Global Price of Foreign Exchange Risk and the Local Factor

Francesca Carrieri, Vihang Errunza and Basma Majerbi[*]

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[*] Carrieri and Errunza are at the Faculty of Management, McGill University, Montreal, Quebec, H3A1G5, Canada, Majerbi is at the University of Victoria, Victoria, British Columbia, V8W 2Y2, Canada. Carrieri may be reached at francesca.carrieri@mcgill.ca; Errunza may be reached at vihang.errunza@mcgill.ca; Majerbi may be reached at majerbi@uvic.ca. We are grateful to Warren Bailey, Geert Bekaert, Jay Choi, Jean-Claude Cosset, Bernard Dumas, Wayne Ferson, Aditya Kaul and Luis Viceira for helpful comments and discussions. This paper has benefited from workshops at McGill University and Laval University. We also thank participants at the International Finance Conference in Hammamet, the Georgia Tech/Fortis Ninth Annual Conference on International Finance, the 2003 European Financial Management Association Meetings, the 2003 Northern Finance Association Meetings and at the 2004 Emerging Markets Conference at the Darden School, University of Virginia. Errunza acknowledges financial support from the Bank of Montreal Chair at McGill University and SSHRC. Carrieri acknowledges financial support from SSHRC and IFM$_2$.

Abstract

This paper provides new evidence on the pricing of exchange risk in global stock markets. We conduct empirical tests in a conditional setting with a multivariate GARCH-in-Mean specification and time-varying prices of risk for the US and nine emerging markets to determine whether exchange risk is priced under alternative model specifications and exchange rate measures. Since inflation rates in emerging markets are high and volatile, we argue that the use of real exchange rates offer a better proxy for risk stemming from purchasing power parity deviations. In addition to using real exchange rates, the empirical model allows for partial integration by including a time-varying price of local risk. Our main results support the hypothesis of significant exchange risk premia related to both emerging and developed markets. The price of exchange risk is also significantly time-varying consistent with previous evidence for major developed markets. The empirical evidence also suggests that there is variation across countries and over time in the relative importance of exchange risk premia. However, currency risk remains an important global risk factor even after accounting for local risk.

Keywords: International Asset Pricing, Currency risk, Emerging Markets, Integration, Segmentation

JEL classification: G12, G15

1. Introduction

Foreign exchange risk is one of the most important dimensions of international asset pricing. Indeed, under deviations from purchasing power parity (PPP), exchange risk should be priced [see, for example, Solnik (1974), Stulz (1981), and Adler and Dumas (1983)].[1] These international asset pricing models (IAPMs) include covariances of asset returns with changes in deviations from PPP in addition to the covariance with the world market portfolio.

Early attempts to test IAPMs in an unconditional setting were inconclusive.[2] More recently, Dumas and Solnik (1995) and De Santis and Gerard (1998) use a conditional framework and find evidence that foreign exchange risk is priced in major developed stock markets. Their results are based on models that implicitly assume full market integration and study major developed stock markets (US, UK, Japan and Germany).[3] Indeed, the available evidence is not sufficient to allow generalization about whether exchange risk is priced globally in different market environments, such as emerging markets (EMs), that are neither fully integrated nor completely segmented. In addition, many EMs have experienced some kind of currency crises with overwhelming negative impact on their economies and stock markets. This may affect the perception of foreign investors with respect to the importance of exchange rate risk.

It is then interesting to empirically see if such perception is reflected in significant and/or larger foreign exchange risk premia in equity returns of emerging markets. Although theoretical models would suggest that currency risk stemming from these markets might not be as important since they represent a small component of the world market capitalization, the issue of whether foreign exchange risk is priced and its global economic relevance is to a large extent an open empirical question.

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[1] See Karolyi and Stulz (2002) for an excellent discussion.

[2] For example, Hamao (1988) and Jorion (1991) found no evidence that exchange risk is priced on the Japanese and US stock markets respectively. However, Vassalou (2000), testing various unconditional asset pricing models for ten developed markets, found evidence that exchange risk can explain part of the within-country cross-sectional variation in returns.

[3] Other studies within a conditional setting, [Choi, Hiraki and Takezawa (1998), Doukas, Hall and Lang (1999), Carrieri (2001)] all tend to strongly support the hypothesis that foreign exchange risk is priced in stock markets of major developed countries.

To date, the literature that focuses on exchange risk related to emerging stock markets is very sparse. Bailey and Chung (1995) study finds evidence that Mexico’s equity market premia are related to risk premia in the currency market. Carrieri et al. (2004) show that information about emerging market episodes of crisis affect the prices of global risk factors such as the world market risk and the major currencies risk. Phylaktis and Ravazzolo (2004) look at risk stemming from local bilateral exchange rates for a number of Pacific Basin markets. Our goal is to enhance our understanding of the role of emerging stock markets in explaining global currency risks by accounting for both developed and emerging markets currencies fluctuations and allowing for time variation in the prices of risk.

For our investigation, we use a conditional framework under different model specifications and exchange risk measures. Based on data from the US and nine emerging markets encompassing different regions and different exchange rate regimes, we attempt to provide some answers to the following related questions:

- Is exchange risk a global factor that commands a significant time varying risk premium in different cross sections of equity returns?
- If so, does the price of exchange risk remain significant once we account for local market risk in a model that assumes partial integration?

Our base model uses the IAPM of Adler and Dumas (1983). The base case assumes emerging markets are fully integrated with the world capital market and allows us to compare our findings with those of Dumas and Solnik (1995) and De Santis and Gerard (1998). This assumption is then relaxed and replaced by a partial integration hypothesis, which is more appropriate for the case of emerging markets. Our empirical methodology is similar to that of De Santis and Gerard (1998) with the exception of the exchange rate specification. We use measures of real exchange rates to investigate the significance of exchange risk pricing in emerging stock markets. We argue that, in the case of EMs, this is more appropriate and also more consistent with the original IAPM of Adler and Dumas (1983) where both world market risk and PPP deviations are priced. Previous empirical tests based on this model have assumed inflation as negligible and simplified the model by identifying changes in PPP deviations only with nominal exchange rate changes. Although this could be considered as a reasonable assumption in the case of major developed markets, we cannot assume that inflation is nonrandom when we deal with the relatively more inflationary and volatile emerging economies. In the absence of such simplifying assumption, we derive our empirical model where the covariances of asset returns with changes in PPP deviations are replaced by the covariances of asset returns with changes in real exchange rates. Since real exchange rates are inflation adjusted, the change in the real exchange rate is a more correct measure of PPP deviations for our setting.

It is well accepted that emerging markets are neither fully integrated nor completely segmented [see for example, Errunza, Losq and Padmanabhan (1992) and Bekaert and Harvey (1995)]. The empirical evidence about the behavior of emerging market returns provided by Harvey (1995) suggests that expected returns in these markets are more likely to be influenced by local rather than global factors. Hence, in our main estimation, we follow Bekaert and Harvey (1995) and De Santis and Gerard (1998) and test for the significance of the pricing of exchange risk within the framework of a model that allows for partial integration by including a time-varying price of local market risk.[4] Its inclusion is motivated by the fact that in partially integrated markets, tests based on an IAPM such as the fully integrated framework of Adler and Dumas (1983) may result in a spurious significance of the exchange risk factor because we are failing to account for other relevant sources of risk such as the volatility of the local market factor.

Our results can be summarized as follows. We find evidence that currency risk is significant and time-varying for a large number of assets from developed and emerging markets. Unlike the US market where the world risk factor is the most important, most emerging markets show larger premia linked to the global exchange risk factors. On average over the whole sample, total currency premia are negative, confirming that the hedging component in currency premia is predominant. Total currency premia are also economically significant as on average they represent 14 percent of the total premium in absolute terms across all global assets. Over subperiods, we find that the contribution from emerging markets currency risk can more than double for some EM assets. Local market risk is often priced and at times it subsumes the statistical importance of currency risk. We take this as indication that in emerging markets it is difficult to disentangle exchange rate risk from country-specific risk. Although over the whole sample local market risk is the largest component, total currency premia still represent on average 21 percent of the total premium across all EM assets. Therefore currency risk is an important economic risk factor in pricing global assets, even after accounting for local risk.

The rest of the paper is organized as follows. Section 2 outlines the model and methodology. Section 3 describes the data and presents some preliminary analysis of emerging market returns. The empirical results from tests of exchange risk pricing under full integration and partial integration specifications are presented in section 4. Section 5 concludes the paper.

2. Model and Methodology

2.1. The model

We begin with the specification based on Adler and Dumas (1983) model that assumes full integration. In a world with L+1 countries, we can write the full integration model of Adler and Dumas (1983) as

$$E(r_{i,t}) = \sum_{j=1}^{L} \delta_{j,t-1} \operatorname{cov}_{t-1}(r_{i,t}, \pi^{\$}_{j,t}) + \delta_{w,t-1} \operatorname{cov}_{t-1}(r_{i,t}, r_{w,t}) \qquad (1)$$

where r_i and r_w are excess returns on the asset i and the world market portfolio respectively, $\pi^{\$}_{j}$ is the rate of inflation of country j expressed in the reference currency, E is the expectations operator, δ_w is the price of world market risk and δ_j 's are the prices of inflation risks. The term cov $(r_i, \pi^{\$}_{j})$ measures the exposure of asset i to purchasing power parity deviations that stem from both the inflation risk and the exchange risk associated with country j.

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[4] Previous empirical studies that include both world and domestic market factors along with other risk factors to test various forms of IAPMs include Chan, Karolyi and Stulz (1992), Choi and Rajan (1997), Choi, Hiraki and Takezawa (1998).

Dumas and Solnik (1995) and De Santis and Gerard (1998) simplified the model by assuming that domestic inflation is non-stochastic. Since $\pi_j^{\$} \approx \pi_j + e_j$,[5] where π_j is the inflation in local currency terms and e_j is the change in the nominal exchange rate between the reference currency and the currency of country *j*, they assume that the only random component in $\pi_j^{\$}$ is the relative change in the exchange rate. Therefore, cov (r_i , $\pi_j^{\$}$), is a pure measure of the exposure of asset *i* to the currency risk of country *j* and δ_j can be interpreted as the price of risk of currency *j*. This simplification is reasonable for major developed countries where the changes in domestic inflation relative to exchange rate fluctuations are almost negligible. However, for many emerging markets where inflation is volatile, we cannot substitute the change in the nominal exchange rate for the inflation rate $\pi_j^{\$}$. In addition, using only nominal exchange rates to proxy for purchasing power parity deviations is likely to cause misspecification of the estimated risk premium as it would not account for the adjustment from local inflation.

