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Local risk factors in emerging markets: Are they separately priced?

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Abstract

We provide new evidence on the pricing of local risk factors in emerging stock markets. We investigate whether there is a significant local currency premium together with a domestic market risk premium in equity returns within a partial integration asset pricing model. Given previous evidence on currency risk, we conduct empirical tests in a conditional setting with time-varying prices of risk. Our main results support the hypothesis of a significant exchange risk premium related to the local currency risk. Exchange rate and domestic market risks are priced separately for our sample of seven emerging markets. The empirical evidence also suggests that although statistically significant, local currency risk is on average smaller than domestic market risk but it increases substantially during crises periods, when it can be almost as large as market risk. Disentangling these two factors is thus important in tests of international asset pricing for emerging markets.

JEL classification: G12; G15
Keywords: International asset pricing; Currency risk; Local market risk; Emerging markets; Integration; Segmentation

1. Introduction

Many emerging markets have experienced recurrent currency crises with negative impact on their economies and stock markets. Yet, there is no comprehensive study that looks at the separate effects of local currency risk and domestic market risk on equity returns and their empirical relationship over time.

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The issue of whether exchange risk is priced in the stock market has been the subject of debate in the empirical literature with mixed evidence and sometimes contradictory results. Early theoretical models of international asset pricing (IAPM) clearly show that under deviations from purchasing power parity (PPP), exchange risk should be priced and expected stock returns include a premium for bearing foreign exchange risk [see, for example, Stulz (1981) and Adler and Dumas (1983) as well as the review by Karolyi and Stulz (2002)]. Attempts to test such IAPMs in an unconditional setting were inconclusive.[1] However, using a conditional framework, studies such as Dumas and Solnik (1995) and De Santis and Gerard (1998) provide stronger evidence that foreign exchange risk is priced in major developed stock markets.[2] However, such evidence is not sufficient to conclude that exchange risk is a relevant pricing factor for equities in different market environments, such as emerging markets (EMs) where other sources of local risk could be more important.

Since there is significant evidence suggesting that expected returns in emerging markets are more likely to be affected by local rather than global risk factors, in this study, we attempt to assess the relative importance of local exchange risk pricing versus local market risk.[3] Although risk from bilateral exchange rates of smaller currencies can be empirically small in an integrated world, it might be more relevant when viewed from a local EM perspective. The large impact of currency crises on emerging markets may indeed result in a significant and/or large exchange risk premium for these assets. However, such significance could be due to a model specification that ignores the effects of other competing sources of risk or it might suggest that exchange risk is separately priced from market risk. Thus, the goal of this paper is to enhance our understanding of the respective role of country-specific risk factors in explaining emerging market equity returns.

To date, the literature that focuses on exchange risk related to emerging market currencies and their impact on equity returns is very sparse. Bailey and Chung (1995) find evidence that Mexico's equity market premia are related to risk premia in the currency market. Carrieri, Errunza and Majerbi (in press-a) look at the impact of an aggregate measure of emerging market currencies on global risk pricing in both developed and emerging equity markets. They find that exchange risk stemming from emerging market currencies is significantly priced in global equity returns and that information about emerging market crisis episodes affect the prices of global risk factors. These results however do not shed light on the relative importance of EM currencies in local risk pricing of equities in these markets, in particular if we allow the pricing model to account for local market volatility on a country-by-country basis.

To our knowledge, only two empirical studies have looked specifically at the role of exchange risk stemming from local bilateral exchange rates in pricing emerging market equities. Phylaktis and Ravazzolo (2004) provide evidence within a dynamic integration framework that a model with a local currency factor is superior to a model without exchange risk for a number of Pacific Basin markets. However, in their setting, the local exchange risk competes with the country-specific market risk only in the period before the liberalization and not thereafter. Carrieri and

[1] For example, Hamao (1988) and Jorion (1991) found no evidence that exchange risk is priced on the Japanese and US stock markets respectively. More recently, 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.

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

[3] See for example, Harvey (1995) and Carrieri, Errunza and Hogan (in press-b).

Majerbi (2006) estimate a partial integration model in an unconditional setting with global and local risk factors for the largest emerging markets in Asia and Latin America. They show that both local and global measures of exchange risk are subsumed by local market risk, particularly at the market level data, despite a highly significant exchange risk factor documented when the model does not account for local market risk. This suggests that exchange risk and local market volatility might be picking up similar things when we analyze their average contribution and failing to account for either may result in a spurious significance of the included factor. Disentangling these two factors is thus important for tests of international asset pricing.

To further investigate this issue, we use a conditional framework that allows for time-variation in the prices of risk, reflecting the changing dynamics of the exchange risk versus local market risk. Based on data from seven emerging markets encompassing different regions and different exchange rate regimes, we attempt to provide some answers to the following related questions:

- Is there a significant local currency risk premium in equity returns within emerging markets after accounting for global factors?
- Does this risk command a different risk premium from local market risk in a model that assumes partial integration? In other words, are the two local risk factors priced separately?

Both questions are very important, not only for international asset pricing modeling and testing, but also for their implications on the cost of capital of firms and on hedging decisions of portfolio investors and corporate managers.

Our results can be summarized as follows. We find evidence that local currency risk and local market risk are significant and time-varying for a number of emerging markets. More importantly, the two local risks are separately priced. On average over the whole sample, total currency premia are negative, confirming that the hedging component in currency premia is predominant. Although statistically significant, the bilateral exchange rate risk is small for some countries but on average it represents almost 15% of the total premium in absolute value across all assets. Over the whole sample, local market risk contributes to more than 50% of the total risk premium across all assets, and for some it can be as large as 80%. Over sub-periods, we find that the contribution from local exchange rate risk can almost double for some EM assets. Local currency risk is thus an important economic risk factor, even after accounting for local market risk. We find however that local market risk contributes the most to the statistical fit of the model.

The rest of the paper is organized as follows. Section 2 outlines the model and methodology. Section 3 describes the data and summary statistics on emerging market equity returns and currencies. The empirical results from tests of exchange risk and market risk pricing are presented in Section 4. Section 5 concludes the paper.

