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Is currency risk priced for emerging stock markets?

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Abstract

In this paper we examine the relevance of currency risk in emerging countries using a conditional version of an international capital pricing model. Our results show that both currency risk and market risk are time-varying and priced in emerging stock markets. In particular, the currency risk premium is economically significant and represents a significant portion of the total risk premium during the crisis periods.

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1. Introduction

During the last decade, emerging markets represent a valuable opportunities for portfolio diversification as they are not fully integrated with those developed ones (Bekaert and Harvey, 1995; Harvey, 1995; Korajczyk, 1996; Li and Majerowska, 2008; Diamandis, 2009). Therefore investors are affected by another important source of risk namely the currency risk. Several studies have shown that foreign exchange rate fluctuations are significantly transmitted to stock markets and this relation is more pronounced during crisis periods (Chkili et al., 2011).

Theoretically, Solnik (1974) and Alder and Dumas (1983) develop an international asset pricing models (ICAMP) with currency risk when purchasing power parity (PPA) is violated. They conclude that currency risk is priced for stock asset returns. Empirically, De Santis and Gérard (1998) find that currency risk is priced in four international stock markets. De Santis et al. (2003) show that currency risk is priced and its impact varies over time as a function of changes in economic and institutional conditions of countries. Moreover, exchange risk premiums are economically significant and time-varying.

The literature that focuses on exchange risk premia in emerging countries is very scarce. Phylaktis and Ravazzolo (2004) study the case of some Asian emerging countries (Korea, Malaysia, Taiwan and Thailand). Their results reveal that currency risk premiums vary significantly over time and across markets and in most time, they form a big part of the total risk premium. Carrieri et al. (2006) test a dynamic conditional version of international CAMP, using a real exchange rate as a proxy for currency risk. Their results support the hypothesis of significant time-varying exchange risk premiums for both emerging and developed market assets. On average they represent about 40 percent of the total premium in absolute value over the whole sample. Finally, they show that currency risk is priced separately from other specific risks and its impact is heightened during crisis episodes.

In this study, we test whether currency risk is relevant for emerging stock markets. We contribute to the related literature in three ways. First, most empirical studies have paid considerable attention to developed countries (see among others, De Santis and Gerard, 1998; De Santis et al., 2003) while little attention has been given to emerging countries. We interest in the present study to some emerging countries namely Indonesia, Korea, Malaysia, Argentina, Brazil and Mexico to assess the importance of exchange rate risk over the turbulent period 1994 – 2009 that covers various crises such as the Mexico currency crisis in 1994, the Asian and Russian financial crises 1997-1998 and the subprime crisis in late 2007. Thus examining this period has a greater interest to portfolio diversification decisions and hedging strategies choice during both turbulent and tranquil periods. Second, unlike studies assuming a full integration of developed stock markets and they incorporate only the global market and currency risks in their models, our study is based on the framework of partially segmented ICAMP which takes into account an additional source of risk related to the local emerging market. Finally, given our main goal, we examine the portions of returns that are explained by currency factors from a decomposition of the total premium into local, global and currency risk premiums, respectively.

The main results show that currency risk is significantly priced in emerging stock markets. The price of currency risk is time-varying and has increased during crisis periods namely during the Asian and subprime crises. The empirical evidence also reveals that risk premiums vary significantly over time and across markets. Therefore, the currency premium is sometimes negative and forms a big part of total premium in emerging countries.

The remainder of the paper is organized as follows. Section 2 presents the model and empirical methodology. Section 3 describes the data and provides some summary statistics. The empirical results are presented in Section 4. Section 5 concludes the paper.

2. The model and methodology

2.1. The model

Following De Santis and Gerard (1998) and De Santis et al. (2003), under the hypothesis of stock market integration and when the purchasing power parity (PPP) is violated, the dynamic version of international conditional asset pricing model (ICAMP) can be written as:

$$E(r_{it}) = \gamma_{w,t-1} cov_{t-1}(r_{it}, r_{wt}) + \sum_{c=1}^{L} \gamma_{c,t-1} cov_{t-1}(r_{it}, r_{ct}) \quad (1)$$

Where r_{it} and r_{wt} are the excess returns on the asset *i* and the world market portfolio respectively. r_{ct} is the changes in exchange rate of currency *c*. $\gamma_{w,t-1}$ is the conditional price of world market and $\gamma_{c,t-1}$ is the conditional price of exchange rate risk for currency *c*. $cov_{t-1}(r_{it}, r_{wt})$ and $cov_{t-1}(r_{it}, r_{ct})$ terms measure the exposure of asset *i* to world market and currency risks, respectively.

