ESSAYS IN INTERNATIONAL ASSET PRICING AND FOREIGN EXCHANGE RISK

Thesis

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Abstract

The purpose of this thesis is to provide new evidence on the pricing of foreign exchange risk in the stock market by testing international asset pricing models (IAPMs) under varying market structures and different exchange rate measures. It is composed of three essays. In the first essay, I test unconditional asset pricing models with exchange risk using country, portfolio and firm level data from nine emerging markets (EMs). It is shown that unlike the case for developed markets where unconditional tests often fail to detect a significant exchange risk premium in stock returns, exchange risk is unconditionally priced in EMs. However, when local market risk is introduced in the model to take into account potential segmentation effects, exchange risk premia are totally subsumed by local risk premia for most countries especially at the firm level. The second essay examines the significance of exchange risk in conditional IAPMs using multivariate GARCH-in-Mean specification and time varying prices of risk. The model tested assumes partial integration and uses real exchange rates to account for both inflation risk and nominal exchange risk. The main empirical results support the hypothesis of significant exchange risk premia in EMs equity returns even after accounting for local market risk. The exchange risk premia are also economically significant as they represent on average 18 percent of total premium, and may reach up to 45 percent of total premium for some countries over sub-periods. In the third essay, I test for the pricing of exchange risk in stock returns using globally diversified sector portfolios. The purpose of this test is to examine the effect of cross-currency diversification on the global price of foreign exchange risk. Since there is no previous evidence on this issue, I use data on the G7 countries and EMs. The results suggest that the effects of exchange risk may be less significant in pricing global assets such as global sector portfolios that are diversified across both developed and emerging markets. Further investigation of this issue is called for. The conclusions of this thesis have important implications for international asset pricing modeling and testing, as well as for hedging policies of corporate managers and portfolio investors.

Résumé

L'objet de cette thèse est de produire de nouveaux résultats sur l'évaluation du risque de change sur les marchés boursiers en testant différents modèles internationaux d'évaluation des actifs (IAPMs) sous différentes spécifications de la structure du marché mondial et différentes mesures du risque de change. La thèse comporte trois essais. Dans le premier, nous testons des modèles d'évaluation des actifs financiers dans une version non conditionnelle en utilisant des données sur neuf marchés émergents. Les tests sont conduits non seulement pour les indices de marchés, mais aussi pour des portefeuilles et des actions de firmes. Les résultats montrent que, contrairement à ce qui a été obtenu pour les marchés développés dans un contexte non conditionnel, le risque de change se traduit par une prime de risque significative dans les rendements boursiers des pays émergents. Toutefois, si l'on introduit le risque de marché domestique dans le modèle afin de tenir compte des potentiels effets de segmentation, la prime de risque de change est complètement absorbée par la prime du risque domestique. Le deuxième essai examine l'importance du risque de change dans les modèles IAPMs conditionnels en utilisant une spécification GARCH-in-Mean multivarié et en supposant que les prix de risque sont variables dans le temps. Nous faisons aussi l'hypothèse que les marchés sont partiellement intégrés et nous utilisons des taux de change réels afin de tenir compte aussi bien du risque d'inflation que du risque de change nominal. Dans ce contexte, les résultats confirment que les primes de risque de change demeurent très significatives même en tenant compte du risque du marché domestique. Les primes de risque de change sont également économiquement significatives puisqu'elles représentent en moyenne 18% de la prime totale de risque et peuvent même atteindre 45% pour certains pays sur certaines périodes. Dans le troisième essai, nous testons un modèle conditionnel d'évaluation des actifs en utilisant les rendements de portefeuilles globalement diversifiés. L'objet de ce test est d'examiner l'effet de la diversification internationale du portefeuille sur le prix mondial du risque de change sur les marchés boursiers. En se basant sur des données sectorielles sur les pays du G7 et les pays émergents, nos résultats montrent que les effets du risque de change sont moins significatifs dans l'évaluation des actifs mondiaux à l'instar des portefeuilles de secteurs industriels notamment lorsque ces derniers sont diversifiés aussi bien à travers les pays développés qu' émergents. Les résultats de cette thèse ont d'importantes implications pour la modélisation et la validation des modèles internationaux d'évaluations des actifs ainsi que pour les stratégies de couverture des gérants corporatifs et des investisseurs.

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To my dear parents / A mes chers parents

Maryem & Salem

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Introduction

Foreign exchange risk is recognized, besides market segmentation or integration, as one of the most important dimensions of international asset pricing and foreign investments. Indeed, the existence of currency risk, due to exchange rates fluctuations, is one of the major issues facing international investors since exchange rate volatility may offset the reduction in security risks achieved through international diversification, at least in the short run. The purpose of this thesis is to investigate whether exchange risk is a priced factor in international asset pricing models (IAPMs) under varying market structures and different exchange rate measures.

Many agree that exchange risk premia in equity returns exist because of deviations from purchasing power parity (PPP). In fact, if PPP holds exactly and if there are no barriers to international investment and no differences in consumption preferences between countries, the traditional single-index asset pricing model, with only one risk premium based on the covariance of assets with the world market portfolio, would also hold internationally. In such a perfect world, foreign exchange risk should have a zero price in the stock market. This means that investors would not require a risk premium to reward the exchange risk related to an investment in foreign securities.

In the real world though, such strict assumptions are hardly satisfied. Various legal and institutional barriers are still faced by investors in many countries. Consumption preferences differ among countries and repeated deviations from PPP are well documented in the economics literature. Under such conditions, investors may consider an investment in foreign securities as more risky and will want to hedge against foreign exchange risk, perceived as a 'real' currency risk.

Many authors tried to theoretically analyze the effects of exchange rate fluctuations on equilibrium prices and developed asset pricing models under PPP deviations (for example Solnik (1974), Grauer, Litzenberger and Stehle (1976) (GLS), Adler and Dumas (1983)). The results are different and depend on the assumptions of each model. For example in GLS model, exchange risk is considered as a money illusion and therefore only world market risk is priced[1]. On the other hand, Solnik (1974) followed by other models consider exchange risk as a priced factor just like market risk. On the empirical side, most studies have focused on few developed markets and the results of early tests were rather inconclusive, until two recent studies by Dumas and Solnik (1995) and DeSantis and Gerard (1998) found consistent evidence showing that exchange risk premium is a significant component of equity returns. This evidence calls for further research to examine the significance of the price of exchange risk in different market environments such as emerging markets (EMs) that are characterized by greater exchange rate uncertainty and where inflation can also be high and volatile.