2. Model and methodology

2.1. The model

We specify the expected returns of each country as a function of a number of risk premia:

$$E_{t-1}(r_{i,t}) = \delta_{w,t-1}\mathrm{cov}_{t-1}(r_{i,t}, r_{w,t}) + \sum_{l=1}^{L} \delta_{l,t-1}\mathrm{cov}_{t-1}(r_{i,t}, \pi^{\$}_{l,t}) + \delta_{i,t-1}\mathrm{var}_{t-1}(r_{i,t}) \tag{1}$$

where r_i and r_w are the excess returns on country i and world market portfolios respectively, measured in a common reference currency (the US dollar); $\pi^{\$}_l$ is the rate of inflation of country

l expressed in the reference currency, with L equals to the number of countries in the world; δ_w, $\sum\delta_l$ and δ_i are respectively the prices of the world market, currencies and local market risks; E is the expectation operator.

Eq. (1) is an ad-hoc specification that draws from both existing theoretical models and empirical evidence. Without the last risk factor, Eq. (1) is consistent with the original model of Adler and Dumas (1983) with a global market factor and as many currency factors as there are currencies in the world. Adler and Dumas (1983) measure the exposure of an asset i to PPP deviations related to currency l with a covariance between the asset and the rate of inflation of country l expressed in the reference currency. Previous empirical tests for major developed countries simplified this specification by assuming that domestic inflation is non-stochastic and that the relative change in the nominal exchange rate is the only random component in $\pi_l^\$$. The covariance terms with $\pi_l^\$$ were then replaced by covariances of the asset returns with measures of nominal exchange rate changes. However, Carrieri, Errunza and Majerbi (in press-a) show that using real exchange rate changes provides a better measure of PPP deviations in high inflation countries such as many emerging markets. As they point out, this would still require an assumption of non-stochastic inflation for the reference currency (the US dollar), which is reasonable.

Hence, we estimate the model in Eq. (1) using real exchange rates. Similar to other empirical studies on currency risk, we use an aggregate exchange rate index for major currencies but consider a separate exchange risk factor related to the emerging country's own currency fluctuations. Since we include local bilateral exchange risk, using real rates allows us to apply the same model for countries with different exchange rate regimes. In addition, it helps us overcome possible complications due to fixed exchange rate regimes over extended sub-periods or large discrete changes in nominal rates due to devaluations or peg removals.

After these simplifications, we can rewrite the pricing equation for each country as a four-factor model:

$$\begin{aligned} E_{t-1}(r_{i,t}) = {} & \delta_{w,t-1}\mathrm{cov}_{t-1}(r_{i,t}, r_{w,t}) + \delta_{mx,t-1}\mathrm{cov}_{t-1}(r_{i,t}, e^r_{mx,t}) \\ & + \delta_{bxi,t-1}\mathrm{cov}_{t-1}(r_{i,t}, e^r_{bxi,t}) + \delta_{i,t-1}\mathrm{var}_{t-1}(r_{i,t}) \end{aligned} \tag{1a}$$

where $e^r_{mx,t}$ is the change in the global currency risk factor measured by the change in a real exchange rate index of major currencies against the reference currency and δ_{mx} is the corresponding price of risk, $e^r_{bxi,t}$ is the change in the real bilateral exchange rate of country i's currency against the reference currency with δ_{bxi} as its price of risk. The rest of the notation is as before.

Differently from the Alder and Dumas specification, Eq. (1a) also includes a local market factor. The presence of local market volatility in this setting is motivated by the mounting empirical evidence suggesting that emerging markets are neither fully integrated nor completely segmented [see for example Bekaert and Harvey (1995), Errunza, Losq and Padmanabhan (1992), Carrieri, Errunza and Hogan (in press-b). Given this evidence, estimating a model without local market factor may result in a spurious significance of the local exchange risk factor because the model does not account for local market volatility. Indeed, Carrieri and Majerbi (2006) show that, in an unconditional setting, local market risk subsumes the significance of the exchange risk factor. Therefore, by including a time-varying price of local market volatility in our specification, we can check the robustness of the pricing of the bilateral exchange risk to other competing sources of local risk.

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 phenomena without explicitly modeling such process. The empirical models of dynamic integration in De

Santis and Imrohoroglu (1997) and Phylaktis and Ravazzolo (2004) use constant prices of risk while exogenously fixing the change at the liberalization date. This implies that markets are fully segmented during the pre-liberalization date (with only local market risk) and fully integrated thereafter (with only world market risk). Another alternative would be to use a switching regime similar to the empirical model proposed in Bekaert and Harvey (1995) where the switch depends on some time-varying probabilities. While also these papers propose ad-hoc modeling of the process, it is possible that our time-varying prices of risk capture both the degree of integration and the compensation for risk. However in this paper we are not making direct inferences on time-varying integration from such prices.

2.2. Empirical methodology

We write the four-factor model in Eq. (1a) for estimation as:

$$r_{i,t} = \delta_{w,t-1} h_{i,w,t} + \delta_{mx,t-1} h_{i,mx,t} + \delta_{bxi,t-1} h_{i,bxi,t} + \delta_{i,t-1} h_{i,i,t} + \varepsilon_{it} \quad \varepsilon_t | \Omega_{t-1} \sim N(0, H_t) \tag{2}$$

where

r_t	is a vector of excess returns for the EM asset, measured in a common currency
$\delta_{w,t-1}$	is the time-varying price of world market risk
$\delta_{mx,t-1}$	is the time-varying price of real exchange rate risk for the major currencies
$\delta_{bxi,t-1}$	are time-varying prices of real bilateral exchange rate risk for each EM
$\delta_{i,t-1}$	is the time-varying price of local market risk for country $i (i=1,\ldots,7)$
Ω_{t-1}	is a set of information variables available to investors at time t_{-1}
$\varepsilon_t = [\varepsilon_{it}, \varepsilon_{bxit}, \varepsilon_{mxt}, \varepsilon_{wt}]'$	are the error vectors
$h_{i,t}$	is a column of the (4×4) covariance matrix H_t.

For each EM stock market index i in our sample, we estimate a multivariate system. This (4×4) system also includes pricing equations for the world market portfolio, the major currency index and the local exchange rate changes. The expected returns of the latter three assets in the system depend only on world market risk and real currency risk, in line with a full integration setting.

