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Macroeconomic Factors and the Pricing of Risk in East Asian Equity Markets

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Abstact: This paper estimates an international conditional capital asset pricing model for seven East Asian equity markets to assess the impact of country-specific macroeconomic variables on the country beta, which in turn determines the risk sensitivity of individual markets to movements in global market returns. The empirical results indicate that there is considerable time variation in the market betas that are significantly related to domestic macroeconomic variables. Besides the global market returns, two additional risk factors that influence excess returns in individual markets are movements in the price of oil and the level of economic activity in the OECD countries.

1. Introduction

Market participants attribute the current market *annus horribilis* in East Asia to increasing risk aversion among international investors that stem from a variety of sources. A part of the rising riskiness in the equity markets is global in origin, emanating from the collapse of stock prices in the United States, the escalation in oil price over a large part of year 2000, and the impending deceleration of economic activities in the industrial countries. In addition, market participants have highlighted the country-specific macroeconomic fragility and political uncertainty in some Asian countries as another source of investment risk.

The paper examines how risks are priced into the market indices of seven East Asian countries, causing investors to require different expected excess returns in these markets. Market risk refers to the exposure to some common global factors. Initially a conditional international capital asset pricing model is employed to evaluate the impact of country-specific macroeconomic variables on the country beta, which in turn determine the risk sensi-tivity of the individual market to the movement in the global market returns. Next the influences of additional global risk factors such as the accent in the price of oil and the slowdown in the level of economic activities of the major industrialised countries are evaluated by estimating a multi-factor asset-pricing model. Section 2 presents the framework of the international asset-pricing model and discusses the econometric methodology for estimating the models. The empirical findings are reported in Section 3 and Section 4 concludes the paper.

2. A Model of International Asset Pricing

The capital asset pricing model (CAPM) provides an elegant and intuitive framework for pricing of risky assets under equilibrium market condition. The model indicates that the expected return of an asset above a risk-free rate is proportional to its non-diversifiable risk, the latter being measured by the covariance of the asset's return with the return on the market

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portfolio. The traditional single factor CAPM, which was originally developed in a domestic context can be modified to price the impact of country-specific economic variables as well as the global risk factors on the expected returns in the national equity markets.

In the original Sharpe (1964) and Lintner (1965) CAPM, investors' demand for each domestic asset is determined on the basis of period-by-period mean variance optimisation. In equilibrium, all investors will hold a combination of the identical portfolio of risky assets and a risk-free asset. Differences among individual wealth portfolio are distinguishable by the proportion of the wealth that is held in the risky portfolio relative to the amount invested in the risk-free asset. Aggregating all investors' optimal portfolio choices and equating them with the supply of securities, results in an equilibrium relationship between the expected return of a security and its risk which can be written as

(1)

where r_{ft} is the interest rate that equates the demand and supply of the risk-free asset, r_{it} is the total nominal return to security *i*, and r_{mt} is the total nominal return to the market portfolio.

Equation (1) indicates a linear relationship between the expected return to asset *i* and the expected return on the market portfolio. The beta of asset *i* is determined by the covariance of the return on security *i* with the return on a portfolio consisting of all available assets in the market, and is taken as a measure of the non-diversifiable risk of the asset. Under the CAPM, investors would be rewarded only for the systematic risk since the non-systematic risk can be diversified away. Therefore, for a given expected return on the market portfolio, a higher covariance of the expected returns of an asset with the returns on the market portfolio would lead to a higher required returns on the asset above the risk-free rate.

The original CAPM was premised on risk averse investors maximising the expected utility of the terminal one-period wealth. However, in the real world where investors live for many periods and where the risk and expected returns vary over time depending on the state of the economy (Fama and French 1989; 1993; Ferson and Harvey 1991; Jaganathan and Wang 1996), the assumption that the moments of the expected returns are stationary appear to be unreasonable. Attempts have been made to formulate a conditional CAPM in which the expected returns, variance, and covariances vary over time, depending on the nature of the information available at a given point in time.

A general specification of the conditional CAPM can be written as

(2)

where $E(\cdot|\Omega_{t-1})$is the conditional expectation operator made on the basis of the information set, Ω_{t-1}, available to the investors at time $t-1$. Equation (2) indicates that beta and the expected risk premium are conditional moments based on the information available to the investor when prices of securities are set.

The domestic CAPM for an asset has been extended to the pricing of a national equity market in an international setting in which the universe of the security portfolio consists of securities issued in different countries and are denominated in different currencies. In an international CAPM (ICAPM),[1] r_{it} refers to the nominal returns in a given market *i* and r_{mt} represents the nominal return on a global portfolio. The application of the domestic CAPM to an international context requires further assumptions, namely that there is no segmentation across equity markets of different countries arising from transaction costs and regulatory barriers to cross-border investment, investors have identical consumption sets, and the purchasing power parity relation (PPP) holds for every period (Solnik 1999). When PPP holds, investors who are concerned with real returns on their investment, measured in their home currencies, will not face the real purchasing power risk. Under such an assumption, equations (1) and (2) hold in an international context.

However, there is overwhelming evidence in the literature that PPP does not hold, at least in the short run (Breuer 1994). Adler and Dumas (1983) and Dumas and Solnik (1995) have formulated an ICAPM under the assumption that PPP does not hold and therefore investors from different countries are faced with different expected real returns from a given asset. In a universe consisting of $L+1$ countries, n number of securities, and L number of money market deposits, the Alder-Dumas international asset pricing model can be written as

(3)

where r_{it} is the return of security i, measured in terms of the reference currency, $i=1,2,\ldots,n,$ that is in excess of the risk-free deposit rate denominated in the reference currency. The covariances of the nominal return on asset i with the rate of inflation in each of the L countries, π_{jt} $j = 1, 2, \ldots, L,$ constitutes the additional source of risk caused by deviations from PPP. It measures the exposure of market i to both the purchasing power risk and the currency risk associated with country j. The specification of the model can be simplified by assuming that the inflation rate in each country is non-stochastic. In such a situation, the only random component of π_{jt} is the movement of the exchange rate of the currency of country j with that of the reference currency. Therefore, the term $(r_{it}, \pi_{jt}|\Omega_{t-1})$ can be considered solely as the exposure of security i to the currency risk of country j and δ_{jt-1} can be interpreted as the price of country j currency risk.