Another important issue that remains relatively unexplored concerns the effect of market segmentation on the significance of exchange risk premia in international asset pricing models. As shown by several studies such as Stulz (1981b), Errunza and Losq (1985), and Hietla (1989), market segmentation may result in heterogeneous portfolio selections that affect the asset pricing relations by incorporating country-specific risk premia. These models, however, have neglected to take into account the exchange risk factor arising from PPP deviations. On the other hand, most IAPMs that incorporate exchange rate risk have ignored local market risk. This may result in a spurious significance of the price of exchange risk because of the missing domestic risk factor in previous empirical tests. Indeed, the existing evidence provides very little indication

[1] I thank Jean-Claude Cosset for pointing out to an unpublished comment "*the virtual GLS reply to Solnik's virtual comment*" where GLS disagree with such an interpretation of their model as considering exchange risk as a money illusion. However, we can still consider GLS model in a separate category compared to the above mentioned models where exchange risk appears as an additional pricing factor.

about the relative importance of exchange risk premia in asset pricing in the presence of local market risk which can be significant in partially segmented markets.

This thesis is an attempt to shed light on some of these issues by conducting three empirical essays that examine the relevance of foreign exchange risk in international asset pricing under different model specifications and varying market structures. The rest of the thesis is organized as follows.

Chapter I presents a review of the theoretical and empirical literature on the effects of exchange risk on stock returns and international asset pricing, the issue of integration versus segmentation of capital markets, as well as other related issues that have been discussed in the international finance literature. The chapter concludes that the existing evidence is not very informative and does not allow one to draw clear conclusions on whether exchange risk is generally priced in the stock market, especially in the context of emerging markets. The following three empirical essays are meant to answer some of the open questions raised in this literature review.

In chapter II, we present the first essay where we test for the existence and significance of exchange risk premia in nine emerging markets using alternative model specifications in an unconditional framework. The empirical tests are performed using market indices, size and industry portfolios as well as firm level returns. The main results show that, unlike the case for developed markets where unconditional tests failed to detect a significant exchange risk premium in stock returns, there is indication that exchange risk is unconditionally priced in EMs. However, when local market risk is introduced in the model to take into account potential segmentation effects, exchange risk premia are totally subsumed by local risk premia for most countries especially at the firm level.

In chapter III, we present the second essay in which we examine the pricing of exchange risk in conditional IAPMs using multivariate GARCH-in-Mean specification and time varying prices of risk. The model tested assumes partial integration and uses changes in the real exchange rates to account for both inflation risk and nominal exchange risk. Since inflation risk is particularly relevant in the context of EMs, we cannot follow previous studies by assuming non-stochastic inflation and simply using nominal exchange rate changes as a measure of PPP deviations. The main empirical results support the hypothesis of significant real exchange risk premia in emerging stock markets even after accounting for local market risk. The price of exchange risk is also significantly time-varying and that is consistent with the evidence for developed stock markets. An estimation of the size of exchange risk premia relative to world and domestic risk premia shows that currency premia represent an important component of EMs equity returns, which at times, and for some countries, can be as high as the local risk pemium.

The third essay is presented in chapter IV. Here we test a conditional IAPM with exchange risk using cross-sections of globally diversified sector portfolios. The purpose of this test is to examine the effect of cross-currency diversification on the global price of foreign exchange risk. To our knowledge, there is no previous evidence on this particular question. We use data on the G7 countries and EMs to construct three sets of global sectors portfolios. One is diversified only across the G7 countries while the two others are constructed to span both developed and emerging markets. Preliminary results of this study suggest that the effects of exchange risk are less significant in pricing global assets such as global sector indexes that cover both developed and emerging markets. Interestingly, when EMs are excluded from the global sectors portfolios, the price of exchange risk remains significantly different from zero. This new evidence calls for further investigation of this issue using different datasets and different methodology to check the robustness of such results.

Chapter V summarizes the main findings of the three studies and concludes the thesis by suggesting some future research venues related to the current subject.

CHAPTER I

Exchange Risk in International Asset Pricing Models: A Review of Theory and Empirical Evidence

1. Introduction

The existence of foreign exchange risk and its effect on equilibrium prices has long been the subject of controversy in the asset pricing debate. Theoretically, if the effects of currency risk do not vanish in a well-diversified portfolio, exposure to this exchange rate factor should yield a risk premium in an asset market in equilibrium. Some authors argued that exchange rate risk is one of the fundamental factors to take into account when moving from domestic to international asset pricing. They developed theoretical models where exchange rate risk is priced along with market risk [Solnik (1974), Sercu (1980), Adler and Dumas (1983)]. This means that, besides the traditional premium based on the covariance of asset returns with the market portfolio, these models also include currency risk premia to reflect the covariances of asset returns with exchange rates fluctuations. However, there also models that ignore the existence of foreign exchange risk and, in line with Grauer, Litzenberger and Stehle (1976) framework, claim that exchange risk is nothing but a "money illusion". On the empirical side, the evidence is also mixed and fragmentary with some studies suggesting that exchange risk is an important factor in international asset pricing while others fail to find any significance evidence on the pricing of exchange risk in stock markets.

The purpose of this chapter is to review and discuss the theoretical and empirical literature related to studying the effects of exchange rate changes on international asset pricing. In particular, we consider the question of whether exchange risk is priced in the sense that it commends a significant risk premium in an international asset pricing model.

The rest of the chapter is organized as follows. In section 2, we discuss the problem of exchange risk in international portfolio investments. Section 3 provides a brief review of the empirical literature about the relation between stock returns and exchange rates fluctuations. In section 4, the relationships between more general tests in international capital markets and the pricing of exchange rate risk are discussed. In section 5, the major empirical models directly testing for the pricing of exchange risk in the stock market are reviewed and analyzed with respect to their results and econometric methodologies. Section 6 discusses the related issue of international market integration versus segmentation in international asset pricing. Finally, section 7 concludes the chapter and summarizes the issues that need further investigation and which will be addressed in the rest of the thesis.