Since we are interested in determining the statistical significance and relative economic importance of global and local premia, 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:[4]

$$H_t = H_0 * (\imath\imath' - aa' - bb') + aa' * \varepsilon_{t-1} \varepsilon_{t-1}' + bb' * H_{t-1} \tag{3}$$

where $\imath$ is a (4×1) vector of ones, a and b are (4×1) vectors of unknown parameters and * denotes the Hadamard (element by element) matrix product.[5]

We model the prices of world market risk and major currencies exchange rate risk ($\delta_{w,t-1}$ and $\delta_{mx,t-1}$) to depend on a set of global information variables $Z_{g,t-1}$, while the prices of bilateral exchange rate risk and domestic market risk ($\delta_{bxi,t-1}$ and $\delta_{i,t-1}$) are dependent on a set of local

[4] 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.

[5] 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.

information variables, $Z_{i,t-1}$, which is country-specific.[6] More precisely, since we want to ensure a positive relationship between asset returns and market risk, we model the prices of world market risk and domestic market risk with a non-linear specification. In particular, we follow previous empirical literature (Harvey (1991) and De Santis and Gerard (1998)) and specify the world price of risk as an exponential function of the information variables. For the price of domestic risk, we use a squared specification.[7] The prices of both currency risks are modeled using a linear functional form as there is no restriction on the price of currency risk to be positive in theoretical asset pricing models.[8]

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

$$\delta_{mx,t-1} = k_{mx}' Z_{g,t-1} \tag{5}$$

$$\delta_{bxi,t-1} = k_{bxi}' Z_{i,t-1} \tag{6}$$

$$\delta_{i,t-1} = (k_i' Z_{i,t-1})^2 \tag{7}$$

The system is estimated using the BFGS (Broyden–Fletcher–Goldfarb–Shanno) algorithm and quasi-maximum likelihood (QML) standard errors are obtained to ensure robustness of the results (see White, 1982).[9]

If there were no limitation on our computational capabilities, we would estimate a large multivariate system with all countries and bilateral exchange rates plus the global benchmarks. To reduce the dimensionality of the system, we have reduced the number of bilateral exchange rates in the system by replacing them with a single exchange rate index for the major currencies.[10] In addition, we estimate smaller systems by considering the pricing of the EM assets country-by-country. This approach has the drawback of estimating as many prices of global risks as the number of countries in our study. To eliminate this inconsistency, we proceed in two steps. We first estimate the prices of risk for the global factors in Eq. (2) within a bivariate system that includes the world market portfolio and the major currency benchmarks. In a second step, we simultaneously estimate the premia of local currency risk and local market risk for each country together with the exposure of the EM assets to the global factors. In this second stage, we impose the price of world market risk $\hat{\delta}_{w,t-1}$, the price of major currency risk, $\hat{\delta}_{mx,t-1}$ and the estimated elements of the (2×2) variance–covariance matrix from the first stage in each country-by-country estimation. This implementation has the advantage of constraining the global prices of risk to be the same for every country. At the same time, it allows estimation of a system with additional local factors, besides the global factors. A similar procedure is used by Bekaert and Harvey (1995) for their regime switching model. As they point out, it has the disadvantage of ignoring the sampling

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

[7] Bekaert and Harvey (1995) use an exponential function while Phylaktis and Ravazzolo (2004) use the absolute value to ensure positivity. In our case, we choose the squared specification. This one performs better with the local information variables that show high standard deviation and large number of outliers while also providing a better fit.

[8] For example, in Adler and Dumas (1983), 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.

[9] See Shanno (1985).

[10] See Jorion (1991), Ferson and Harvey (1993, 1994), Choi, Hiraki and Takezawa (1998).

errors from the first stage and thus the true standard errors might be larger than what we compute. However, by imposing the restrictions, it generates a more powerful test.

3. Data and summary statistics

This study covers seven emerging markets that represent the most important countries in Asia and Latin America and for which we have the longest data period available. These are: Argentina, Brazil, Chile, India, Korea, Mexico and Thailand.[11] The same sample of countries is covered in Carrieri and Majerbi (2006) and thus we can compare our results to those obtained in an unconditional setting.

Country returns are computed from national total return indices (including dividends) of the S&P/IFC's Emerging Market Database (EMDB). The dividend adjusted world market return is obtained from MSCI. We use monthly data from January 1976 to December 2000.[12] All returns are expressed in US dollars and computed in excess of the 30-day eurodollar deposit rate, available from DataStream. 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 2, we use a real trade-weighted exchange rate index of the US dollar against major currencies computed by the Federal Reserve Board to account for the global exchange risk factor.[13] This index referred to as the "major partners" index, includes the currencies of the euro-area countries plus Australia, Canada, Japan, Sweden, Switzerland, and the United Kingdom.

Table 1 reports summary statistics for excess asset returns and real exchange rate changes as well as some correlations measures. Panel A shows that compared to the world return characteristics, emerging market returns have much higher volatility although in some cases they also have lower average returns over the sample period. 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. Chile, Mexico and Thailand also show highly autocorrelated returns as indicated by the $Q(z)_{12}$ statistics. There is also a high level of autocorrelation in the squared returns series for all seven EMs.

Panel B reports the summary statistics for the real bilateral exchange rates computed for the seven emerging markets plus the major currency index. On average, over the sample period, most currencies depreciated in real terms against the US dollar, with the exception of the Argentine currency. We also note that in general, Latin American countries show larger variations in the real bilateral exchange rates than Asian countries. The test for normality is also strongly rejected in the exchange rate series in all countries, but not for the major currency index, while autocorrelation levels are high only for Argentina, Korea, Mexico, and Thailand.

In Panel C, we report the correlation measures between the countries excess returns and the global risk factors as well as with the bilateral exchange rate changes. We note that EM assets

[11] The Emerging Market Database also includes Greece and Zimbabwe at the start of the sample. Greece however has been later upgraded as a Developed Market, while most of our local data is not available for Zimbabwe. Thus we omit these countries from our study.

[12] For Brazil, the estimations are run from January 1980, because some of the local information variables are not available before that date.

