CURRENCY RISK IN EMERGING EQUITY MARKETS

Kate Phylaktis*

Cass Business School
Frobisher Crescent
Barbican Centre
London EC2Y 8HB
Fax: (44) 020 7040 8881
Email: K.Phylaktis@city.ac.uk

Fabiola Ravazzolo

Allianz Dresner Asset Management
Nymphenburger Strasse 112-116
80636 Munich
Germany
Fax: (49) 89 1220 7799
Email: F.Ravazzolo@dit.de

JEL Classification Numbers: F31, G12

Keywords: International capital asset pricing models (ICAPM); currency risk; capital market integration; emerging markets; and Pacific Basin capital markets.

Abstract

The paper develops an international capital asset pricing model, which includes foreign currency risk, and examines the impact of capital market liberalisation on the pricing of risks. It applies the model to data from Pacific Basin financial markets and finds substantial evidence that not only currency risk is priced in both pre and post liberalisation periods, but the model is superior to one which does not include currency risk. This evidence suggests that an international capital asset pricing model, which omits currency risk, will be misspecified. Furthermore, the results imply that since currency risk is priced and investors are compensated for bearing such risk they should not be discouraged by more flexible exchange rate regimes from investing in emerging markets.

* Correspondence to: Kate Phylaktis

1. Introduction

The recent emergence of highly remunerative equity markets, following the relaxation of foreign investment restrictions, and the developments in communication and trading systems, has attracted the attention of academics to explain their impressive returns. Their low correlation with the developed financial world has also intensified the interest of international fund managers as opportunities for portfolio diversification benefits. Evidence of that is the increasing flow of funds from developed countries towards the newly established financial markets.[1] The adoption of more flexible exchange rate regimes by many emerging economies however in the late eighties and early nineties is likely to have affected the foreign currency risk associated with international investment and to have made the choice of currency denomination an important element in the overall portfolio decision.

The objective of this paper is to develop an international capital asset pricing model, which includes currency risk, and to examine the impact of capital market liberalisation on the pricing of risks. Previous capital asset pricing models can be classified into three groups based on the type of risk considered in pricing expected returns: segmented market models, integrated market models, and partially segmented market models. The segmented market model evaluates expected equity returns as a function of only the country-specific risk represented by stock returns variance. A classic segmented market framework is the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965) and Black (1972), applied to one country's data. Such

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We are grateful to the Emerging Markets Group, (EMG) Cass Business School, London, (the new name for City University Business School), for financial support.

[1] See e.g. Hawawini (1994) for evidence on the increasing flow of funds to new capital markets and the importance of these markets to portfolio management.

a framework is suitable if the market is completely segmented or if it represents a proxy for the world market. The suitability of this model has however diminished over the years as the market capitalisation of any one single market as a proportion of the world market has decreased. Within the class of asset-pricing models for integrated markets there are studies that assume that all the world capital markets are perfectly integrated, and therefore the source of their risk can be associated with the covariance of the local stock market returns with the world market portfolio. These include studies of an international CAPM (see Grauer, Litzenberger and Stehle, 1976); a world consumption-based model (see Wheatley, 1988); world arbitrage pricing theory (see Solnik,1983); world multibetas models (see Ferson and Harvey, 1993 and 1994); and world latent factor models (see Campbell and Hamao, 1992 and Bekaert and Hodrick, 1992). The polar approaches have produced on the whole poor results. An alternative asset pricing model (see Errunza, Losq, and Padmanabhan, 1992) considers a framework in which the polar segmented/integrated cases are replaced by a mild segmentation structure. While this model presents the advantage of avoiding the choice between the scenario of full segmentation and perfect integration, the framework has the disadvantage of selecting a degree of segmentation that is fixed through time.

Errunza, Losq, and Padmanabhan's limitation has recently been overcome by Bekaert and Harvey (1995) and De Santis and Imrohoroglu (1997). Bekaert and Harvey (1995) proposed a one-factor asset pricing model that allows the conditional expected returns of a country to be affected by their covariance with a world benchmark portfolio and by the variance of the country returns. If the market was perfectly integrated then only the covariance counted; while if the market was completely segmented then the variance was the relevant measure of market risk.

Bekaert and Harvey (1995) use a conditional regime-switching model to account for periods when national markets were segmented from world capital markets and when they became integrated later in the sample. They applied the model to monthly observations of equity returns of a group of emerging capital markets including the countries in our sample, over the period 1975 to 1992. They found that integration was substantial also for countries presenting extensive foreign ownership restrictions, such as Korea and Taiwan.

De Santis and Imrohoroglu (1997) considering a group of emerging equity markets covering the regions of Latin America, Middle-East and Asia for the period December 1988 to May 1996, use the CAPM framework to study the stock returns and the volatilities of these capital markets under different degrees of integration. They introduce a dynamic integration version of the classic CAPM framework that assumes full market segmentation until the official liberalisation date of each capital market, and full integration thereafter to capture the fact that the analysed markets were legally segmented for part of the sample period. The evidence shows that neither the country specific risk is priced when are markets are segmented, nor the world market risk when the markets are integrated.[2]

De Santis and Imrohoroglu's weak findings might be affected by two limitations in their methodology. First, in contrast to Bekaert and Harvey (1995), the date when each country switches from being fully segmented to being fully integrated is fixed and the process is irreversible. Secondly, the lack in pricing the country-specific risk might have been caused by the omission of currency risk, which affects the expected returns of the local stock market. Dumas (1994) shows theoretically,

[2] Country specific risk is not priced even when market segmentation is assumed for the whole sample period.

while Dumas and Solnik (1995) empirically, that by applying the International CAPM (ICAPM) framework with currency risk the latter is priced.

Dumas (1994) notes that if Purchasing Power Parity (PPP) does not hold, the rates of inflation in the various countries, all expressed in U.S. dollars, are not equal and their differences are random. On this point, Solnik shows that this is entirely reflected by the random fluctuations of each currency against the dollar (see Solnik, 1974). Therefore, if PPP does not hold, any investment in a foreign asset is a combination of an investment in the performance of the foreign asset and an investment in the performance of the domestic currency relative to the foreign currency. Thus, in applying international capital asset pricing models one should endeavour to price it as its omission might bias findings.

Dumas and Solnik (1995) using the conditional version of ICAPM based on a methodology originally proposed by Harvey (1991) show that the currency risk is significantly different from zero for a sample of securities in Germany, US, Japan and UK for the period March 1970 to December 1991. De Santis and Gerard (1998) consider also a conditional version of the ICAPM based on multivariate GARCH, which includes the foreign exchange risk for equity markets and one-month Eurocurrency deposits for the same group of countries examined by Dumas and Solnik (1995) but for the period June 1973 to December 1994. The results indicate that investors require a premium for bearing currency risk.[3]

[3] Carrieri (2001) repeats the same analysis of De Santis and Gerard (1998), but for France, Italy, Germany and U.K., using monthly observations for the period March 1974 to August 1995. She finds also that the currency risk is priced for these European equity returns.

Based on the results about the importance of currency risk, our paper extends the dynamic integration conditional CAPM of De Santis and Imrohoroglu (1997) by including currency risk. We conduct our analysis by considering the same Asian Pacific countries (with the only exception of India) analysed by De Santis and Imrohoroglu, 1997), but extend the sample period from January 1980 to May 2000, compared to their sample period of December 1988 to December 1996. Our analysis shows that the limited relationship found in De Santis and Imrohoroglu (1997) between risk and returns was due to the omission of currency risk.[4]

Thus, our main objective and contribution to the literature is the examination of the importance of currency risk in explaining the stock returns of emerging equity markets using a framework which allows for a regime switch in the sources of risk affecting stock returns when they become open to foreign investors. Although our model (as is De Santis and Imrohoroglu's) is limited by the assumption that the date when each country switches from being fully segmented to being fully integrated is fixed and the process is irreversible, studies, such as Bekaert and Harvey (1995), which allows for time–vaying integration, does not consider foreign currency risk. Our approach of incorporating currency risk within an ICAPM framework is in fact a variation of De Santis and Gerard (1998). Our specification, however, reflects the limitations of data availability regarding suitable series for interest rates.

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[4] Asian Capital markets (Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan Province of China and Thailand) have attracted substantial capital flows during the 1990's. For example, in 1996, 48 percent of the net private capital flows to all emerging economies was directed to these markets (see World Economic Outlook, October 2000, published by the International Monetary Fund).

The paper is structured as follows. Section 2 explains the dynamic integration asset-pricing model of equity returns with and without currency risk. It also introduces the dynamic integration asset-pricing model for the currency returns. Finally, it explains the estimation method of their conditional variances and covariances by using a trivariate Generalised Autoregressive Heteroskedastic (GARCH) process. Section 3 reports the summary statistics of each variable and background information on the liberalisation of the financial markets in our sample. Section 4 discusses the empirical results. The final section summarises the main findings and offers some concluding remarks.

2. The model

2.1 *Dynamic integration ICAPM with market and currency risks*

The static version of CAPM whereby the expected return on the equity index of country i is a linear function of the covariance between the return on that asset and the return on the market portfolio can be given below when applying the GARCH methodology

$$E_{t-1}(R_{i,t}) = m_{10,i} + m_{11,i}R_{i,t-1} + m_{15,i}h_{im,t}, \quad (1)$$

where $h_{im,\,t}$ represents the conditional covariance between the return on index i and the return on the world market portfolio. An autoregressive component is introduced to take into account the effect of non-synchronous trading in the assets that make up a market index, which is a usual phenomenon in emerging markets.[5]

The choice of the component representing the market risk depends on the degree of financial integration of the analysed country. In a completely segmented

[5] Following Black (1972) a risk-free rate is not included. That is due to the lack of a monthly such rate for our sample period for the countries in this study.

capital market, the expected returns on the local market index is only associated with the country-specific risk, which is proxied by the conditional variance of its equity index returns. Under this scenario the expected return on an equity market i is expressed as follows by modifying equation (1)

$$E_{t-1}(R_{i,t}) = m_{10,i} + m_{11,i} R_{i,t-1} + m_{12,i} h_{ii,t}, \quad (2)$$

where $h_{ii,t}$ is the conditional variance of the market index of country i. In equation (2) it is expected to obtain a significant and positive value for the coefficient $m_{12,i}$, which indicates that investors require higher expected returns when the market risk increases. In contrast, under the scenario of a fully-integrated capital market, the source of risk of the expected return of country i index is affected by its covariance with the world market portfolio returns. This parameterisation has been reported in equation (1), where $h_{im,t}$ indicates the covariance between the returns of market index i and the returns of a selected world market portfolio.

However, when examining emerging markets the degree of their integration might not be identified by one of the two polar scenarios of perfect segmentation and perfect integration. Therefore, in this case it is more appropriate to consider a dynamic integrated CAPM framework. De Santis and Imrohoroglu (1997) introduced a structure that allows in a single model a situation of full market segmentation until the official liberalisation date, and full integration thereafter. The model is as follows

$$E_{t-1}(R_{i,t}) = m_{10,i} + m_{11,i} R_{i,t-1} + m_{12,i} h_{ii,t} DC_{i,t} + m_{15,i} h_{im,t}(1-DC_{i,t}), \quad (3)$$

where DC_i is a dummy variable, which is equal to one before the opening date of market i to foreign investors and zero otherwise. The dynamic integration framework of equation (3) assumes that the price of risk is country-specific before liberalisation, which is represented by the conditional variance of market index i, $h_{ii,t}$, and world market when markets become integrated, which is indicated by the covariance of the returns of market index i and the world market portfolio, $h_{im,t}$.

As it was mentioned before, one of our contributions to the literature is the incorporation of the currency risk in the dynamic integration ICAPM framework. This source of risk is important since PPP does not hold and investors of diverse countries appreciate differently the real returns from the same securities. According to Dumas (1994), the expected nominal rate of return on the market index of country i, expressed in dollar units, using the ICAPM, is as follows (see Appendix A for details of the derivation of this framework)

$$E_{t-1}(R_{i\$,t}) = r + b_i \operatorname{cov}(R_{i\$,t}, X_{i\$,t}) + c_i \operatorname{cov}(R_{i\$,t}, R_{m,t}), \qquad (4)$$

where the two market premiums are related to the market i's covariance with the rate of appreciation of the currency of country i with respect to the U.S. dollar ($\operatorname{cov}(R_{i\$,t}, X_{i\$,t})$) and to the covariance with the dollar rate of return on the optimal portfolio held by investors of country i ($\operatorname{cov}(R_{i\$,t}, R_{m,t})$). *b* and *c* relate to the market's risk aversion. The variable $X_{i\$,t}$ indicates the rate of change of the spot exchange rate expressed in dollars per unit of nondollars currency of country i and r indicates the nominal riskless rate of return for country i.