One way to overcome the difficulty in empirical testing of IAPMs for the case of high inflation countries is to proxy the term $\pi_j^{\$}$ by the change in the real exchange rate of currency *j* instead of the nominal exchange rate (see proof in appendix 1)[6]. As explained in the appendix, this would still require an assumption about inflation for the reference currency (the US dollar) to be non stochastic, which is reasonable. Intuitively, it is also more appealing to approximate the risk stemming from PPP deviations with the real exchange risk, since changes in the real exchange rate come from the combined effects of changes in the inflation differential (between country *j* and the US) and changes in the nominal currency value. In addition, using changes in the real exchange rate helps

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[5] If P_j is the price level in country *j* (expressed in the local currency *j*), then the price level of country *j* expressed in U\$ is: $P_j^{\$} = P_j \times S_j$ where S_j is the nominal exchange rate expressed as U\$/FC$_j$

Thus, $\frac{dP_j^{\$}}{P_j^{\$}} = \frac{dP_j}{P_j} + \frac{dS_j}{S_j} + \frac{dP_j}{P_j} \times \frac{dS_j}{S_j}$ and, $\pi_j^{\$} \approx \pi_j + e_j$

[6] Including both inflation risk and nominal exchange risk in the same model would lead to multicollinearity problems given the generally high correlation between inflation rates and exchange rates. As shown in Vassalou (2000), while both inflation risk and exchange risk are significant pricing factors when considered separately in various models, none of these factors is significant when included jointly in the same asset pricing model.

overcome possible complications due to fixed exchange rate regimes or discrete changes in nominal exchange rates due to devaluations or peg removals.[7]

Therefore, we estimate the following version of the Adler-Dumas model where only the reference country inflation rate (US) is assumed to be non-stochastic:

$$E(r_{i,t}) = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{i,t}, r_{w,t}) + \sum_{j=1}^{L} \delta_{j,t-1}\,\mathrm{cov}_{t-t}(r_{i,t}, e_{j,t}^{r}) \qquad (1a)$$

where e_j^r is the change in the real exchange rate of currency *j* vis-à-vis the US dollar. δ_j can be interpreted as the price of exchange risk after adjusting for inflation changes.

Theoretical models such as the one we propose above do not account for local sources of risk.[8] However, there is mounting evidence that emerging markets are neither fully integrated, nor completely segmented [see Bekaert and Harvey (1995), Carrieri, Errunza and Hogan (2003)]. A relevant empirical issue is then whether local risk is also priced for EMs, separately from currency risk. Thus, we modify the model in (1) to depict a more realistic global market environment. We follow De Santis and Gerard (1998) who include a constant price of local risk in a model with global covariance risk. In our case, we test for the significance of the pricing of exchange risk within a framework that allows for partial integration by adding a time-varying price of local market risk:

$$E(r_{i.t}) = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{i,t}, r_{w,t}) + \sum_{j=1}^{L} \delta_{j,t-1}\,\mathrm{cov}_{t-1}(r_{i,t}, e_{j,t}^{r}) + \delta_{i,t-1}\,\mathrm{var}_{t-1}(r_{i,t}) \qquad (1b)$$

where, δ_i, the price of local market risk for country *i*, is incorporated to measure country-specific factors such as legal barriers to portfolio flows or differential tax treatment across countries that are not captured by the full integration model. This extension is important from an empirical perspective since we want to avoid a spurious significance of the currency risk due to missing factors.

Our empirical specification with time-varying prices of world and local market risks has the advantage of accommodating the evolution of the integration versus segmentation

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[7] Using real exchange rates also allows us to apply the same model for countries with different exchange rate regimes.

[8] At present, there is no theoretical model that accounts for both PPP deviations and barriers to investments that result in market segmentation.

phenomena without having to fix the liberalization date as in the dynamic integration models of De Santis and Imrohoroglu (1997) and Phylaktis and Ravazzolo (2004).[9] This is because some countries may have financial markets that are integrated with the international capital market even in the presence of barriers, as shown in Bekaert and Harvey (1995) for countries like Korea and Taiwan.

2. 2. Empirical Methodology

We first estimate the full integration model in equation (1a) jointly for a system of countries. The empirical model includes a time-varying price of world market risk and time-varying prices of real exchange rate risk,

$$r_t = \delta_{w,t-1} h_{w,t} + \sum_{j=1}^{L} \delta_{l,t-1} h_{n+j,t} + \varepsilon_t \qquad \varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t) \qquad (2)$$

where:

r_t is a vector of excess returns of S assets measured in a common currency;

$\delta_{w,t-1}$ is the price of world market risk;

$\delta_{j,t-1}$ are the prices of real exchange rate risks;

Ω_{t-1} is a set of information variables available to investors at time t;

$h_{i,t}$ is a column of the $(S \times S)$ covariance matrix H_t.

We estimate the system in (2) for S assets, that include $1<n<L$ country equity portfolios, up to L real currency portfolios and the world market portfolio. The general IAPM in (1) also provides a risk-adjusted equilibrium relationship between riskless interest rates differential and expected changes in the nominal exchange rates. For this reason, Dumas and Solnik (1995) and De Santis and Gerard (1998) use the IAPM equation to price the deviations from uncovered interest rate parity and estimate the exchange premia in (1) through uncovered excess currency deposits. We focus on risk due to real exchange rate changes. By replacing nominal rates with real rates and inflation rates, we express the

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[9] These models typically assume that markets are fully segmented during the pre-liberalization date (including only local risk) and fully integrated thereafter (including only world market risk) and do not model prices of risk as time-varying.

currency portfolio pricing equation in terms of changes in the real exchange rate. This implies that real exchange rate risk can be explained by a sum of premia. The first risk premium is the world market risk premium while the other premia are due to purchasing power parity deviations as in equation (1).

We then modify our framework to account for partial segmentation as in (1b). For each EM country in the study, we estimate a system where the pricing equation for the country return includes a time-varying price of domestic market risk, $\delta_{i,t-1}$, in addition to a time-varying price of world market risk and time-varying prices of real exchange rate risks:

$$r_{i,t} = \delta_{w,t-1}h_{i,w,t} + \sum_{j=1}^{L}\delta_{j,t-1}h_{i,n+j,t} + \delta_{i,t-1}h_{i,i,t} + \varepsilon_{it} \qquad \varepsilon_{\mathrm{t}} \mid \Omega_{t-1} \sim N(0,H_t) \qquad (3)$$

The expected return of the other assets in the system will depend only on world market risk and real currency risk, in line with the original model of equation (1a). Differently from Bekaert and Harvey (1995), this empirical approach allows us to simultaneously estimate time-varying global and local risk prices from the cross-section of assets.

We model the prices of world market risk and exchange rate risk ($\delta_{w,t-1}$ and $\delta_{j,t-1}$) to depend only on a set of global information variables $Z_{g,t-1}$, while the price of local risk $\delta_{i,t-1}$ is dependent on a set of local information variables, $Z_{i,t-1,}$ which is country-specific.[10] More precisely, we model the price of world market risk as an exponential function of the information variables to ensure that this price is always positive as implied by the theoretical model. The prices of currency risk can be modeled using a linear functional form as there is no restriction on the price of currency risk to be positive in the model.[11] The same linear specification is also used for the price of the local risk factor.

$$\delta_{w,t-1} = \exp\,(k_w{}'Z_{g,t-1}\,) \qquad (4)$$

$$\delta_{j,t-1} = k_j{}'Z_{g,t-1}, \quad j = 1 \text{ to } L \qquad (5)$$

$$\delta_{i,t-1} = k_i{}'Z_{i,t-1} \qquad (6)$$

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[10] We follow Dumas and Solnik (1995) and De Santis and Gerard (1998) who use the same set of global instruments for the price of world risk and the prices of currency risk. For the instruments for the price of local risk, we rely on Harvey (1991), and Bekaert and Harvey (1995).

[11] In Adler and Dumas (1983) theoretical model, the price of market risk is always positive as long as investors are risk averse. However, the price of currency risk can be negative if the degree of risk aversion is greater than one.

We use a linear specification for the price of local risk since we want to accommodate negative expected returns that can be justified in periods of high volatility or high inflation when stocks act as inflation hedge. This could be of particular relevance for assets in emerging markets that are characterized by high volatility and, at times, high inflation.

Since in this study we are interested in determining the statistical and economic significance of currency risk premia relative to world and domestic risk premia in pricing emerging market assets, we follow the fully parametric approach used in De Santis and Gerard (1997, 1998). We impose a diagonal structure on the matrices of coefficients and assume that the system is covariance-stationary so that we can rewrite H_t as a function of the unconditional covariance matrix of the residuals H_0 and a reduced number of parameters:[12]

$$H_t = H_0 * (ii' - aa' - bb') + aa' * \varepsilon_{t-1}\varepsilon_{t-1}' + bb' * H_{t-1} \tag{7}$$

where i is ($Sx1$) vector of ones, a and b are ($Sx1$) vectors of unknown parameters and * denotes the Hadamard (element by element) matrix product.[13] The system is estimated using the BHHH (Bernt, Hall, Hall and Hausman (1974)) algorithm and quasi-maximum likelihood (QML) standard errors are obtained to ensure robustness of the results (see White (1982)).

Even with this parsimonious specification, a joint multi-country estimation of the model is computationally very difficult since it would include a large number of currency premia and local premia. In fact, according to the theoretical model, there should be as many currency premia as there are countries in the world. Previous studies with similar methodologies were limited to using few countries at a time.[14] To reduce the dimensionality of a model, a common way used in the literature is to replace the different

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[12] This means that we assume that the variances depend only on lagged squared errors and lagged conditional variance while covariances depend on the cross-product of lagged errors and lagged conditional covariances.

[13] This symmetric specification for the conditional variance-covariance matrix has been successfully applied also to EMs data in De Santis and Imrohoroglu (1997). Moreover, modeling asymmetry for EM returns would be very complicated as they typically show no specific pattern in terms of positive or negative asymmetry. However, we check the relevance of asymmetry in the residual diagnostics.

[14] For example, four countries in the case of De Santis and Gerard (1998), with three currency premia.

currency exchange rates by a single exchange rate measure such as a trade-weighted exchange rate index [see Jorion (1991), Ferson and Harvey (1993, 1994), Choi, Hiraki and Takezawa (1998)]. To investigate a large cross section of countries, other studies, such as Hardouvelis et al. (2002) estimated similar models in two steps.[15]

Clearly there are shortcomings to both approaches. By using a single currency index, we lose information regarding the relative pricing of some currencies with respect to others, while a two-step estimation procedure results in errors in variable problems and may affect the significance of the parameter estimates. In our study, we find a compromise by investigating various versions of the model within systems of different number of assets. In our largest joint estimation, we reduce the dimensionality of the model by using two real exchange rate indices to separate the effects of EM currencies fluctuations from those of major currencies. When we account for local market risk alongside world and exchange rate risk, we reduce parameters proliferation by considering a smaller number of assets. This setting also allows us to use real bilateral exchange rates as an alternative measure for the exchange risk factor to determine the relative importance of the local currency risk versus local market risk separately for each country.