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

Table 1
Summary statistics of assets and currencies

	Mean	S.D.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Panel A: Assets Excess Returns							
Argentina	0.914	22.26	0.08	5.45**	356.5**	10.43	48.86**
Brazil	0.539	16.81	−0.50**	2.74**	84.88**	12.62	32.89**
Chile	1.163	9.93	0.31*	1.92**	48.61**	50.16**	41.94**
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**
Mexico	0.470	13.29	−2.04**	9.92**	1390.3**	29.11**	31.74**
Thailand	−0.100	10.30	−0.49**	3.31**	142.64**	48.89**	182.89**
MSCI World	0.443	4.03	−0.73**	2.32**	89.99**	12.41	7.61
Panel B: real exchange rates							
Argentina	0.180	14.18	−3.06**	36.04**	16 146**	42.29**	78.94**
Brazil	−0.103	5.20	−2.98**	36.66**	13 907**	17.63	3.91
Chile	−0.114	3.99	−7.26**	94.85**	111 331**	14.51	1.70
India	−0.278	2.31	−2.77**	19.26**	4854**	8.70	0.74
Korea	−0.087	3.20	−4.72**	55.20**	37 918**	28.19**	57.27**
Mexico	−0.043	6.47	−5.31**	40.16**	20 876**	29.16**	32.31**
Thailand	−0.191	2.99	−0.57**	32.52**	12 784**	23.63*	110.43**
Major currency index	−0.026	1.73	0.20	0.32	3.12	40.01**	8.92
Panel C: correlations between assets and currencies							
	Argentina	Brazil	Chile	India	Korea	Mexico	Thailand
Corr(r_i, r_w)	0.07	0.19	0.14	0.04	0.31	0.32	0.34
Corr(r_i, e^r_{mx})	−0.02	0.09	0.01	0.09	0.10	−0.06	0.13
Corr(r_i, e^r_{bxi})	0.14	0.13	0.25	0.16	0.49	0.49	0.30

All country returns in Panel A 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 all countries except Brazil (January 1980 to December 2000). Panel B reports the statistics about the changes in the real bilateral exchange rates for each country plus the major currency index against the US dollar. All rates are computed in continuous time and expressed in percent per month. In Panel C, r_i refers to the country's excess return; r_w is the world market excess return; e^r_{mx} is the change in the major currency index; and e^r_{bxi} is the change in the country's real bilateral exchange rate against the US dollar. 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. ** and * denote statistical significance at the 1% and 5% levels respectively.

have lower correlations with both the world market return and the major currency index compared to what is commonly observed for developed market assets. Korea, Mexico and Thailand show the highest correlations with the world market portfolio (between 0.31 and 0.34) while Thailand has the highest correlation with the major currency index (0.13). Finally, we note that Korea and Mexico have the highest correlations with the real bilateral exchange rate changes (around 0.5), followed by Thailand (0.3) and Chile (0.2).

Table 2 contains the summary statistics for the instruments used to describe the conditioning information sets of the investors. The choice of the global information variables is mainly drawn from previous empirical literature such as De Santis and Gerard (1998) and Carrieri, Errunza and Majerbi (in press-a). The set of global instruments $Z_{g,t-1}$ 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-

Table 2
Summary statistics of the information variables

Panel A: global information variables

	Mean	S.D.	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	S.D.	Pairwise correlations	
XLDY			with LagRet	with ΔLCinf.
Argentina	−0.4835	0.3449	0.0059	0.0032
Brazil	−0.1929	0.2621	−0.2759	−0.0830
Chile	−0.2485	0.2938	0.0905	−0.0180
India	−0.4376	0.2384	0.0011	−0.0181
Korea	−0.3489	0.2351	−0.0043	0.0235
Mexico	−0.3102	0.3315	−0.0319	0.0547
Thailand	−0.2296	0.2275	0.0202	0.0296
ΔLCinf.				
Argentina	−0.0581	7.4455	−0.1995	
Brazil	0.0010	3.9901	−0.2081	
Chile	−0.0218	2.0718	−0.0412	
India	0.0104	0.9196	−0.0840	
Korea	−0.0014	0.7780	−0.0649	
Mexico	0.0002	1.1950	−0.1834	
Thailand	0.0007	0.7826	0.0167	

The global information set includes a constant, the world dividend yield in excess of the 1 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 1 month lag with respect to the returns series.

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, $Z_{i,t-1}$, 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*.

4. Empirical results

We first estimate the global prices of risk in a bivariate system that only accounts for the global market and the major currency risk premium. In this step, we find that while global market risk is significantly time-varying at any statistical level, the significance of the major currency risk is not confirmed (p-value is 0.095). This result is in contrast with previous works, such as Dumas and

Table 3
Tests of the four-factor model

The estimated model is:

$$r_{it}=\hat{\delta}_{w,t-1}\ \mathrm{cov}_{t-1}\ (r_{it},r_{wt})+\hat{\delta}_{mx,t-1}\ \mathrm{cov}_{t-1}\ (r_{it},e^{r}_{mx,t})+\delta_{bxi,t-1}(r_{it},e^{r}_{bxi,t})+\delta_{i,t-1}(r_{it})+\varepsilon_{it}$$

$$\text{where}\begin{cases}\delta_{w,t-1} = \exp(k_w' Z_{g_{t-1}})\\ \delta_{mx,t-1} = k_{mx}' Z_{g_{t-1}}\\ \delta_{bxi,t-1} = k_{bxi}' Z_{i,t-1}\\ \delta_{i,t-1} = (k_i' Z_{i,t-1})^2\end{cases}$$

$$\varepsilon_t = [\varepsilon_{it}, \varepsilon_{bxit}, \varepsilon_{mxt}, \varepsilon_{wt}]', \varepsilon_t|\Im_{t-1} \sim N(0, H_t) \quad \text{and} \quad H_t = H_0^{*}(\iota\iota'-aa'-bb) + aa'{*}\varepsilon_{t-1}\varepsilon_{t-1}' + bb'{*}H_{t-1}$$

where r_i is the excess return on the asset of country *i*, r_w is the excess return on the world market portfolio, e^{r}_{mx} is the change in the real *Major currency index,* e^{r}_{bxi} is the change in the real bilateral exchange rate of the local currency of country *i* with respect to the dollar; Z_g is a set of *j* global information variables which includes a constant, the world dividend yield in excess of the risk free rate, the change in the term structure spread and the default spread. Z_i is a set of *j* local information variables (specific to country *i*) which includes a constant, the local market dividend yield in excess of the Eurodollar rate, the local market lagged excess return and the change in the local inflation rate. *a* and *b* are 4×1 vectors of unknown parameters and ι is a 4×1 vector of ones.