Dumas and Solnik (1995) and De Santis and Gerard (1997) have tested the above conditional version of the ICAPM in which the world market and currency risk are parameterised as independent risk factors. The authors have found statistically significant currency risk premium in the equity markets of the industrial economies. Harvey (1995a), using a different specification of ICAPM, found the currency risk factor to be an important determinant of the excess returns in several emerging markets.

In the following empirical analysis, we initially estimated a conditional single-factor ICAPM in which the conditional country beta was linked to the country-specific fundamental variables, while the global market risk premium depends on worldwide information variables. The specification, therefore, assumes that the market impounds only country-specific information in their assessment of the systematic risk of the individual market as

(4)

where Ω_{it-1} is the country specific information set. A linear parameterisation of the conditional country beta allows it to be expressed as

[1] For convenience of exposition, the acronym ICAPM is used although this acronym is commonly associated with Merton's intertemporal CAPM.

(5)

where X_{it-1} is a vector of country-specific macroeconomic variables that are likely to affect a country's exposure to global market risk and these variables are known to investors at time t–1.[2] The macroeconomic variables are the change in the log of the nominal exchange rate against the US dollar, the growth in the real GDP, current account deficit (as a percentage of nominal GDP), change in the short-term money market interest rate, the inflation rate, and the ratio of international reserves to the stock of external debt.[3] We have confined the list of instruments to macroeconomic variables and ignored purely financial valuation indicators like the price-earning ratio of the market, the dividend yield, and the price-to-book ratio. (Ferson and Harvey 1998).[4] The specification of the beta in equation (5) therefore allows one to evaluate the manner in which a country's macroeconomic conditions influence the sensitivity of its market returns to movement in prices of securities globally. A conditional beta in excess of unity would magnify the impact of global market movement on the returns in the domestic market.

The ICAPM singles out the global portfolio excess return as the only source of systematic risk that affects the return of each individual market differently depending on the variation in the country beta. However, the development of the arbitrage asset pricing (APT) model has shown that there are other sources of systematic risks, many of which are macroeconomic in nature, which influence excess returns in all markets.[5] In this spirit, we included two potential systematic global factors into the return generating function, besides the world portfolio excess return. The additional risk factors are the changes in the level of economic activities in the OECD and the movement in the price of oil

(6)

where, $\beta_{i1} = \lambda_0 + \lambda_1' X_{it-1}$ OIL_t is the percentage change in the price of crude oil, and $YOECD_t$ is the growth rate of real gross domestic product of the OECD countries.

3. Empirical Results

2 Other authors have specified the price of risk as an exponential function of a set of known instruments in order to incorporate Merton's (1980) argument that a non-negativity restriction should be incorporated into the model specification in order to avoid possible biases in the estimation of excess returns (Bekaert and Harvey 1995; De Santis and Gerard 1997).

3 Some of these variables have been found to be significant determinants of various country risk rating measures. For example, Cantor and Packer (1996) found that six macroeconomic indicators explain over 90 per cent of the cross-sectional variation in the S&P and Moody's sovereign credit ratings. Erb, Harvey, and Viskanta (1997) have shown that a group of seven macroeconomic variables explained over 80 per cent of the Euromoney Country Risk Rating and the Institutional Investor Country Credit Rating. Erb, Harvey and Viskanta (1996), employing a sample of 48 developed and emerging market countries, have made the country beta a function of an index of economic risk. The authors found this risk adjusted beta to be positively correlated with expected returns.

4 Ferson and Harvey (1998) have included these valuation variables as additional instruments for the country beta following the controversial findings by Fama and French (1992) that the univariate cross-section relationship between the beta and stock returns is weak and that the average returns can be better explained by firm size and the book-to-market value of equity. Following the conclusion that CAPM is invalid, Fama and French (1996) proposed a three-factor pricing model that includes the market portfolio and two factors designed to mimic risk variables related to size and book-to-market value.

The ICAPM outlined in the previous section is estimated for the equity markets of Thailand, Singapore, Malaysia, Indonesia, the Philippines, Hong Kong, and Korea. The excess returns for each country and the global portfolio were calculated using the country and World stock market indices compiled by Morgan Stanley Capital International (MSCI). These indices are expressed in USD and the excess return in each market is calculated as the annualised first difference of the logarithm of the index less the returns on the US 3-month Treasury bill. The sample consists of quarterly observations from 1987:1 to 2000:2. A quarterly sample is used since macroeconomic variables like the real GDP, current account, and external debt are available only on quarterly basis.

Figure 1 shows plots of the annualised unconditional excess returns in each of the seven East Asian markets and Table 1 provides the summary statistics of the excess returns. With the exception of the Hong Kong and Singapore markets, the average excess returns, expressed in USD, in the other five markets were negative. The negative excess returns reflected to some extent the sharp depreciation of the currencies of these countries during the East Asian financial crisis which erupted in July 1997. Excluding the observations from the period of the financial crisis, the mean excess returns from these markets were positive, except for Korea.

Table 1 shows the Sharpe reward-risk ratio for the seven markets. If the MSCI World index is regarded as the global market portfolio, then its Sharpe ratio will proxy for the slope of the efficient frontier or the capital market line of the ICAPM. Before the outbreak of the financial crisis, five markets had a Sharpe ratio in excess of the ratio for the MSCI World portfolio. When the observations from the period of the financial crisis were included in the sample, the reward-to-risk ratios of all the seven East Asian markets were below the global ratio.