4. Data and Summary Statistics

This study covers the US plus four countries in Latin America (Brazil, Colombia, Chile and Mexico) and five countries in Asia (India, Korea, Malaysia, Philippines and Thailand). We use monthly data from January 1976 to December 2000. Country returns are computed from national total return indices (inclusive of dividends) of the S&P/IFC's Emerging Market Database (EMDB). The dividend adjusted US market and world market returns are obtained from MSCI. All returns are expressed in US dollar and computed in excess of the 30-day eurodollar deposit rate, used as a proxy for the risk-free rate, available from DataStream.

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[15] Hardouvelis, Malliaropulos and Priestley (2002) use a similar empirical framework but with a time-varying degree of integration for the EMU countries. Their empirical methodology involves a two-step estimation where estimates of the world and currency prices of risk obtained in the first step are imposed in the second stage to get estimates of the individual country prices of risk. This procedure has the advantage of reducing considerably the number of parameters to be estimated but leads to a loss of efficiency compared to the

Nominal bilateral exchange rates with respect to the dollar are from the International Monetary Fund's *International Financial Statistics* (IFS) and DataStream. We compute real bilateral exchange rates for each country using nominal exchange rates and CPI indices available from the IFS database. All bilateral rates are expressed in US dollars by unit of the foreign currency so that a positive (negative) change in the rate represents an appreciation (depreciation) of the foreign currency with respect to the dollar.

As mentioned in section 3, we use two trade-weighted exchange rate indices computed by the Federal Reserve Board to separate the effects of EMs currency fluctuations from those of major currencies.[16] These two currency indices represent two non-overlapping sets of all the important U.S. trading partners. The emerging markets group of currencies is included in the "other important trading partners" (*OITP)* index. We will refer to this as the *EM currency index*. This group includes nineteen currencies that are not heavily traded outside their respective home markets.[17] The second group is summarized in the "major partners" index, which we will refer to as the *Major currency index*. [18] This group comprises sixteen major currencies until the introduction of the euro and seven currencies after that event.[19] These two currency indices are computed on a price-adjusted basis (real exchange rate indices) and provide a measure to approximate the sum of the various real exchange rates that should be included in the model (see proof in appendix 2).[20]

Table 1 reports summary statistics and correlations between excess market returns and the global risk factors (world return and real exchange rate indices). Compared to the world return characteristics, emerging market returns are large in some cases and show

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simultaneous estimation procedure suggested by De Santis and Gerard (1997, 1998). It also fails to provide information about the statistical relevance of global risks using the cross-section of assets.

[16] For more information on these indices, see the Federal Reserve Bulletin, October 1998.

[17] These countries are Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela in Latin America; China, Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand in Asia; Israel and Saudi Arabia in the Middle East and Russia in Eastern Europe.

[18] Many EMs are quite sensitive to the change in the value of the dollar with respect to major currencies such as the Japanese yen or European currencies due their trade patterns or currency regimes. For instance, many East Asian economies, due to their de facto peg to the dollar, are quite sensitive to the yen/U$ exchange rate fluctuation. Moreover, for many East Asian countries the volume of trade with Western Europe is comparable to their trade with the US and Japan.

[19] These are the currencies of the euro-area countries plus Australia, Canada, Japan, Sweden, Switzerland, and the United Kingdom.

[20] We use the log-change in the inverse of each of the indices to capture the change in the real value of the foreign currencies with respect to the dollar as it should appear in the model.

high volatility. The data also shows high levels of skewness and kurtosis and the hypothesis of normally distributed returns is clearly rejected by the Bera-Jarque test for all countries. Unlike the case of developed markets, emerging market returns are highly autocorrelated as indicated by the $Q(z)_{12}$ statistics in almost all countries except Brazil, India and Korea. There is also a high level of autocorrelation in the squared returns series. The correlations between EMs returns and the world market return are generally low compared to what is commonly observed for developed markets. Malaysia, Philippines, Mexico, Korea and Thailand show the highest correlations to the world market portfolio (between 0.3 and 0.4). The correlations of country returns with the real *EM currency index* are generally higher than their correlations with the real *Major currency index*, except for Brazil and Colombia. Malaysia, Philippines and Thailand have the highest correlation with the real *EM currency index* (between 0.25 and 0.37).

Table 2 reports summary statistics for the real bilateral exchange rates computed for the nine emerging markets. In general, Latin American countries show larger variations in the changes in real bilateral exchange rates. The test for normality is also strongly rejected in the exchange rate series in all countries, while autocorrelation levels are high only for Columbia, Korea and Mexico. In terms of correlation of exchange rate changes with the countries excess returns, Korea, Malaysia and Mexico have the highest correlation (around 0.5) followed by Thailand with a 0.3 correlation coefficient.

Table 3 contains summary statistics for the instruments used to describe the conditioning information set of the investor. The choice of the global information variables is mainly drawn from previous empirical literature such as De Santis and Gerard (1998) and Dumas and Solnik (1995) to facilitate comparison. The set of global instruments includes a constant, the world dividend yield in excess of the risk-free rate (XWDY), the change in the US term premium spread (ΔUSTP) and the US default premium spread (USDP). The world dividend yield is the dividend yield on the world equity index available from DataStream. The term premium spread is computed from the yield on the ten-year US Treasury notes in excess of the yield on the three-month bills, both available from the Federal Reserve Board (FRB). The default spread is measured by the difference between Moody’s Baa-rated and Aaa-rated corporate bonds also available from the FRB. All variables are used with one-month lag relative to the equities excess returns and the risk factors.

As for the local information set, we rely on the work of Harvey (1991) and Bekaert and Harvey (1995). We use a predetermined selection of country-specific variables which includes: a constant, the local market dividend yield in excess of the risk free rate (LCDY), the lagged local market excess return (LagRet), and the change in local inflation rate (ΔLCinf). Data on local market dividend yield are from the S&P/IFC Emerging Market Database. Local inflation rates are computed from the log change in the countries CPIs obtained from the International Monetary Fund's *International Financial Statistics*.

5. Empirical Results

5.1. Exchange Risk Pricing Under Full Integration

We first estimate model (2) where only the world market and exchange rate factors are priced. This is the base case and can be interpreted as a test of the conditional IAPM of Adler and Dumas (1983) in equation (1), under the assumption of full integration and PPP deviations. Since we are interested in the question of whether currency risks are truly global, we always include the US asset in our estimations.

We estimate a system of six country returns (Brazil, Chile, Korea, Mexico, Thailand and the US), two exchange rate indices (EM and Major currencies) and the world market return where the prices of risk are constant.[21] We find that neither world risk nor currency risks are priced. The findings of Dumas and Solnik (1995) and De Santis and Gerard (1998) on the importance of conditioning information are thus confirmed for a sample of emerging markets.

Table 4 summarizes the results for the previous system of assets with time-varying prices of risk. Consistent with previous evidence for developed markets, we find that *Major currency risk* is priced. There is also evidence that the price of *EM currency risk* is statistically different from zero and significantly time-varying. The hypothesis of constant prices for the two currency risk factors is rejected at the 1% level. On the other hand, there

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[21] We use a subset of countries with the longest available data series.

is no strong evidence on the time-variation of the price of global market risk. Diagnostics are provided in panel C. There is evidence that GARCH effects have been removed by the specification and the non-normality in the data is reduced although not eliminated. This supports our use of robust tests for inference. We also provide statistics for the presence of negative and positive asymmetry. The results indicate that for the vast majority of the countries the estimated residuals show no asymmetry.

We report the graphs of the estimated prices of risk and the corresponding risk premia in Figure 1 and Panel A of Figure 2, respectively. The average price for both sources of currency risk is negative and quite similar in size, -2.67 for the major currencies and –2.94 for the EM currencies. Their size is also consistent with previously reported prices of exchange rate risk estimated from developed markets data. Looking at the risk premia, we note some important cross-country variations in the relative sizes of world market versus exchange risk premia. Unlike the US market where the world market premium is the most important, most emerging markets show larger premia linked to the exchange risk factor, particularly with respect to the risk of *EM currency index*. It is also evident that total currency premia are negative on average over the whole sample and this conforms to the belief that the hedging component in currency premia is predominant.[22] Interestingly, over the Nineties, the EM currency premium is positive for all assets. This might be indication that in this period characterized by persistent depreciations, the hedging component is not as important and investors require positive compensation from taking on risk attached to EM currencies.

Table 5 reports the estimated premia as percentages of the absolute total premium. From the table we infer that total currency premia are also economically significant as on average they represent 14 percent of the total premium in absolute terms across all assets. Looking only at emerging markets, we find that for all of them, except Korea, the average contribution of the currency component is larger, reaching almost 20 percent in the case of Chile and Thailand. When we focus on the two elements of the total currency premium, it is evident that for emerging markets the largest portion is represented by the EM currency premium component, while the Major currency premium component represents the largest

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[22] However, since total currency premia are smaller than the market premium, the total premium is positive on average.

part for the world market portfolio. Currency risk is the smallest in the case of the US, which is the reference currency, a finding similar to De Santis and Gerard (1998). Interesting insights can be obtained when we investigate premia over subsamples. We report statistics for two decades, the Jan. 1976 – Dec. 1985 subsample that includes the Latin American debt crisis, and the Jan. 1991 – Dec. 2000 subsample that includes a large number of currency crisis, from the Tequila crisis in Mexico in 1994, to the Asian crisis in 1997, to the Russian default of 1998 and the Brazilian real devaluation in 1999. It is evident that the size of the currency premium widens at times and over subperiods it can represent up to 50 percent of the total premium, such as in the case of Chile. In the five-year period between the two sub-samples characterized by the large depreciation of the dollar in real terms, we find that the Major currency premium component is significantly larger than its sample average, representing 17 percent of the total.