Nevertheless, several studies have shown that emerging stock markets are not fully integrated (see, eg. Bekaert and Harvey, 1995; Carrieri et al. 2006; Boubakri and Guillaumin, 2011; Guesmi and Nguyen, 2011), for this reason, we incorporate the local risk factor into the asset pricing model as follows:

$$E(r_{it}) = \gamma_{w,t-1} cov_{t-1}(r_{it}, r_{wt}) + \sum_{c=1}^{L} \gamma_{c,t-1} cov_{t-1}\left(r_{it}, r_{c,t}\right) + \gamma_{l,t-1} var_{t-1}(r_{it}) \quad (2)$$

where $\gamma_{l,t-1}$ is the price of local market risk and var_{t-1} is the conditional variance of the national emerging stock market.

2.2. Empirical methodology

At the empirical step the pricing model in eq.(2) will be simultaneously estimated for the excess returns on national equity portfolios, the returns on real exchange rates and the return on the world portfolio. The estimated system of asset pricing restrictions is as follows:

$$r_{it} = \gamma_{w,t-1} h_{iw,t} + \sum_{c=1}^{L} \gamma_{c,t-1} h_{ic,t} + \gamma_{l,t-1} h_{i,t} + \varepsilon_t \qquad \varepsilon_t/\varphi_{t-1} \sim N(0, H_t) \quad (3)$$

where r_{it} denotes the $s \times 1$ vector of excess returns, which includes six national stock returns, six real exchange rates and the world equity portfolio. φ_{t-1} is the set of information available at time $t-1$ and H_t is the $s \times s$ time-varying variance-covariance matrix of asset returns.

As De Santis and Gérard (1997, 1998), we use a diagonal GARCH process proposed by Ding and Engle (1994) to parameterize the conditional variance-covariance matrix of asset pricing models. We assume that the system is covariance stationary, so that the H_t matrix can be written as follows:

$$H_t = H_0 * (\imath\imath' - aa' - bb') + aa' * \varepsilon_{t-1}\varepsilon'_{t-1} + bb' * H_{t-1} \quad (4)$$

where H_0 is the unconditional variance-covariance matrix of innovations, ε_t. *a* and *b* are $s \times 1$ vectors of unknown parameters, $\imath$ is the $s \times 1$ vector of ones and * denotes element by element matrix product.

Under the assumption of conditional normality, the log-likelihood is given by the following function:

$$lnL(\Omega) = -\frac{Ts}{2}ln2\pi - \frac{1}{2}\sum_{t=1}^{T} ln|H_t(\Omega)| - \frac{1}{2}\sum_{t=1}^{T} \varepsilon_t(\Omega)' H_t(\Omega)^{-1}\varepsilon_t(\Omega)$$

where Ω is the vector of unknown parameters to estimate. We use the quasi-maximum likelihood (QML) approach proposed by Bollerslev and Wooldridge (1992) and the BHHH[1] algorithm to estimate the model.

To model the dynamic of the time-varying prices of market and currency risks, we take into consideration the implications of the theoretical model developed by Adler and Dumas (1983). Given that the model implies that the market price should be positive, we choose to model it as an exponential function. However, the model does not restrict the price of currency to be positive, so we use a linear function to model the dynamic of each currency price.

$$\gamma_{w,t-1} = exp(\emptyset_w' Z_{t-1}^w)$$

$$\gamma_{l,t-1} = exp\left(\emptyset_l' Z_{t-1}^l\right)$$

$$\gamma_{c,t-1} = \emptyset_c' Z_{t-1}^w$$

where Z_{t-1}^w and Z_{t-1}^l are the vectors of global and local information variables available to investors at time t-1.

3. Data and Summary Statistics

We use monthly returns on stock indices for six emerging countries (Indonesia (IND), Korea (KOR), Malaysia (MAL), Argentina (ARG), Brazil (BRA) and Mexico (MEX)) plus a value-weighted world index (WOR) for the period January 1994-Mars 2009 for a total of 183 observations. All stock returns are computed from the MSCI total return indices and are measured in US dollars in excess of one month Eurodollar deposit rate quoted on the last day of the month as a proxy for the risk-free rate. The log first difference of the real exchange rate of currency *c* against the dollar is used as a proxy for the currency risk[2].

Table 1 contains summary statistics for the stock market returns and changes in bilateral exchange rates. Brazil has the highest average excess returns (0.605%) and Indonesia has the lowest monthly excess returns. The volatility of the excess returns on stock markets, as measured by the standard deviation, is higher than that of exchange rates. For all series, the Kurtosis and the Jarque-Bera test statistics strongly reject the null hypothesis of normal distributed returns. Furthermore, the Ljung-Box test statistics on the squared returns at 12 lags show strong linear and non-linear dependencies in these return series, suggesting the presence of volatility clustering or ARCH effects and justify our choice of GARCH parameterization for the conditional variance processes. The last column of table 1 reports the result for stationarity in each series using the Augmented Dickey-Fuller (ADF) test. The results allow

[1] Bernt, Hall, Hall and Hausman (1974).