We use the two factor asset pricing model of equation (4) to derive the ICAPM introduced in equations (1) and (2), but include the currency risk under the scenarios of perfect segmentation and perfect integration (see Appendix B). On the basis of the two polar cases, we derive the dynamic integration ICAPM of equation (3) inclusive of currency risk by allowing full segmentation until liberalisation (equation (5)) and perfect integration thereafter (equation (6)). The two polar cases are given below

$$E_{t-1}(R_{i\$,t}) = m_{10,i} + \sum_{k=1}^{p} m_{11k,i} R_{i\$,t-k} + m_{12,i}h_{ii,t} + m_{13,i}h_{xx,t} + 2m_{14,i}h_{ix,t}\ , \qquad (5)$$

$$E_{t-1}(R_{i,\$t}) = m_{10,i} + \sum_{k=1}^{p} m_{11k,i} R_{i\$,t-k} + m_{15,i}h_{im,t} + m_{16,i}\ h_{xm,t} + m_{17,i}h_{ix,t} + m_{18,i}h_{xx,t}. \qquad (6)$$

Bearing in mind that the rate of return of market index i expressed in US dollars is equal to the return in local currency plus the change in the exchange rate (see B.3 in Appendix B), the dynamic integration ICAPM process inclusive of currency risk that we estimate is

$$R_{i,t} = m_{10,i} - X_{i\$,t} + \sum_{k=1}^{p} m_{11k,i}(R_{i,t-k} + X_{i\$,t-k}) + m_{12,i}h_{ii,t}DC_{i,t} + m_{13,i}h_{xx,t}DC_{i,t}$$
$$+\ 2m_{14,i}h_{ix,t}DC_{i,t} + m_{15,i}h_{im,t}(1-DC_{i,t}) + m_{16,i}h_{xm,t}(1-DC_{i})$$
$$+ m_{17,i}h_{ix,t}(1-DC_{i,t}) + m_{18,i}h_{xx,t}(1-DC_{i,t}) + \varepsilon_{1,t}, \quad e_{1t}|I_{t-1} \sim N(0,H_t) \qquad (7)$$

where $R_{i,t}$ represents the rate of return on market index i expressed in local currency; $X_{i\$}$ indicates the rate of appreciation of the local currency against the U.S. dollar; h_{ii} is the variance of the returns expressed in local currency of the market index i; h_{xx} is the variance of the rate of appreciation (depreciation) of the local currency against the US dollar; h_{ix} is the covariance of the returns expressed in local currency of market index i with the rate of appreciation (depreciation) of the local currency with respect to the US dollar; h_{im} is the covariance of the returns expressed in local currency of market index i with the world market portfolio; and h_{xm} is the covariance between the world market portfolio and the rate of appreciation (depreciation) of the local currency against the US dollar. DC_i is a dummy variable that assumes the value of one before liberalisation and zero otherwise. H_t is the conditional covariance matrix, which will be discussed in section 2.2.

In estimating equation (7) we impose the condition that the coefficients $m_{12,i}$ and $m_{15,i}$ are positive by taking their absolute value as a higher level of country-specific or world market risk can only be compensated by higher stock returns. In contrast, a linear specification is adopted for the currency risk (i.e. for $m_{13,i}$, and $m_{18,i}$) as theory does not preclude the price of currency risk to be negative. According to Glosten et al. (1993) investors may not require a high risk premium if the risky time periods coincide with periods when investors are better able to bear particular types of risk (as might be the currency one). Furthermore, if the future seems risky the investor may want to save more in the present thus lowering demand for larger premia. Therefore, both a positive and a negative relationship between stock returns and these risks are possible. The prices of covariances (i.e. $m_{14,i}$, $m_{16,i}$, $m_{17,i}$) will be discussed later on.

In our analysis we are also interested in modelling the rate of appreciation of the local currency against the U.S. dollar. In particular, we use the risk-adjusted uncovered interest rate parity (UIRP) condition introduced by Dumas (1994), to derive the structures under the scenarios of full segmentation and full integration. We proceed by combining the two polar cases to obtain the dynamic integration model, which allows full segmentation before liberalisation and full integration thereafter. The rate of appreciation of the local currency against the U.S. dollar, in the case of full segmentation is given as follows (see Appendix B.3 for details of the derivation)

$$X_{i\$,t} = m_{20,i} + \sum_{k=1}^{p} m_{21k,i} X_{i\$,t-k} + m_{22,i} h_{xx,t} + m_{23,i} h_{ix,t} + \varepsilon_{2,t}, \qquad e_{2,t} | I_{t-1} \sim N(0, H_t) \tag{8}$$

under the case of full integration is given as

$$X_{i\$,t} = m_{20,i} + \sum_{k=1}^{p} m_{21k,i} X_{i\$,t-k} + m_{24,i} h_{xx,t} + m_{25,i} h_{mx,t} + \varepsilon_{2,t}, \qquad e_{2,t} | I_{t-1} \sim N(0, H_t)$$

(9)

and by the combination of equations (8) and (9), the dynamic integration process is

$$X_{i\$,t} = m_{20,i} + \sum_{k=1}^{p} m_{21k,i} X_{i\$,t-k} + m_{22,i}\, h_{xx,t} DC_{i,t} + m_{23,i}\, h_{ix,t} DC_{i,t}$$

$$+ m_{24,i}\, h_{xx,t}(1-DC_{i,t}) + m_{25,i} h_{mx,t}(1-DC_{i,t}) + \varepsilon_{2,t}, \quad e_{2,t} \middle| I_{t-1} \sim N(0, H_t) \quad (10)$$

where the rate of appreciation of the local currency is associated with the risk represented by its variance and covariance with the local market index return expressed in local currency before liberalization (h_{xx} and h_{ix} respectively); and it is related to its variance (but probably with a different magnitude), and its covariance with the world market returns thereafter (h_{xx} and h_{mx} respectively). De Santis and Gerard (1998) have also used Dumas's (1994) UIRP condition under risk aversion to incorporate currency risk. They have, however, on the left hand side the return of country i' deposit measured in the reference currency i.e. the U.S. dollar, and assume that it reflects the relative change in the exchange rate between currency i and the U.S. dollar.

The coefficients $m_{22,i}$ and $m_{24,i}$ could be either negative or positive. On the one hand, investrors should be compensated for the high volatility of exchange rates, giving a positive coefficient. On the other hand, high volatility of exchange rates is usually associated with current account disequilibria and predominantly with deficit situations, which according to "flow models" of exchange rate determination (see e.g. Dornbusch and Fisher, 1980) will cause the exchange rate to depreciate. Furthermore, such disequilibria might lead to speculative attacks increasing volatility of exchange markets and contributing to the currency depreciation. It is possible that $m_{22,i}$ and $m_{24,i}$ might take different values since the abolition of foreign exchange restrictions increases the volatility of exchange rates (see Phylaktis and Wood, 1984).

The prices of covariances between stock and foreign exchange returns in equations (7) and (10) can also take either positive or negative values. There are two channels connecting the foreign exchange market and the domestic and foreign stock markets. On the one hand, the exchange rate affects the stock market through its impact on economic activity and the current and future cash flows of companies implying a positive relationship between a depreciation of the domestic currency and the stock market (flow channel). On the other hand, the stock market affects the exchange rate through its effect on wealth and the demand for assets implying a negative relationship between a depreciation of the domestic currency and the stock market (stock channel).[6]

Equations (7) and (10) require the estimation of the conditional variances of both equity market returns and the rate of appreciation of the local currency with the U.S. dollar. They also include the covariance of the returns of equity and foreign exchange markets with the world market. Therefore, we need to generalize the process for the conditional second moments to a trivariate framework to inlcude a third equation representing the expected world market returns, which is estimated as follows:

$$R_{m,t} = m_{30} + \sum_{k=1}^{p} m_{31k} R_{m,t-k} + m_{32} h_{mm,t} + \varepsilon_{3,t}, \qquad e_{3,t} | I_{t-1} \sim N(0, H_t), \quad (11)$$

where $R_{m,t}$ represents the rate of return of the world market portfolio; and h_{mm} indicates its variance. As for equation (7), we estimate the parameters of equation

[6] The latter channel is based on the portfolio-balance models to exchange rate determination (see Branson, 1983) and Frankel, 1983). Gavin (1989) presents evidence, which confirms the effect of equities on the demand for real money balances.

(11) by taking the absolute value of the coefficient m_{32} because a higher level of return is usually associated with a higher level of market risk.

However, this parameter is not restricted to be the same across countries in the single country estimation. This differs from the previous studies of De Santis and Gerard (1997, 1998), and De Santis and Imrohoroglu (1997), where the premiums of risks associated with the stock returns of all the countries are estimated under the condition that the world market price is the same across countries. Our parameterisation also differs from that of Bekaert and Harvey (1995) for although their implementation uses a common world market price for all the countries it requires a two step estimation procedure. In the first step the authors consider only the world market returns and estimate the price of risk associated with it, which they then use in the second step to estimate the country-specific risk associated with the stock returns of each country. However, our model presents a complex parameterisation by allowing not only the stock returns of each market to include country-specific and world market risks, but it also requires the estimation of the price associated with the covariance of exchange rate returns and world market returns, and the covariances between local stock returns and world market returns and between currency returns and world market returns to differ in pre and post liberalisation periods. Therefore, in order to operate with a more flexible model that allows us to focus on our research questions, we did not restrict the world market price of risk associated with the world returns to be the same across countries in the single country estimation.

2.2 *The conditional variances and covariances*

Since financial series present volatility clustering we estimate simultaneously the system of equations (7), (10), and (11) with conditional dynamics using the parsimonious multivariate GARCH(p,q)-in-Mean specification where the GARCH components follow the diagonal BEKK representation of Baba, Engle, Kraft and Kroner (1990) and rearranged by Engle and Kroner (1995). This model guarantees positive definite conditional variance matrices without imposing any condition. In addition, the model economizes on parameters relative to other multivariate GARCH processes. Under the case of a GARCH(1,1), this is specified as follows

$$H_t = AA' + BH_{t-1}B' + C\varepsilon_{t-1}\varepsilon'_{t-1}C', \qquad (12)$$

where A, B, and C are symmetric matrices. In particular, by expanding the conditional covariance matrix the conditional variances and covariances of the three variables are given as follows

$$h_{ii,t} = a_{11}^2 + b_{11}^2 h_{ii,t-1} + c_{11}^2 e_{1,t-1}^2$$

$$h_{xx,t} = a_{21}^2 + a_{22}^2 + b_{22}^2 h_{xx,t-1} + c_{22}^2 e_{2,t-1}^2$$

$$h_{mm,t} = a_{31}^2 + a_{32}^2 + a_{33}^2 + b_{33}^2 h_{mm,t-1} + c_{33}^2 e_{3,t-1}^2$$

$$h_{ix,t} = a_{11}a_{21} + b_{11}b_{22}h_{ix,t-1} + c_{11}c_{22}e_{1,t-1}e_{2,t-1},$$

$$h_{im,t} = a_{11}a_{31} + b_{11}b_{33}h_{im,t-1} + c_{11}c_{33}e_{1,t-1}e_{3,t-1}$$

$$h_{xm,t} = a_{21}a_{31} + a_{22}a_{32} + b_{22}b_{33}h_{xm,t-1} + c_{22}c_{33}e_{21,t-1}e_{3,t-1} \qquad (13)$$

Engle and Kroner (1995) have shown that the necessary and sufficient conditions for covariance stationarity of the trivariate GARCH model of equation (13) are given as $b_i b_j + c_i c_j$ < 1. Another important factor is that the sum of b_{11}^2 and c_{11}^2, of b_{22}^2 and c_{22}^2, and of b_{33}^2 and c_{33}^2, represent the change in the response function of shocks to volatility per period. A value greater than unity implies that the response function of volatility increases with time and a value less than unity implies shock decay with time (Chou, 1988); the closer to unity the value of the persistence-measure, the slower is the decay rate. Non-linear optimization techniques are used to calculate the maximum likelihood estimates based on the Broyden, Fletcher, Goldfarb and Shanno (BFGS) algorithm. White's (1982) standard errors are reported which are robust to misspecification of the distribution of the error term.[7,8]

2.3 *Liberalisation and Asian financial crisis effects on the conditional variances*

How the opening of financial markets to foreign investors affects volatility of these capital markets has been a controversial issue. On the one hand, Domowitz et al. (1997) support the view that capital market liberalisation can induce greater participation by foreign investors, whose entry can reduce price volatility. New investors by entering the market dampen the effect of flow shocks on prices and may also make prices more efficient by increasing the precision of public information regarding fundamental values. Support for this view is given by Richards (1996), Bekaert and Harvey (1997), and Domowitz et al. (1997) who find a reduction of volatility following capital market liberalisation. On the other hand, volatility might

[7] See also Bollerslev and Wooldridge, 1992.