Panel A: specification tests

		Argentina	Brazil	Chile	India	Korea	Mexico	Thailand
Null hypothesis	*df*	*p*-value	*p*-value	*p*-value	*p*-value	*p*-value	*p*-value	*p*-value
1) Is the price of real bilateral XR risk=zero?								
H_0: $k_{bxi,\ j}=0\ \forall j$	3	0.0004	0.0439	0.0000	0.0350	0.0000	0.0001	0.0527
2) Is the price of real bilateral XR risk constant?								
H_0: $k_{bxi,\ j}=0\ \forall j>1$	4	0.0002	0.0914	0.0000	0.5819	0.0855	0.0007	0.4056
3) Is the price of domestic market risk=zero?								
H_0: $k_{i,j}=0\ \forall j$	3	0.0115	0.0000	0.0000	0.0000	0.0000	0.9982	0.1857
4) Is the price of domestic market risk constant?								
H_0: $k_{i,j}=0\ \forall j>1$	4	0.0073	0.0000	0.0000	0.0001	0.0000	0.9915	0.1353

Panel B: diagnostics tests for residuals

	Argentina	Brazil	Chile	India	Korea	Mexico	Thailand
B-J	251**	29.5**	51.57**	10.56**	6.32*	164.27**	58.31**
$Q(z)^{a}_{12}$	11.34	7.48	21.63*	6.51	21.4*	36.54**	30.91**
$Q(z^2)^{a}_{12}$	7.69	14.08	11.79	21.88*	33.77**	13.35	13.35
RMSE	20.18	16.58	9.35	7.84	11.00	13.67	10.44
Pseudo-R^2 (all)	3.10%	2.40%	4.64%	2.67%	−4.13%	−7.48%	0.27%
Pseudo-R^2 (domestic market)[b]	3.67	1.36	4.53	2.67	−5.78	−1.43	−0.12
Pseudo-R^2 (exchange rate)[c]	−2.02	−2.62	−0.50	0.08	−1.68	−7.89	0.89

** and * denote the statistical significance at the 1% and 5% levels respectively. [a]Ljung-Box test statistic for residuals and residuals squared. [b]Pseudo-R^2 with the global factors plus the domestic market factor only. [c]Pseudo-R^2 with the global factors plus the bilateral exchange risk factor only.

Solnik (1995) and De Santis and Gerard (1998), that find support for major currency risk. However, those studies use the cross-section of developed market asset returns to establish the importance of currency risk, thus our test is likely to have less power. We find that the average price of global market risk is 3.61 while the average price of major currency risk is −3.96. These estimates are in line with previously reported measures (see for example Dumas and Solnik (1995) and De Santis and Gerard (1998)).

In the second step, we estimate for each country the prices of bilateral exchange rate risk and the domestic market risk, while imposing the estimated prices of global risks from the first step.

That is, while the local risk premia are freely estimated, we only estimate the risk exposures for the global factors since the prices of risk for those factors are imposed from the first step estimation. Table 3 contains the results on the significance of the local risk factors estimated from Eq. (2). Since we are not focusing on individual coefficients, we do not present all estimated parameters, but only the p-values on the joint hypotheses. The first question is on the significance of the local currency risk. We find that the price of bilateral exchange rate risk is significant in all cases but we cannot find substantial time-variation in the prices of risk for India and Thailand. The second question is on the importance of the local market factor. The domestic market risk is also priced almost everywhere with the exception of Mexico and Thailand. Thus, differently from what Carrieri and Majerbi (2006) obtain in an unconditional setting, we find evidence that in a conditional framework the two local risks are separately priced for this set of emerging markets. This result is analogous to the finding on currency risk for developed markets, where a number of papers have found consistent evidence that exchange rate risk is priced with conditional tests.

With respect to the conditional variation in the variance–covariance matrix, the GARCH coefficients (not reported) are always significant and of the usual size for the country assets. In the case of the bilateral exchange rate changes, in a few cases we find a large a coefficient while the b coefficient is of small size and not significant. We present the diagnostics tests in Panel B of Table 3. The B-J test and the test on the squared residuals provide support for the GARCH parameterization. The autocorrelation in the squared residuals is eliminated everywhere while the non-normality is reduced. On the other hand, we find that the autocorrelation of residuals is reduced but not eliminated and in two cases, it actually increases.

Panel B also includes the root mean squared errors (RMSE) and the pseudo-R^2 to convey information on the ability of the model to fit the data. The average of the RMSE across countries is 12.72, while the average standard deviation of the raw data in Table 1 is 13.03, an indication that the proposed specification contributes to reducing the volatility of the assets. The pseudo-R^2 measures the portion of the explained sum of squares over the total sum of squares from the estimated model. With the exception of Mexico and Korea, the proposed model provides a good fit. To gauge the relative contribution of the two estimated local risk premia to the fit of the model, we also provide two additional R^2 obtained from the estimation. R^2 (domestic market) only accounts for the domestic market risk while R^2 (exchange rate) only accounts for the bilateral exchange rate risk. In both cases when computing these statistics, we always account for the global factors and thus we are considering the fit of a three-factor model with the third factor being either local market risk or local exchange risk.[14] Without the domestic market risk, the model is one of full integration while without the bilateral exchange rate risk it is a model of partial integration where currency risk only stems from major currencies. The statistics reveal that in most cases the most important factor is represented by the domestic market factor, while the bilateral exchange rate factor improves the fit of the model for the cases of Brazil, Thailand and to a limited extent for Chile and Korea. Thus while the exchange rate risk is always conditionally priced, its contribution on average to the model fit is substantial only in a few cases. This could explain why unconditional tests cannot confirm its statistical significance.

Table 4, Panel A, reports the estimates of each price of risk and risk premia as averages over the whole sample. The domestic market risk premium is generally the largest, with the exception of Thailand and especially Mexico. For these two countries, the price of domestic market risk is not significant and we find that the average is the smaller among all the countries. We will revisit this

[14] The statistics are obtained estimating the entire system. Due to the restrictions across equations in the system, there is no guarantee that the pseudo-R^2 increases in all cases from a three-factor to a four-factor model.