The coefficient of skewness indicates that for the whole sample period, the excess returns in Malaysia and Korea (as well as the returns on the world portfolio) have a long left tail and the Kurtosis statistic shows that the tail of the distribution of the excess returns in these markets is much thicker than normal. The Jarque-Bera statistic confirms the null hypothesis that the excess returns have a normal distribution that can be rejected at 5 per cent level.

The relatively large autocorrelation coefficients at various lags indicate that the excess returns can be predicted on the basis of past market returns.[6] The predictability of the actual excess returns provide the justification for the specification of the conditional model where both the $\beta_{it}(\Omega_{it-1})$ and $E(r_{mt} - \gamma_{ft} \mid \Omega_{t-1})$ vary with the available information set. On the other hand, in a CAPM that assumes expected returns are constant over time, predictability of returns could be inferred as evidence of market inefficiency. The negative autocorrelation coefficients that follow the positive coefficients suggest certain mean-reverting behaviour. In fact a closer examination of the excess return plots in Figure 1 in the seven markets indicate

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[5] According to the APT, the rate of return of a security is a linear function of k factors:

$$r_i = E(r_i) + \beta_{i1}F_1 + \ldots + \beta_{ik}F_k + U_i$$

where β_{ik} is the covariance of the ith asset's returns and the kth factor, F_k is the zero-mean factor, common to all returns, U_i is arandom term for the ith asset. Ross (1976) has shown that such pricing relationship is derived from the concept of arbitrage portfolios which use no wealth, are riskless, and earn zero average returns. While the APT states that returns are generated by k independent factors, the theory does not specify how large k is. In a pioneering empirical work, Chen, Roll, and Ross (1986) have identified four economic factors that influence returns, instead of one as suggested by the CAPM.

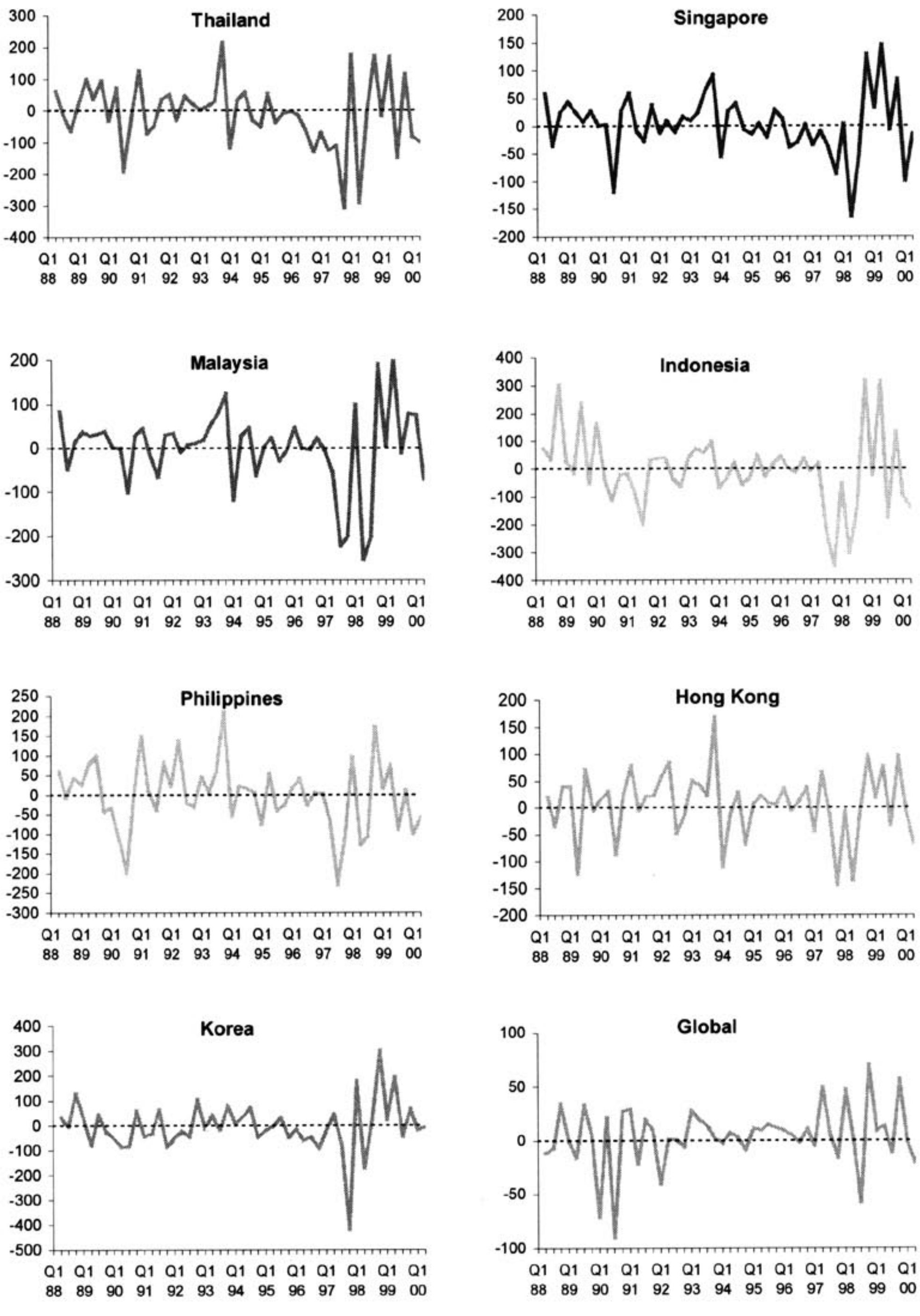

Figure 1: Excess returns in East Asian equity markets (USD) (1988:1 – 2000:2)