[2] Several studies (Carrieri et al, 2006; Chaieb and Errunza, 2007; among others) suggest that the local inflation rate is random in emerging countries and they use the real exchange rate, that combined both changes in nominal currency value and changes in the rate of inflation, as a measure of PPP deviations.

us to reject the null hypothesis for the existence of a unit-root in favor of alternative hypothesis of stationarity for all series.

We choose a set of global instrumental variables that have been widely used in previous research (Tai, 2007; De Santis and Gerard, 1998; De Santis et al., 2003; Carrieri et al., 2006; Chaieb and Errunza, 2007; Saleem and Vaihekoski, 2010; Antella and Vaiheoski, 2011), to describe the changes in the prices of world market and exchange rate risks. The global information set includes a constant, the world dividend yield in excess of the one-month Eurodollar interest rate (WDY), the change in one month Eurodollar deposit rate (EDR), the change in the US term premium spread (TPS), measured by the yield on the ten-year US treasury in excess of the yield on the one month Eurodollar rate and the US default premium (UDP), measured by the yield difference between Moody's Baa- and Aaa- rated bonds. Table 2 presents the summary statistics and unconditional correlations of the instrumental variables. The correlation matrix shows a low pairwise correlation suggesting that the variables contain sufficiently orthogonal information and can be jointly estimated.

To explain the changes in the local price risk for each country we choose two local information variables in addition to the constant term. The first is the change in 1-month local interest rate (LIR). The second is the local equity price return in excess of the risk-free rate[3].

4. Empirical results

4.1. The base specification

Table 3 reports the estimation results and residual diagnostics of the dynamics ICAMP with time-varying world market and currency risk prices. Panel A contains the estimated parameters of the mean and conditional variance equations, respectively. For the prices of world market risk and currency risk, some coefficients of instrumental variables used to model them are statistically significant, namely the excess dividend yield of the world market and the change in one month Eurodollar deposit rate. Turning to the conditional covariance process, all the estimated parameters in the vectors *a* and *b* are statistically significant at the 1% level and satisfy the stationarity condition in all cases. Moreover, in agreement with studies that uses GARCH process to model second moments (Tai, 2007; Saleem and Vaihekoski, 2010; Chaieb and Errunza, 2007; among others) the elements in *b* are considerably larger than those in *a* and in most cases near the unity suggesting the persistence of volatility in emerging stock markets.

To investigate the significance and time variation in the prices of world market and exchange rate risks, we use the robust Wald tests. The results and *p*-values of those tests are reported in Panel B of table 3. First, we test the null hypotheses that the price of world market risk is zero and constant, respectively. The Wald test statistics indicate the rejection of the null hypotheses at 1% level given that the *p*-value is equal to zero. Second, we test the null hypothesis that the currency risk factor is equal to zero for each countries. Again the null hypothesis is rejected at the 5% level or less in all cases, except for Indonesia, suggesting that currency risk is priced in emerging stock markets. Finally, the Wald test statistics reject the assumption of constant price of currency risk (p-value<0.01). Consistent with previous evidence for emerging markets (Carrieri et al., 2006; Tai, 2007; Guesmi and Nguyen, 2011) we find that currency risk is not only significantly priced but it also changes over time. In fig. 1 we depict the time series for the global risk factors calculated using the parameter estimates in table 3. One can clearly see that the dynamics of the prices of world market risk and each

[3]We exclude the dividend of local stock market since the data are not available for emerging markets over the whole period.

of currency risk are time-varying. Therefore, all series exhibit high volatility and have increased during crisis periods namely during the Asian and subprime crises.

Panel C of table 3 reports a number of diagnostic test statistics of the estimated results. The Jarque-Bera test statistics are significant in all cases except for Malaysia stock returns, which lead to reject the null hypothesis of normality. The Ljung-Box test statistics show that there is no more serial correlation in the standardized residuals, indicating that the GARCH process is correctly specified.