Table 4
Estimates of the prices of risk and risk premia

	Argentina	Brazil	Chile	India	Korea	Mexico	Thailand
Panel A. summary statistics							
Price of bilateral exchange rate risk	−0.90	−0.45	1.79	−4.81	−2.59	−0.62	0.21
	(*0.96*)	(*5.42*)	(*1.04*)	(*4.59*)	(*2.16*)	(*3.78*)	(*4.86*)
Price of domestic market risk	0.09	0.45	1.60	1.04	1.05	0.04	0.45
	(*0.23*)	(*0.55*)	(*1.35*)	(*1.64*)	(*1.28*)	(*0.02*)	(*0.60*)
Bilateral exchange rate risk premium	−3.31	−1.60	1.10	−1.58	−5.41	−3.27	−1.16
	(*15.08*)	(*21.74*)	(*1.31*)	(*1.50*)	(*17.41*)	(*37.08*)	(*22.41*)
Domestic market risk premium	8.10	17.91	16.26	8.22	17.46	1.01	5.07
	(*46.88*)	(*42.67*)	(*15.69*)	(*15.91*)	(*36.90*)	(*2.12*)	(*9.39*)
Panel B. average contribution to total risk premium							
Full sample							
Global market risk premium	20.60%	11.41%	14.35%	2.47%	17.95%	57.72%	45.00%
Major currency risk premium	1.2	12.4	0.2	7.6	2.9	10.4	3.3
Bilateral exchange risk premium	22.7	6.4	5.4	14.5	18.7	24.3	9.6
Domestic market risk premium	55.6	69.9	80.0	75.5	60.4	7.5	42.1
From 1981–1985							
Global market risk premium	35.1	28.3	26.3	14.8	31.2	33.2	49.0
Major currency risk premium	30.6	8.7	0.4	19.3	7.4	9.0	8.2
Bilateral exchange risk premium	15.2	2.0	5.7	27.7	11.0	54.9	8.0
Domestic market risk premium	19.2	60.9	67.6	38.2	50.4	2.9	34.8
From 1986–1990							
Global market risk premium	1.24	10.76	9.32	4.55	40.71	63.50	45.03
Major currency risk premium	15.4	0.1	3.2	15.4	11.5	7.0	18.2
Bilateral exchange risk premium	13.8	13.3	3.3	17.7	12.4	14.5	4.6
Domestic market risk premium	69.6	75.8	84.2	62.3	35.3	15.0	32.1
From 1991–1995							
Global market risk premium	36.2	33.8	11.6	6.2	25.1	61.7	49.0
Major currency risk premium	0.1	3.3	2.7	3.5	4.5	0.1	11.6
Bilateral exchange risk premium	33.9	4.1	5.5	5.2	16.5	31.9	1.9
Domestic market risk premium	29.8	58.8	80.1	85.1	53.9	6.3	37.6
From 1996–2000							
Global market risk premium	32.2	39.8	19.8	6.1	9.3	68.0	31.9
Major currency risk premium	11.1	23.0	3.7	8.4	0.8	17.1	2.3
Bilateral exchange risk premium	36.1	7.1	6.9	8.3	26.8	7.5	27.0
Domestic market risk premium	20.6	30.1	69.6	77.2	63.0	7.3	38.8

This table contains estimates from the model in Table 3. In panel A, we report the average prices of risk and the average for the two local risk premia as annualized percentage. Standard deviations are in parentheses. In Panel B, we report the average contribution of each component as a fraction of the total risk premia in absolute value. The averages are percentages of the total absolute premium.

issue later in our robustness checks. In most of the cases, the averages of the premium linked to currencies are negative, an indication that the hedging component is predominant. Since the exposure of each country return to its own exchange rate is positive, a negative premium implies that investors are willing to accept lower returns from those assets that can provide a hedge. The currency premium is on average of smaller size but still represents about one third of the domestic premium for countries like Argentina and Korea. In the case of Mexico, it seems that the importance of the exchange rate risk factor is larger than the domestic market factor. The size of the global market premium is very similar across the Latin American countries on one side and the

Asian countries on the other side. It is substantially larger for Mexico and smaller in the case of India that often shows a negative covariance with the world market portfolio.

Fig. 1 presents the plots of the estimated premia. We provide the domestic market and the bilateral exchange rate risk premia to show their relative dynamics during the period. Since we want to focus on the relative importance over time of the local currency factor and the local market factor, we omit the global premia. Further, since the size of the local market risk premium is larger than that of the currency premium for most of the countries, we plot the two premia on separate axis that will allow us to focus on their time-variation. Although in some cases periods of market turmoil are mostly captured by the local market risk factor, we can also identify periods of crisis that are characterized by an increase in absolute value of the local currency premium. We see this as an indication that over these periods hedging opportunities are more valuable. This is the case for Brazil, Chile and Mexico during the Latin American debt crisis of 1982–83 and Korea and Thailand during the Asian crisis of 1997–99.

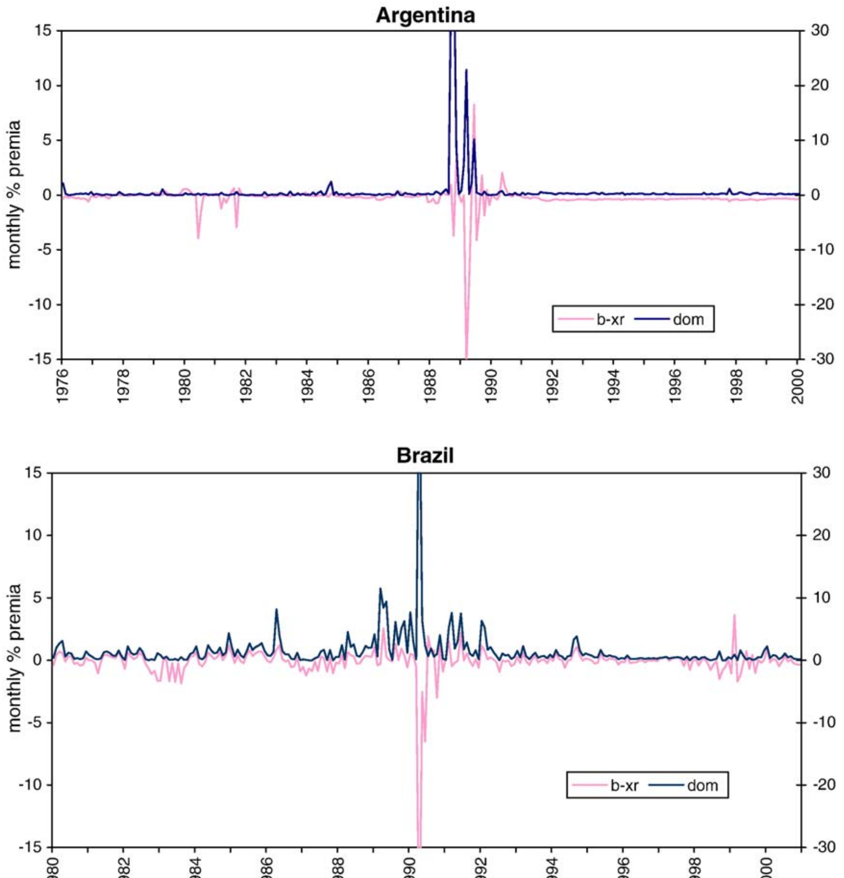

Fig. 1. Estimated risk premia. For each country, the plots show the estimated risk premia for the local currency risk (b-xr) on the left axis and the local market risk (dom) on the right axis. These risk premia are computed from the prices of risk obtained from the estimates in Table 3. The sample period is from January 1976 to December 2000 for all countries except Brazil which starts in January 1980.