Table 1: Annualised quarterly excess returns (1988:1 – 2000:2)

Market	Mean	Standard Deviation	Sharpe Ratio	Skewness	Kutorsis	Jarque-Bera Statistic	ρ_1	ρ_2	ρ_3	ρ_4	*Q(6)*
1988:1 – 2000:2											
Global	3.770	28.712	0.131	-0.802	5.272	15.791*	-0.311	-0.072	0.277	-0.166	13.749*
Thailand	-9.952	107.350	-0.092	-0.464	3.803	3.081	-0.228	0.198	0.171	-0.028	9.688
Singapore	3.002	55.572	0.054	-0.261	4.512	5.223	0.020	0.097	-0.019	-0.105	3.262
Malaysia	-0.083	89.815	-0.001	-0.787	4.499	9.648*	0.045	0.002	0.252	-0.065	8.821
Indonesia	-4.831	134.307	-0.036	0.162	4.143	2.881	0.032	0.240	0.067	-0.217	9.763
Philippines	-0.709	86.403	-0.008	-0.121	3.549	0.736	0.109	-0.080	0.074	-0.017	3.452
Hong Kong	6.708	61.890	0.108	-0.392	3.692	2.231	-0.186	-0.028	0.208	-0.354	11.870
Korea	-3.729	101.594	-0.036	-0.653	8.506	65.371*	-0.153	0.149	0.167	-0.241	8.816
1988:1 – 1997:1											
Global	1.139	25.590	0.044	-1.878	7.244	48.197*	-0.280	0.030	0.247	-0.402	14.382*
Thailand	2.131	76.531	0.028	0.078	3.989	1.504	-0.120	-0.107	0.166	0.064	3.323
Singapore	6.336	38.709	0.164	-0.625	4.692	6.651*	-0.068	-0.190	0.136	0.144	4.899
Malaysia	10.238	48.251	0.212	-0.547	4.063	3.497	-0.139	-0.253	0.194	0.021	6.135
Indonesia	13.818	90.962	0.152	0.954	5.476	14.664*	0.030	0.107	0.232	-0.082	5.421
Philippines	13.193	73.690	0.179	0.011	4.566	3.677	0.113	-0.098	-0.012	-0.141	3.453
Hong Kong	10.841	55.307	0.196	-0.156	4.416	3.152	-0.314	-0.141	0.278	-0.302	13.287*
Korea	-7.544	56.928	-0.133	0.521	2.535	1.955	0.006	0.115	0.163	-0.080	3.494

Notes: * indicates that the test statistic is significant at 5 per cent. ρ_i is the autocorrelation coefficient at lag *i*.
Q(6) is the Ljung-Box *Q*-statistic calculated over 6 lags.

that returns varied in a counter-cyclical manner. Excess returns and equity risk premia tend to increase during periods of economic slowdown and recession and fall during the period of accelerating economic growth.[7]

We first estimated the single-factor conditional ICAPM in which β is fixed and only the expected excess returns are time-varying. The instruments used were two quarterly lagged excess returns to the domestic market and two quarterly lagged excess returns to the world portfolio. The Hansen (1982) generalised method of moments (GMM) was used to estimate the β parameter. Let $\in_{it} = \phi(\beta_i, Z_{t-1})$ be the forecast error of the excess return in market *i*, and $\in_{it}$ can be heteroskedastic and serially correlated. If the model is correctly specified and the information variables are adequately selected, the estimate of β_i would ensure that $\in_{it}$ is orthogonal to the set of instruments Z_{t-1}. The GMM procedure selects the parameter estimate so that the correlation between the instruments and the estimated parameter is close as possible to zero, according to a quadratic form criterion function. The minimised value of the quadratic form, denoted as *J*, is distributed as chi-square under the null hypothesis that the over-identifying restrictions are satisfied. The *J*-test, therefore, provides a summary evaluation of the goodness of fit of the estimated model. A rejection of the null hypothesis indicates that the model is mis-specified and the choice of instruments inappropriate.

Table 2 presents the GMM estimates of the conditional single-factor ICAPM. The estimates indicates that the β*'s* in all the seven equity markets are statistically significantly different from zero, indicating that the returns on the world market portfolio have considerable influence on the expected excess returns in the markets of East Asia, with the size of the coefficient varying from 0.96 for Korea to a high of 1.78 for Thailand. The *p*-values of the *J*-test indicate that the over-identifying restrictions of the model are satisfied for all the markets. The magnitude of the estimated betas and their *t*-values are larger than the estimates obtained by Buckbery (1995) and Harvey (1995a; 1995b) who employed a sample spanning the late 1980s and the early 1990s. This suggest that the equity markets in East Asia are increasingly being integrated with the rest of the world since the early 1990s.

The next step in our analysis is to investigate the extent to which the individual market's β is time-varying and is conditioned by country-specific macroeconomic factors. The variables in the instrument vector X_{it-1} of equation (5) are one-quarter lagged real GDP growth, current

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[6] Given, that there are 158 observations in the sample, the 95 per cent confidence interval for the autocorrelation coefficient is ± 0.1591.

[7] When we regressed the excess returns in each market against the cyclical component of the real GDP gap of the country, the coefficient of the gap was negative for all the seven countries. The GDP gap was constructed as the difference between the logarithm of the real GDP and its Hodrick-Prescott trend.