2. The problem of foreign exchange risk in international portfolio investment

Over the last two decades, we witnessed an increasing trend towards international diversification of investment portfolios into stock markets throughout the world. The basic argument in favor of international diversification is that it allows reduction in total portfolio risk for a given level of expected returns. This reduction in risk is achieved because of the generally low correlations that exist between assets in different national markets. The existence of currency risk, though, may offset the reduction in security risks achieved by international diversification[1]. Hence, a growing attention has

[1] Whether the extent of diversification gains varies between hedged and unhedged portfolios is a matter of empirical evidence. This is an interesting question that still needs to be addressed in the literature. Yet, by diversifying internationally, an investor has to face a new source of uncertainty related to currency movements. This may offset some of the diversification gains if the exchange rate uncertainty is not compensated in terms of expected returns or if hedging implies high costs for the portfolio investor.

been paid to the problem of foreign exchange risk in portfolio theory, especially since the introduction of floating exchange rates after the breakdown of the Bretton Woods system in the early 1970's.

In fact, under flexible exchange rates, the potential gains from international diversification are more likely to be reduced or even offset because investments in foreign securities (with realized returns in foreign currencies) are subject to exchange rate fluctuations. As such, foreign equity investments may be perceived as riskier because of the additional exchange risk dimension. For instance, Eun and Resnick (1988) argue that exchange rate uncertainty contributes to the risk of a foreign investment not only through its own variance but also through its 'positive' covariance with the local market returns. Their study documented the existence of significant correlations between stock market indices and currency movements in seven industrial countries. They found that, over the 1980-1985 sample period, exchange rate volatility accounts for about 50 percent of the volatility of dollar returns from investments in the stock markets of such major countries as Germany, Japan and the UK.

In a more recent study, Eun and Resnick (1994) analyzed the effect of exchange rate uncertainty on international bond and stock portfolios from both the US and the Japanese perspectives over a longer time horizon (1978-1989). They found that, in the case of stock portfolios[1], exchange risk accounts for about 30 percent of the total portfolio risk in terms of both the dollar and the yen. The ratio exceeds 50 percent in the case of mixed portfolios comprising bonds and stocks, and is as high as 77 percent of the variance of dollar returns of bond portfolios.

[1] The authors constructed equally weighted portfolios from seven developed markets over the sample period based on monthly returns.

Given such evidence, the question of whether exchange rate risk is a priced factor in stock returns becomes an important issue in international asset pricing modeling and testing. The answer to this question could also contribute some new insights to the dilemma of hedge-no-hedge strategy faced by international investors. As pointed out by Jorion (1991), modern portfolio theory emphasizes that investors would not be willing to pay a premium for stocks of firms with active hedging policies if foreign exchange risk can be diversified away. In other words, corporate hedging will be valuable to investors only if foreign exchange risk is priced in the stock market.

3. Exchange rate fluctuations and stock returns

Many authors believe that exchange rate movements should have an impact on asset prices and widely accepted theoretical foundations support such view. For instance, bond prices tend to be strongly correlated to exchange rate movements because of the fundamental relationship between interest rates and exchange rates. As for stock prices, early theoretical models such as Shapiro (1974) and Dumas (1978), have identified potential impacts of exchange rate movements on the firm's expected cash-flows[1] and hence on its market value and share prices. In addition, stock markets and exchange rates might be correlated because they are both subject to the effects of similar macroeconomic variables.

Empirically, the evidence is mixed, depending on whether we consider the relation between stock prices and exchange rates at the firm level or at the aggregate market level. At the market level, most of the existing evidence point towards a very low positive correlation between stock market indices and currency movements[2]. In the

[1] Firms operating cash flows are subject to transaction and economic exchange risk exposures.
[2] See Solnik (1994) for a review. Also, Cosset (1984, p.143) provides a purely empirical explanation for the lack of correlation between world stock market indices (a proxy for world wealth) and foreign exchange rates.

case of EMs, a recent study by Abdalla and Murinde (1997) examined the causality link between stock prices and exchange rates in five countries, using a VAR framework. A unidirectional causality from exchange rates to stock price indices is documented for all countries except one, over the period 1985-1994.

Other studies investigated the relation between risk premia in stock markets and risk premia in foreign exchange markets. They documented the presence of a small positive link between dollar risk premia on foreign currency deposits and risk premia on the US equity market [Giovannini and Jorion (1987), Chiang (1991), McCurdy and Morgan (1992), Korajczyk and Viallet (1992)]. It should be noted though, that such aggregate level analyses may not be able to detect the true sensitivities of firm values to exchange rate changes.

At the individual firm (and portfolio) level, the results are quite mixed, depending on the research design and the types of firms in the samples. For instance, Jorion (1990) found only a weak link between contemporaneous exchange rate changes and stock returns of US multinationals. Using portfolio data on Canada, Japan and the US, Bodnar and Gentry (1993) also found minimal evidence of stock returns sensitivity to exchange rate movements. A similar result was obtained in Bartov and Bodnar (1994) on the basis of individual firm data.[1] In contrast to these results, Choi and Prasad (1995) found that exchange rate changes do affect firms prices for a sample of 409 multinational firms in the US over the period 1978-1989. Interestingly, when the data on those firms is grouped into 20 SIC-based industry portfolios, the authors found limited support for exchange rate sensitivity, though some cross-sectional and inter-temporal variations were still present in the exchange rate coefficients.

[1] Lagged exchange rate changes, however, were found to be significantly related to stock returns in this study.

Another study by Bartov, Bodnar and Kaul (1996) examined the second moments relation between exchange rates and stock returns of US multinationals by investigating whether part of the additional risk, if any, is systematic or diversifiable. The intuition behind this study is the following: If increased exchange rate variability leads to a higher volatility of stock returns and if this additional risk is non-diversifiable, then we should expect investors to demand a higher required rate of returns which translates into a higher cost of capital for the firm. In other words, exchange rate movements may affect firm pricing via their impact on the firm's market risk (beta).