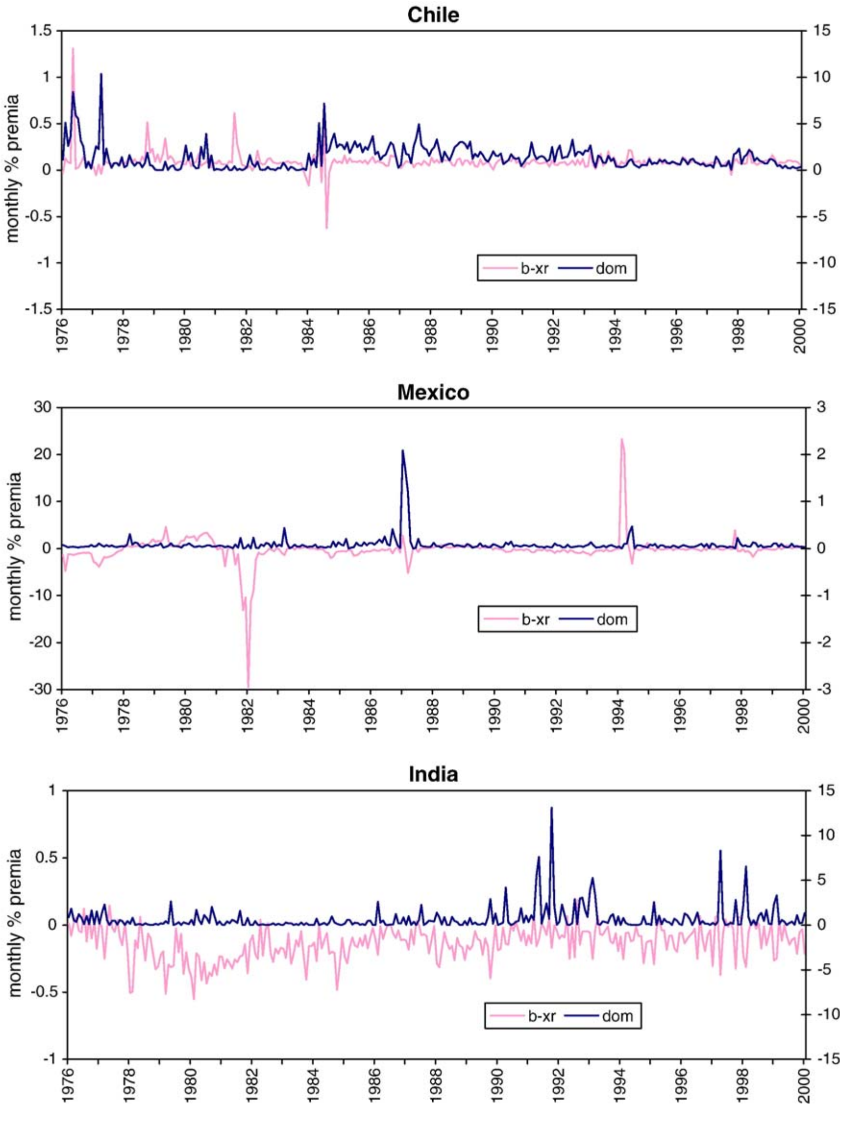

Fig. 1 *(continued)*.

Panel B of Table 4 shows the relative contribution of each premium to the total risk premium over the whole sample and over five-year sub-periods to further investigate the importance of time-variation for each component. On average, we find that for both sets of Latin American and Asian countries, the global components represent 30% of the total premium in absolute value, with the domestic market component accounting for 55% and the bilateral exchange risk for about 15%. Of the global premia, the world market has the largest share. However, there are substantial differences across countries and over time. For example, the local market component accounts for 80% of the total premium for Chile and

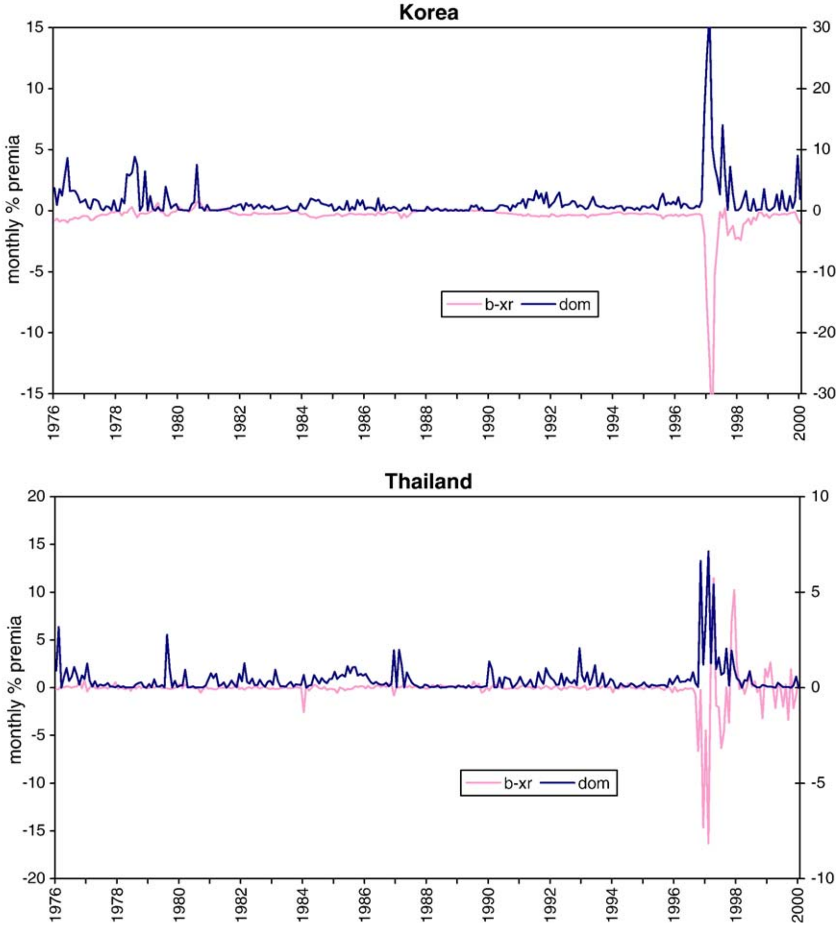

Fig. 1 *(continued)*.