[8] We have also tried the estimation by fitting a t-distribution on the vector of errors, with v degrees of freedom as recommended by Engle and Bollerslev (1986) and Bollerslev (1987). However, the t-distribution did not give good results. As noted by Bera and Higgings (1993) this could be due to the fact that although conditional t-distribution allows kurtosis to exceed 3, it assumes it constant since the estimated degrees of freedom v are time invariant. Therefore, we proceed by focusing on QMLE parameters.

increase because of the increase in the amount of capital flows. Bekaert and Harvey (2000) find a small but statistically insignificant increase in the volatility of stock returns following liberalisation. Other studies, such as Kim and Singal (2000), find no change in the volatility in the first two years of opening.

Looking now at exchange rate returns, theoretical analysis tells us that foreign exchange controls reduce the volatility of exchange rates (see e.g. Phylaktis and Wood, 1984). In addition, there is an argument supporting the view that shifts in policy, such as a relaxation of foreign exchange restrictions, may have important implications for the persistence of shocks to volatility,[9] i.e. whether past volatility explains current volatility. Because of this argument and the results of previous studies, which generally indicate the existence of an effect of openness on the volatility of local financial markets, we include a dummy variable on the conditional variance of stock and foreign exchange returns, which assumes the value of one before the official liberalisation date and zero otherwise and that is indicated with DC_i. Furthermore, we test whether the Asian financial crisis of mid 1997 had an effect on the conditional variance of stock and exchange rate returns. Previous studies, such as Schwert (1990), Engle and Mustafa (1992) Choudhry (1996) on the financial crash of 1987, and of Choudhry (1995) on the great depression of 1929, show that stock market volatility increased extensively after the crash or during a crisis, but returned to pre-crash levels relatively quickly. Thus, in order to examine the effects of the Asian financial crisis of mid 1997 on price volatility of Pacific Basin countries' equity and foreign exchange markets, we include another dummy variable, (DUM) in the conditional variances of these two series, which assumes a value of one

[9] See for instance Lastrapes, 1989 and Lamourex and Lastrapes, 1990.

from July 1997 to February 1998, and zero otherwise.[10] The framework for the conditional variances and covariances is modified as follows:

$$h_{ii,t} = a_{11}^2 + b_{11}^2 h_{ii,t-1} + c_{11}^2 e_{1,t-1}^2 + D1^2 (1 - DC_{i,t}) + DC1^2\, DUM$$

$$h_{xx,t} = a_{21}^2 + a_{22}^2 + b_{22}^2 h_{xx,t-1} + c_{22}^2 e_{2,t-1}^2 + D2^2 (1 - DC_{i,t}) + DC2^2\, DUM$$

$$h_{mm,t} = a_{31}^2 + a_{32}^2 + a_{33}^2 + b_{33}^2 h_{mm,t-1} + c_{33}^2 e_{3,t-1}^2$$

$$h_{ix,t} = a_{11} a_{21} + b_{11} b_{22} h_{ix,t-1} + c_{11} c_{22} e_{1,t-1} e_{2,t-1},$$

$$h_{im,t} = a_{11} a_{31} + b_{11} b_{33} h_{im,t-1} + c_{11} c_{33} e_{1,t-1} e_{3,t-1}$$

$$h_{xm,t} = a_{21} a_{31} + a_{22} a_{32} + b_{22} b_{33} h_{xm,t-1} + c_{22} c_{33} e_{21,t-1} e_{3,t-1}\,. \qquad (14)$$

While this structure presents the advantage of recognizing the existence of potential effects due to liberalisation and the Asian financial crisis on the conditional volatilities of equity and foreign exchange returns, it does not allow the identification of the sign. However, this framework allows the covariance matrix to be positive definite without imposing any condition.

3. Capital market characteristics

3.1 *Data*

The sample of countries examined in the paper includes: Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand. Hong Kong and Singapore have been excluded as both countries had completely open capital markets since 1978, i.e. before the beginning of our sample period. The data consist of end-of-month observations of stock market index prices, and of local bilateral spot exchange rates expressed as units

[10] The selection of this period is based on a previous study of Phylaktis and Ravazzolo (1999), where considering the same countries, the authors identified that the Asian crisis affected these economies for the above indicated period.

of U.S. dollar against one unit of each local Pacific Basin currency. The sample covers monthly observations for the period 1980.01 to 2000.05 for Korea, Malaysia, Taiwan and Thailand, and 1983:05 to 2000:05 and 1986:01 to 2000:05 for Indonesia and Philippines respectively. All the data are from *Datastream* database.

3.1 *Characteristics of stock and foreign exchange returns distribution*

As a preliminary data analysis we applied the unit root testing methodology of Philipps and Perron (1988) and failed to reject the null hypothesis of a unit root in the logarithmic first difference of the price index of any of the time series under analysis. The first difference of the stock price index and exchange rate of country i is respectively defined as:

$$R_{i,t} = 100(\log P_{i,t} - \log P_{i,t-1}), \qquad (15)$$

$$X_{i,t} = 100(\log S_{i,t} - \log S_{i,t-1}), \qquad (16)$$

where $P_{i,t}$ indicates the level of the stock prices for the index of country i, expressed in local currency, and $S_{i,t}$ represents the bilateral spot exchange rate expressed as units of U.S. dollar versus one unit of the local currency of country i.

Table 1 contains summary statistics for the data corresponding to stock and foreign exchange returns. Not surprising, they have high means, which are associated with high volatility. In particular, in most of the cases the standard deviation of stock returns is higher than the standard deviation of foreign exchange returns. The most volatile market is the Taiwanese one, which also presents one of the highest means (see Panel A). In most of the cases the data corresponding to the time series of returns on the stock and foreign exchange markets show skewness and high level of kurtosis. The Bera-Jarque test statistic strongly rejects the hypothesis of normaly distributed returns for all the markets under consideration.

Panel B in Table 1 reports autocorrelations for the returns in both stock and foreign exchange markets. The predominant presence of autocorrelation in the return series reveals that, in our analysis, we generally need to correct for autocorrelation in the stock and currency markets induced by non-synchronous trading in the assets of the financial markets as suggested by Lo and MacKinley (1988). Panel C in Table 1 contains the autocorrelation in the squared returns. The presence of statistically significant autocorrelation in squared returns suggests that a GARCH parameterisation for the second moments is required. The analysed market returns present autocorrelation in their squared returns, with the exception of the Indonesian and Philippines stock market returns, suggesting the use of conditional variance processes in estimating second moments. As a result, we have excluded Indonesia and Philippinnes from our sample.

3.2 *Official liberalisation dates*

In defining the dummy variable DC_i, which takes a value of one before liberalization and zero otherwise, we consider the official liberalization date as reported by the International Finance Corporation (IFC). The IFC date is based on the Investibility Index, which represents the ratio of the market capitalization of stocks that foreigners can legally hold to total market capitalization. A large jump in the Index is evidence of an official liberalization. The official liberalization date for the countries in our sample is as follows: Korea, January 1992, when a new law was introduced allowing foreign investors to own up to 10% of domestically listed firms; Malaysia, December 1988, when foreign investors were allowed to own up to 100% of domestic firms; Taiwan, January 1991, when foreign investors were allowed to own up to 10% in any of the domestic listed companies; and Thailand, September 1987. This date for

Thailand corresponds to the launch of the Alien Board in the Thai stock exchange, where only securities available to foreign investors where traded. However, international investors were still facing a foreign ownership limit of 49% and a lower limit of 25% for commercial banks and finance companies.[11]

4. Empirical results

4.1 *Conditional dynamic integration model on stock returns*

We start our empirical analysis by estimating the conditional dynamic integration model of De Santis and Imrohoroglu (1997) for the equity stock market returns of Korea, Malaysia, Taiwan and Thailand, where the stock indices are expressed in local currency (i.e. equations (3) and (11)). We take as a proxy for the world market portfolio the U.S. stock market index. The findings are reported in Table 2. In selecting the order of autoregressive components in the mean equation, we added lags until the residuals did not present autocorrelation using the Ljung-Box statistic of order twelve. We obtained that the order is one for Korea and Taiwan; four for Malaysia and five for Thailand. In accordance with the results of De Santis and Imrohoroglu (1997), the country-specific risk and the world market risk are not priced for all countries, with the exception of Malaysia, where the estimated coefficients are very small. The results also show that the conditional second moments are appropriately described by the multivariate GARCH process. All the parameters in matrices A, B, and C are statistically significant except a_{31} and c_{33} for Korea and a_{11}

[11] For Thailand the IFC official liberalisation date is December 1988. However, as noted by Bekaert and Harvey (2000), this date is not associated with any particular regulatory changes. We do not present information for Indonesia and Philippines as both of these countries were eventually left out from estimation.

for Thailand. The point estimates reveal that all the variance processes in H_t are stationary and highly persistent. The Ljung-Box statistic tests of order twelve on the standardized and squared standardized residuals show lack of autocorrelation and in most cases the index of kurtosis for the standardized residuals is lower than the corresponding index for the returns. However, it is still statistically significant suggesting that the GARCH parameterization can accommodate part of the kurtosis in the data.

Based on the obtained results, which show no relationship between expected returns and market risks when estimating the dynamic integration model, we proceed to re-estimate it by including the currency risk.

4.2 *Conditional dynamic integration model with currency risk*

The dynamic integration CAPM with currency risk relates to equations (7), (10) and (11). The number of autoregressive components included in each of the mean equations was selected as before through the use of the Ljung-Box statistic test of order twelve.

In order to test whether volatility in our sample of countries changes over time in a predictable fashion we estimate two versions of the model composed of the three equations (7), (10) and (11). We refer to Model A when we assume constant conditional variances and covariances, whereas we refer to Model B when we assume that the conditional variances and covariances follow a GARCH(p,q) process. For both models, we estimate the standardized residuals ($\hat{z}_t = \hat{u}_t \hat{h}_t^{-1/2}$) and the squared standardized residuals and then, for each series, we compute the Ljung-Box (LB) statistic to test the null hypothesis of no autocorrelation up to order twelve. Overall, the results in Table 3 support our specification.

Considering first the LB test statistic for the standardized residuals, the results show that all market returns do not present residual autocorrelation, with the exception of the Korean exchange rate, where the null hypothesis is rejected at the 10% level. The LB test for the squared standardized residuals shows that the estimated statistics obtained from Model A have some form of autocorrelation. With the exception of Taiwan, the autocorrelation disappears when the conditional variances and covariances are assumed to follow a GARCH(p,q) process.

Finally, we perform the likelihood ratio statistic test on the estimated unconditional and conditional processes, where we test for the null hypothesis that the coefficients of the time varying variances and covariances of the conditional model are equal to zero. In all the cases, the statistic tests reject the null hypothesis indicating that the conditional structure outperforms the unconditional one. Therefore, we use the parsimonious trivariate GARCH-in-Mean specification presented in equation (13) to estimate the system composed of the expected equity returns in local and U.S. markets and the currency returns as specified in equations (7), (10), and (11).

The results of the trivariate conditional dynamic integration model inclusive of currency risk are reported in Table 4.[12] The following points can be made. First, the results show that all GARCH parameters are highly significant. Secondly, the c_i^2 are smaller than the b_i^2, which is an indication that lagged variances and covariances have more weight than past innovations in explaining current variances and covariances. This implies that large market surprises induce relatively small revisions in future volatility. Third, the persistence of the conditional variance process, measured by b_i^2

[12] We used the Akaike and the Schwarz information criteria to identify the best performing GARCH(p,q) model.

+ c_i^2, is high and often close to the Integrated GARCH model of Engle and Bollerslev (1986). According to Lamourex and Lastrapes (1990) the detected large persistence may represent misspecification of the variances and result from structural change in the unconditional variances of the process, as represented by changes in $a_i a_j$ in equation (13). A discrete change in the unconditional variances of a process produces clustering of large and small deviations, which may show up as persistence in a fitted GARCH model. As previously discussed in Section 2.3, the liberalisation of the financial markets under consideration and the Asian financial crisis of mid 1997 could represent events, which might have caused a structural change in the unconditional variances of the estimated process. Therefore, we re-estimate the system of equations (7), (10) and (11) by fitting a GARCH process on their conditional variances and covariances (equation (14)) that allows for the two structural changes in relation to capital market liberalisation and the Asian financial crisis. The results are reported in Table 5.