To further enhance our understanding on the relevance of global currency risks, we estimate a multi-country model with the four largest financial markets plus Mexico and Korea.[23] The evidence that we obtain is qualitatively similar. The specification tests show that world risk is now marginally significant while currency risk is priced at any statistical level, confirming the global significance of *EM currency risk* also in a system that accounts for fewer EM assets. For this set of countries, we also conduct a likelihood ratio test between an unrestricted model with two currency premia and a model that excludes the currency premium from the EM currencies. The restricted model is rejected in favor of the unrestricted model with a p-value of 0.007. Total currency premia represent on average over the whole period almost 15 percent of total absolute premium across all assets. Interestingly, even for developed market assets, the premium attached to EM currencies is of significant size when we compute it over subperiods. The EM currency component is indeed as important as the Major currency component over the 76-85 period and the 91-00 period, while the Major currency component is larger during the dollar depreciation period.[24]

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[23] These are Germany, Japan, UK and the US, the same countries as in Dumas and Solnik (1995) and De Santis and Gerard (1998).

[24] We do not report detailed results since they are in line with previously reported evidence, but they are available from the authors upon request.

Overall, these results confirm those of previous studies for developed markets and, most importantly, offer initial evidence that financial assets worldwide provide compensation not only for the risk of major currencies but also for currency risk of smaller financial markets.

5.2. Exchange Risk Pricing Under Partial Integration

The statistical significance and the size of the currency premium could be due to the failure to include local market risk premia. That is, the time-varying risk premium for emerging markets could be attributed to the importance of a local component of systematic risk rather than a risk premium attached to currencies. To shed light on this issue we estimate a conditional IAPM with time-varying prices of world and exchange risk and we include local risk. Although this specification is not based on an explicit theoretical model, the factors are motivated by widely used IAPMs and past empirical findings as explained in section 3. Thus, in the absence of a formal model, we follow the established econometric tradition.

We first estimate a multivariate system for Brazil, Chile, Korea, Mexico, Thailand and the US but we add a constant price of local risk for each EM country return. The evidence on the significance of currency risk is unchanged. Overall, currency risk is the most relevant global source of risk since world risk is still marginally significant. Both currency groups are priced. When we look at the significance of local pricing, we cannot reject the hypothesis that the prices of domestic risk are jointly equal to zero. In particular, we find that the individual p-values for the prices of local risks are, respectively, 0.5983 for Brazil, 0.1782 for Chile, 0.8199 for Mexico, 0.2997 for Korea and 0.9614 for Thailand.

This evidence on constant country-specific risk is similar to the findings in De Santis and Gerard (1998) on the four largest world financial markets and in De Santis and Imrohoroglu (1997) on a sample of emerging markets. However, we know that often risk is priced only in a conditional framework. Hence, we next estimate the full model with equation (3) that includes a time-varying price of local market risk for each EM country. Since estimation of a large multi-country system with time-varying prices for all sources of risk is very difficult, we investigate this issue within a smaller setting to reduce the dimensionality of the problem. This will also allow us to test for the significance of EM currencies risk using real bilateral exchange rate measures to capture the effects of a country's own currency risk on its equities.[25]

We conduct separate estimations for each country in our sample within a reduced system that includes five assets: the EM country, the US, the world and two currency factors: the *Major currency risk* and the local currency risk measured by the real bilateral exchange rate of the country's currency with respect to the US dollar (the reference currency).[26] This test using bilateral exchange rates is important for at least two reasons. First, since some previous studies on currency risk pricing used bilateral exchange rates [e.g. Dumas and Solnik (1995), De Santis and Gerard (1998), and Philaktis and Ravazzolo (2004) for Asian EMs], it is interesting to know whether our previous results on the importance *EM currency risk* are sensitive to the choice of exchange rate measures. Second, the significance of the local factor in the partial integration model could reflect the importance of the local currency risk factor that is undermined by using an aggregate exchange rate measure for EM currencies. It is therefore important to isolate the effect of the local currency factor from the broader country-specific factor and determine the relative importance of the risk premia associated to these factors.

Table 6 reports the results of this partial integration model which includes besides the world and the Major currency risk factors the local market risk as well as the local currency risk for each emerging market.[27] Unlike the results with constant price of local risk, we find that the time-varying price of local market risk is highly significant for Chile, Colombia, Korea, Mexico and Philippines, marginally significant for Thailand, but not significant for Brazil, India and Malaysia. Among these countries, it is interesting to note that Chile and Korea showed no significant country-specific risk in the constant price specification.

The local currency risk is also significant for Chile, Colombia, Korea and Philippines and for these countries it is not subsumed by the significance of the local

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[25] Estimating exchange rate risk with bilateral exchange rates within a system with a large number of assets would be unmanageable, as it would imply inclusion of at least n-1 exchange rate premia for n assets.

[26] For the last four assets we use the same pricing equation as in (2).

market risk. On the other hand, the significance level of the *Major currency risk* is affected by the introduction of the bilateral rate and local risk factor as we find that overall the price of currency risk is now significant for five countries. Finally, the price of world market risk remains significant in all cases except Mexico[28]. Therefore, even within smaller systems that account for local risk, currency risk enters significantly as a global pricing factor.

Table 8 reports estimated risk premia as percentages of the absolute total premium for the partial integration model estimated above. We find that although local risk represents on average the most important component of the total risk premium for emerging markets, total currency premia still represent about 21 percent of total premium for emerging market assets. One might assume that in the absence of a local factor, the currency factor might proxy for local risk and thus its size would be significantly reduced in a model with local risk. However, this is clearly not the case, since *EM currency risk* remains an important component even after accounting for local risk. When we investigate premia over subsamples, it is evident that the size of the *EM currency premium* widens at times and over subperiods it can represent almost 40 percent of the total premium, such as in the case of Colombia, Malaysia and Thailand in the Nineties, while in Mexico it accounts for over 50% of the total premium during the subperiod that covers the Latin American debt crisis. Total currency premia can often be as large as the world risk premium. The magnitude of the *Major currency premium* is also larger over sub-samples, implying that at times EM assets provide sizable compensation for currency risk also to developed markets investors. As before, we find that overall this component of the currency premium is larger during the period of the real dollar depreciation of the second half of the Eighties.

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[27] Given the importance of the major currencies as a global risk factor documented in previous studies, we keep the *Major currency index* in the system that includes bilateral exchange rates for EM currencies.

[28] Although the evidence for Mexico is surprising, since it is expected to be one of the most integrated emerging markets, previously reported evidence on this issue is also conflicting. For example, Bekaert and Harvey (1995) show that the estimated degree of integration for Mexico is among the lowest, and Carrieri et al. (2003) find that conditional local risk is priced while global risk is not.

5.3. Robustness Checks

Given previous evidence in the literature on the sensitivity of the results with respect to the exchange rate measure, we conduct two robustness checks.

First, we re-estimate the nine systems in the previous test substituting for the real bilateral exchange rate, the change in the *EM currency index.* Overall, we find that the significance of the local market factor seems to be largely unaffected by the use of the *EM currency index* in place of the bilateral exchange rate. It is still significantly different from zero and time-varying for five countries. We also find that the price of exchange risk remains significant for most countries. When we look at the relative statistical importance of the two currency groups, the *Major currency risk* is always priced at the 10% significance level or better, while the *EM currency risk* is priced for Brazil, Chile, India, Mexico and Thailand and not priced in the case of Colombia, Korea, Malaysia and Philippines. Compared to the results in Table 6, the only differences are for Mexico and Malaysia. For Mexico, exchange rate risk is now significant, while local risk becomes insignificant. In the case of Malaysia, we observe the opposite result. Thus, for some countries, there is a link between the local risk factor and the exchange risk factor and their relative importance is affected by the exchange rate measure.

In Panel B of Figure 2, we report graphs of the risk premia estimated from this specification with the two currency indices and local risk. Note that this setting is similar to the base case of full integration except for the addition of local market risk for the EM country. Therefore, it allows us to compare the robustness of the dynamics for the currency risks and to evaluate the contribution of the local risk factor. Since we want to focus on the relative importance over time of the currency factors and the local factor, we omit the world risk premium.[29] We can clearly see that the pattern of both currency risk premia is consistent to that obtained for the same countries in panel A. We also observe that for most countries, the size of the local market risk premium is much higher than both the world (not shown on graphs) and the currency risk premia. Although in some cases periods of large swings in the risk premia are mostly captured by the local risk factor, we can still identify periods of crisis that are characterized by an increase in EM currency premia such as Brazil, Chile and Mexico during the Latin American debt crisis of 1982-83 and Korea and Thailand during the Asian crisis of 1997-99.

As a second check on the sensitivity of the results with respect to the exchange rate measure, we exclude the *Major currency index* from the systems of Table 6 and re-estimate the partial integration model using the bilateral exchange rates as the only currency risk factor besides the world and local risk factors. We find that the price of exchange risk remains highly significant for Mexico, Korea and Malaysia, significant but time invariant for India, marginally significant for Chile, while it is not significant for Brazil, Colombia and Thailand. Recall that for the last three countries, the exchange risk factor was significant in the previous models that include exchange risk stemming from major currencies in addition to EM currencies.[30]

These results suggest that, for some countries, the significance of currency risk can be sensitive to the choice of the exchange rate measure, and that the relevance of such risk factor relative to the local risk factor differs across countries. However, we find evidence that for the vast majority of countries, local market risk and exchange rate risk are priced separately, although in some cases it is hard to disentangle the two risk factors.[31]

In summary, the evidence reported in this section suggests that currency risk from emerging markets is a global factor since we find it to be statistically and economically significant, even after accounting for local risk.

6. Conclusions

The objective of this paper was to investigate the global pricing of exchange risk for emerging stock markets using a conditional international asset pricing model that allows for partial integration. To our knowledge, this is the first test for EMs that takes into account both exchange rate risk and local market risk with time-varying prices in addition

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[29] We only report plots of those countries included in the multi-country system of table 4. Graphs for the other countries of table 6 show similar dynamics with large swings in both currency and local risks over some crisis periods for EMs. They are available on request.

[30] In all our robustness checks, the price of world market risk is always significant for all countries.

[31] For example, Bailey and Chung (1995) find that, in the context of Mexico, it may be difficult to separate inflation, currency and political factors.

to the time-varying price of global market risk. This model specification is the most appropriate in the case of EMs because testing for exchange risk pricing using an ICAPM assuming fully integrated markets may result in a spurious significance of the exchange rate risk due to the missing local risk factor. Since inflation rates are high and volatile in EMs, real exchange rates provide a better proxy for PPP deviations since they capture both inflation and nominal exchange rate risk. Thus, in addition to using an empirical model that allows for partial integration, we also use real exchange rates.

Our analysis establishes the importance of currency risk as a global pricing factor, even after accounting for local risk. We find evidence that emerging market assets do provide compensation for PPP deviations to global investors. Our empirical results support the hypothesis of a significant price of exchange risk for emerging stock markets, in addition to the exchange rate risk of developed markets. The price of exchange risk is also significantly time-varying, which is consistent with previous evidence for major developed markets. While on average total currency premia represent about 14 percent of the total premium in absolute terms, over subperiods the total exchange risk premium increases for all global assets and more than double for some emerging market assets. When we include local risk, currency risk still represents a significant portion of total premium.