4.2. The size of the risk premiums

Now, we use the estimation results of the asset pricing model to calculate the risk premium associated with each source of risk. Therefore, to assess the economic importance of currency risk in emerging stock market, we decompose the total premium (TP) into three risk premiums: the world risk premium (WP), the local risk premium (LP) and the currency risk premium (CP) as follows:

Total premium: $TP = WP + LP + CP$
Word market premium: $WP = \gamma_{w,t-1} cov_{t-1}(r_{it}, r_{wt})$
Local market premium: $LP = \gamma_{l,t-1} var_{t-1}(r_{it})$
Currency premium: $CP = \sum_{c=1}^{L} \gamma_{c,t-1} cov_{t-1}(r_{it}, r_{c,t})$

The time variations of the total risk premium and the currency risk premium for each emerging stock market are reported in Fig 2. Since we want to focus on the relative importance over time of the exchange rate risk, we plot jointly the total risk premium and the currency risk premium. Interestingly, the size and dynamics of each premium component vary significantly across markets and over time. Moreover, graphs reveal some similarities within region. For the three Asian countries, the economic importance of currency premium is rather small during the two sub-periods from February 1994 to June 1997 and from January 2002 through the beginning of 2007. Furthermore, the contribution of the currency premium to the total premium has increased significantly during the crisis periods. For instance, we find that the total risk premium is entirely explained by its exchange rate risk component during the Asian financial crisis, the Russian crisis and the subprime crisis. We link this finding to the increase in the price of currency risk in the crisis specification. For the three Latin American countries, the currency risk premium varies considerably through time and in some periods it determines most of the total premium namely during the 1999-2001 subsample covering the Argentine crisis and the terrorist attacks of 11 September as well as during the subprime crisis between 2008-2009.

Fig. 3 plots the structure changes in aggregate currency premiums for the whole period and the two sub-periods from February 1994 until December 2000 and January 2001 until March 2009. Over the whole sample, we can see that the average values of currency premiums are positive for all markets except for Argentina and Mexico, and go from a minimum of -2.51% for Argentina to a maximum of 2.12% for Korea. When we consider the first sub-period, the values of premium associated to currency risk are positive in most cases. This can be explained by the economic events that took place during this sub-period such as the Asian crisis, the Russian crisis and the Brazilian crisis. Indeed, these events have increased the exchange rate fluctuations and uncertainty on the future value of emerging currencies. Since, investors are risk aversion and so require higher risk premiums. Turning to the second sub-period, we can see that the average values of currency premiums are negative and rather more important in absolute value than for the first sub-period in most cases. A possible explanation of this finding could be in the predominance of hedging components. Moreover, with the development of derivative markets in emerging countries since 2000, investors are willing to pay a portion of the total premium to hedge against the unanticipated changes in exchange rates.

5. Conclusion

In this paper we investigate the pricing of market and currency risks in some emerging stock markets during the turbulent period 1994-2009. We use an international version of conditional asset pricing models which allows to the prices of risk to be time varying and we utilize the multivariate GARCH process of De Santis and Gérard (1997, 1998) to model the conditional variance-covariance matrix. The main results show that the currency risk is significantly priced in emerging stock markets. We also find that the price of currency risk is time-varying and it is affected by the crises that occurred during the period under investigation. In addition, our results suggest that the contribution of currency premium to total premium varies significantly through time and across countries. For instance, the total premium is entirely explained by currency risk premium during crisis episodes namely during the Asian crisis and the subprime crisis. These results have important implications for international portfolio diversification and currency hedging strategies.

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Appendices

Table 1 : Summary statistics of returns series

	Mean (%)	Std. Dev.	Skewness	Kurtosis	J-B	$Q^2(12)$	ADF-test
Panel A : Excess returns on stock market indices							
IND	-0.576	14.382	-0.536	5.189	45.061**	113.18**	-10.865**
KOR	-0.128	11.887	0.224	5.611	53.611**	80.620**	-12.291**
MAL	-0.408	9.189	-0.148	7.097	127.85**	165.14**	-6.748**
ARG	-0.384	11.845	-0.706	6.013	83.98**	12.866	-12.558**
BRE	0.605	11.998	-0.878	5.119	57.48**	11.87	-12.504**
MEX	-0.015	9.595	-1.458	6.936	181.97**	11.55	-12.217**
WOR	0.0389	4.432	-1.223	5.899	109.11**	28.332**	-11.335**
Panel B : Returns on real exchnage rate indices							
TCIND	-0.121	5.767	-0.320	9.600	333.468**	194.40**	-10.738**
TCKOR	0.226	3.706	4.745	42.641	12599.3**	8.188	-9.620**
TCMAL	-0.032	0.892	0.230	5.302	41.806**	64.289**	-10.200**
TCARG	0.060	0.943	0.776	8.758	269.73**	61.71**	-10.888**
TCBRE	-0.162	3.437	0.102	4.658	21.172**	74.75**	-9.672**
TCMEX	0.175	3.751	3.388	27.975	5078.44**	67.12**	-6.431**

Note : ** statistical significance at the 5% level. J-B is the Jarque-Bera test statistic for normality. $Q^2(12)$ is the Ljung-Box test statistics for up to the 12^{th} order correlation applied to squared returns. TC is the real exchange rate.