Fama and French (1989) have provided reasons for the inverse relationship between the excess returns on stocks and business cycle conditions. First, during the economic downturns, the higher business risk tends to coincide with the weaker capacity of the investors to bear risk. Second, the peak of the business cycle is often characterised by poor investment opportunities while strong earnings can be expected from investment opportunities after the economy has bottomed out of the business cycle. Hence expected returns tend to be low around the peak of the business cycle and high after the trough of the cycle is reached. Third, the modern consumption asset pricing model points to securities as a hedge against consumption risk (Cochrane 1997; Campbell 1996). Household savers seek to smoothen their consumption profile over the business cycle. During periods of economic boom, where current income rises above their permanent wealth, consumers would smoothen their consumption by saving a larger fraction of their income, and as such they do not require higher expected returns for foregoing current consumption. During the cyclical downturn, where current income falls, and consumers need to draw down their wealth to maintain the existing level of consumption, higher expected returns would be required to induce consumers to forego consumption.

account deficit (as a percentage of nominal GDP), change in the short-term money market interest rate, inflation rate, and the ratio of the foreign exchange reserves to total external debt, and the nominal exchange rate against the USD.

The results of estimating the single-factor conditional ICAPM with time-varying country beta are presented in Table 3. Among the six macroeconomic variables, the current account deficit (as a percentage of GDP) appears to be the most consistent determinant of the country beta, where it is statistically significant in six out of the seven countries, namely in Thailand, Malaysia, Indonesia, the Philippines, Hong Kong and Korea. The estimates indicate that a rising current account deficit or a reduction in the current account surplus is associated with greater risk exposure of the individual markets to the changes in the global risk premium.

Table 2: Conditional ICAPM with constant beta

Market	β	*p*-value for *J*-test
Thailand	1.7799	0.2617
	(13.4744)*	
Singapore	1.2983	0.2393
	(12.0256)*	
Malaysia	1.1902	0.2561
	(14.7875)*	
Indonesia	1.3526	0.2338
	(9.5581)*	
Philippines	1.6738	0.0835
	(2.2885)*	
Hong Kong	1.2524	0.2571
	(14.9254)*	
Korea	0.9575	0.2537
	(9.3078)*	

Notes: Figures in parentheses are *t*-values; * indicates coefficient is significant at 5 per cent level.

Inflation and the ratio of international reserves to the stock of external debt impart significant influence on the conditional betas of four markets. Rising inflationary pressures in Thailand, Malaysia, Indonesia, and Hong Kong tend to increase the market conditional beta. The beta is sensitive to the reserves cover of the external debt in Thailand, Indonesia, the Philippines, and Korea. A higher stock of international reserves relative to the outstanding external debt lowers the risk sensitivity. Systematic risk exposure of a market is significantly affected by country economic growth only in Singapore, Indonesia, and Hong Kong. A higher previous quarter economic growth reduces the current level of systematic risk in Singapore and Hong Kong but appears to increase the sensitivity of the local market to the global market risk factor in Indonesia. Changes in the domestic interest rate impart significant influence on the beta in Malaysia, Korea, and Indonesia. In the first two countries, rising interest rate appears to increase the sensitivity of the local market excess returns to movement in the global market risk factor, while in Indonesia higher interest rate tends to lower the risk sensitivity. The conditional beta is sensitive to the movement of the domestic currency against the USD only in the case of Malaysia and Korea, where a depreciation of the nominal exchange rate tends to increase the covariance risk of the market.

Table 3: Single-factor conditional ICAPM with time-varying beta

Market	$ERWMSCI_t$	$ERWMSCI_t$ X $RGDP_{i,t-1}$	$ERWMSCI_t$ X $INF_{i,t-1}$	$ERWMSCI_t$ X $CAGDP_{i,t-1}$	$ERWMSCI_t$ X $INTR_{i,t-1}$	$ERWMSCI_t$ X $DEBT_{i,t-1}$	$ERWMSCI_t$ X $EX_{i,t-1}$	*p-value for J-test*	χ^2 *(7)*
Thailand	1.7921	-0.0142	0.7775	1.2754	-0.1942	-16.9175	-0.0160	0.1653	96.8280
	(5.0515)*	(-0.2920)	(3.7473)*	(6.6038)*	(-1.3491)	(-5.4381)*	(-0.7175)		(0.0000)
Singapore	0.8972	-0.2170	-0.1319	-0.0529	0.0006		-0.0459	0.1931	24.0204
	(0.2981)	(-3.8641)*	(-0.7624)	(-1.1234)	(0.0017)		(-1.7952)		(0.0000)
Malaysia	1.5026	0.0893	1.3725	0.3881	5.6602	1.1713	0.3188	0.1799	205.0544
	(1.6064)	(1.1035)	(2.8024)*	(4.4274)*	(3.525)*	(0.7272)	(3.9541)*		(0.0000)
Indonesia	3.0201	0.2135	0.1650	0.1309	-0.1721	-0.4662	-0.0129	0.2231	137.3900
	(3.1395)*	(3.3980)*	(3.2778)*	(3.7197)*	(-1.5918)*	(-2.4640)*	(-0.4930)		(0.0000)
Philippines	1.2359	-0.0986	-0.0900	0.4463	0.1347	-0.1281	0.0087	0.1838	67.5711
	(2.7064)*	(-1.5637)	(-1.7061)	(5.8941)*	(1.05001)	(-5.1147)*	(0.7441)		(0.0000)
Hong Kong	2.0781	-0.0836	0.0894	-0.1109	-0.3384	-3.8508	-0.2992	0.2174	42.4931
	(3.17018)*	(-3.8304)*	(4.1855)*	(-4.2024)*	(-1.1821)	(-1.4294)	(-1.2844)		(0.0000)
Korea	2.6789	-0.0844	-0.0698	0.0054	0.6027	-3.6969	0.0657	0.2003	257.3390
	(4.7221)*	(-1.1504)	(-0.5559)	(2.2696)*	(5.1051)*	(-5.1050)*	(3.4619)*		(0.0000)

Notes: Figures in parentheses are *t*-values; * indicates coefficient is significant at 5 per cent level;
ERWMSCI = excess return on MSCI world portfolio; *RGDP* = growth in real GDP; *INF* = inflation rate;
CAGDP = rate of current account to nominal GDP; *INTR* = change in money market interest rate;
DEBT = ratio of international reserves to external debt, *EX* = percentage change in the exchange rate, χ^2 (7) statistic tests the joint hypothesis that the coefficients of the seven domestic variables are equal to zero.