The results also suggest that the use of an IAPM without exchange risk (local risk) may be misspecified even when the model includes both global and local (exchange) risk factors. This is because, the significance of the local risk factor may be overestimated since it may subsume the missing exchange risk factor or vice versa. When we estimate a model that accounts for both risks, we find that at times the contribution of currency risk to total premia can be as large as that of local risk. Thus, disentangling these two risks is clearly important for the investment and risk management decisions of portfolio investors or companies interested in foreign direct investment, particularly in emerging markets.

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Table 1. Summary Statistics of Asset Excess Returns

All country returns are in US dollar and in percent per month, computed in continuous time and in excess of the one-month Eurodollar interest rate. The sample period is from January 1976 to December 2000 for Brazil, Chile, India, Korea, Mexico and Thailand, and from January 1985 to December 2000 for Colombia, Malaysia and Philippines. The test for kurtosis coefficient has been normalized to zero. B-J is the Bera-Jarque test for normality based on excess skewness and kurtosis. Q is the Ljung-Box test for autocorrelation of order 12 for the excess returns and the excess returns squared.

Panel A: Summary Statistics

	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Brazil	0.122	15.88	-0.45**	3.05**	120.9**	13.38	46.89**
Chile	1.163	9.93	0.31*	1.92**	48.61**	50.16**	41.94**
Colombia	0.767	8.65	0.69**	2.02**	44.76**	43.53**	111.29**
India	0.301	7.92	0.21	0.95**	12.60**	13.13	58.09**
Korea	0.072	10.70	0.41**	3.15**	126.43**	12.95	136.85**
Malaysia	-0.288	10.27	-0.17	3.36**	84.77**	34.84**	100.32**
Mexico	0.470	13.29	-2.04**	9.92**	1390.3**	29.11**	31.74**
Philippines	0.833	10.89	0.04	1.91**	26.96**	30.82**	9.80
Thailand	-0.100	10.30	-0.49**	3.31**	142.64**	48.89**	182.89**
USA	0.528	4.30	-0.82**	3.81**	207.39**	9.31	6.64
MSCI World	0.443	4.03	-0.73**	2.32**	89.99**	12.41	7.61
Real *EM currency index*	-0.086	1.17	-1.31**	4.88**	369.91**	33.16**	54.17**
Real *Major currency index*	-0.026	1.73	0.20	0.32	3.12	40.01**	8.92

** and * significant at 1% and 5% level respectively

Panel B: Cross-correlations

	Bra	Chl	Col	Ind	Kor	Mal	Mex	Phi	Tha	USA	Word	EM	Major
Brazil	1.00												
Chile	0.12	1.00											
Colombia	0.13	0.22	1.00										
India	0.07	0.16	0.02	1.00									
Korea	0.08	0.13	0.09	0.08	1.00								
Malaysia	0.14	0.35	0.09	0.14	0.27	1.00							
Mexico	0.11	0.23	0.09	0.09	0.15	0.35	1.00						
Philippines	0.18	0.37	0.19	0.05	0.30	0.52	0.22	1.00					
Thailand	0.09	0.23	0.11	0.14	0.36	0.65	0.26	0.56	1.00				
USA	0.15	0.13	0.11	0.02	0.22	0.44	0.35	0.34	0.30	1.00			
MSCI World	0.19	0.14	0.11	0.04	0.31	0.43	0.32	0.41	0.34	0.82	1.00		
Real *EM currency index*	0.02	0.18	0.07	0.16	0.12	0.37	0.18	0.31	0.25	0.06	0.11	1.00	
Real *Major currency index*	0.09	0.01	0.14	0.09	0.10	0.10	-0.06	0.16	0.13	0.10	0.32	0.19	1.00

Table 2. Summary Statistics for Real Bilateral Exchange Rates

In this table, we report the statistics about the changes in the real bilateral exchange rates for each country. All rates are computed in continuous time and expressed in percent per month. The sample period is from January 1976 to December 2000 for Chile, India, Korea, Mexico and Thailand; January 1980 to December 2000 for Brazil, and January 1985 to December 2000 for Colombia, Malaysia and Philippines. The test for kurtosis coefficient has been normalized to zero. B-J is the Bera-jarque test for normality based on excess skewness and kurtosis. Q is the Ljung-Box test for autocorrelation of order 12.

Panel A: Summary Statistics

	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Brazil	-0.103	5.20	-2.98**	36.66**	13907**	17.63	3.91
Chile	-0.114	3.99	-7.26**	94.85**	111331**	14.51	1.70
Colombia	-0.173	2.29	0.70**	8.78**	596.6**	86.11**	4.54
India	-0.278	2.31	-2.77**	19.26**	4854**	8.70	0.74
Korea	-0.087	3.20	-4.72**	55.20**	37918**	28.19**	57.27**
Malaysia	-0.259	2.82	1.69**	30.37**	7075**	9.49	61.11**
Mexico	-0.043	6.47	-5.31**	40.16**	20876**	29.16**	32.31**
Philippines	-0.334	2.04	-3.31**	13.85**	1794**	9.91	5.76
Thailand	-0.191	2.99	-0.57**	32.52**	12784**	23.63*	110.43**

** and * denote statistical significance at the 1% and 5% levels respectively.

Panel B: correlations with the countries excess returns

	Brazil	Chile	Colombia	India	Korea	Malaysia	Mexico	Philippines	Thailand
$Corr(r_i, e^r_i)$	0.130	0.247	0.193	0.163	0.487	0.507	0.494	0.081	0.303
$Corr(r_i, e_i)$	0.144	0.203	0.162	0.223	0.493	0.494	0.459	0.060	0.322

r_i is the country's excess return;
e^r_i and e_i are the changes in the country's real and nominal exchange rates respectively.

Table 3. Summary Statistics of the Information Variables

The global information set includes a constant, the world dividend yield in excess of the one-month eurodollar rate (XWDY), the change in the US term premium (ΔUSTP) and the US default premium (USDP). The local information set for each country includes a constant, the local market dividend yield in excess of the one-month eurodollar rate (XLDY), the lagged excess market return (LagRet) and the change in the local inflation rate (ΔLCinf). All variables are in percent per month and are used with one month lag with respect to the returns series.

Panel A: Global information variables

	Mean	Std.Dev.	Pairwise correlations		
XWDY	-0.4023	0.2349	1.0000	0.0870	-0.5330
ΔUSTP	-0.0098	0.4689		1.0000	0.1370
USDP	1.0986	0.4616			1.0000

Panel B: Local information variables

		Mean	Std.Dev.	Pairwise correlations	
XLDY				with LagRet	with ΔLCinf.
	Brazil	-0.1929	0.2621	-0.2759	-0.0830
	Chile	-0.2485	0.2938	0.0905	-0.0180
	Colombia	-0.1325	0.2167	0.1497	0.0252
	India	-0.4376	0.2384	0.0011	-0.0181
	Korea	-0.3489	0.2351	-0.0043	0.0235
	Malaysia	-0.3313	0.1446	-0.0129	-0.0346
	Mexico	-0.3102	0.3315	-0.0319	0.0547
	Philippines	-0.3781	0.1320	0.1234	-0.0118
	Thailand	-0.2296	0.2275	0.0202	0.0296
ΔLCinf.					
	Brazil	0.0010	3.9901	-0.2081	
	Chile	-0.0218	2.0718	-0.0412	
	Colombia	-0.0087	0.8282	0.0752	
	India	0.0104	0.9196	-0.0840	
	Korea	-0.0014	0.7780	-0.0649	
	Malaysia	0.0031	0.4242	0.1041	
	Mexico	0.0002	1.1950	-0.1834	
	Philippines	-0.0139	0.9800	0.0489	
	Thailand	0.0007	0.7826	0.0167	

Table 4. QML Estimates of the Conditional IAPM with Time Varying Prices of World and Currency Risk

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The estimated model is:

$$r_{it} = \delta_{w,t-1}\operatorname{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{em,t-1}\operatorname{cov}_{t-1}(r_{it}, r_{emt}) + \delta_{mj,t-1}\operatorname{cov}_{t-1}(r_{it}, r_{mjt}) + \varepsilon_{it} \quad i{=}1...N \ \ (N{=}9 \text{ assets})$$

$$\text{where } \begin{cases} \delta_{w,t-1} = \exp(k'_w Z_{t-1}) \\ \delta_{em,t-1} = k'_{em} Z_{t-1} \\ \delta_{mj,t-1} = k'_{mj} Z_{t-1} \\ \varepsilon_t \left| \Im_{t-1} \sim N(0, H_t) \right. \end{cases}$$

where r_i is the excess return on asset *i*, r_{em} is the change in the real *EM currency index*; r_{mj} is the change in the real *Major currency index*, and r_w is the excess return on the world portfolio;
Z is a set of global information variables, which includes a constant, the world dividend yield in excess of the risk free rate (XWDY), the change in the term structure spread (ΔUSTP) and the default spread (USDP).

The conditional covariance matrix H_t is parameterized as follows:

$$H_t = H_0 * (ii' - aa' - bb) + aa' * \varepsilon_{t-1}\varepsilon'_{t-1} + bb' * H_{t-1}$$

where * denotes the Hadamard matrix product, a and b are 9×1 vectors of unknown parameters estimated jointly with the risk premia parameters, and *i* is a *9x1* vector of ones.

Panel A: Parameters Estimates

	k_w			k_{em}			k_{mj}		
	Estim.	std.err.	*p*-value	estim.	std.err.	*p*-value	estim.	std.err.	*p*-value
Const	-2.8414	1.0786	0.0084	0.2726	0.1411	0.0532	-0.0186	0.0974	0.8482
XWDY	2.3274	1.0937	0.0334	0.0780	0.3501	0.8238	0.5957	0.1942	0.0022
ΔUSTP	-1.1329	1.0775	0.2930	0.2665	0.1612	0.0982	-0.1294	0.0877	0.1400
USDP	0.3412	1.1878	0.7740	-0.2440	0.1722	0.1566	0.2096	0.1153	0.0690

All GARCH parameters are significant and satisfy the stationarity condition.