The empirical results for the sample of US firms (both domestic and multinational) covered in Bartov et al. (1996) provided evidence that: 1) stock return volatility was positively related to exchange rate variability and, 2) US multinationals experienced an increase in market risk (beta) corresponding to the increased exchange rate variability in the floating rate system. These results are interesting and motivate, in some sense, the need for further investigation of the pricing of exchange risk in the stock market at the individual firm level.

4. International market efficiency and asset pricing

Although the main focus of this literature review is on the pricing of exchange risk in the stock market, it is worth noting that many empirical results relevant to this subject can be derived from more general types of studies such as those testing for international market efficiency, which, in turn, is related to tests of integration versus segmentation of global financial markets. In fact, market efficiency is one of the classic tests in the financial literature as most asset pricing models are based on the assumption that markets are efficient. With respect to international capital markets, it is argued that in a fully efficient, integrated, market, buying the world market portfolio would be the natural strategy (mean-variance efficiency of the world portfolio). In this context, assets in different markets are priced according to their covariances with the world market portfolio return. Exchange risk should not be a priced factor in such a perfect and efficient world capital market.

International market efficiency has been tested using cointegration and unit roots tests. The cointegration literature states that if markets in different countries are collectively efficient in the long run, then asset prices in these markets are not cointegrated. This technique was widely applied to foreign exchange markets[1] but was first applied to stock markets by Chan et al (1992) for major Asian markets and the US. They found that stock prices in different markets are not cointegrated and concluded that the markets tested are weak-form efficient.

It is also interesting to consider the results of tests of foreign exchange market efficiency as some relevant conclusions derived from this literature concern the existence and the behavior over time of risk premia on foreign exchange markets. Such results are important since one of the basic assumptions underlying tests of international asset pricing models is about the time behavior of the risk premia included in the model. One of the classic tests in the foreign exchange literature was to determine whether forward rates are unbiased estimators of the future spot exchange rates. Most of the empirical evidence suggests that forward exchange rate prices are not unbiased predictors of future spot exchange rates [see review by Hodrick(1987), Cumby(1988), and Baillie and McMahon (1989)]. This result was first interpreted as evidence of inefficiency of the forward foreign exchange market. Other studies [Solnik (1974) and Grauer, Litzenberger and Stehle (1976)] showed that the presence of an exchange risk premium causes the forward rate to be a biased estimator of the future

[1] See Baillie, R.T. and T. Bollerslev, 1989, *Common Stochastic Trends in a System of Exchange Rates*, The Journal of Finance, 44(1), 167-181.

spot rate. This led to an alternative interpretation suggesting the existence of forward premia that are time-varying.

Using the currency options market to measure time-varying expected second moments, Lyons (1988) found that changes in the market's second moments expectations are systematically related to expected returns differentials between assets denominated in different currencies. He interpreted this finding as substantial evidence that a risk premium does exist, as opposed to the alternative interpretation of a violation of the rational expectations hypothesis. According to Lyons (1988), the rejection of the hypothesis that forward exchange rates are unbiased predictors of the future spot rates, offers a stronger basis to interpret this result as evidence for the existence of a non-zero risk premium on the foreign exchange market. This explanation is consistent with the existing evidence of time variation of risk premia in common stock returns [Cosset (1984), McCurdy and Morgan (1989)].

5. Exchange risk in IAPMs

The empirical evidence reviewed in section 3 suggests that there is rather a weak link between aggregate stock market returns and exchange rate changes while mixed results hold for returns at the individual firm level. Nonetheless, as noted by Jorion (1991), a weak correlation between stock market indices and currency movements does not rule out a significant cross-sectional relation between stock returns and currency movements. The relevance of exchange risk in asset pricing relations cannot be simply deduced from a correlation analysis between exchange rates and stock returns. Thus, numerous attempts have been made to directly test whether exchange risk is priced in the stock market in the sense that it commands a non-zero risk premium in an international asset pricing model.

We can classify the existing empirical studies into two categories, based on the underlying theoretical framework. First, those using an international version of the single-index asset pricing model of Sharpe-Lintner (CAPM), and second, those using an extension of Ross's (1976) APT to an international context. We can add to these two categories a third approach, which attempts to use consumption-based asset pricing models (see Cumby, 1990). We will focus our discussion mainly on the two first approaches as they encompass most of the major studies testing for the significance of exchange risk in international asset pricing models. But first, the recent evidence on PPP is briefly reviewed, since PPP deviations constitute one of the basic assumptions underlying the derivation of IAPMs where exchange risk is a priced factor.

5.1. The evidence on PPP deviations

There is a vast literature on testing purchasing power parity for many countries. The consensus among many economists is that some variant of PPP holds in the long run while exchange rates deviations from their PPP values can be quite frequent and persistent in the short run. Moreover, short-term deviations are large and volatile and most evidence suggests that the speed of convergence to PPP is very slow. For instance, some early empirical studies failed to reject the random walk hypothesis for real exchange rates, therefore failing to prove the existence of any convergence toward PPP even in the long run [Roll (1979), Adler and Lehman (1983)].

However, more recent studies using longer horizon data and applying more advanced techniques, including unit root and cointegration methods[1], found some support for relative PPP (by rejecting the random walk model), with estimates of half-

[1] If PPP holds, then the two variables (nominal exchange rates and the ratio of price levels) are cointegrated, i.e., a linear combination of these variables is stationary and converges to an equilibrium level.

life PPP deviations[1] typically falling between three and five years [Abuaf and Jorion (1990), Glen (1992)]. Similar results are obtained when using data from high inflationary countries [Liu (1992), Zhou (1997)]. Such evidence led to the now well-established consensus among researchers that deviations from PPP tend to disappear in the long run, although at a slow rate[2]. In a recent study covering five major OECD countries, Malliaropulos (1998) examined the link between international stock return differentials (relative to the US), and exchange rate deviations from relative PPP. He documented a negative relationship: foreign stock markets outperform the US stock market in countries where the currency appreciates in real terms against the dollar.

Since deviations from PPP and the adverse effect of inflation on stock returns may be quite persistent, fluctuations in real exchange rates may lead to substantial changes in the relative performance of international equity returns when expressed in a common currency. In other words, exchange rate changes constitute additional sources of risk in asset pricing models.