We conducted a Wald test to evaluate whether the set of macroeconomic factors is systematically related to the conditional beta of each country. The results presented in Table 3 indicate the null hypothesis that the set of six macroeconomic variables is jointly zero is rejected in all seven East Asian markets with a *p*-value of zero. The test results therefore indicate that the market beta in these countries is time-varying and the macroeconomic performance of those countries is priced into the investors' assessment of the systematic risk of the markets.

On the basis of the parameter estimates reported in Table 3, we generated the values of the time-varying beta for each of the seven markets. The summary statistics of the betas are given in Table 4 and the plots are presented in Figure 2. The average of values of the time-varying beta is lower than the point estimates of the beta from the fixed-coefficient single factor model as reported in Table 2. The estimates from the time-varying model indicate that Thailand and Korea have, on an average, highest risk exposure to global market risk factor while Singapore has the lowest risk sensitivity as well as the smallest variability in the beta. The standard deviations are the largest for Thailand and Malaysia.

Figure 2 indicates that the estimated betas of the seven markets rose sharply following the outbreak of the East Asian financial crisis in July 1997. The beta peaked at 3.3 for Indonesia (1998:4), 3.6 for Korea (1998:1), 1.9 for Hong Kong (1998:3), 1.4 for Singapore (1998:4), and 4.9 for Malaysia (1998:2). With the exception of Korea where the beta declined almost continuously, the risk sensitivities in the other market have remained relatively high even after the financial crisis abated. The high beta-risk sensitivities therefore would make these markets more vulnerable to a given downturn in the global equity market.

While the *J*-test indicates that the over-identifying restrictions of the estimated single factor CAPM canot be rejected, the pricing errors of the estimated model tend to be relatively large (Table 6). We next estimated the multi-factor model (with the single factor CAPM as a special case) and evaluated whether the excess returns predicted by the model would be more consistent with the actual average returns. Table 5 reports the results of the multi-factor conditional asset pricing model. The additional instruments used in the GMM estimates were two quarterly lags of each of the two additional factors. The coefficient estimates indicate that changes in the level of economic activities in the OECD economies constitute an additional significant global risk factor for markets in Singapore, Indonesia, the Philippines, and Korea, where deceleration of economic growth can be expected to raise the degree of non-diversifiable risk in these markets. Among these markets, the estimated betas indicate that the Korean market has the highest risk sensitivity to OECD economic growth while the Singapore market shows the lowest sensitivity. The results also indicate that with the exception of Singapore, the returns in the other six markets are sensitive to the movement in the price

Table 4: Summary statistics of time-varying betas (1988:1 - 2000:2)

Market	Mean	Standard Deviation
Thailand	1.4400	1.2143
Singapore	0.8311	0.3880
Malaysia	0.8720	1.2192
Indonesia	0.8991	0.6812
Philippines	1.1331	0.7552
Hong Kong	0.9861	0.6321
Korea	1.3250	0.8489