Panel B: Specification Tests

Null hypothesis	χ^2	df	*p*-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0 \ \forall j > 1$	6.1070	3	0.1065
(2) Is the price of real *EM currency* risk equal to zero? $H_0 : k_{em,j} = 0 \ \forall j$	12.0959	4	0.0167
(3) Is the price of real *EM currency* risk constant? $H_0 : k_{em,j} = 0 \ \forall j > 1$	12.0951	3	0.0071
(4) Is the price of real *Major currency* risk equal to zero? $H_0 : k_{mj,j} = 0 \ \forall j$	10.1030	4	0.0387
(5)) Is the price of real *Major currency* risk constant? $H_0 : k_{mj,j} = 0 \ \forall j > 1$	9.8030	3	0.0203
(6) Are the prices of all currencies risk equal to zero? $H_0 : k_{em,j} = k_{mj,j} = 0 \ \forall j$	19.8501	8	0.0109
(7) Are the prices of all currencies risk constant? $H_0 : k_{em,j} = k_{mj,j} = 0 \ \forall j > 1$	19.6693	6	0.0032
Likelihood function		-8146.92	

Panel C: Diagnostics Tests for Residuals

	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Brazil	-0.32*	1.59**	9.22	13.67
Chile	-0.11	1.62**	36.91**	15.51
Korea	-1.44**	4.76**	12.45	12.54
Mexico	0.22	1.65**	23.46*	13.33
Thailand	-0.47**	2.74**	40.97**	29.47**
USA	-0.79**	3.59**	10.20	5.37
EM currency index	-1.27**	4.38**	24.76*	8.23
Major currency index	0.32*	0.43	33.22**	7.11
World	-0.70**	2.30**	14.82	5.36

[a] Ljung-Box test statistic for residuals and residuals squared.

** and * denote statistical significance at the 1% and 5% levels respectively.

Table 5. Estimated Risk Premia

This table contains averages for the risk premia estimated from the full integration model in Table 4. The averages are percentages of the total absolute premium. We report the world market risk premium (WMP), the emerging market currencies risk premium (EMCP) and the major currencies premium (MJCP).

	WMP	EMCP	MJCP	WMP	EMCP	MJCP	WMP	EMCP	MJCP
	all sample			Jan 76 - Dec 85			Jan 91 - Dec 00		
Brazil	84.4%	3.5%	12.1%	83.0%	6.3%	10.7%	92.9%	4.3%	2.9%
Chile	80.6	17.0	2.4	41.9	56.6	1.5	65.2	31.5	3.3
Mexico	83.2	11.7	5.1	61.7	36.1	2.2	80.0	17.5	2.5
Korea	89.4	4.2	6.4	70.1	27.3	2.7	77.9	17.2	4.8
Thailand	81.3	9.9	8.8	51.3	43.3	5.4	68.3	24.8	6.9
USA	96.1	1.7	2.2	92.2	5.9	1.9	95.8	2.4	1.8
World	90.0	2.8	7.2	84.4	9.8	5.8	91.6	4.4	4.0
average	86.4	7.3	6.3	69.2	26.5	4.3	81.7	14.6	3.7
avg. among EMs	83.8	9.3	7.0	61.6	33.9	4.5	76.9	19.0	4.1

Table 6. Hypotheses Testing of the Partial Integration Model with T.V. Prices of World, Currency and Domestic Risk

- using real bilateral exchange rates and *Major currency index* -

The estimated model is:

$$r_{it} = \delta_{w,t-1}\operatorname{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{ci,t-1}\operatorname{cov}_{t-1}(r_{it}, r_{cit}) + \delta_{mj,t-1}\operatorname{cov}_{t-1}(r_{it}, r_{mjt}) + \delta_{i,t-1}\operatorname{var}_{t-1}(r_{it}) + \varepsilon_{it}$$

$$\text{where} \begin{cases} \delta_{w,t-1} = \exp(k'_w Z_{t-1}) \\ \delta_{ci,t-1} = k'_{c1} Z_{t-1} \\ \delta_{mj,t-1} = k'_{c2} Z_{t-1} \\ \delta_{i,t-1} = k'_d Z_{i,t-1} \\ \varepsilon_t \big| \Im_{t-1} \sim N(0, H_t) \end{cases}$$

where r_i is the excess return on asset *i*, r_{cit} is the change in the real bilateral exchange rate of the local currency of country *i* with respect to the dollar; r_{mj} is the change in the real *Major currency index*, r_w is the excess return on the world market portfolio; *Z* is a set of global information variables (same as in previous model); Z_i is a set of local information variables (specific to country *i*) which includes a constant, the local market dividend yield in excess of the eurodollar rate (XLDY), the local market lagged excess return (LAGRet), and the change in the local inflation rate (ΔLCinf).

$H_t = H_0 * (u' - aa' - bb) + aa' * \varepsilon_{t-1}\varepsilon'_{t-1} + bb' * H_{t-1}$; where *a* and *b* are 5×1 vectors of unknown parameters.

Panel A: Specification Tests

	BRAZIL			CHILE			COLOMBIA		
Null hypothesis	χ^2	df	*p*-value	χ^2	df	*p*-value	χ^2	df	*p*-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0 \ \forall j > 1$	13.3412	3	0.0040	12.1663	3	0.0068	9.0554	3	0.0286
(2) Is the price of real bilateral XR risk equal to zero? $H_0 : k_{c1,j} = 0 \ \forall j$	1.3475	4	0.8533	9.3732	4	0.0524	148.2758	4	0.0000
(3) Is the price of real bilateral XR risk constant? $H_0 : k_{c1,j} = 0 \ \forall j > 1$	1.3293	3	0.7222	6.3340	3	0.0964	61.9434	3	0.0000
(4) Is the price of real Major currency risk equal zero? $H_0 : k_{c2,j} = 0 \ \forall j$	4.5142	4	0.3409	4.9135	4	0.2963	14.8105	4	0.0051
(5) Is the price of real Major currency risk constant? $H_0 : k_{c2,j} = 0 \ \forall j > 1$	3.6010	3	0.3079	4.9108	3	0.1784	12.7680	3	0.0052
(6) Are the prices of all currencies risk equal to zero? $H_0 : \sum k_{c,j} = 0 \ \forall c, j$	6.8257	8	0.5555	14.7971	8	0.0632	209.8522	8	0.0000
(7) Are the prices of all currencies risk constant? $H_0 : \sum k_{c,j} = 0 \ \forall c, \forall j > 1$	6.1716	6	0.4043	11.9099	6	0.0640	92.7355	6	0.0000
(8) Is the price of domestic market risk equal to zero? $H_0 : k_{d,j} = 0 \ \forall j$	0.8237	4	0.9352	16.4085	4	0.0025	39.0678	4	0.0000
(9) Is the price of domestic market risk constant? $H_0 : k_{d,j} = 0 \ \forall j > 1$	0.5555	3	0.9065	16.0849	3	0.0011	39.0676	3	0.0000

Table 6. cont.

	INDIA			KOREA			MALAYSIA		
Null hypothesis	χ^2	df	*p*-value	χ^2	df	*p*-value	χ^2	df	*p*-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0 \ \forall j > 1$	18.3407	3	0.0004	12.5515	3	0.0057	11.1013	3	0.0112
(2) Is the price of real bilateral XR risk equal to zero? $H_0 : k_{c1,j} = 0 \ \forall j$	7.4389	4	0.1144	10.6102	4	0.0313	20.6165	4	0.0004
(3) Is the price of real bilateral XR risk constant? $H_0 : k_{c1,j} = 0 \ \forall j > 1$	0.0498	3	0.9971	8.0047	3	0.0459	20.5771	3	0.0001
(4) Is the price of real Major currency risk equal zero? $H_0 : k_{c2,j} = 0 \ \forall j$	5.1747	4	0.2698	11.5611	4	0.0209	10.3089	4	0.0355
(5) Is the price of real Major currency risk constant? $H_0 : k_{c2,j} = 0 \ \forall j > 1$	5.0139	3	0.1708	11.4241	3	0.0096	10.1971	3	0.0170
(6) Are the prices of all currencies risk equal to zero? $H_0 : \sum k_{c,j} = 0 \ \forall c, j$	15.3084	8	0.0534	22.0012	8	0.0049	32.0667	8	0.0001
(7) Are the prices of all currencies risk constant? $H_0 : \sum k_{c,j} = 0 \ \forall c, \forall j > 1$	5.1242	6	0.5280	19.1527	6	0.0039	27.6601	6	0.0001
(8) Is the price of domestic market risk equal to zero? $H_0 : k_{d,j} = 0 \ \forall j$	0.3616	3	0.9481	15.2101	3	0.0016	1.0878	4	0.8962
(9) Is the price of domestic market risk constant? $H_0 : k_{d,j} = 0 \ \forall j > 1$	0.2913	2	0.8645	13.7352	2	0.0010	0.5681	3	0.9037

Table 6. cont.

	MEXICO			**PHILIPPINES**			**THAILAND**		
Null hypothesis	χ^2	df	*p*-value	χ^2	df	*p*-value	χ^2	df	*p*-value
(1) Is the price of world market risk constant?									
$H_0 : k_{w,j} = 0 \; \forall j > 1$	3.0915	3	0.3777	14.4995	3	0.0023	13.7239	3	0.0033
(2) Is the price of real bilateral XR risk equal to zero?									
$H_0 : k_{c1,j} = 0 \; \forall j$	5.1700	4	0.2703	10.3489	4	0.0349	4.5179	4	0.3404
(3) Is the price of real bilateral XR risk constant?									
$H_0 : k_{c1,j} = 0 \; \forall j > 1$	3.0008	3	0.3915	1.0857	3	0.7805	3.5252	3	0.3175
(4) Is the price of real Major currency risk equal zero?									
$H_0 : k_{c2,j} = 0 \; \forall j$	8.6022	4	0.0719	11.0818	4	0.0257	9.3911	4	0.0520
(5) Is the price of real Major currency risk constant?									
$H_0 : k_{c2,j} = 0 \; \forall j > 1$	6.9689	3	0.0729	10.3171	3	0.0161	8.5828	3	0.0354
(6) Are the prices of all currencies risk equal to zero?									
$H_0 : \sum k_{c,j} = 0 \; \forall c, j$	14.2015	8	0.0767	22.3021	8	0.0044	12.9177	8	0.1147
(7) Are the prices of all currencies risk constant?									
$H_0 : \sum k_{c,j} = 0 \; \forall c, \forall j > 1$	9.7689	6	0.1347	10.7919	6	0.0950	11.5267	6	0.0734
(8) Is the price of domestic market risk equal to zero?									
$H_0 : k_{d,j} = 0 \; \forall j$	14.5893	4	0.0056	20.3783	4	0.0004	7.3556	4	0.1182
(9) Is the price of domestic market risk constant?									
$H_0 : k_{d,j} = 0 \; \forall j > 1$	13.4024	3	0.0038	20.0171	3	0.0002	7.0104	3	0.0716

Panel B: Diagnostics Tests for Residuals

	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Brazil	-0.43**	1.64**	7.84	13.14
Chile	-0.05	1.76**	14.09	10.35
Colombia	0.17	1.44**	8.87	14.45
India	0.35*	0.59*	6.51	16.83
Korea	0.07	1.13**	27.33**	25.25*
Malaysia	-0.89**	3.57**	17.65	4.94
Mexico	-1.51**	6.21**	18.23	12.19
Philippines	0.31	1.47**	8.75	8.93
Thailand	-0.16	2.29**	36.66**	16.18

[a] Ljung-Box test statistic for residuals and residuals squared.