The evidence shows that in most of the cases there is a considerable reduction in the persistence of the conditional variances in both stock and exchange market returns. Secondly, the dummy variables for liberalisation and the Asian crisis are highly statistically significant with the exception of the liberalisation dummy for the currency returns in Taiwan and Thailand. In particular, the estimated coefficients show that the effect of the Asian financial crisis is bigger than that of the liberalisation on the volatility of the stock and currency returns of these markets. Moreover, we identify a stronger effect on the financial markets of Thailand, followed by Korea and Malaysia, while Taiwan is the country with the smallest effect. These effects correspond to the strength of the crash in each of the countries. In general, these findings show that there is an improvement in the specification of the modified model when allowing for structural changes. In addition, even if the kurtosis of the standardized residuals remains statistically different from zero and quite high for the Thai currency returns, in almost all the cases there is a fall in the degree of leptokurtosis from that reported in Table 1 for the raw data. This implies that the model is correctly specified according to Hsieh (1989). Finally, the LB statistic tests on both standardized and squared standardized residuals show absence of autocorrelation and ARCH effect on the errors indicating the goodness of the fitted GARCH process. As a result of the improved performance of the modified model, we concentrate our discussion of the next two sections on the results obtained by it.

4.2.1 *Equity markets*

One of the major objectives of our analysis is to identify if the inclusion of the currency risk improves the performance of the dynamic integration asset-pricing model of De Santis and Imrohoroglu (1997) in pricing market risk. Our findings show that the country-specific market risk is priced before liberalisation in all the countries apart from Korea, while the world market risk is priced after liberalisation in all the countries of our sample. The statistical significance of the coefficients corresponding to the price of the world market risk suggests that all four Pacific Basin capital markets are integrated after liberalisation. These findings are in accordance with Bekaert and Harvey's (1995) results, who find also that these countries are integrated with the world markets.[13] However, we noted that the world market

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[13] One should be, however, cautious with Bekaert and Harvey’s results for two reasons. First, their specification tests suggest that the model specification is rejected; and secondly, according to the authors the estimation for Korea was extremely ill-behaved and the model for Malaysia did not converge.

coefficients assume small values indicating that even if these countries are integrated, there are still possibilities for obtaining portfolio diversification benefits.

An important result of our analysis is that the currency risk is found to affect expected stock returns. Moreover, this risk is priced in both pre and post liberalisation periods. This evidence is in accordance with previous studies of Dumas and Solnik (1995) for US; De Santis and Gerald (1998) on the developed markets of U.S., Japan, U.K. and Germany; and Carrieri (2001) on the European markets of France, Germany, Italy, and U.K. In particular, the absolute value of the currency price (see $m_{13,i}$ and $m_{18,i}$ in Table 5) is higher than the price of the market risk.[14] The estimated price of currency risk is negative in four of the six cases. According to Dumas and Solnik (1995) the world price of currency risk should be negative when the risk aversion of each investor sub-population is greater than one. In addition, covariances are found to be statistically significant in ten out of twelve cases (see $m_{14,i}$, $m_{16,i}$ and $m_{17,i}$ in Table 5). Overall this evidence indicates that an international asset-pricing model without exchange rate as a source of risk would be misspecified. Therefore, the model used by De Santis and Imrohoroglu (1997) which does not consider currency risk in pricing international assets might be misspecified.

The finding that currency risk affects stock market returns, particularly in the pre-liberalisation period, is really interesting. This can be explained by the "flow" channel discussed in Section 2.2, which links stock and foreign exchange market

[14] Bailey et a. (2000) analysing the effect of association between stock and exchange rate returns and variances on the Mexican financial markets during the peso crisis of 1994 noted that adverse exchange rate movements not only have an impact on Mexican equity prices, but appear to lead many investors to rebalance their holdings away from Mexico, causing a downward movement in the local equity returns.

movements, and can be related to economic integration found to be important for financial integration even in the presence of capital restrictions (see Phylaktis and Ravazzolo, 2002.

Focusing on the results for the world market return, which in our case is represented by the U.S. stock returns, we find the estimated price for the world market risk to be generally statistically significant (the only exception being Taiwan), but small in magnitude. This evidence differs from the studies of De Santis and Gerard (1997, 1998), Bekaert and Harvey (1995), De Santis and Imrohoroglu (1997), and Harvey (1995). The previous findings show that the world market risk is not priced when considering a model with constant world market price. For instance, De Santis and Gerard (1997) obtained an estimated world price of 0.025 with statistical significance of only 15 percent when considering the U.S. stock returns. However, the different results might be related to the fact that with the exception of Bekaert and Harvey (1995), all the mentioned studies estimated jointly the stock returns of all the countries (including the world market returns) under the restriction that this parameter is the same across different stock market returns.

4.2.2 *Foreign exchange markets*

The results for the currency returns show that there exists a statistically significant relationship between currency risk and exchange rate returns in three out of four pre-liberalisation cases (see coefficient $m_{22,i}$ in Table 5) and two out of the four post-liberalisation cases (see coefficient $m_{24,i}$ in Table 5). In three of the above cases the relationship is negative indicating that high volatility corresponds to a depreciation of the local currency. As discussed in Section 2.2, this can be explained by the fact that expectations of a depreciation of the local currency against the U.S. dollar, which can be related to current account disequilibrium in pre-liberalisation period, and to both current and capital account disequilibria in post liberalisation, may lead to speculative attacks and to a fall in their value.

The results also show that in post liberalisation the price corresponding to the covariance between the rate of appreciation and the world market returns (see coefficient $m_{25,i}$) is for all the countries a statistically significant component of currency returns supporting the view that these markets are financially integrated. Finally, the market price for the country-specific risk before liberalisation (see coefficient $m_{23,i}$) is significant for Korea, Taiwan and Thailand, but not for Malaysia. This provides evidence that these stock and foreign exchange markets are also linked in pre liberalisation period, through a "stock" and/or a "flow" channel.

4.2.3. *The size of the risk premiums in equity markets*

In this section, we present the market risk and exchange risk premiums and compare their size and variance over different sub-periods and markets. Figures 1a – 1d present plots of the total risk premium which is measured in the pre-liberalisation period by

$$TRP = m_{12,i}h_{ii,t} + m_{13,i}h_{xx,t} + m_{14,i}h_{ix,t} \qquad (17)$$

and post-liberalisation period by

$$TRP = m_{15,i}h_{im,t} + m_{16,i}h_{xm,t} + m_{17,i}h_{ix,t} + m_{18,i}h_{xx,t}. \qquad (18)$$

The first term in both expressions represents the market risk premium and the rest the currency risk premium. The plots show in the case of Korea, Taiwan and Thailand and perhaps less so in the case of Malaysia that risk premiums were considerably more variable in the pre-liberalisation period compared to the post-liberalisation period until the outbreak of the crisis in mid-1997.[15]

In Table 6, we report summary statistics for the total risk premium and its decomposition into market and currency components. The statistics are given for the full period and for the sub-periods identified by the plots. Namely, they are given for the pre-liberalisation sub-period, the post-liberalisation until the crisis, the crisis period until the end of the sample and the full sample period. The dates for the first two sub-periods differ across countries since each one of them liberalised at different times. Over the whole sample period, the annualised average value for the total premium ranges from 2.09% for Taiwan, to 3.33% for Korea, to 7.32% for Thailand and to –25.16% for Malaysia. The currency risk premium is substantial and forms a big part of the total risk premium. In fact, in the case of Korea and Thailand, the average value of the total risk premium is dominated by the value of the currency risk premium, implying that the total premium from international investment is mostly a reward for exposure to currency risk. In the case of the other two countries, the currency risk premium is big and negative, and more than offsets the market risk premium in the case of Malaysia, while it reduces the market risk premium from 14.51% to 2.09% in the case of Taiwan.

Looking however at the figures for the premiums for the various sub-periods, one can see that the average figures for the whole sample period would have been misleading as premiums varied substantially during the period. The currency risk premium and total risk premium are bigger and more variable in the pre-liberalisation period than in the post-liberalisation until the crisis, except for the case of Malaysia.

[15] The rather quiet period in the early years in Taiwan and Thailand might reflect the lack of development in these stock markets during that period.

In the post crisis period, the currency risk premium rises substantially across all markets, is negative, and becomes also substantially variable. In the other sub-periods no regularity concerning the sign of the currency risk premium is observed. The premium takes positive and negative values.

5. Conclusion

In this paper, we have developed an international capital asset pricing model, which included both market and currency risks and allowed full market segmentation until the official liberalisation date and full integration thereafter. The dynamic integration structure was also applied to pricing currency returns in accord with a risk adjusted UIRP model. We used a parsimonious multivariate GARCH-in-Mean process in estimating the conditional dynamics of our system of equations, which allowed also for the examination of the effects of capital market liberalisation and the Asian Financial crisis of mid 1997 on the volatilities of stock and currency returns.

Our main contribution is the incorporation of the currency risk in pricing expected stock returns for markets whose degree of capital market integration changes, which is a phenomenon of emerging markets. Consistent with Dumas and Solnik (1995) and De Santis and Gerald (1998) we find strong support for the specification of an ICAPM that includes both market and currency risk. Furthermore, the risk is priced in both pre and post liberalisation periods. Thus, omitting foreign currency risk in pricing international assets might give rise to model misspecafiction as we have shown to be the case for De Santis and Imrohoroglu (1997). Bakaert and Harvey (1995) attributed the rejection of the specification of their time-varying world market integration model to the omission of currency risk too.

We also found that currency returns are related to their risk. In addition, we noted that their covariance with the local stock market returns in pre-liberalisation and with the world market returns in post-liberalisation are important explanatory factors.

Consistent with previous studies, such as Bekaert and Harvey (1995), our results indicate that the Pacific Basin countries are integrated with world markets. In particular, we noted integration also for countries such as Korea and Taiwan, which maintained extensive capital controls during the 90s. These results have implications for the use of foreign exchange restrictions to isolate capital markets from world influences.

The empirical evidence reveals that the components of the risk premiums vary significantly over time and across markets. The currency risk premium is substantial and forms a big part of the total risk premium, dominating it at times. It is also bigger and more variable when markets are segmented. In post Asian financial crisis period it became negative across all markets and once again substantially variable.

Finally, our results show that market liberalisation and the Asian financial crisis of mid 1997 affected the conditional variances of the stock and foreign exchange returns. Unfortunately, our parameterisation did not allow us to infer the direction of this effect. They highlight however the importance of taking into account such structural changes when estimating international asset pricing models.

In general, our results have shown that currency risk is an important component in international capital asset pricing models even during periods when markets are not officially open to international investors. Since indeed currency risk is priced and investors are compensated for bearing such risk they should not be discouraged by more flexible exchange rate regimes from investing in emerging markets.

Appendix A

Considering ρ_i the rate of return on security i, over a short holding period, expressed in real terms (i.e. adjusted for inflation); the classic CAPM of Sharpe (1964) and Lintner (1965) says that, in equilibrium, there must exist two numbers η and θ such that

$$E(\rho_i) = \eta + \theta cov(\rho_i, \rho_m) \quad (A.1)$$

where ρ_m represents the real rate of return on the market portfolio. The coefficient η indicates the real riskless rate of return; and the coefficient θ can be interpreted as the market average degree of risk aversion. The real rate of return is given as:

$$\rho_i = \frac{1+R_i}{1+p_i} - 1, \quad (A.2)$$

where R_i is the nominal rate of return of asset or market index i expressed in U.S. dollar term, and p_i is the rate of inflation of country i expressed in U.S. dollar. Using the Ito approximation and substituting equation (A.2) into equation (A.1), as in Dumas (1994), we obtain

$$E(R_i) - E(\pi_i) + var(\pi_i) - cov(R_i, \pi_i) = \eta + \theta cov(R_i - \pi_i, R_m - \pi_i) \quad (A.3)$$

or rearranging the terms of equation (A.3),

$$E(R_i) = \eta + E(\pi_i) - (1-\theta)var(\pi_i) - \theta cov(\pi_i, R_m) + (1-\theta)cov(R_i, \pi_i) + \theta cov(R_i, R_m) \quad (A.4)$$

In equation (A.4) the first four terms of the right side of the equation sum to the nominally riskless rate of return r. Hence, we can rewrite equation (A.4) as

$$E(R_i) = r + (1 - \theta)cov(R_i, \pi_i) + \theta cov(R_i, R_m). \quad (A.5)$$

Equation (A.5) states that risky inflation produces a separate premium in nominal returns. It is important to underline that the rate of inflation in any country may be measured in any currency. For instance considering both the expected rate of return on market index i and of inflation expressed in U.S. dollar, (A.5) becomes

$$E(R_{i\$}) = r + (1 - \theta)cov(R_{i\$},\pi_{i\$}) + \theta cov(R_{i\$},R_m), \quad (A.6)$$

where $E(R_{i\$})$ is the nominal rate of return of country i expressed in U.S dollar and $\pi_{i\$}$ is the rate of inflation of country i expressed in U.S. dollar. According to Solnik's case the randomness of the rate of inflation of country i expressed in U.S. dollar is only due to random fluctuation of the local currency of country i against the U.S. dollar. Therefore, the term $cov(R_{i\$},\pi_{i\$})$ of equation (A.6) can be substituted by the covariance between the rate of return on asset (or market index) i expressed in U.S. dollar units and the rate of appreciation (depreciation) of the currency i respects to the U.S. dollar. Therefore we can rewrite (A.6) as

$$E(R_{i\$}) = r + (1 - \theta)cov(R_{i\$},X_{i\$}) + \theta cov(R_{i\$},R_m), \quad (A.7)$$

with $X_{i\$}$ the rate of appreciation of currency i against the U.S. dollar.

