liquidity factor, and the Campbell (1996) five-factor model. These authors report that the Campbell model performs best in terms of the HJ distance and the Hansen J-test. Kim, B. J.

distribution with degrees of freedom equal to the number of moments minus the number of parameters.

and Cho (2010) also conductsimilar comparisons including the above four models plus the C-CAPM, the Jagannathan and Wang (1996) conditional CAPM, the Cochrane (1996) production-based CAPM. These authors report that the Jagannathan and Wang conditional CAPM, the Campbell model, and the Fama and French three-factor model perform best in terms of the HJ distance. Son, Kim, and Yoon (2009) and Kim, B. J. and Cho (2010) both report that when the models are conditioned on several instrumental variables, the performance of pricing ability is significantly improved.[28] By employing Lamont's (2001) economic tracking portfolio approach, Jung and Kim, D. (2010) construct a factor portfolio tracking innovations in future money supply (as a state variable) and test whether it is priced by using the Fama and MacBeth CSR method and the SDF approach. Their test period is March 1995 through December 2008. These authors report that risks caused by innovations in future money supply are priced. Also, they compare several models and report that a four-factor model containing the Fama and French three factors plus the money supply factor performs best in terms of the HJ distance.

Recently, Kim, Kim, and Shin (2010) comprehensively evaluate and compare various asset pricing models in the Korean stock market over the period 1990~2009 by conducting time-series and cross-sectional tests based on individual *t*-tests, the GRS *F*-tests, the HJ distance, and the Kandel and Stambaugh (1995) R-squares. They report that the Fama and French (1993) five-factor model performs most satisfactorily amongthe asset pricing models considered in explaining the intertemporal and cross-sectional behavior of stock returns in Korea. The Fama and French three-factor model, the Chen, Novy-Marx, and Zhang (2010) three-factor model, and the Campbell (1996) model are next. They also report that over the two sub-periods before and

28) As instrumental variables, Son, Kim, and Yoon (2009) employ term spread, default spread, and dividend yield, and Kim, B. J. and Cho (2010) employ industrial production and export. In particular, Kim, B. J. and Cho (2010) argue that the use of industrial production substantially improves the performance of the conditional models.

after the Asian foreign currency crisis (1990~1998 and 1999~2009), the results are similar.

Ⅳ. Summary and Concluding Remarks

This paper reviews 30 years of empirical research on asset pricing models in the Korean stock markets. Asset pricing models reviewed include the CAPM (conditional and unconditional), APT, I-CAPM, and C-CAPM. This paper also provides explanations of the testing methodologies used in the literature for the asset pricing models: time-series tests, CSR tests, and tests by the SDF approach implemented by the GMM estimation method.

Since its introduction in 1964, the CAPM has become a backbone of financial economics. Nonetheless, the validity of the CAPM has been seriously challenged in Korea as well as in the other countries. The overall empirical results in Korea show, as they do in other countries, that the static CAPM fails to explain for stock returns in Korea. Contrary to the prediction of the CAPM, firm characteristic variables such as firm size, book-to-market, and earnings-to-price ratio have significant explanatory power for average stock returns in the Korean stock markets. However, the following points should be made regarding tests of the CAPM. The test results are subject to several econometric issues; the EIV problem in CSR tests, the use of mis-specified beta estimates, time-varying properties of market betas and risk premia, and arbitrary choice of the return measurement interval, among others. After resolving some of these issues, some papers report that the explanatory power of market betas for stock returns becomes stronger. It would be premature, therefore, to reject the validity of the CAPM before these issues are satisfactorily resolved.

Along with the above-mentioned econometric issues in the CAPM tests, the following points should also be considered. Many papers use returns on KOSPI. However, these returns do not include dividends. Thus, returns with dividends should be used as long as returns with dividends for individual stocks are used. Most papers use the yield of the government short-term bills as a proxy for the risk-free return. This yield is a promised (or ex ante) yield, not a realized (or ex post) yield. Insofar as realized stock returns are used in the tests, it is reasonable to use realized government bill yields for the risk-free return. Another issue is the sensitivity of portfolio formation to the test results. Many papers employ portfolios sorted by firm size and book-to-market as test assets. Since the test results could be sensitive to portfolio formation, it is necessary to consider various portfolios as test assets.

This paper also reviews the published works on testing various models of the APT-motivated models and the I-CAPM-motivated models. The Fama and French three-factor model is overall acceptable in the case of Korea. However, some papers report that other multi-factor models perform better in explaining stock returns than does the Fama and French three-factor model. Thus, a better multi-factor model should be pursued in future work.

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