** and * denote statistical significance at the 1% and 5% levels respectively.

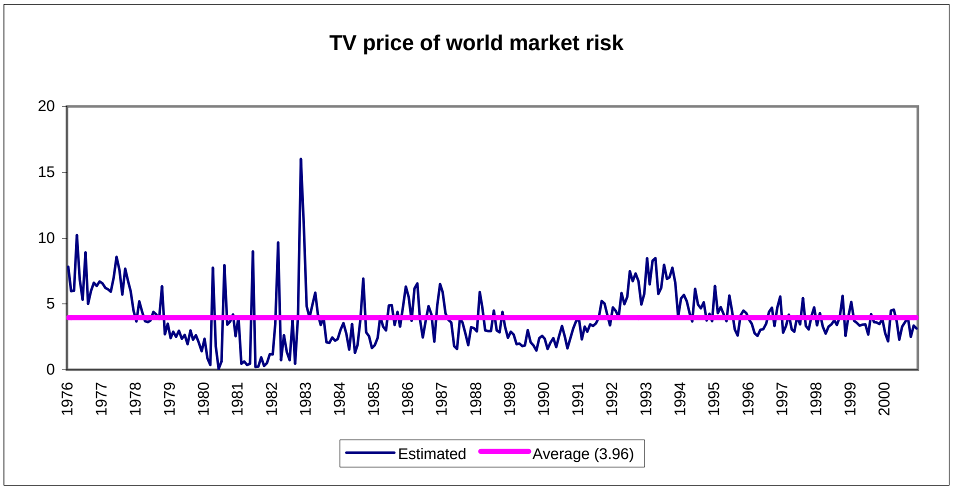
Table 7. Estimated Risk Premia

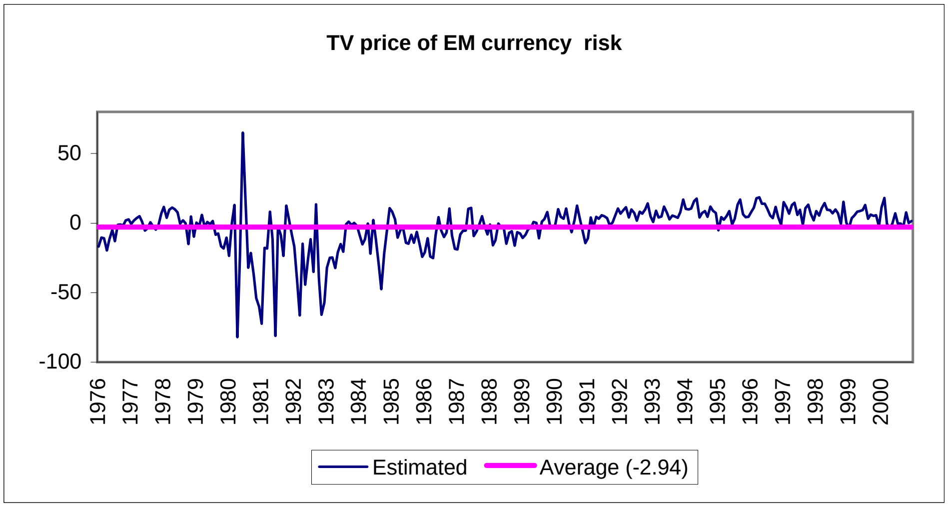
This table contains averages for the risk premia estimated from the partial integration model in Table 6. The averages are percentages of the total absolute premium. We report the world market risk premium (WMP), the emerging market currency risk premium (EMCP) which in this case refers to the premium attached to the local currency (changes in bilateral exchange rate), the major currencies premium (MJCP) and the local market risk premium (LMP).

	WMP	EMCP	MJCP	LMP	WMP	EMCP	MJCP	LMP	WMP	EMCP	MJCP	LMP
	All sample				Dec 76 - Dec 85				Jan 91 - Dec 00			
Brazil [a]	43.4%	4.5%	9.9%	42.1%	30.8%	15.9%	16.6%	36.6%	57.8%	1.3%	5.1%	35.9%
Chile	27.6	15.6	0.0	56.8	19.8	10.4	0.2	69.6	15.6	11.3	2.2	70.9
Colombia [b]	1.4	26.7	3.2	68.7	--	--	--	--	0.1	47.2	16.2	36.5
India	0.7	25.7	9.0	66.0	20.8	52.3	16.2	10.8	9.1	3.4	0.7	86.8
Korea	28.0	6.2	4.9	60.9	29.4	23.6	7.4	39.5	13.5	24.0	0.4	62.2
Malaysia [b]	54.5	7.0	2.6	36.0	--	--	--	--	24.0	38.1	6.1	31.8
Mexico	56.3	19.2	2.9	21.6	25.6	58.7	2.8	13.0	52.3	28.1	1.8	17.8
Philippines [b]	64.6	16.8	4.8	13.8	--	--	--	--	48.2	16.5	17.6	17.7
Thailand	52.0	20.3	10.5	11.3	63.2	10.0	23.5	3.2	46.6	36.8	4.6	12.0
USA [c]	96.2	0.7	3.0	--	93.3	3.1	3.6	--	96.7	2.2	1.1	--
World [c]	88.4	1.9	9.7	--	81.3	7.3	11.4	--	92.3	4.3	3.5	--
avg. among EMs	36.5	15.8	5.3	41.9	31.6	28.5	11.1	28.8	29.7	23.0	6.1	41.3

[a] sample available from Jan 80 - Dec 00 (missing data on bilateral exchange rate)
[b] sample available from Jan 85 - Dec 00
[c] as average across all nine estimated systems

Figure 1. Time Varying (TV) Prices of Risk Estimated from Full Integration Model





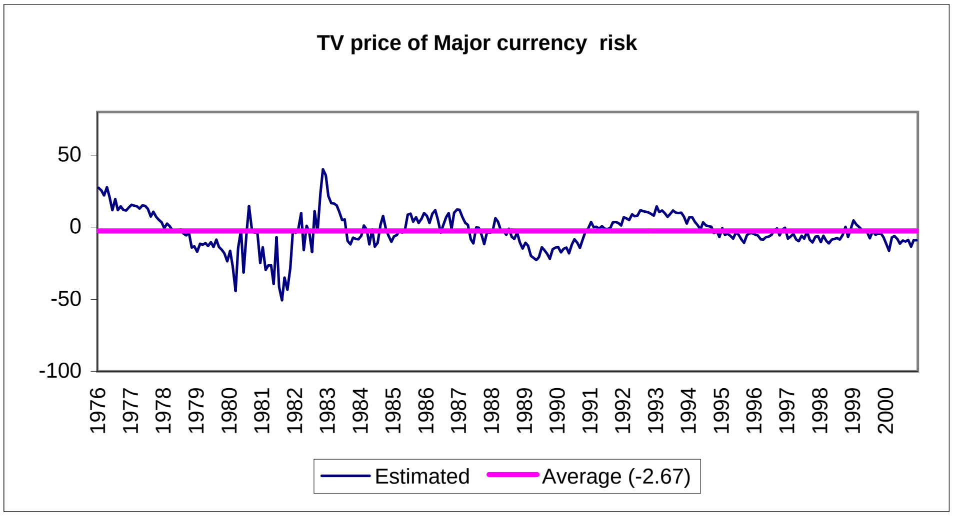
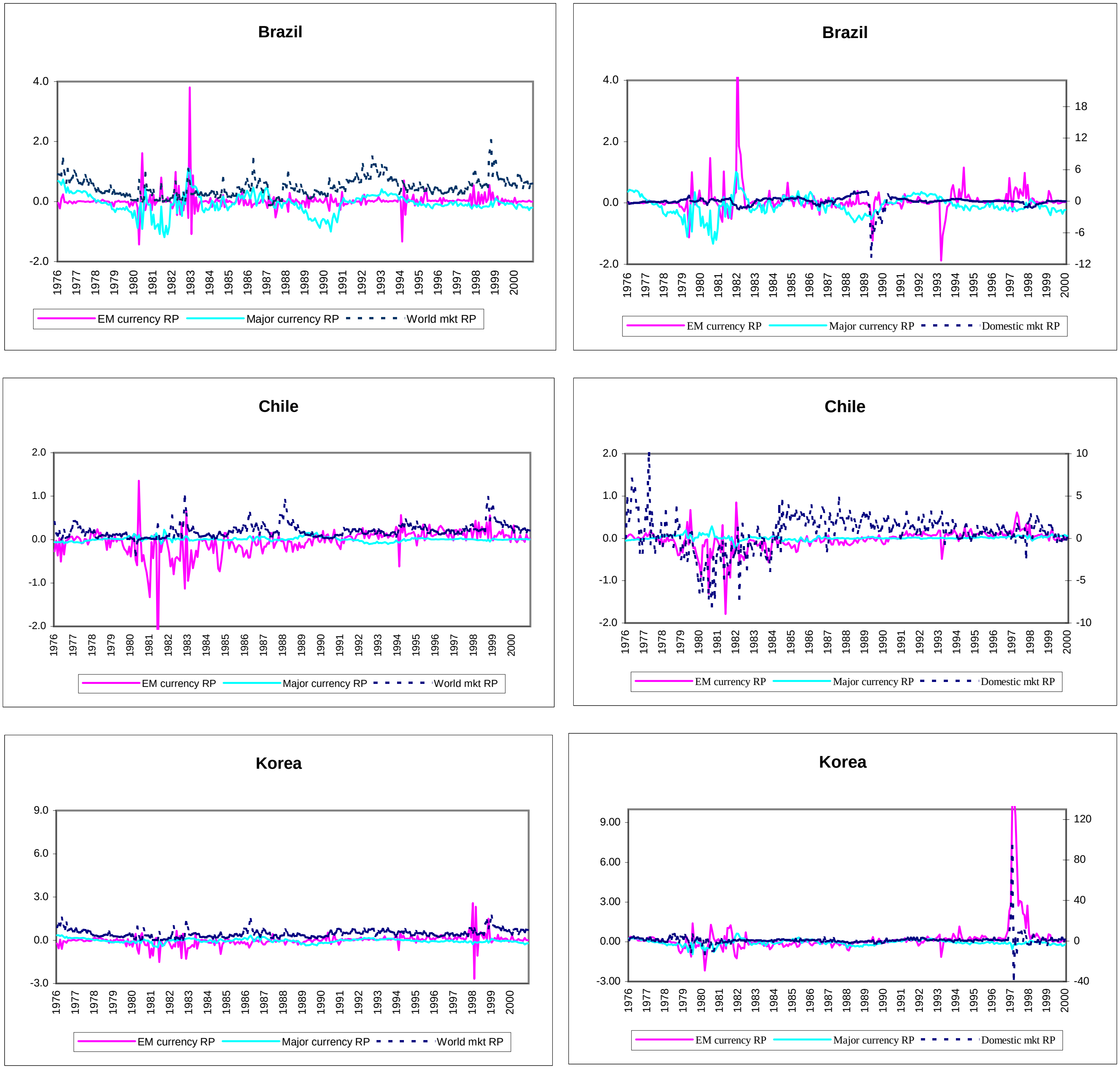