Table 2 : Global information variables

	Mean(%)	Std.dev	Min	Max	Pair-wise correlations			
WDY	1.0371	16.971	-0.608	1.135	1.000			
EDR	-0.6202	16.858	-1.225	0.615	0.108	1.000		
TSP	1.0514	20.658	-1.426	1.468	-0.205	0.212	1.000	
UDP	0.1600	1.768	-0.065	0.099	0.384	-0.455	-0.125	1.000

Table 3: Estimates results of the conditional international CAMP

Panel A: parameter estimates of the prices of risks

	Constant	WDY	EDR	TSP	UDP
Price of world risk	0.842*** (0.192)	0.097*** (0.027)	0.093** (0.038)	-0.014 (0.009)	-1.021*** (0.200)
Price of currency risk					
Indonesia	-0.021 (0.436)	-17.869* (10.117)	-16.468 (10.599)	-1.128 (2.141)	-4.493 (28.219)
Korea	-0.323 (0.271)	-22.468*** (6.288)	-20.906*** (6.588)	-1.011 (1.331)	10.824 (17.542)
Malaysia	-0.013 (0.065)	-4.552*** (1.522)	-4.312*** (1.594)	-0.532* (0.321)	-1.559 (4.244)
Argentina	0.083 (0.069)	-4.564*** (1.605)	-5.508*** (1.682)	0.421 (0.339)	-11.275** (4.478)
Brazil	-0.086 (0.248)	-23.897*** (5.769)	-26.099*** (6.044)	0.841 (1.221)	-8.744 (16.091)
Mexico	0.289 (0.275)	-24.512*** (6.381)	-25.337 ***(6.685)	-0.146 (1.350)	-15.572 (17.985)

	Indonesia	Korea	Malaysia	Argentina	Brazil	Mexico	World
a_i	0.386***(0.068)	0.157***(0.050)	0.283***(0.063)	0.241***(0.062)	0.027(0.035)	0.150***(0.065)	0.110***(0.055)
b_i	0.869***(0.035)	0.962***(0.013)	0.936***(0.023)	0.917***(0.049)	0.989***(0.008)	0.974***(0.014)	0.979***(0.012)

Panel B: specification tests

	χ^2	*df*	*p-value*
Is the price of global market risk equal to zero? H_o: $\emptyset_{w,j} = 0\ \forall j$	29.4298	5	0.0000
Is the price of global market risk constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	14652.6	4	0.0000
Is the price of currency risk in Indonesia equal to zero? H_o: $\emptyset_{c,j} = 0\ \forall j$	10.9738	5	0.0519
Is the price of currency risk in Korea equal to zero? H_o: $\emptyset_{c,j} = 0\ \forall j$	16.4714	5	0.0056
Is the price of currency risk in Malaysia equal to zero? H_o: $\emptyset_{c,j} = 0\ \forall j$	12.0895	5	0.0336
Is the price of currency risk in Argentina equal to zero? H_o: $\emptyset_{c,j} = 0\ \forall j$	15.2287	5	0.0094
Is the price of currency risk in Brazil equal to zero? H_o: $\emptyset_{c,j} = 0\ \forall j$	20.5992	5	0.0010
Is the price of currency risk in Mexico equal to zero? H_o: $\emptyset_{c,j} = 0\ \forall j$	15.3827	5	0.0088
Is the price of currency risk in Indonesia constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	10.4396	4	0.0336
Is the price of currency risk in Korea constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	15.7017	4	0.0034
Is the price of currency risk in Malaysia constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	35.6970	4	0.0000
Is the price of currency risk in Argentina constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	14.4857	4	0.0059
Is the price of currency risk in Brazil constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	20.1412	4	0.0005
Is the price of currency risk in Mexico constant? H_o: $\emptyset_{w,j} = 0\ \forall j > 1$	14.9599	4	0.0048

Panel C: diagnostic tests

	Indonesia	Korea	Malaysia	Argentina	Brazil	Mexico	World
Skewness	-1.432	-1.177	-0.294	-0.854	-1.149	-0.934	0.204
Kurtosis	7.404	5.448	3.445	5.994	5.665	5.578	44.701
J-B	209.28***	87.492***	4.117	90.093***	93.988***	76.877***	45.968**
Q(12)	5.004[0.958]	26.011[0.011]	20.337[0.061]	11.823[0.460]	7.304[0.837]	10.947[0.534]	22.414[0.033]

Note: standard errors are reported in parentheses. *,**and ***indicate the significance at the 10%, 5% and 1% levels, respectively. Q(12) is the Ljung-Box test statistics for autocorrelation of order 10 applied to standardized residuals. J-B is the Jarque-Bera test statistic for normality. *P-value* are in brackets [.].