Appendix B

The rate of return of market index i denominated in U.S. dollar can be written as follows:

$$R_{i\$} = (1+R_i)(1+X_{i\$}) - 1, \quad \text{(B.1)}$$

where R_i is the rate of return of market index i in local currency; and $X_{i\$}$ is the rate of appreciation (or depreciation) of the local currency versus the U.S. dollar, where the exchange rate is expressed as units of U.S. dollar against one unit of each local currency. Equation (B.1) can be rearranged as follows:

$$R_{i\$} = R_i + X_{i\$} + R_i X_{i\$}. \quad \text{(B.2)}$$

Since the cross-product term, $R_i X_{i\$}$, is normally small, we can write (B.2) as follows:

$$R_{i\$} = R_i + X_{i\$}. \quad \text{(B.3)}$$

B.1 Derivation of the ICAPM under full segmentation

In case of full segmentation, the risk associated with the rate of return of the local market index i is associated with the country-specific risk, which is only affected by the variation of the domestic market index returns. Under this scenario, according to the International Capital Asset Pricing Model (ICAPM) of Dumas (1994) and Dumas and Solnik (1995) reported in equations (A.7), we can explain the rate of return on the stock market index of country i, expressed in U.S. dollar, as follows:

$$E_{t-1}(R_{i\$,t}) = r + b_i Cov(R_{i\$,t}, R_{i,t}) + c_i Cov(R_{i\$,t}, X_{i\$,t}), \quad \text{(B.4)}$$

where the coefficient b_i captures the sensitivity of the rate of return of the stock index of country i, expressed in U.S. dollar, to the covariance between itself and the rate of return of the stock index of country i; and the coefficient c_i captures the sensitivity of the rate of return of the stock index of country i, expressed in U.S. dollar, to the covariance between itself and the rate of appreciation (depreciation) of the local currency with respect to the U.S. dollar. b_i and c_i relate to the market's risk aversion and r is the riskless rate of return if there is one. Using (B.3) equation (B.4) can be rearranged as follows:

$$E_{t-1}(R_{i\$,t}) = r + b_i Cov(R_{i,t}+X_{i\$,t}, R_{i,t}) + c_i Cov(R_{i,t}+X_{i\$,t}, X_{i\$,t}). \quad (B.5)$$

Expanding the right hand side and noting that $Cov(X_{i\$,t}, R_{i,t})$ appears twice, we write (B.5) in a more general way amenable to empirical testing and using symbols consistent with the ones in the rest of the paper as

$$R_{i\$,t} = m_{10,i} + \sum_{k=1}^{p} m_{11k,i} R_{i\$,t-k} + m_{12,i}\, h_{ii,t} + m_{13,i} h_{xx,t} + 2m_{14,i}\, h_{ix,t} + \varepsilon_{1,t},$$

$$e_{1,t} \mid I_{t-1} \sim N(0, H_t) \quad (B.6)$$

where $h_{ii,t}$ represents the conditional variance of the rate of return of the stock market of country i, expressed in local currency; $h_{ix,t}$ represents the conditional covariance between the rate of return of the stock market index of country i and the rate of appreciation (depreciation) of currency i; and $h_{xx,t}$ indicates the conditional variance of the rate of appreciation (depreciation) of currency i.

B.2 Derivation of the ICAPM under full integration

As for the full segmentation scenario, we use the ICAPM of Dumas (1994) and Dumas and Solnik (1995), which was introduced in equation (A.7), and explain the rate of return on the stock index of country i, expressed in U.S. dollar as follows:

$$E_{t-1}(R_{i\$,t}) = r + b_i Cov(R_{i\$,t}, R_{m,t}) + c_i Cov(R_{i\$,t}, X_{i\$,t}), \quad (B.7)$$

where the coefficient b_i measures the sensitivity of the rate of return on the stock index of country i, expressed in U.S. dollars, to its covariance with the market portfolio rate of return; and the coefficient c_i indicates the sensitivity of the rate of return on the stock index of country i, expressed in U.S. dollar, to its covariance with the rate of appreciation (depreciation) of the local currency. Using (B.3) equation (B.7) can be rearranged as

$$E_{t-1}(R_{i\$,t}) = r + b_i Cov(R_{i,t}+X_{i\$,t},R_{m,t}) + c_i Cov(R_{i,t} + X_{i\$,t}, X_{i\$,t}). \qquad (B.8)$$

Expanding the right-hand side and once again using a more general framework and symbols consistent with the ones in the rest of the paper we write (B.8) as

$$R_{i\$,t} = m_{10,i} + \sum_{k=1}^{p} m_{11k,i} R_{i\$,t-k} + m_{15,i} h_{im,t} + m_{16,i} h_{xm,t} + m_{17,i} h_{ix,t} + m_{18,i} h_{xx,t} + \varepsilon_{1,t},$$

$$e_{1,t} | I_{t-1} \sim N(0,H_t), \qquad (B.9)$$

where $h_{im,t}$ represents the conditional covariance of the rate of return of the stock market of country i, expressed in local currency and the market portfolio return; $h_{mx,t}$ represents the conditional covariance between the rate of return of the market portfolio and the rate of appreciation (depreciation) of currency i; $h_{ix,t}$ represents the conditional covariance of the rate of return of the stock market of country i, expressed in local currency and the rate of appreciation of currency i; and $h_{xx,t}$ indicates the conditional variance of the rate of appreciation (depreciation) of currency i.

B.3 The derivation of the rate of appreciation of the local currency

Dumas (1994) argues that if the financial market is integrated, the CAPM of equation (A.5) applies to all securities. In fact equation (A.5) can be applied to explain the rate of return from a foreign currency deposit, expressed in U.S. dollar as follows

$$r_i = (1 + r^*_i)(1 + X_{i\$}) - 1, \qquad (B.10)$$

where r_i represents the rate of return on a currency deposit of country i, expressed in U.S. dollar; r^*_i indicates the rate of return on a currency deposit of country i, expressed in currency i; and $X_{i\$}$ is the rate of appreciation (depreciation) of the currency of country i with respect to the U.S. dollar. Equation (B.10) can be rearranged as

$$r_i = r^*_i + X_{i\$} + r^*_i X_{i\$}, \tag{B.11}$$

where the term $r^*_i X_{i\$}$ is a really small number and therefore it can be rewritten as follows

$$r_i = r^*_i + X_{i\$}. \tag{B.12}$$

Thus, applying equation (A.5) to explain the rate of return on a foreign currency deposit, expressed in U.S. dollars, we have

$$r^*_{i,t} + E_{t-1}(X_{i\$,t}) = r_{i,t} + (1 - \theta)\text{cov}(X_{i\$,t}, \pi) + \theta\text{cov}(X_{i\$,t}, R_{m,t}), \tag{B.13}$$

where $r^*_{i,t}$ indicates the rate of return on a currency deposit of country i, expressed in currency i; and $X_{i\$,t}$ is the rate of appreciation (depreciation) of the currency of country i with respect to the U.S. dollar. This is a relationship between two short-term nominal interest rates quoted in two different currencies or equivalently, between the short-maturity forward premia and the expected spot exchange rate. Equation (B.13) follows from viewing currency i's nominally riskless asset as a risky asset from the viewpoint of a U.S. dollar investor, and noting that, according to Dumas (1994), risks and required returns have the same equilibrium pricing structure, whether a risky asset is a stock or a foreign currency deposit. Equation (B.13) provides the deviation from the traditional UIRP, which prevails when investors are risk averse and PPP does not hold. In equation (B.13) there exists equilibrium but the equilibrium relationship between interest rates incorporates an inflation premium, which is a deviation from nominal UIRP, and the reason being that investors care about real returns. Equation (B.13) can be rearranged as follows

$$E_{t-1}(X_{i\$,t}) = r_{i,t} - r^*_{i,t} + (1 - \theta)\text{cov}(X_{i\$,t}, \pi) + \theta\text{cov}(X_{i\$,t}, R_{m,t}). \tag{B.14}$$

Assuming Solnik's special case as in Appendix A, where the rate of inflation in country i is nonrandom, while the rate of inflation in country i measured in dollars is random because of the randomness in the exchange rate, the term $cov(X_{i\$,t}\ \pi)$ is equal to $cov(X_{i\$,t},\ X_{i\$,t})$, which corresponds to $var(X_{i\$,t})$, where the only random component of inflation π is $X_{i\$,t}$. Based on this assumption, we can rewrite equation (B.14) as

$$E_{t-1}(X_{i\$,t}) = r_{i,t} - r^*_{i,t} + (1 - \theta)var(X_{i\$,t}) + \theta cov(X_{i\$,t},R_{m,t}). \qquad (B.15)$$

Equation (B.15) represents the rate of appreciation of currency i in the case of full integration. In the scenario of full segmentation, the component $cov(X_{i\$,t},R_{m,t})$ can be substituted by the rate of return on the local stock market, expressed in domestic currency, R_i, and it becomes

$$E_{t-1}(X_{i\$,t}) = r_{i,t} - r^*_{i,t} + (1 - \theta)\ var(X_{i\$,t}) + \theta cov(X_{i\$,t},R_{i,t}). \qquad (B.16)$$

Using the same symbols as for the stock market returns and assuming that the interest rate differential is constant as there were no risk free interest rate data for our emerging markets, the rate of appreciation of currency i in the scenario of full segmentation is

$$E_{t-1}(X_{i\$,t}) = m_{20,i} + \sum_{k=1}^{p} m_{21k,i} X_{i\$,t-k} + m_{22,i} h_{xx,t} + m_{23,i} h_{ix,t} + \varepsilon_{2,t};$$

$$e_{2,t}|I_{t-1} \sim N(0,H_t), \qquad (B.17)$$

where h_{xx} represents the variance of the rate of appreciation of currency i, indicated as $X_{i\$}$; h_{ix} represents the covariance between the rate of appreciation of currency i and the rate of return on the local stock market index of country i expressed in domestic currency; and H_t is the conditional covariance matrix. Under the scenario of full integration, equation (B.15) becomes

$$X_{i\$,t} = m_{20,i} + \sum_{k=1}^{p} m_{21k,i} X_{i\$,t-k} + m_{24,i} h_{xx,t} + m_{25,i} h_{mx,t} + \varepsilon_{2,t}, \quad e_{2,t} | I_{t-1} \sim N(0, H_t),$$

(B.18)

where h_{xm} is the covariance between the rate of appreciation of currency i and the rate of return of the world market portfolio.