5.2. The International CAPM and the pricing of exchange risk[3]

Theoretically, if the international capital market is efficient and the real prices of consumption goods are identical in every country (i.e., PPP holds exactly), then the classic CAPM should hold internationally with the market portfolio being replaced by the world market portfolio[4]. The risk-return pricing relation of any asset in this fully efficient world market should include only one risk premium proportional to the

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[1] The half-life measure used in the literature refers to the expected number of years for a PPP deviation to decay by 50 percent.

[2] Given the half-life estimates indicated above, the convergence rate is estimated at about 15 percent per annum.

[3] We will use the ICAPM terminology to distinguish between IAPM derived from a CAPM-like theoretical framework (using only a world market factor besides the exchange risk factors) from models using a more general multi-factor framework in the spirit of the APT.

[4] Refers to the market capitalization-weighted portfolio of all assets in the world.

covariance of the asset return with the world market portfolio. In such an ideal world, exchange rate uncertainty can be viewed as a simple money illusion and receives a zero price in the stock market since there is no 'real' exchange risk from holding foreign securities. This conclusion is consistent with Grauer, Litzenberger and Stehle (1976) model. But as discussed above, empirical evidence shows that deviations from PPP are the major sources of exchange rate variations, and can be quite persistent.

Therefore, investors, knowing that a real currency risk exists, are willing to hedge their international portfolios against foreign exchange rate movements. An international CAPM has been suggested in which the equilibrium asset pricing relation includes additional risk premia to reflect the presence of PPP deviations [Solnik (1974), Sercu (1980), Adler & Dumas (1983)]. The general setting of this type of models can be summarized as follows:

If there are *L+1* countries in the world economy, the expected return on an asset measured in a base currency is given by:

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

where r_i and r_w are excess returns on the asset i and the world market portfolio, $\pi^{\$}_c$ is the rate of inflation of country c expressed in the reference currency , E is the expectations operator, δ_w is the price of world market risk and δ_c 's are the prices of inflation risks. The term $\operatorname{cov}(r_i , \pi^{\$}_c)$ measures the exposure of asset i to both the inflation risk and the exchange risk associated with country c.

On the empirical side, there are few tests of the international CAPM as described above [see the review by Dumas and Solnik (1995) and Solnik (1997)]. In some of the early tests, the simple unconditional version of the international CAPM (including the world portfolio factor and an exchange rate factor) is rejected by the data, while the classic CAPM (including only the world portfolio factor) is not. This evidence was interpreted as an indication of a zero price for the exchange rate factor. For instance, Jorion (1991) tested a two-factor model on a sample of value-weighted US equity portfolios and found that the risk premium attached to the exchange risk factor (δ_c) was small and never significant. He concluded that foreign exchange risk did not seem to be priced in the US stock market. More recent studies, however, tested conditional versions of the ICAPM [Dumas and Solnik (1995), De Santis and Gerard (1998) and Carrieri (2001)], and found strong evidence that exchange risk premia are significant, indicating that international investors are rewarded for their exposure to currency risk.

Dumas and Solnik (1995) model is an extension of the asset pricing model used by Harvey (1991) by including three additional factors to account for the uncertainty from 3 major currencies with respect to the US dollar. Unlike previous models, and following Harvey (1991), expected asset returns in this conditional model are assumed to vary over time as a linear function of a vector of information variables while risk premia are allowed to vary freely over time. The results of the various tests conducted by Dumas and Solnik (1995) in this conditional framework support the hypothesis that the currency risk factors are significant and reject the classic CAPM[1] in the context of an international market. They also reject the null hypothesis that the world prices of market risk and foreign exchange risk are time-invariant.

Although the evidence by Dumas and Solnik (1995) strongly supports the hypothesis that exchange risk is priced, their model gives no estimate of the size of the risk premium attached to foreign exchange risk because there is no specification of the

[1] a single-index model including only the world market factor and no exchange rate factor

second moments behavior in their model. De Santis and Gerard (1998) addressed this issue by using a fully parametric approach that allows for the estimation of the size of exchange risk premium which is found to be economically significant relative to the market premium. In addition, De Santis and Gerard (1998) found that the components of the risk premiums vary significantly over time and across markets (their sample includes Germany, Japan UK and US). It is also important to note that in this study, the exchange risk component was detected only after allowing for time variation in the price of risk. This may explain why earlier unconditional tests failed to reject the hypothesis of a zero-price for exchange risk.

Finally, Carrieri (2001) provided further evidence that the size of the currency risk premium is economically significant for four major European countries (Germany, UK, France and Italy) using an international asset pricing model with a multivariate GARCH-in-Mean specification and time varying prices of risk. Another recent study by Ferson and Harvey (1999), where different economic and fundamental factors driving expected returns in world markets are explored, tested an international CAPM model that includes two currency factors based on the Euro and the Japanese Yen. They found that this model outperforms the single factor CAPM for 18 developed markets over the 1975-1997 period. This study also shows that there is no additional explanatory power of global price-to-book factor proposed by Fama and French (1998) over a model that includes currency risk.

In summary, we can say that conditioning information seems to play a crucial role in discriminating between the results of the various studies testing the international CAPM. Unconditional tests, where expected returns and risk premia are constant over time, tend to support the hypothesis that exchange risk is not priced. Conversely, conditional tests, where both expected returns and risk premia are allowed to vary over time, reject the hypothesis that exchange risk is not priced in the stock market.

We should also note that the international CAPM is sometimes tested using a single factor for the different exchange rates to simplify the model. For example, Jorion (1991), Ferson and Harvey (1993, 1994) used the trade-weighted exchange rate index of the dollar to approximate for the different exchange rates changes. But one can argue that such approximations make the results of those tests difficult to interpret. However, studies using bilateral exchange rates were limited to covering only a few countries at a time given the difficulty of estimating a model with multiple exchange risk premia. On the other hand, we should recall that models based on the International CAPM assume that the world capital market is fully integrated. It has been shown, though, that some form of market segmentation exists and that portfolios in some countries can be strongly biased toward domestic investments [French and Poterba (1991), Cooper and Kaplanis (1994), Tsar and Werner (1995)]. Further discussion of the assumption of market integration versus segmentation is provided in section 6 below.