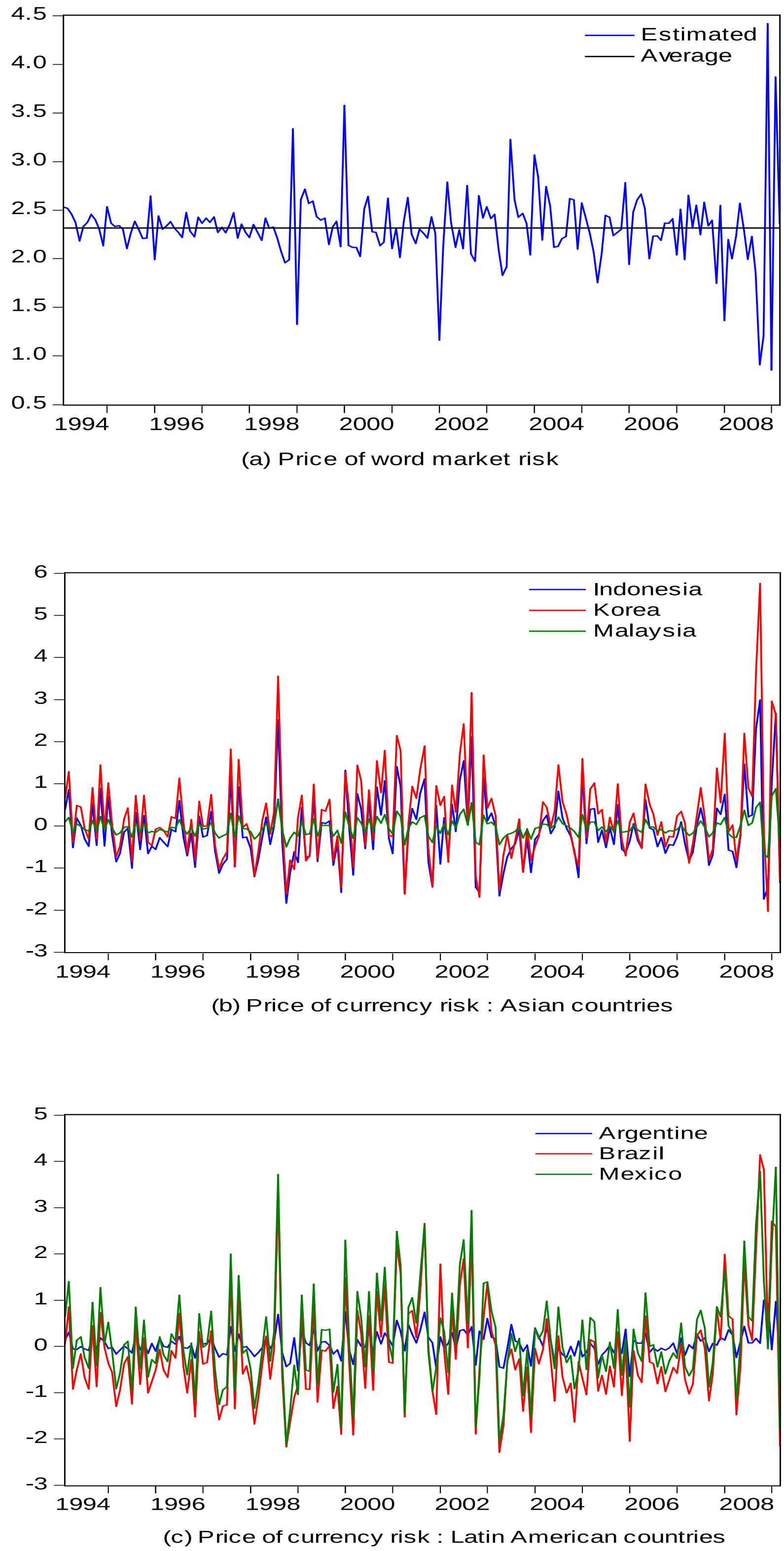

Fig 1: Estimated prices of global risks: (a) price of world market risk, (b) prices of currency risk in emerging Asian countries (Indonesia, Korea, Malaysia), (c) prices of currency risk in emerging Latin American countries (Argentina, Brazil, Mexico).