Figure 2. Estimated Risk Premia



Panel A

Full Integration Model

Panel B

Partial Integration Model*

* the domestic market RP is plotted on the right axis

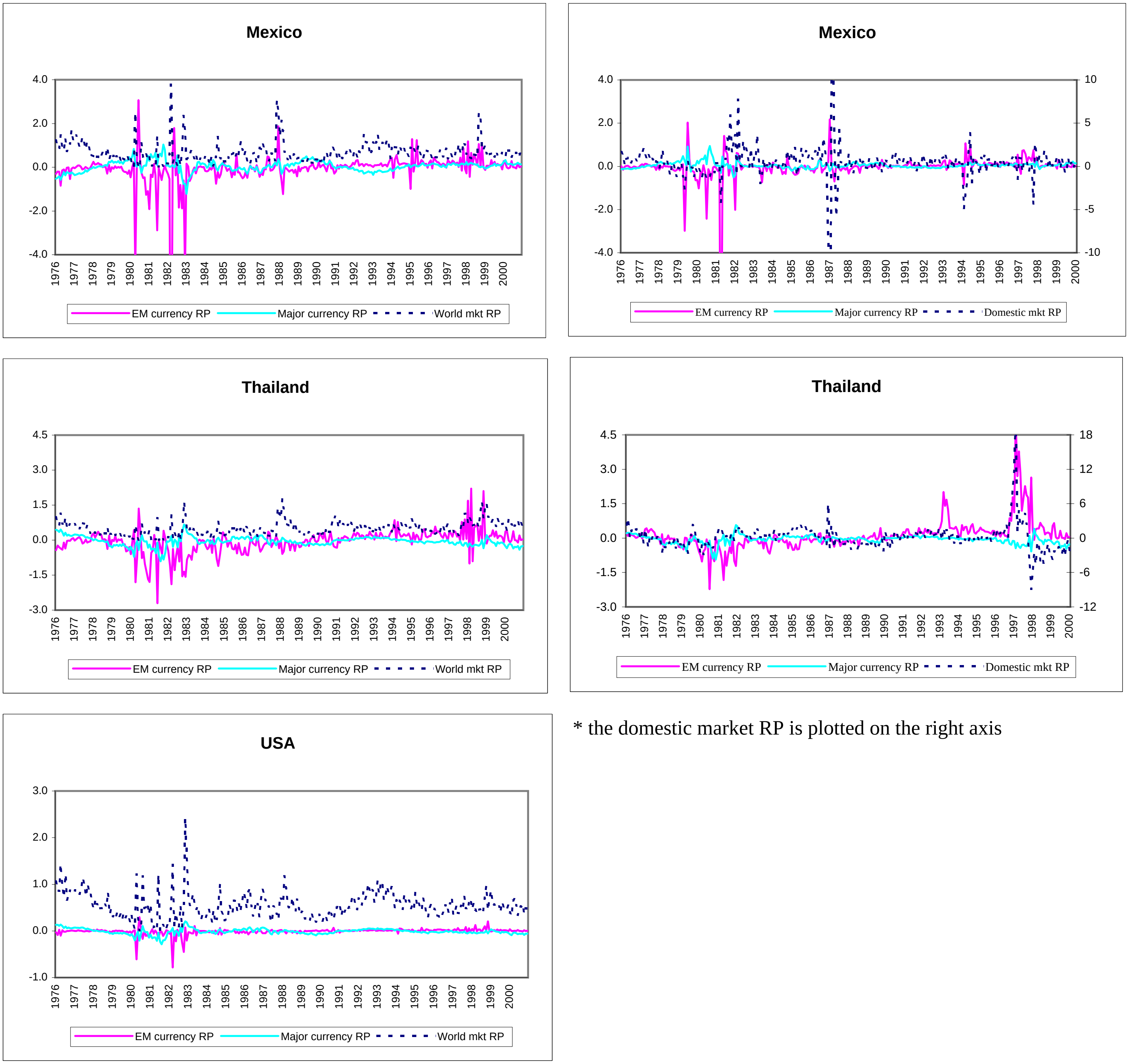
Figure 2. Estimated Risk Premia

Panel A

Full Integration Model

Panel B

Partial Integration Model *



* the domestic market RP is plotted on the right axis

Appendix 1

Explanation for the use of real exchange rates as currency risk factors

Define S_j^r as the real exchange rate of currency *j* vis-à-vis the U$

$$S_{jt}^r = S_{jt} \times \frac{P_{jt}}{P_t} \Leftrightarrow S_{jt}^r \times P_t = S_{jt} \times P_{jt}$$

where S_{jt} is the nominal exchange rate (U$/FC$_j$), P_t is the price level in the US, P_{jt} is the price level in country *j*.

We can rewrite the above equation as:

$$P_{jt}^\$ = S_{jt}^r \times P_t$$

where $P_{jt}^\$ = S_{jt} \times P_{jt}$ is the price level in country *j* expressed in the reference currency (U$).

The inflation rate of country *j* expressed in U$, referred to as $\pi_{jt}^\$$ in Adler and Dumas (1983) model, is given by:

$$\Delta \ln(P_{j,t}^\$) = \Delta \ln(P_t) + \Delta \ln(S_{j,t}^r)$$

Thus, if we assume inflation in the reference currency (i.e., the change in P_t) is non-stochastic, $\pi_{jt}^\$$ can be approximated by the change in the real exchange rate of currency *j*.

Appendix 2

The trade weighted exchange rate indices computed by the Federal Reserve Board (FRB) giving the foreign exchange value of the US$ are constructed as follows:

Nominal Index

$$I_t = I_{t-1} \prod_j (e_{jt} / e_{jt-1})^{w_{jt}}$$

Where e_{jt} is the price of the U$ in terms of foreign currency j at time t *(FC/U$)*,
and w_{jt} is the weight of currency j at time t in the total competitiveness index for the U$. According to this formulation, an increase in the index gives the appreciation / depreciation of the US$:

$$\log\left(\frac{I_t}{I_{t-1}}\right) = \sum_j w_{jt} \log\left(\frac{e_{jt}}{e_{jt-1}}\right)$$ → weighted average of the appreciation/depreciation of the US$ against all other FC_s included in a given index.

To get the change in the FC value against the dollar (as should be in the IAPM to be estimated), we can compute: $\log\left(\frac{I_{t-1}}{I_t}\right) = \sum_j w_{jt} \log\left(\frac{1/e_{jt}}{1/e_{jt-1}}\right)$

$1/e_{jt} = S_{jt}$: the exchange rate expressed in $U\$/FC_j$.

Real Index

The FRB uses the following formula to construct the real exchange rate index:

$$I_t^R = I_{t-1}^R \prod_j \left(\frac{e_{jt} P_t / P_{jt}}{e_{jt-1} P_{t-1} / P_{jt-1}}\right)^{w_{jt}}$$

Where P_t is the consumer price index (CPI) for the US at time t and P_{jt} is the CPI for country j at time t.

So the change in the real FC value against the U$ is given by $\log\left(\frac{I_{t-1}^{R}}{I_{t}^{R}}\right)$.

$$\frac{I_{t-1}^{R}}{I_{t}^{R}}=\prod_{j}\left(\frac{P_{jt}}{e_{jt}P_{t}}\bigg/\frac{P_{jt-1}}{e_{jt-1}P_{t-1}}\right)^{w_{jt}}$$ which can be written as follows:

$$\frac{I_{t-1}^{R}}{I_{t}^{R}}=\prod_{j}\left(\frac{S_{jt}P_{jt}}{P_{t}}\bigg/\frac{S_{jt-1}P_{jt-1}}{P_{t-1}}\right)^{w_{jt}}$$

define $P_{jt}^{\$}=S_{jt}P_{jt}$: the CPI in country *j* expressed in US$, then we can rewrite

$$\frac{I_{t-1}^{R}}{I_{t}^{R}}=\prod_{j}\left(\frac{P_{jt}^{\$}}{P_{t}}\bigg/\frac{P_{jt-1}^{\$}}{P_{t-1}}\right)^{w_{jt}}=\prod_{j}\left(\frac{P_{jt}^{\$}}{P_{jt-1}^{\$}}\bigg/\frac{P_{t}}{P_{t-1}}\right)^{w_{jt}}$$

$$\log\left(\frac{I_{t-1}^{R}}{I_{t}^{R}}\right)=\sum_{j}w_{jt}\left[\log\left(\frac{P_{jt}^{\$}}{P_{jt-1}^{\$}}\right)-\log\left(\frac{P_{t}}{P_{t-1}}\right)\right]=\sum_{j}w_{jt}\left[\pi_{jt}^{\$}-\pi_{t}\right]$$

where $\pi_{jt}^{\$}=\log\left(\frac{P_{jt}^{\$}}{P_{jt-1}^{\$}}\right)$ *and* $\pi_{t}=\log\left(\frac{P_{t}}{P_{t-1}}\right)$ are, respectively, the rate of inflation of country *j* expressed in U$ and the rate of inflation in the US.

Finally, we can write $\log\left(\frac{I_{t-1}^{R}}{I_{t}^{R}}\right)=\sum_{j}w_{jt}\pi_{jt}^{\$}-\pi_{t};\quad\sum_{j}w_{jt}=1$

So the (log) change in the real index represents a weighted average of the rates of inflation of countries *j* included in the index expressed in U$ minus the US inflation.

In the case of the OITP index (other important trading partners) which covers EMs currencies, it is reasonable to assume that the US inflation term is negligible relative to the other countries inflation. Therefore, we can consider the log change of the real OITP index as computed above as a fairly good approximation of the (average) inflation rates of the EMs expressed in U$.