the local exchange rate risk accounts for more than 20% of total premia for Argentina and Mexico. In the 1996–2000 sub-period that includes the Asian currency crisis, both Thailand and Korea show a substantial increase in the currency risk component. Phylaktis and Ravazzolo (2004) also document a large negative change in the currency premium in the crisis period. Similarly, in the 1991–1995 sub-period, currency risk is much larger for Mexico as a result of the Tequila crisis. Although for Argentina the nominal exchange rate was fixed over these two sub-periods, we still find a large component related to the real exchange risk of the local currency. The 1986–1990 period is characterized by larger contribution stemming from the domestic risk for the Latin American countries, as a likely consequence of the hyperinflation in Argentina and Brazil and the debt crisis. Finally, in the 1981–1985 period, the contribution of the currency factor is much larger for Mexico, as an indication that the turmoil of the country at the time is also related to currency factors. This analysis points out that although on average over all of the countries for the 25 years of our sample, the bilateral exchange rate risk represents a smaller component of local risk, over sub-periods and for some countries its contribution can be substantial, reaching 30% of the total risk premium.[15]

4.1. Robustness checks

The proposed empirical model imposes a number of constraints dictated by existing theoretical asset pricing models. First, we have estimated the price of domestic market risk as a non-linear function to ensure that we preserve a positive relationship between the asset and its market risk. Second, we have constrained the global prices of risk from a first step estimation since in a financially integrated world, global risks should have the same price, irrespective of where the assets are traded. However, it is possible that such constraints have consequences on the results of our estimation.

Since we are interested in investigating the separate significance of the local exchange rate and the local market risk factors, we have re-estimated the models with a linear specification for the domestic market risk. By relaxing the positivity constraint, we want to verify that the separate significance is not driven by the specification imposed. We find that the prices of exchange rate risk have similar significance and their averages are of similar size to those obtained in the constrained estimation. In the case of the domestic market risk, we find that the statistical significance is confirmed, while the averages of the prices of risk are lower, which is not surprising since at times they can reach negative values in the linear specification. The average of the pseudo-R^2 increases to 1.27 while the average in the non-linear specification statistics reported in Table 3 (Panel B) is 0.21. The most interesting result is for Mexico and Thailand where the domestic market risk was not significant in the constrained estimation reported in Table 3. In this case, we observe that the average of the estimated linear price of domestic market risk is negative only in the case of Mexico and Thailand, while it remains positive for all other countries. This explains also why the estimates of the average domestic market risk premium shown on Table 4 (Panel A) are the lowest in the case of these two countries. For both countries, the domestic market risk is now priced and the bilateral exchange rate risk is of similar significance and size to the estimation in Table 3.[16]

Stemming from the positivity restriction, another issue exists with respect to the autocorrelation of the residuals. De Santis and Gerard (1997) show that with the non-linearity restriction we cannot remove all the predictability present in the asset returns. With a similar result, in the estimation with a linear price of domestic risk, we find that the autocorrelation of the residuals is further decreased from the statistics in Panel B of Table 3, except for Korea. Overall this analysis provides confirmation that a specification that conforms to our a priori expectations cannot always account for the empirical characteristics of the data.

As a last check on the robustness of our results, we run the system estimation from Eq. (2) in one-step, allowing for different prices of global risks in each country-by-country system. The significance of both local factors is confirmed, as in our two-step estimation. Furthermore, similar to the results obtained in the two-step estimation, we find that the price of domestic market risk is not significant for Mexico and Thailand under the non-linear specification (p-values of 0.942 and 0.289 respectively) while becoming significant and negative on average with a linear specification (p-values of 0.012 and 0.041 respectively for Mexico and Thailand).

[15] It is worth pointing out that since the global prices of risk are constrained from previous estimation, only covariances with the global factors can adjust to time-varying market conditions such as market crushes or currency crises. This is likely to constrain also the time-variation in the local factors.

[16] Detailed results for this section can be obtained from the authors.

Thus, we are confident that the local exchange risk is separately priced from local market risk and both can be successfully disentangled.

5. Conclusions

The objective of this paper is to investigate the separate importance of local exchange rate and local market risk for pricing emerging market equities. Since previous studies could not confirm the relevance of exchange rate risk in the presence of local market risk in unconditional setting, we use a conditional framework. In addition, we use real exchange rates that provide a better proxy for PPP deviations since they capture both inflation and nominal exchange rate risks. To our knowledge, this is the first test for emerging markets that takes into accounts both local exchange rate risk and local market risk with time-varying prices, in addition to time-varying prices of global market risks. This model specification is the most appropriate in the case of EMs because testing for exchange risk pricing using an ICAPM that assumes fully integrated markets may result in a spurious significance of the exchange rate factor due to the missing local market risk factor.

Our analysis establishes the importance of local currency risk as a pricing factor, separately from the local market factor. The empirical results support the hypothesis of a significant price of local exchange risk for emerging stock markets, in addition to a significant price of local market risk. 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 almost 15% of the total premium in absolute value, over sub-periods the total exchange risk premium doubles for some emerging market assets. The contribution of the domestic market risk is on average 50% of the total premium and it can be as large as 80% for some countries. Although currency risk is an important component both in statistical and economic terms, we find that the domestic market factor is the one that on average contributes the most to the fit of the model.

These results suggest that, for emerging markets, the use of an asset pricing model without local exchange risk (local market risk) may be misspecified even when the model includes both global and local market (local exchange) risk factors. This is because the significance of the local market risk factor may be overestimated since it may subsume the missing exchange risk factor or vice versa. The estimated risk premia indeed reveal that at times the contribution of currency risk to the total premia can be as large as that of local market 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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