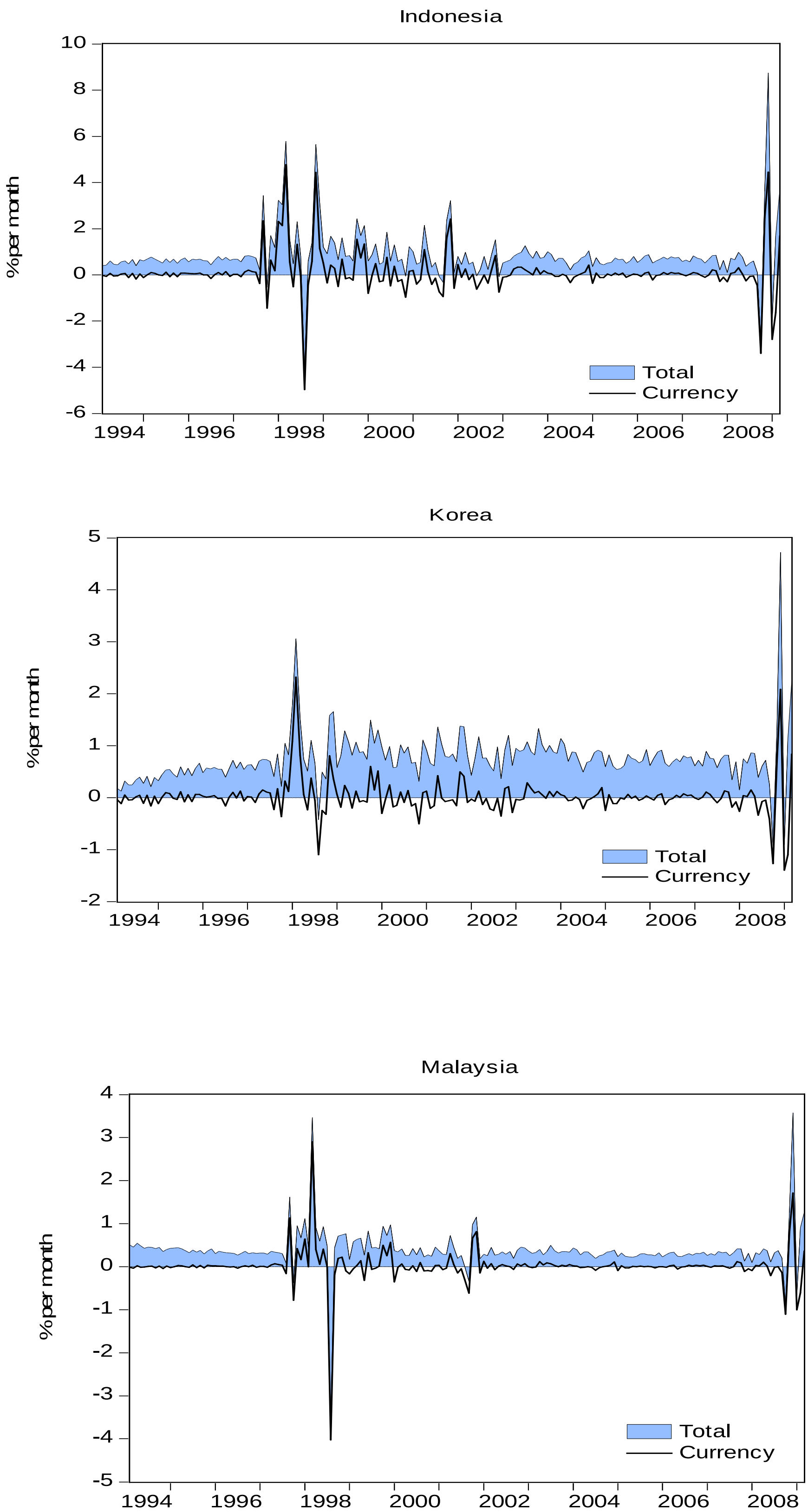

Fig 2: Estimated risk premiums. For each emerging markets ''total'' represent the sum of the estimated currency, local market and world market premiums and ''currency'' represents the portion of the total premium associated to currency risk