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Table 1: Summary statistics of stock and foreign exchange returns

Panel A: Summary of statistics

Country	*Mean*	*Stand Dev.*[a]	*Skewness*	*Kurtosis*[b]	*B-J*[c]	*Q(12)*[d]	*Min.*	*Max.*
Indonesia								
Stock	0.72	35.13	1.37**	12.41**	775.**	10.09	-39.56	69.06
returns	(1.01)		[0.00]	[0.00]	[0.00]	[0.60]	08.97	12.88
Exchange	1.07*	29.17	4.61**	43.16**	15941.**	32.5**	-34.87	80.25
rate returns	(1.81)		[0.00]	[0.00]	[0.00]	[0.00]	10.98	01.98
Korea								
Stock	0.53	28.11	0.53**	2.52**	23.6**	14.51	-26.34	36.79
returns	(1.44)		[0.00]	[0.00]	[0.00]	[0.27]	11.97	01.98
Exchange	-0.35	12.39	5.11**	55.210**	27054.8**	24.6**	-16.62	37.60
rate returns	(1.51)		[0.00]	[0.00]	[0.00]	[0.02]	03.98	12.97
Malaysia								
Stock	0.56	33.17	-0.77**	3.70**	25.8**	22.2**	-42.33	33.61
returns	(0.91)		[0.00]	[0.00]	[0.00]	[0.03]	10.87	09.98
Exchange	0.23	8.92	-0.98**	30.12**	7393.2**	13.0	-21.77	16.00
rate returns	(1.37)		[0.00]	[0.00]	[0.00]	[0.37]	02.98	01.98
Philippines								
Stock	1.27	38.49	0.34*	2.15**	14.98**	11.72	-33.44	45.37
returns	(1.49)		[0.08]	[0.00]	[0.00]	[0.46]	09.90	06.87
Exchange	0.4**	9.46	1.44**	6.79**	89.38**	6.31	-8.48	14.28
rate returns	(2.05)		[0.00]	[0.00]	[0.00]	[0.90]	03.98	12.97
Taiwan								
Stock	1.14	40.63	-0.42**	4.61**	9.04**	10.84	-53.55	43.59
returns	(1.51)		[0.00]	[0.00]	[0.011]	[0.54]	10.87	08.87
Exchange	-0.06	5.06	-0.06	7.75**	227.9**	42.8**	-7.23	7.91
rate returns	(0.67)		[0.68]	[0.00]	[0.00]	[0.00]	04.89	10.97
Thailand								
Stock	0.32	32.46	-0.16	3.28**	5.65*	23.8**	-37.65	39.78
returns	(0.54)		[0.30]	[0.00]	[0.06]	[0.02]	10.87	01.98
Exchange	0.27	11.11	0.75**	29.23**	6853.4**	22.9**	-24.68	21.78
rate returns	(1.30)		[0.00]	[0.00]	[0.00]	[0.03]	02.98	07.97
U.S.								
Stock	1.0**	14.46	-1.06**	5.64**	27.34**	7.62	-24.68	13.24
returns	(3.98)		[0.00]	[0.00]	[0.00]	[0.81]	10.87	01.87

Panel B: Autocorrelations of stock and exchange rate returns

Country	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6
Indonesia						
Stock returns	0.138**	-0.031	-0.014	-0.003	0.018	0.078
Exchange rate returns	-0.04	0.108	-0.18**	-0.099	-0.020	0.001
Korea						
Stock returns	0.135**	-0.008	-0.035	-0.006	0.043	0.112*
Exchange rate returns	0.094	0.090	-0.081	-0.067	-0.019	0.067
Malaysia						
Stock returns	0.108*	0.113*	-0.13**	-0.054	-0.067	-0.086
Exchange rate returns	0.065	-0.005	0.043	-0.008	0.116*	-0.110*

Philippines						
Stock returns	0.195**	-0.017	-0.022	0.004	0.020	-0.019
Exchange rate returns	0.019	0.091	0.000	0.111	0.015	0.032
Taiwan						
Stock returns	0.055	-0.023	-0.056	0.051	0.029	-0.060
Exchange Rate returns	0.124**	0.136**	0.170**	-0.019	0.169**	0.159**
Thailand						
Stock returns	0.124**	0.056	-0.032	-0.112*	-0.130**	0.041
Exchange rate returns	0.151**	-0.094	0.023	-0.062	0.132**	0.063
U.S.						
Stock returns	0.008	-0.062	-0.063	-0.057	0.081	-0.032

Panel C: Autocorrelations of squared stock and exchange rate returns

Country	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6
Indonesia						
Stock returns	0.001	-0.006	0.032	0.021	0.032	-0.019
Exchange rate returns	0.138**	0.013	0.034	0.189**	0.223**	0.034
Korea						
Stock returns	0.058	0.407**	0.161**	0.185**	0.137**	0.130**
Exchange rate returns	0.287**	0.068	0.170**	0.054	0.021	0.003
Malaysia						
Stock returns	0.247**	0.080	0.235**	0.037	0.044	0.183**
Exchange rate returns	0.464**	0.180**	0.083	0.221**	0.210**	0.199**
Philippines						
Stock returns	0.087	0.074	0.039	0.000	0.094	0.046
Exchange rate returns	0.160**	0.162**	0.335**	0.130*	0.148*	0.155**
Taiwan						
Stock returns	0.353**	0.502**	0.319**	0.174**	0.205**	0.150**
Exchange rate returns	0.148**	0.002	0.180**	0.200**	0.018	-0.019
Thailand						
Stock returns	0.139**	0.158**	0.172**	0.181**	0.214**	0.097
Exchange rate returns	0.334**	0.256**	0.097	0.077	0.201**	0.167**
U.S.						
Stock returns	0.060	0.050	0.008	0.032	-0.017	-0.003

Figures in parenthesis are t-statistics and in brackets p-values.
[a] Each standard deviation is the monthly annualised one. This is computed by multiplying by 12 the variance of the monthly data and taking the squared root of this value.
[b]Equal to zero for the normal distribution.
[c]Bera-Jarque test statistic for normality.
[d]Ljung-Box test statistic of order 12.
* and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 2: Conditional dynamic integration model of stock returns

Quasi-maximum likelihood estimates of the model consisting of equations (3), (11) and the conditional covariance matrix given by (13) but excluding $h_{xx,t}$, $h_{ix,t}$ and $h_{xm,t}$. The results are obtained using monthly returns from January 1980 to May 2000. L.F. indicates the maximum likelihood function. Figures in parenthesis are t-statistics and those in brackets are p-values. Estimates of constants and the autoregressive components in the mean equations are not presented.

Coefficients	**Korea**	**Malaysia**	**Taiwan**	**Thailand**
$m_{12,I}$	0.003 (0.567)	0.002** (177.0)	0.007 (1.191)	0.005 (0.107)
$m_{15,I}$	0.005 (0.029)	0.000** (12.50)	0.00 (0.295)	0.00 (0.044)
$m_{32,I}$	0.002 (0.584)	0.004** (288.30)	0.010 (1.125)	0.002 (0.215)
$a_{11,i}$	1.640** (12.727)	-0.021** (-625.63)	-2.788** (4.781)	0.272 (1.066)
$a_{31,i}$	0.358 (1.174)	0.012** (765.85)	-0.264* (-1.680)	0.354** (3.606)
$a_{33,i}$	-0.449** (-5.060)	-0.022** (-754.40)	-1.378** (-2.308)	0.222** (2.757)
$b_{11,i}$	0.886** (120.46)	0.945** (56.70)	0.809** (9.883)	0.983** (3.304)
$b_{33,i}$	0.987** (669.82)	0.872** (158.77)	0.920** (39.583)	0.993** (309.9)
$c_{11,i}$	0.431** (49.33)	0.318** (13.03)	0.570** (3.153)	0.156** (4.943)
$c_{33,i}$	0.070 (1.574)	0.479** (15.47)	0.218** (4.262)	0.033** (2.480)
$b^2_{11,i} + c^2_{11,i}$	0.970	0.994	0.979	0.990
$b^2_{33,i} + c^2_{33,i}$	0.979	0.990	0.894	0.986
L.F.	-1037	-1024	-1097	-1047

Diagnostic statistics for residuals:	Korea	US	Malaysia	US	Taiwan	US	Thailand	US
Skewness	0.30* [0.06]	-1.0** [0.00]	-0.52** [0.00]	-0.57** [0.00]	0.21 [0.18]	-1.11** [0.00]	-0.73 [0.0]	-1.10** [0.00]
Kurtosis[a]	1.06** [0.00]	6.** [0.00]	2.25** [0.00]	2.11** [0.00]	1.44** [0.00]	6.62** [0.00]	6.99** [0.00]	6.69** [0.00]
Q(12)[b]	11.4 [0.49]	5.7 [0.90]	16.28 [0.18]	15.75 [0.20]	8.80 [0.72]	5.43 [0.94]	8.83* [0.72]	6.11 [0.91]
$Q^2(12)$[c]	10.14 [0.60]	9.52 [0.70]	16.64 [0.16]	6.62 [0.88]	21.91** [0.03]	6.32 [0.90]	11.25 [0.51]	10.26 [0.59]

[a] Equal to zero for the normal distribution.
[b & c] Ljung-Box test statistic of order 12.
* and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 3: Specification tests

Country	$Q_{12}(uh^{-1/2})$		$Q_{12}(uh^{-/12})^2$		*Likelihood ratio test*
	Model A	Model B	Model A	Model B	
Korea					
Stock returns	18.29	18.07	129.5**	9.15	692.0**
	[0.11]	[0.11]	[0.00]	[0.77]	[0.00]
Exchange rate returns	16.98	21.37*	75.41**	18.59	
	[0.15]	[0.06]	[0.00]	[0.10]	
Malaysia					
Stock returns	18.50	10.50	99.43**	7.60	374.0**
	[0.10]	[0.57]	[0.00]	[0.82]	[0.00]
Exchange rate returns	15.99	12.10	65.72**	15.30	
	[0.19]	[0.44]	[0.00]	[0.23]	
Taiwan					
Stock returns	9.18	9.28	121.11**	21.41**	126.0**
	[0.69]	[0.68]	[0.00]	[0.04]	[0.00]
Exchamge rate returns	19.09*	17.99	33.58**	29.43**	
	[0.09]	[0.12]	[0.00]	[0.00]	
Thailand					
Stock returns	15.38	15.34	68.05**	13.43	232.0**
	[0.22]	[0.22]	[0.00]	[0.34]	[0.00]
Exchange rate returns	18.16	17.16	80.51**	3.11	
	[0.11]	[0.14]	[0.00]	[0.99]	

The first four columns contain Ljung-Box test statistics for the standardized residuals $uh^{-1/2}$ and the squared standardised residuals $(uh^{-1/2})^2$. The statistics are computed for two models. Model A asssumes a constant variance. Model B assumes a GARCH(p,q) process for the conditional variance. Both models assume a quasi-maximum likelihood distribution. The numbers in brackets are p-values. The maximum order of auto-correlation is 12. The column labelled Likelihood ratio test contains the likelihood ratio test statistics and correspondent p-values of the hypothesis of conditional homoskedasticity. The test is distributed as a chi-squared with 8 degrees of freedom for Korea and 6 for the rest of the countries. * and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 4: Conditional dynamic integration model inclusive of currency risk

Quasi-maximum likelihood estimates of the model consisting of equations (7), (10), (11) and the conditional covariance matrix given by (13). The results are obtained using monthly returns from January 1980 to May 2000. L.F. indicates the maximum likelihood function. Figures in parenthesis are t-statistics and those in brackets are p-values. Estimates of constants and the autoregressive components in the mean equations are not presented.

Coefficients	Korea	Malaysia	Taiwan	Thailand
$m_{12,I}$	0.001 (0.00)	0.014** (2.919)	0.023** (2.713)	0.044** (2.735)
$m_{13,i}$	0.000 (0.580)	-0.547** (-2.604)	0.060** (3.184)	-0.225** (-6.789)
$m_{14,i}$	3.013** (3.483)	-0.006** (-2.391)	-0.029** (-1.968)	0.007** (4.991)
$m_{15,i}$	0.394** (2.119)	-0.000 (-0.681)	0.002** (1.959)	0.003** (9.926)
$m_{16,i}$	0.350** (3.449)	-0.028 (-0.352)	0.044 (0.123)	-0.015 (-1.166)
$m_{17,i}$	1.490 (1.384)	0.000 (0.378)	-0.096** (-3.261)	0.027** (9.967)
$m_{18,i}$	-0.384** (-5.724)	-0.012 (-0.113)	1.579** (4.600)	-0.320** (-12.858)
$m_{22,i}$	-0.426** (-3.968)	0.002** (3.720)	-0.087 (-1.458)	-0.147** (-3.487)
$m_{13,I}$	0.212** (4.354)	0.061 (1.404)	0.005* (1.700)	-0.154 (-1.231)
$m_{24,i}$	-0.004 (-0.433)	-0.012 (-0.611)	-0.122** (-2.182)	0.007 (1.305)
$m_{25,i}$	0.956** (5.014)	0.000 (0.141)	0.037 (0.536)	-0.073** (-9.068)
$m_{32,i}$	0.016** (1.909)	0.001 (0.141)	0.004 (0.682)	0.024** (3.405)
$a_{11,i}$	1.273** (32.683)	2.122** (4.758)	2.351** (10.37)	0.034** (9.185)
$a_{21,i}$	0.337** (25.428)	0.574** (186.43)	0.133** (4.97)	0.718** (5.632)
$a_{22,i}$	0.008 (0.174)	-0.628** (-4.169)	0.006 (0.371)	0.961** (3.581)
$a_{31,i}$	1.643** (27.07)	0.612** (3.673)	0.520** (4.206)	0.453** (3.092)
$a_{32,i}$	0.338** (6.432)	0.213* (1.899)	0.018 (1.056)	0.015 (0.243)
$a_{33,i}$	-1.084** (-5. 647)	-0.566** (-3.654)	-1.050** (-5.873)	1.182** (6.115)
$b_{11,i}$	0.869** (122.6)	0.858** (56.707)	0.905** (220.53)	0.947** (65.207)
$b_{22,i}$	0.430** (53.94)	0.601** (20.832)	0.996** (14.49)	-0.375** (-3.595)
$b_{222,i}$	-0.078* (-1.646)			
$b_{33,i}$	0.855** (93.03)	0.953** (180.85)	0.938** (144.67)	0.929** (533.84)
$c_{11,i}$	0.427** (81.173)	0.475** (8.719)	0.369** (32.13)	0.199** (32.56)