5.3. Arbitrage pricing and multi-factor models

According to the arbitrage pricing theory, as first suggested by Ross (1976), and later extended to an international context by Solnik (1983)[1], if the economy is described by a small number of factors, then these factors may well be priced in the sense that investors will be willing to pay a premium to avoid these sources of risk. Different empirical tests use different factors and one of the questions raised in this context was to determine whether exchange risk is one of the priced factors. If this is true, in the sense that investors consider exchange rate movements as an additional source of risk, then such a factor should command a nonzero risk premium in an

[1] The model assumes perfect and complete asset markets, positive marginal utility of wealth, homogeneous expectations, and a linear k-factor return generating process.

equilibrium asset pricing relation. Below, we review some empirical tests of the pricing of foreign exchange risk in the stock market conducted using a multi-factor framework.

One of the early well known studies in this category is Jorion (1991) who extended the arbitrage pricing model of Chen, Roll and Ross (1986)[1] by adding the exchange rate as a seventh factor. The empirical model tested over the period 1971-1987 and using monthly data from the NYSE, was the following:

$$\widetilde{R}_{it} = E(\widetilde{R}_{it}) + \sum_{j=1}^{6} \beta_i^j \left[\widetilde{F}_{jt} - E(\widetilde{F}_{jt})\right] + \beta_i^s \widetilde{F}_{st}^7 + \widetilde{\varepsilon}_{it}$$

where: $$E(\widetilde{R}_{it}) = \delta_0 + \sum_{j=1}^{6} \delta_j \beta_i^j + \delta_s \beta_i^s$$

and $$\widetilde{F}_{st}^7 = \widetilde{R}_{st} - (\hat{\gamma}_0 + \sum_{j=1}^{6} \hat{\gamma}_j \widetilde{F}_{jt})$$

In this multi-factor model, exchange rate is priced if δ_s (the risk premium associated with the exchange rate factor) is nonzero. Jorion (1991) estimated the parameters β_i^j and δ_j jointly by maximum-likelihood and found no evidence that foreign exchange risk is priced by investors in the US stock market. More precisely, the average coefficients for the exchange rate factor (δ_s) over the sample period were always small, unstable over sub-periods and never significant. Overall, Jorion found that the unconditional premium attached to foreign exchange risk in the US market is of the order of 0.2% per year, both economically and statistically insignificant. Similar results from unconditional multi-factor models, were previously obtained for the Japanese stock market by Hamao (1988), and Brown and Otsuki (1990).

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[1] CRR(1986) use a six-factor model (macroeconomic factors)

Fang and Loo (1996) proposed a three-factor model that includes a world factor (R_w), a national factor (R_{km} for country k) and a foreign exchange risk factor (R_{ks}): [1]

$$\tilde{R}_{ikt} = \alpha_{ik} + \beta_{ikw}\tilde{R}_{wt} + \beta_{ikm}\tilde{R}_{kmt} + \beta_{iks}\tilde{R}_{kst} + \tilde{\varepsilon}_{ikt}$$

Based on a sample of 20 portfolios constructed from all common stocks listed on New York, Toronto, London and Tokyo stock exchanges, over the period 1981-1989, Fang and Loo (1996) found that stock returns are significantly affected by foreign exchange risk cross-sectionally[2]. They also documented a significant negative risk premium for exchange rate risk in the UK, which means that portfolios with negative betas with respect to foreign exchange movements are expected to yield higher rates of returns.

Choi et al. (1998) study provides further evidence that exchange risk is priced using Japanese stock market data. They used both unconditional and conditional versions of a multi-factor asset pricing model to conduct their tests. Interestingly, the results of this study differ depending on the measure used for the exchange risk factor. When the bilateral JPY/US$ exchange rate was used, the test results support the hypothesis that exchange risk is priced in both the unconditional and conditional versions of the model. On the other hand, when the trade-weighted exchange rate is used as a measure for the exchange risk factor, the results are mixed, though the conditional model still offered evidence for the pricing of exchange risk. This fact is quite interesting as it stresses the importance of the exchange rate measure to be used in an international asset pricing model that incorporates a currency factor.

5.4. Econometric issues in testing for the pricing of exchange risk

Tests of the international CAPM are subject to the same methodological problems that arise in testing the domestic CAPM. First, we have the problem of identifying the exact world market portfolio. Second, there is the problem related to the time varying nature of expected returns and risk premia. In fact, a major difference in the empirical results of various studies reviewed above is related to whether the tests conducted are conditional or unconditional. Unconditional tests make the assumption that expected returns and risk premia are constant over time, while conditional tests allow both expected returns and risk premia to vary over time in some specified way.

Given the growing evidence in favor of time-varying risk premia in both stock markets and foreign exchange markets, we can argue that the failure of early tests to reject the hypothesis of a zero risk premium for the exchange risk factor in an unconditional model, such as Jorion (1991), does not mean that exchange risk is not priced. This was clearly demonstrated in Dumas and Solnik (1995) where both the conditional and the unconditional version of their asset pricing model are tested. While they cannot reject the hypothesis that exchange rate risk is not priced in the unconditional version of the model, tests of the conditional version, using the same international data, yield very different results, mainly supporting the significance of the exchange risk factor in the asset pricing model. The hypothesis that the world price of foreign exchange risk is time invariant was also rejected in the conditional framework.

It should be noted, though, that conditional models such as the international CAPM of Dumas and Solnik (1995) or the international APT of Ferson and Harvey 1993), typically estimated by GMM and found to be valid according to the standard J-

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[1] Note that by introducing a national factor, this model assumes market segmentation

[2] 4 portfolios in the US, 1 in Canada, 2 in Japan and 2 in the UK (out of 5 portfolios for each country).

test for overidentifying restrictions, are subject to the problem of low power of J-tests against many specific alternatives and the resulting pricing errors.

Furthermore, a study by Kichiam, Garcia and Ghysels (1995), using several diagnostics for the empirical fit of these models, shows that although they could not be rejected on the basis of the overidentifying restrictions test, these models are not very useful for consistently predicting the conditional first and second moments of equity and foreign exchange returns over time. The authors also showed that the use of an alternative conditional specification with a factor ARCH[1] outperforms the previous models specification where conditional moments are modelled as linear projections on a set of information variables. They found strong support for such ARCH-specification not only with the J-statistic criteria, but also according to a number of other diagnostics tests, such as tests for parameter stability, orthogonality of residuals and explicit analysis of pricing errors.