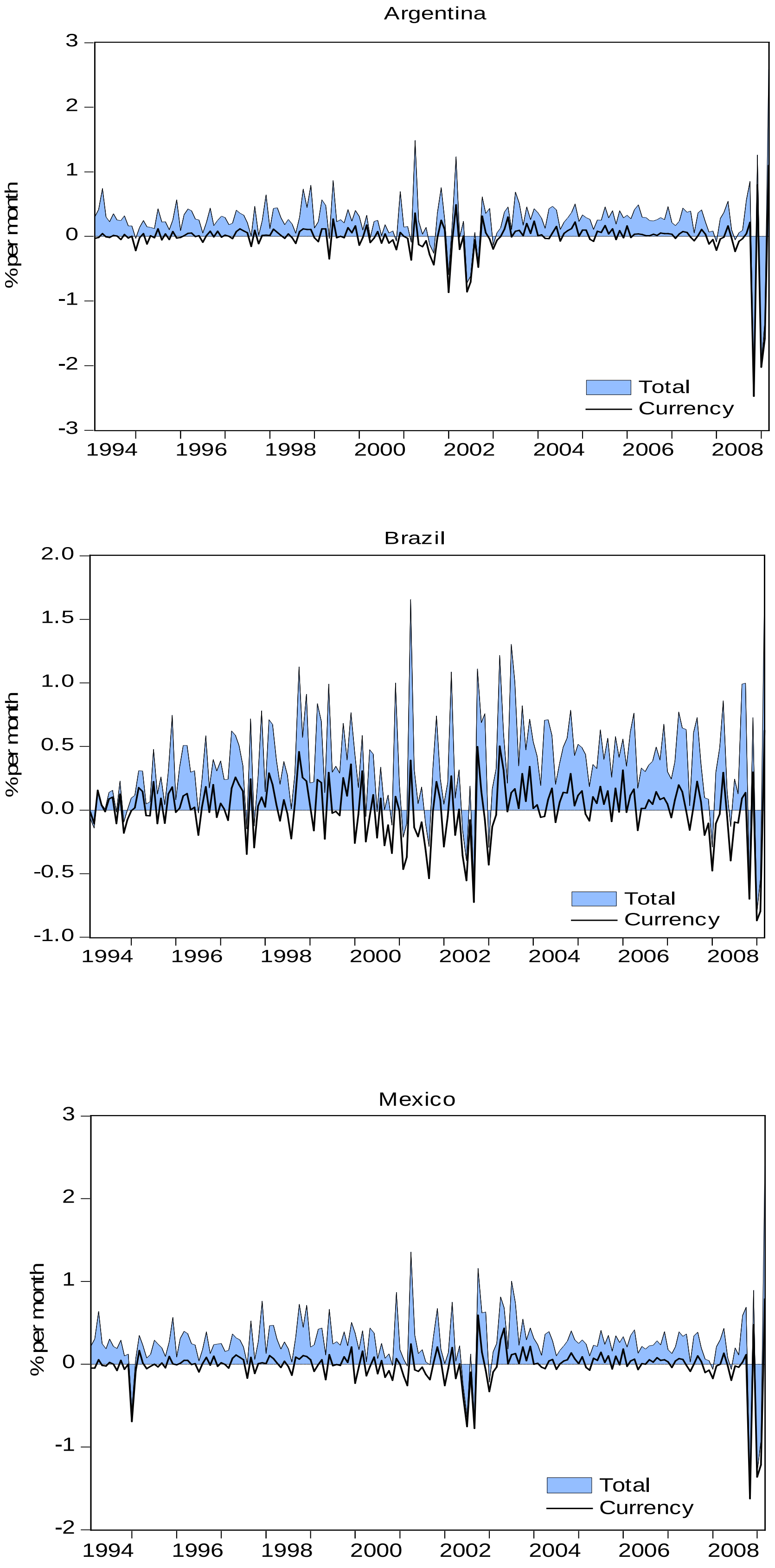

Fig 2. *(continued)*

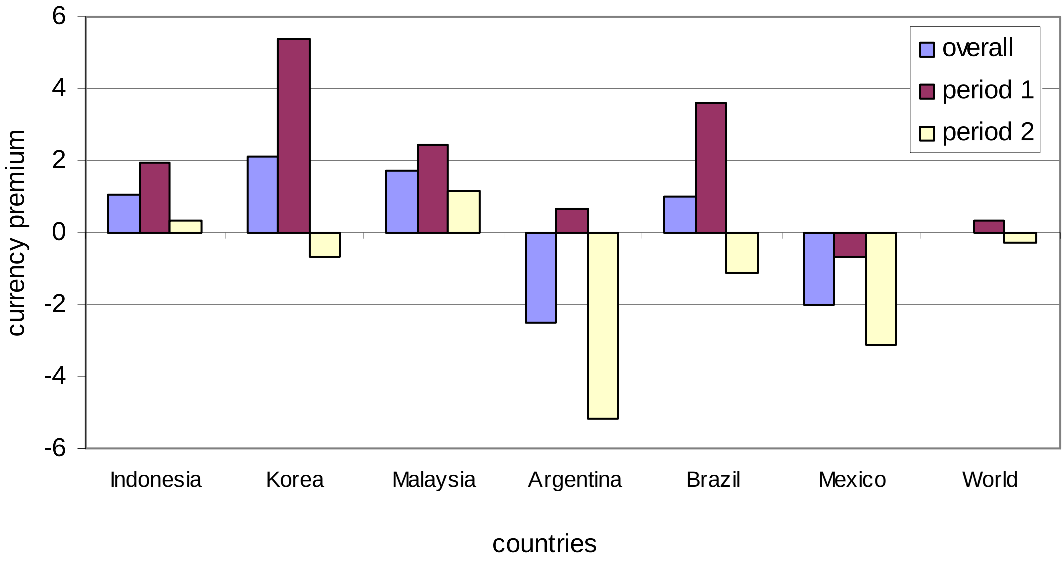

Fig 3: Structural changes in currency premia.