$c_{22,i}$	0.420** (7.619)			0.644** (11.348)			0.036** (3.522)			0.520** (21.580)		
$c_{222,i}$	0.790** (100.73)											
$c_{33,i}$	0.150** (4.797)			0.222** (11.936)			0.216** (18.451)			0.184** (58.750)		
$b_{11,i}^2 + c_{11,i}^2$	0.937			0.962			0.953			0.936		
$b_{22,i}^2 + c_{22,i}^2$	0.991[d]			0.775			0.993			0.411		
$b_{33,i}^2 + c_{33,i}^2$	0.755			0.957			0.926			0.897		
L.F.	-1118			-1234			-1285			-1362		
Diagnostic statistics for residuals	Korean stock returns	Exchan ge rate retuns	U.S. stock returns	Malaysian stock returns	Exchan ge rate rate	U.S. stock returns	Taiwanese stock returns	Exchan ge rate rate	U.S. stock returns	Thailand stock returns	Exchan ge rate rate	U.S. stock returns
Skewness	0.22 [0.20]	-0.5** [0.02]	-0.23 [0.25]	-0.68** [0.00]	-1.07** [0.00]	-0.31 [0.13]	0.18 [0.27]	0.33 [0.11]	-0.29 [0.15]	-0.35** [0.02]	-5.29** [0.00]	-0.28 [0.16]
Kurtosis[a]	1.23** [0.00]	3.04** [0.00]	0.79* [0.06]	2.36** [0.00]	5.84** [0.00]	0.77* [0.06]	1.53** [0.00]	6.71** [0.00]	0.80* [0.05]	2.98** [0.00]	48.25** [0.00]	0.80* [0.05]
Q(12)[b]	18.07 [011]	21.37* [0.06]	6.04 [0.90]	10.50 [0.57]	12.10 [0.44]	6.28 [0.90]	9.28 [0.68]	17.99 [0.12]	6.10 [0.91]	15.34 [0.22]	17.16 [0.14]	5.87 [0.92]
$Q^2(12)$[c]	9.15 [0.77]	18.59 [0.10]	10.2 [0.59]	7.60 [0.82]	15.30 [0.23]	6.58 [0.88]	21.41** [0.04]	29.43** [0.00]	6.41 [0.89]	13.43 [0.34]	3.11 [0.99]	6.87 [0.87]

[a]Equal to zero for the normal distribution.

[b & c] Ljung-Box test statistic of order 12.

[d]This is the sum of $b_{22,i}^2, b_{222,i}^2, c_{22,i}^2$ and $c_{222,i}^2$.

* and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 5: Conditional dynamic integration model inclusive of currency risk, and dummies for capital market liberalisation and Asian crisis.

Quasi-maximum likelihood estimates of the model consisting of equations (7), (10) and (11) and the conditional covariance matrix given by (14). The results are obtained using monthly returns from January 1980 to May 2000. L.F. indicates the maximum likelihood function. Figures in parenthesis are t-statistics and those in brackets are p-values. Estimates of constants and the autoregressive components in the mean equations are not presented.

Coefficients	**Korea**	**Malaysia**	**Taiwan**	**Thailand**
$m_{12,i}$	0.000 (0.011)	0.024** (2.577)	0.008** (1.925)	0.011* (1.650)
$m_{13,i}$	0.837** (17.055)	-0.731 (-1.091)	-0.059** (-6.547)	5.824** (11.195)
$m_{14,i}$	0.049 (0.719)	-0.037** (-3.306)	0.107** (-5.383)	-0.532** (-8.417)
$m_{15,i}$	0.013** (10.005)	0.004** (16.595)	0.098** (2.138)	0.002** (3.017)
$m_{16,i}$	-1.021** (-16.345)	-0.011** (-4.843)	-0.045 (0.728)	0.862** (7.267)
$m_{17,i}$	0.007** (7.839)	0.008** (89.48)	-0.263** (-5.868)	-0.044** (-2.115)
$m_{18,i}$	-0.023** (-4.785)	-0.522** (-11.98)	-0.181** (-5.635)	0.045 (0.538)
$m_{22,i}$	-1.482** (-15.06)	-0.110 (-1.303)	-1.023** (-6.904)	0.447** (3.346)
$m_{23,i}$	0.269** (25.113)	-0.003 (-0.893)	0.431** (4.927)	-0.106** (-5.440)
$m_{24,i}$	-0.004 (-0.370)	0.025** (5.124)	-0.063** (-2.408)	-0.017 (-0.453)
$m_{25,i}$	0.028** (3.918)	0.044** (38.916)	0.168** (2.068)	0.084** (14.978)
$m_{32,i}$	0.086** (17.394)	0.001** (2.615)	0.004 (0.552)	0.017** (19.792)
$a_{11,i}$	-2.275** (-9.182)	-0.791** (-35.756)	2.351** (3.250)	-2.167** (-7.269)
$a_{21,i}$	-0.082** (-2.912)	0.541** (64.987)	0.264** (5.350)	-1.076** (-31.299)
$a_{22,i}$	0.357** (21.870)	0.594** (4.892)	-0.119** (-5.662)	-0.516* (-1.900)
$a_{31,i}$	2.458** (19.503)	-1.003** (-9.269)	0.584** (5.816)	-1.432** (-4.966)
$a_{32,i}$	0.128** (6.653)	-0.757** (-5.011)	0.116** (4.300)	1.058** (6.556)
$a_{33,i}$	2.127** (10.634)	-1.103** (-10.797)	-0.924** (-5.856)	-0.817** (-2.288)
$b_{11,i}$	0.760** (148.03)	0.883** (154.6)	0.852** (4.486)	0.780** (31.343)
$b_{22,i}$	0.278** (36.550)	0.330** (99.90)	0.964** (3.654)	0.352** (4.562)
$b_{222,i}$	0.603** (15.897)	-		
$b_{33,i}$	0.732**	0.899**	0.953**	0.797**

	(69.869)			(207.45)			(3.400)			(79.655)		
$c_{11,i}$	0.419** (173.783)			0.429** (177.57)			0.476** (39.090)			0.082** (10.638)		
$c_{22,i}$	0.032** (15.683)			0.257** (438.12)			0.027 (0.877)			0.014** (2.570)		
$c_{222,i}$	0.475** (59.531)			-								
$c_{33,i}$	0.065** (2.941)			0.206** (75.12)			0.145** (9.305)			0.420** (33.281)		
D1	0.130** (16.013)			0.727* (1.668)			-2.374* (-1.708)			5.177** (11.948)		
D2	0.344** (2.046)			0.402** (27.67)			-0.005 (-0.149)			0.009 (0.221)		
DC1	10.037** (4.216)			9.315** (25.99)			0.762 (0.282)			11.288** (2.476)		
DC2	10.773** (40.308)			4.942** (47.41)			-1.026** (-3.475)			11.864** (10.42)		
$b^2_{11,i}+c^2_{11,i}$	0.753			0.964			0.951			0.615		
$b^2_{22,i}+c^2_{22,i}$	0.665[d]			0.174			0.959			0.124		
$b^2_{33,i}+c^2_{33,i}$	0.553			0.850			0.928			0.814		
L.F.	-1135			-1231			-1261			-1285		
Diagnostic statistics for residuals	Korean Stock returns	Exchange rate retuns	U.S. stock returns	Malaysian stock returns	Exchange rate rate	U.S. stock returns	Taiwanese stock returns	Exchange rate returns	U.S. stock returns	Thailand stock returns	Exchange rate rate	U.S. stock returns
Skewness	0.59** [0.00]	-0.03 [0.83]	-1.06** [0.00]	-0.35** [0.03]	-0.04 [0.78]	-1.12** [0.00]	0.14 [0.37]	0.56* [0.00]	-1.1** [0.00]	-0.47** [0.00]	-3.78** [0.00]	-1.51** [0.00]
Kurtosis[a]	0.72** [0.02]	1.28** [0.00]	6.01** [0.00]	1.56** [0.00]	2.01** [0.00]	6.50** [0.00]	1.19** [0.00]	6.30** [0.00]	6.43** [0.00]	2.94** [0.00]	36.2** [0.00]	9.6** [0.00]
Q(12)[b]	12.36 [0.42]	15.54 [0.21]	6.05 [0.91]	10.56 [0.57]	14.13 [0.29]	6.11 [0.91]	7.89 [0.79]	11.12 [0.51]	6.10 [0.92]	6.68 [0.88]	11.85 [0.46]	7.05 [0.85]
$Q^2(12)$[c]	10.38 [0.58]	16.21 [0.18]	9.52 [0.66]	5.70 [0.93]	12.99 [0.37]	6.43 [0.89]	15.01 [0.24]	7.42 [0.83]	7.55 [0.82]	8.89 [0.71]	0.64 [0.99]	3.97 [0.98]

[a]Equal to zero for the normal distribution.

[b & c] Ljung-Box test statistic of order 12.

[d]This is the sum of $b^2_{22,i}$, $b^2_{222,i}$, $c^2_{22,i}$ and $c^2_{222,i}$.

* and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 6: Summary statistics for equity premiums

The table contains annualised means and standard deviations in brackets, in percent, for the risk premiums esimated for the dynamic integration model with currency risk and dummies for the Asian crisis and capital market liberalisation. The total risk premium (TRP) is measured as the sum of the market risk premium (MRP) and currency risk premium (CRP). The premiums for each stock market are measured in the pre-liberalisation period by

$$TRP = m_{12,i}h_{ii,t} + m_{13,i}h_{xx,t} + m_{14,i}h_{ix,t}$$

and post-liberalisation period by

$$TRP = m_{15,i}h_{im,t} + m_{16,i}h_{xm,t} + m_{17,i}h_{ix,t} + m_{18,i}h_{xx,t}.$$

Country	TRP	MRP	CRP
Korea			
Pre-liberalisation 80.01 - 91.12	30.72 (273.94)	0.00 (0.00)	30.72 (273.94)
Post-liberalisation (excluding crisis) 92.01 - 97.06	-0.13 (44.41)	0.09 (3.68)	-0.23 (45.38)
Post-crisis 97.06 - 00.-5	12.06 (52.67)	17.46 (6.75)	-5.42 (50.42)
Full sample period 80.01 - 00.05	3.33 (255.67)	0.93 (5.56)	2.35 (257.14)
Malaysia			
Pre-liberalisation 80.01 – 88.11	24.32 (66.44)	24.66 (64.14)	-1.55 (9.34)
Post-liberalisation (excluding crisis) 88.11 - 97.06	-8.76 (25.30)	0.41 (1.12)	-9.08 (25.13)
Post-crisis 97.06 - 00.-5	-433.92 (374.0)	1.00 (3.97)	-434.92 (378.0)
Full sample period 80.01 - 00.05	-25.16 (234.48)	11.49 (44.07)	-36.66 (228.67)
Taiwan			
Pre-liberalisation 80.01 - 90.12	10.11 (64.47)	18.39 (43.30)	-8.28 (21.17)
Post-liberalisation (excluding crisis) 90.12 - 97.06	-1.76 (45.52)	5.61 (30.28)	-7.37 (15.24)
Post-crisis 97.06 - 00.05	-19.53 (68.4)	17.86 (55.57)	-37.39 (48.05)
Full sample period 80.01 - 00.05	2.09 (66.99)	14.51 (41.98)	-12.41 (25.00)
Thailand			
Pre-liberalisation 80.01 - 87.08	24.96 (75.24)	2.43 (3.05)	22.56 (74.88)
Post-liberalisation (excluding crisis) 87.09 - 97.06	-2.20 (28.70)	0.42 (2.22)	-2.62 (29.96)
Post-crisis 97.06 - 00.05	-403.94 (699.66)	2.69 (1.04)	-406.63 (699.56)
Full sample period 80.01 - 00.05	7.32 (62.16)	1.32 (3.06)	6.00 (61.56)