The choice of an explicit specification for the dynamics of the conditional second moments in an empirical asset pricing model is also important as for the estimation of the size of risk premia and other quantities of interest to investors. For instance, using a fully parametric approach with a multivariate GARCH process for second moments, De Santis and Gerard (1998) were able to estimate the size of risk premia and assess the relative magnitude of the exchange risk premium compared to the market premium, which could not be determined within Dumas and Solnik (1995) framework. Similarly, Carrieri (2001) used a multivariate GARCH-in-mean specification to estimate an IAPM for major European countries using the maximum likelihood estimation procedure. .This specification allowed her to estimate the size of currency risk premia and evaluate their economic significance.

[1] Where conditional moments are modelled as projections on lagged square returns only.

6. Market integration versus segmentation in IAPMs

Integration versus segmentation of international capital markets is another crucial issue in international investments and asset pricing theories. In fact, while most asset pricing models are based on the assumption that markets are efficient, the fundamental issue in international market efficiency is often viewed in terms of market integration or segmentation (Solnik (1997)). An integrated world financial market would achieve international efficiency, while a segmented market (for example, due to the existence of barriers to international investments) would prevent international capital flows from fully taking advantage of relative mispricing among countries, even if each national market is efficient when considered in isolation. Whether the world capital market is assumed fully integrated or completely segmented will have important implications on the choice of the appropriate asset pricing model to use when testing for the existence and significance of exchange risk premia in stock returns.

Capital markets are integrated if assets with perfectly correlated rates of return in a given currency have the same price regardless of the location in which they are traded (Stulz, 1981b). In contrast, markets are segmented if securities with the same risk characteristics but traded in different locations, have different values. For a long time, investors have gained from mispricing of assets due to capital market segmentation. These gains have existed because of various barriers to the mobility of capital between countries, transactions and information costs, political risks and other types of imperfections. Hence, the priced factors and the rewards for risk could differ across markets, given the limited mechanisms available to permit the elimination of arbitrage opportunities. As explained by Bekaert and Harvey (1995), in a completely integrated market, risk refers to exposure to some common world factor. In this context, the reward to risk is not important in explaining the cross-section of expected returns, because it is common to all the integrated countries. However, if a market is segmented from the rest of the world, its covariance with a common world factor may have little or no ability to explain its expected return. Therefore, the rewards to risk in segmented markets may not be the same because the sources of risk are different.

Many asset pricing studies have assumed that world capital markets are fully integrated. For example, Harvey (1991) test of the world CAPM and Dumas and Solnik (1995) test of the international CAPM with exchange risk. Indeed, the elimination of various barriers to international trade and capital flows as well as the deregulation of some major markets, suggest that capital markets should be moving towards a more integrated pricing of assets, in particular within developed markets. This implies that the risk-adjusted returns around the world should be converging toward a common price of risk. But as noted by Harvey (1991), even with increasingly integrated financial markets, we still see industrial countries showing much different average stock returns. This may be due to the existence of yet other sources of risk that are country-specific and which are not captured by a single factor international asset pricing model such as the world CAPM.

Consistent with this reality, some studies proposed international asset pricing models under various forms of market segmentation [Stulz (1981b), Errunza and Losq (1985), Hietala (1989)]. These models provide an alternative specification where expected asset returns are allowed to depend on both global and national factors. For example, the theoretical asset pricing model of Errunza and Losq (1985) includes a 'super' risk premium that is country specific (proportional to the conditional local market risk), along with a global risk factor represented by the covariance of the asset with the world market portfolio. An interesting feature of this model is that it can accommodate the two polar cases of complete segmentation and perfect integration as well as various intermediate cases depending on the barriers to investment and the availability of substitute assets.

On the empirical side, studies testing for integration versus segmentation of international stock markets provide mixed conclusions. Jorion and Schwartz (1986) study is among the early tests that rejects full integration of international capital markets. Errunza, Losq and Padmanabhan (1992) investigated the structure of world capital markets by testing the competing hypotheses of integration, segmentation and mild segmentation for a group of emerging markets. Their test, based on the theoretical model of Errunza and Losq (1985), rejects complete segmentation while offering inconclusive results for full integration. More recent studies tested models of time varying integration [Bekaert and Harvey (1995), Carrieri, Errunza, and Hogan (2001)] arguing that the degree of integration is very likely to vary, not only across countries, but also through time. For example, Bekaert and Harvey (1995) estimate an integration index and conclude that a number of emerging markets exhibit time-varying integration. Their results, based on a country-specific investigation, are not consistent with the perception that world capital markets have become more integrated since some countries are found segmented even though foreigners have relatively free access to their capital markets. Using a different methodology and time-varying integration measure, Carrieri, Errunza and Hogan (2001) also find evidence against complete integration. Their results suggest that local risk is the most important factor in explaining time-variation of returns in seven emerging markets.

To summarize, we can say that the existing empirical results provide strong evidence in favour of a non-polar market structure and the increasingly accepted notion that the world markets are neither fully integrated nor completely segmented.

Despite this fact, most studies about the pricing of exchange risk in the stock market are conducted under the implicit assumption of complete integration. This could be considered a reasonable assumption in the case of some developed stock markets. For instance, Carrieri (2001) found that the four major European markets covered in her study are effectively integrated even before the legal liberalization introduced by the EEC. However, in the case of a large majority of less mature markets, such as EMs, the integration assumption would be less appropriate. Indeed, it is unlikely that an asset pricing model based on the assumption of full integration, would be able to fully describe the behavior of security prices in these markets, where expected returns are more likely influenced by local rather than global information variables. It would then be more appropriate to test for the significance of the price of exchange risk in an asset pricing model that allows for some form of market segmentation, particularly when we deal with emerging stock markets.