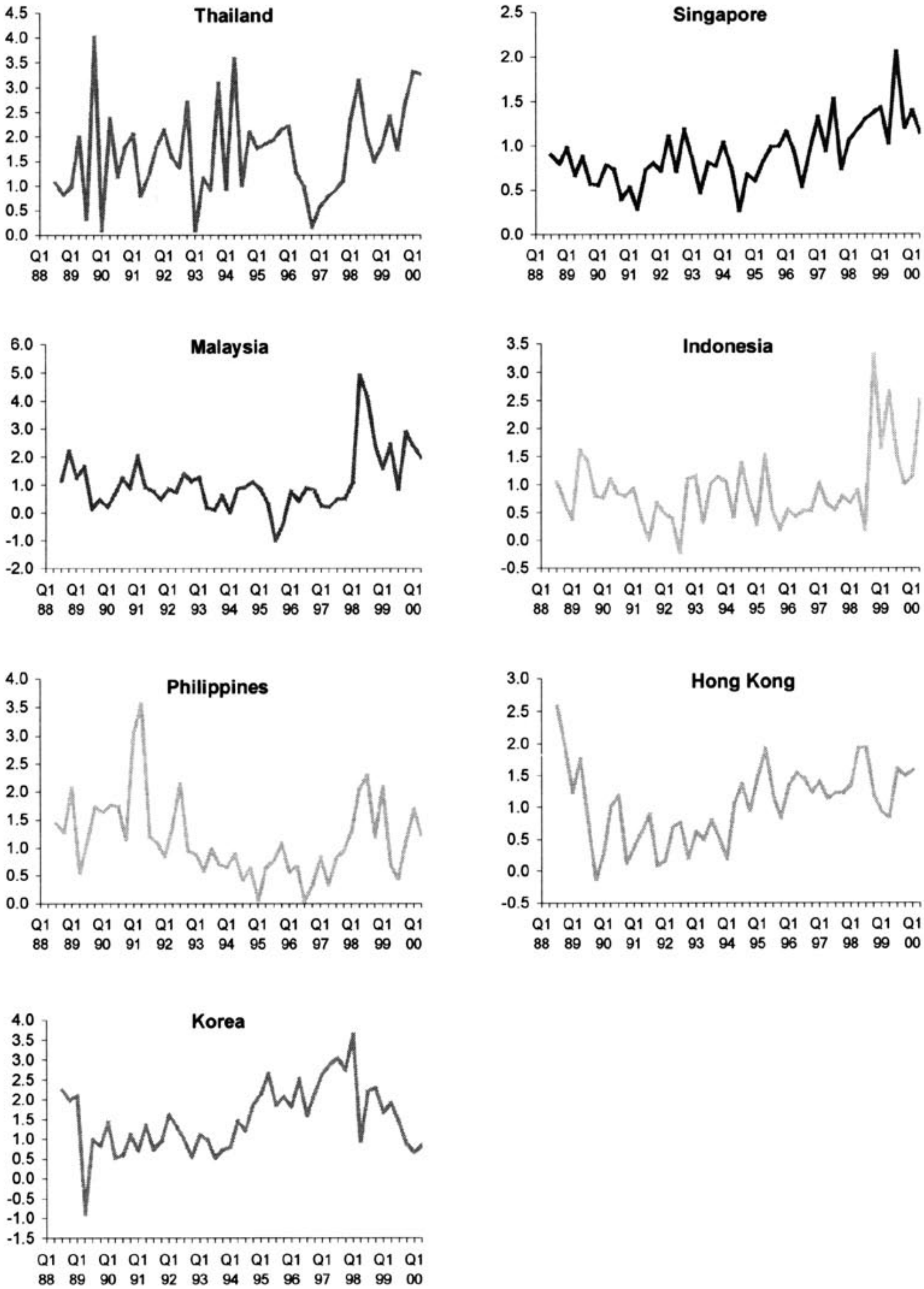

Figure 2: Time-varying beta (1988:1 – 2000:2)

of oil. An increase in the price of oil leads to higher excess returns required by the markets in these countries with the Korean and the Thai markets having the highest risk exposure. A Wald test confirms that the two additional global risk factors jointly contribute to explaining the variation in the excess returns in each of the seven markets. The test results therefore indicate that for open economies like those in East Asia, the two exogenous shocks from abroad constitute an independent source of non-diversifiable risk that are directly priced into the equity markets. The inclusion of the two additional global risk factors, however, raises the factor sensitivity of the markets in Indonesia, Malaysia, and the Philippines to the global excess returns while reducing the factor sensitivity in the other four markets.

Table 6 compares the average pricing errors of the three estimated models. The pricing errors should capture both the unpredictable component of the excess returns and any specification errors arising from the estimated models. For example, in specifying the asset-pricing model, we imposed the restrictions that the country-specific macroeconomic variables influence the excess return through the market beta while the global instruments impact only on the world risk factors. If the model is correctly specified, then the errors should be orthogonal to any information known at time *t*.

Table 6 shows the mean of the pricing errors for the three estimated models, calculated over the sample period 1987:1 to 1997:1. We excluded the observations from the currency crisis period as the errors were exceptionally high. PE1 refers to the average pricing errors of the single factor conditional ICAPM with a constant beta (Table 2), while PE2 and PE3 are the pricing errors of the single factor ICAPM with time-varying beta (Table 3) and the pricing errors of the multi-factors conditional model (Table 5) respectively.

The mean annualised pricing errors from a single-factor model which allows the beta to vary with the domestic macroeconomic variables are lower than the errors from the model which restricts the beta to be constant for all the markets except for the market in Korea.[8] The average errors from the former model are largest for Indonesia and Korea, and are the lowest for Thailand, Hong Kong, and Singapore, where the mean errors vary from 1 to 2 per cent per annum. Average pricing errors for the multi-factor model are lower than the model where the world equity portfolio is the only risk factor, with the exception of the Philippines. In Hong Kong and Thailand, the mean errors vary from 0.14 to 0.67 per cent per annum. Therefore, it appears that the high average excess returns earned in the East Asian markets before the outbreak of the currency crisis are to a considerable extent compensation for economic risks. Table 6 also presents the test results which show that the pricing errors are unpredictable on the basis of available information. The Ljung-Box *Q*-test indicates that the pricing errors in all the market are serially uncorrelated up to six lags. The results of the Wald test indicate the null hypothesis that the pricing errors are orthogonal to select information variables cannot be rejected at 5 per cent level.[9]

Overall, our empirical results provide some optimism that the conventional asset-pricing model can provide a useful framework to identify and measure risk in the East Asian equity markets. One reason for the relative success of the empirical model is that markets in the region have increasingly been liberalised and hence are becoming more integrated with the

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[8] Ghysels (1998) has shown that even though the estimated conditional CAPM satisfies the *J*-test for over-identifying restrictions, the model could still lead to a mispricing of the excess returns if the beta is subject to structural breaks.