Figure 1a

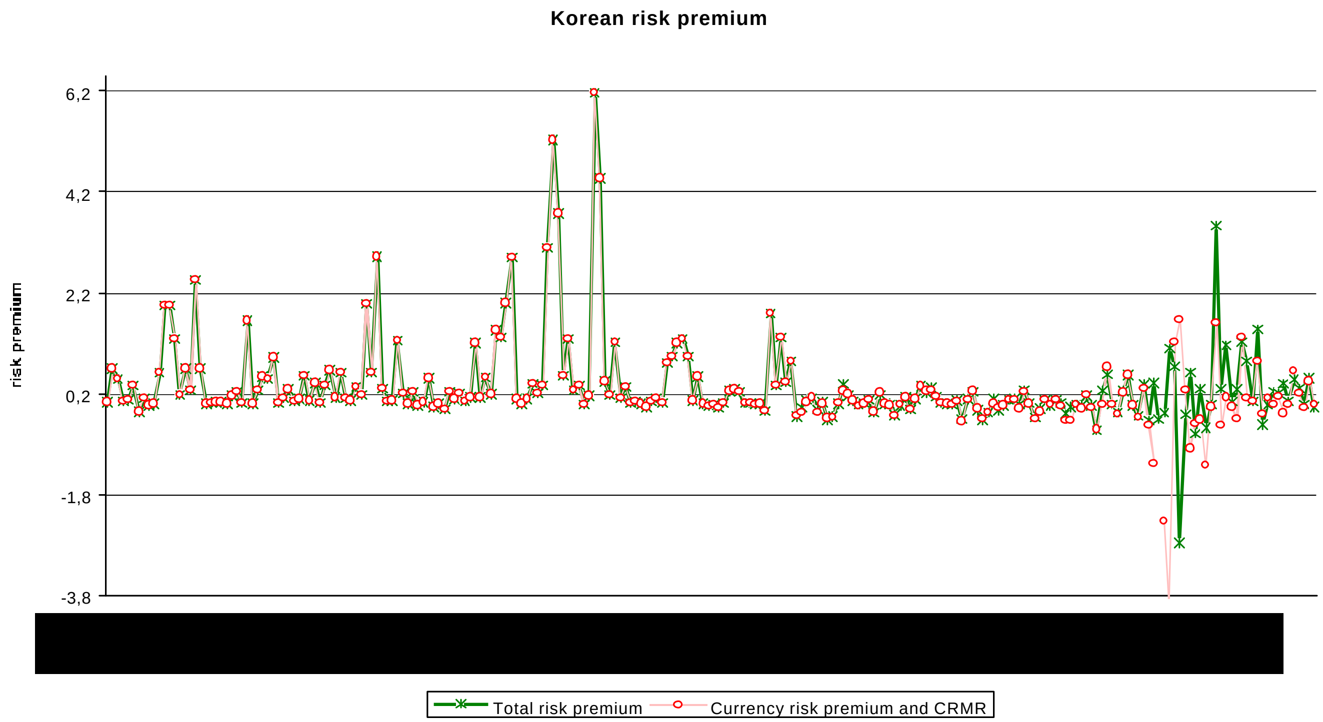


Figure 1b

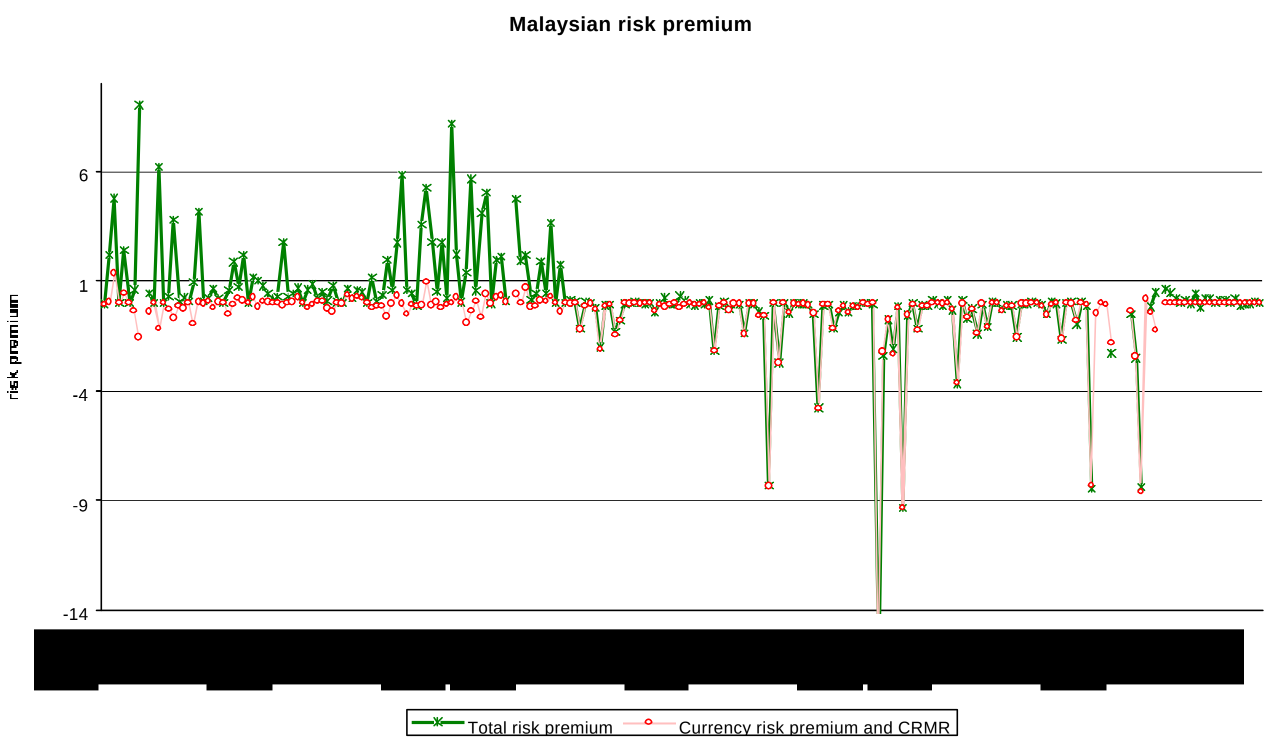
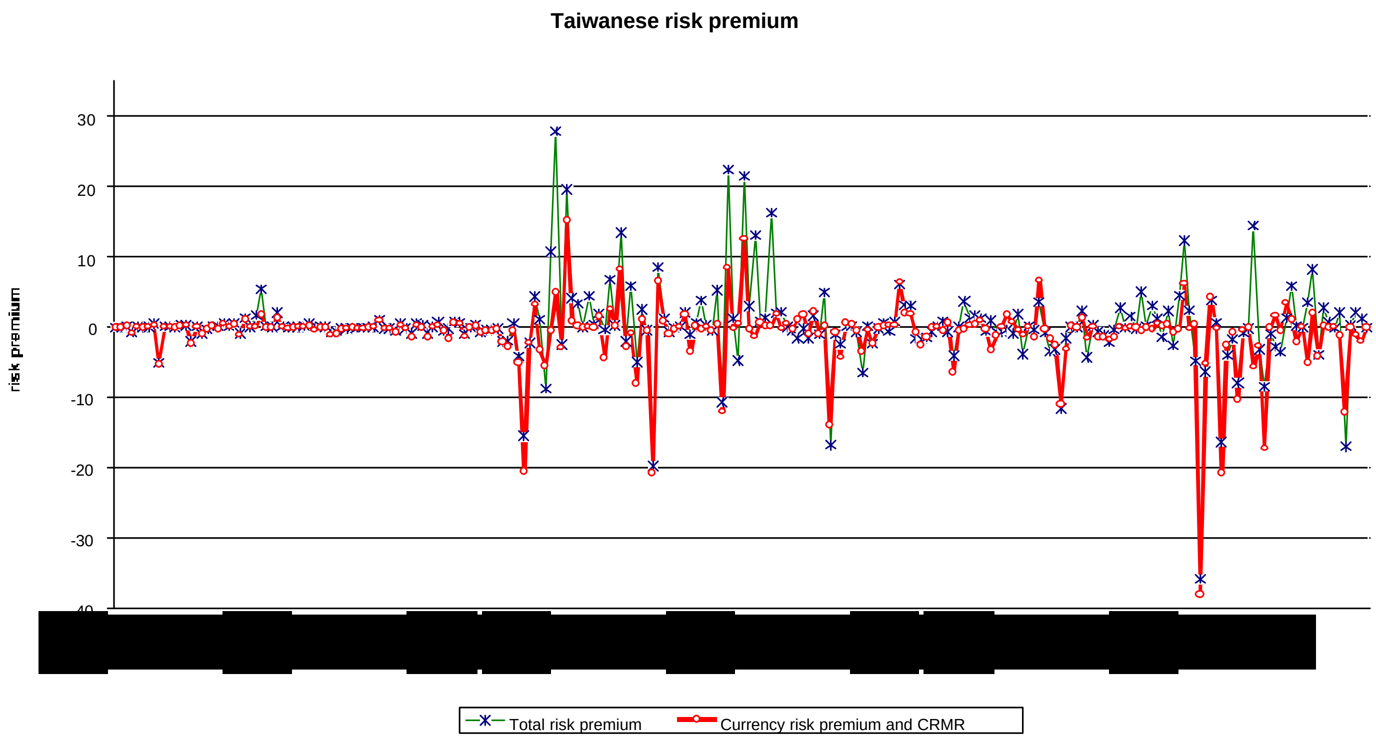
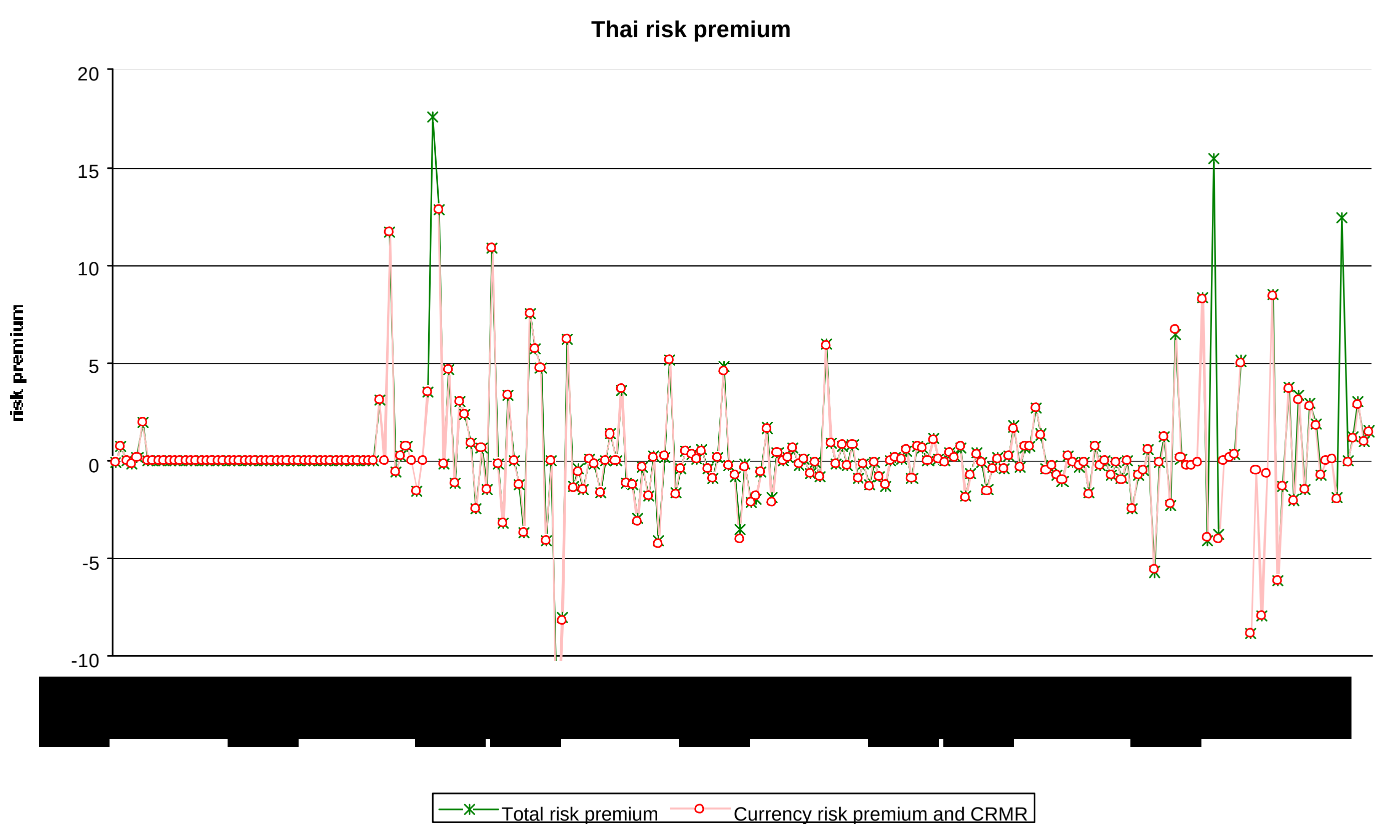


Figure 1c



[redacted]

Figure 1d



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