Table 5: Multi-factor conditional ICAPM with time-varying beta

Market *i*	$ERWMSCI_t$	$ERWMSCI_t$ X $RGDP_{i,t-1}$	$ERWMSCI_t$ X $INF_{i,t-1}$	$ERWMSCI_t$ X $CAGDP_{i,t-1}$	$ERWMSCI_t$ X $INTR_{i,t-1}$	$ERWMSCI_t$ X $DEBT_{i,t-1}$	$ERWMSCI_t$ X $EX_{I,t-1}$	$YOECD_t$	OIL_t	*p-value for J-test*	χ^2 *(2)*
Thailand	1.3011	-0.3795	1.0097	0.0741	-1.0704	-3.5452	-0.4782	-5.9497	0.5293	0.1519	13.6649
	(2.2338)*	(1.0736)	(2.5142)*	(0.8691)	(-4.7011)*	(-1.9569)*	(-1.6837)	(-1.6593)	(3.1285)*		(0.0010)
Singapore	0.4153	-0.3917	-0.8693	-0.0110	-0.5473		-0.1356	-7.3049	0.0259	0.1532	22.7483
	(0.2987)	(-3.9441)*	(-0.1808)	(-0.1740)	(-1.3441)		(-3.4401)*	(-4.6831)*	(0.3071)		(0.0000)
Malaysia	2.0013	-0.0039	0.8602	0.1272	2.3815	2.3857	0.0451	5.2417	0.1122	0.2068	7.5416
	(1.8233)	(-0.0807)	(3.4070)*	(2.1746)*	(3.0969)*	(1.3587)	(1.3969)*	(1.2947)	(2.0186)*		(0.0229)
Indonesia	3.6061	-0.0137	-0.0151	0.5112	-0.7740	-0.8245	0.0266	-7.9931	0.4772	0.2066	159.1501
	(5.9991)*	(-0.1976)	(-0.2650)	(3.1962)*	(-2.3211)*	(-6.7401)*	(1.4831)	(-4.7051)*	(6.0064)*		(0.0000)
Philippines	3.0951	-0.1783	0.0644	0.1621	0.7681	-0.0211	-0.0085	-9.8077	0.3997	0.2046	22.2861
	(2.9143)*	(-1.3889)	(0.8083)	(1.5094)	(3.6891)*	(-0.7098)	(-0.3667)	(-4.5623)*	(2.6360)*		(0.0000)
Hong Kong	0.7038	0.0340	0.0768	-0.1249	0.4903	3.3691	0.8415	1.4765	0.1617	0.1985	21.3711
	(1.3071)	(0.8087)	(2.0774)*	(-2.0274)*	(3.3069)*	(0.7336)	(1.1311)	(1.1004)	(3.0891)*		(0.0000)
Korea	0.7111	0.0661	-0.9521	0.0454	0.7853	-2.1784	-0.1776	-11.6511	0.5797	0.1385	101.2271
	(2.2124)*	(0.8851)	(-1.5611)	(7.1831)*	(6.2773)*	(-2.6611)*	(-3.9672)*	(-9.5844)*	(7.0091)*		(0.0000)

Notes: Figures in parentheses are *t*-values; * indicates coefficient is significant at 5 per cent level;
ERWMSCI = excess return on MSCI world portfolio; *RGDP* = growth in real GDP; *INF* = inflation rate;
CAGDP = rate of current account to nominal GDP; *INTR* = change in money market interest rate;
DEBT = ratio of international reserves to external debt, *EX* = percentage change in the exchange rate;
YOECD = percentage change in *OECD* real GDP; *OIL* = percentage change in price of oil; $\chi^2(2)$ statistic tests the joint hypothesis that the coefficients of the two global variables are equal to zero.

Table 6: Market average pricing errors

Market	PE1			PE2			PE3		
	Mean	Q(6)	$\chi^2(8)$	Mean	Q(6)	$\chi^2(8)$	Mean	Q(6)	$\chi^2(8)$
Thailand	-3.0168	6.1636	9.001	-1.6614	3.4960	7.172	0.6614	6.2163	9.036
		(0.405)	(0.3812)		(0.745)	(0.4384)		(0.399)	(0.3817)
Singapore	5.1017	14.0970	10.0711	3.6991	6.2573	9.3824	2.6718	7.3076	10.0041
		(0.029)	(0.3121)		(0.517)	(0.4301)		(0.298)	(0.3761)
Malaysia	8.7811	9.5277	5.0020	7.9814	8.8672	3.8711	6.7811	10.5141	12.6924
		(0.146)	(0.7323)		(0.114)	(0.8114)		(0.091)	(0.1488)
Indonesia	12.5284	7.5025	9.6163	10.3103	5.0469	11.3941	9.6710	0.8055	4.1882
		(0.326)	(0.3027)		(0.538)	(0.1804)		(0.992)	(0.8397)
Philippines	11.7721	25.7744	8.1428	8.5273	2.5597	7.399	13.4901	25.7740	8.1428
		(0.0000)	(0.4196)		(0.862)	(0.4983)		(0.0000)	(0.4196)
Hong Kong	0.0413	5.4932	5.6631	2.2783	11.4857	7.9931	0.1421	4.7716	10.8970
		(0.532)	(0.6848)	(0.7567)	(0.075)	(0.6108)		(0.573)	(0.2076)
Korea	-9.3191	2.8921	2.8661	-9.9811	4.6975	3.1597	6.5511	3.5670	12.5073
		(0.819)	(0.8997)	(0.6815)	(0.583)	(0.8694)		(0.735)	(0.1301)

Notes: PE1, PE2, PE3 refer to the means of the pricing errors of estimated models presented in Tables 2, 3 and 5 respectively;
Q(6) is the Q-statistic testing for serial correlation in 6 lags;
$\chi^2(8)$ statistic tests the joint hypothesis that the coefficients of the eight information variables are equal to zero.

world capital market.

4. Summary and Conclusions

The paper is concerned with the pricing of risk in the equity markets of East Asia where risk is defined in terms of exposure to some global factors. The study uses variants of the conditional international asset pricing model to investigate how the level of risk and excess returns in the markets and their variations over time are influenced by domestic macroeconomic performance and the global economic environment. The estimates from a conditional ICAPM indicate that the excess returns in the East Asian markets have become increasingly more sensitive to changes in the returns on the global market since the early 1990s, indicating that these markets are becoming more integrated into the world capital markets. The analysis found considerable time variation in the market betas and that the risk sensitivity is significantly related to the domestic macroeconomic variables of the countries. Additional global risk factors in the form of movement in the price of oil and in the level of economic activities of the OECD economies are found to have a further impact on returns in the East Asian market. The empirical models therefore provide us with a framework to identify the sources of rising risk premium in the East Asian markets i.e. the expected slowdown in the major OECD economies, the high price of oil, and the higher level of risk in the major international equity markets (the impact of which tends to be amplified by the domestic macroeconomic performance).

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[9] Eight variables lagged two quarters were used as instruments. They were domestic inflation, current account, interest rate, reserves to external debt ratio, exchange rate, excess returns on global portfolio, OECD GDP growth, and the change in the price of oil.

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