Table 1. Summary of major previous empirical studies testing for the pricing of exchange risk in the stock market

	Model and Methodology	The Data	Results and Conclusions	Comments/limitations
Jorion (1991)	- Unconditional multi-factor arbitrage pricing model - Includes CRR(1986) 6 factors *plus* an exchange rate factor - Betas and risk premia are jointly estimated by a maximum likelihood procedure	- US market (1971-87) - Monthly returns of 20 VW industry portfolios covering all NYSE stocks - Exchange risk factor is measured by the change in the trade-weighted XR	- Exchange risk does not affect expected returns - The premium attached to the XR factor is small, unstable over sub-periods and never significant.	- Portfolio level analysis - Price of exchange risk factor is assumed to be constant over time - Aggregate measure of the exchange rate factor - Assume complete segmentation
Dumas-Solnik (1995)	- Test a conditional version of International CAPM versus the 'domestic' CAPM - Follows same methodology as Harvey (1991) - factors sensitivities and risk primea are estimated by GMM	- US, UK, Germany, Japan - Monthly returns on market indices and currency deposits - 3 exchange rate factors: GBP, DM & JY against US	- Exchange risk is priced for equity and currency markets - Exchange risk premia are significantly different from zero - Rejects ICAPM with the world market factor only	- Market level analysis - Model specifications do not allow estimation of the size of risk premia - Assume perfect integration of world capital markets
Choi et al (1998)	- Test conditional and unconditional multi-factor APM - Factors: national market, interest rate and exchange rate - Estimation using stochastic discount factor approach	- Japanese market (1974-95) - Monthly returns of industry portfolios - 2 measures of exchange risk (bilateral Yen/US and trade weighted)	- Exchange risk is priced - Results vary depending on the exchange rate measure (less evidence with the aggregate measure) - Exchange premium changes sign intertemporally	-Portfolio level analysis - - Assume completely segmented capital markets by using a national market index only
De Santis-Gerard (1998)	- Test a conditional version of the international CAPM - Uses a fully parametric approach with a multivariate GARCH specification - Assume time varying prices of risk - Parameters estimated by MLE	- US, UK, Germany, Japan - Monthly returns on market indices and euro-currency deposits - Bilateral exchange rates	- Exchange risk is priced - Significant currency risk premium detected only when allowing for time variation in the price of risk - Components of risk premium vary significantly over time and across markets	- Market level analysis - Assume perfect integration of capital markets

7. Conclusions

The relation between exchange rates and asset prices is one of the central issues in international asset pricing. This chapter attempted to review the theoretical and empirical literature related to the question of whether foreign exchange risk is a priced factor, in the sense that it commands a nonzero risk premium, in an international asset pricing model.

The existing empirical evidence is quite mixed and fragmentary, with more recent studies, such as Dumas and Solnik (1995), De Santis and Gerard(1998) and Carrieri (2001) strongly supporting the hypothesis that foreign exchange risk is priced by investors in stock markets of major developed countries. Previous tests, such as Hamao (1988) and Jorion (1991), found no evidence that exchange risk is priced on the Japanese and US stock markets. These early tests though, were based on the assumption that the price of foreign exchange risk is constant over time. In other words, these are tests of the hypothesis of a nonzero unconditional risk premium. Many studies have shown that foreign exchange markets, along with stock markets, are characterized by time varying risk premia, i.e., nonzero conditional risk premia. Thus, conditional models with time varying expected returns and prices of risk are offer a better framework to detect exchange risk premia in stock returns.

Some of the limitations that arise from this literature review and which will be addressed in the following chapters can be summarized as follows. First, most of the existing empirical studies are based on data from major developed stock markets and derived by testing models that implicitly assume market integration. This is not very informative about the global pricing of exchange risk in different market environments such as in emerging stock markets which are shown to be neither fully integrated nor completely segmented from global financial. It is indeed very likely that the pricing of assets in emerging markets obeys to a different structure of risk premia to reward specific local sources of risk other than the global market risk factor used in models assuming full integration. Hence, testing whether exchange risk is priced in emerging stock markets should be conducted using an appropriate empirical pricing model that reflects both local and global sources of risk. This is important from an empirical perspective to avoid a possible spurious significance of an exchange risk premium in stock returns because of a missing local risk factor.

The second limitation is related to the fact that the existing evidence is derived from empirical models that assume non-stochastic inflation. That is why most of the studies reviewed above typically focus on nominal exchange risk premia and assume that inflation risk is negligible compared to nominal exchange rate changes considered as the major source of PPP deviations. This assumption is acceptable when we deal with some developed markets where inflation rates are relatively small and non random compared to exchange rate changes. In the context of EMs, however, such assumption would be unrealistic and ignoring inflation risk may result in overestimating exchange risk premia in asset returns. A careful specification of the exchange risk factor that also takes into account inflation risk is then necessary in the case of EMs.

Finally, we note that all previous studies on the pricing of exchange risk in the stock markets are based either on country-level data (using country return indices) in multi-country studies or portfolio-level data in single-country studies (using single currency portfolios). In reality, though, international investors, seeking to take advantage of the benefits of international diversification into foreign equity markets, hold geographically diversified portfolios that also involve a certain level of cross-currency diversification. Moreover, geographically diversified portfolios in the form of regional or sector/industry indices can be considered as an important part of the traded assets in the global capital market. Surprisingly, there are no empirical studies that estimate an international asset pricing model using cross-sections of globally diversified portfolios to investigate whether exchange risk is priced. This is an interesting question because we know that cross currency diversification could reduce the exchange risk exposure of the internationally diversified portfolio returns. Thus, using cross-sections of multi-currency portfolios will allow us to examine the significance of the price of exchange risk in stock returns after taking away all the diversifiable component of such risk via cross-currency diversification. We will examine this question in chapter IV.

CHAPTER II

The Pricing of Exchange Risk in Emerging Stock Markets: An Exploratory Analysis

Abstract

The purpose of this paper is to find preliminary evidence on the pricing of exchange risk in the stock market based on emerging markets (EMs) data. Previous empirical studies, mainly based on data from few major developed countries, offer mixed results about this issue and do not allow one to draw clear conclusions on whether exchange risk is generally priced in the stock market. We conduct empirical tests using cross-sectional data at the market, portfolio and firm level from nine EMs and try to determine whether exchange risk is priced under alternative model specifications and exchange rate measures. Our main results support the hypothesis of a significant unconditional exchange risk premium in emerging stock markets. The empirical evidence also suggests that there is some variation of exchange risk premia across countries/regions and over time. For most countries, the results are sensitive to the exchange rate measure used in the model.

1. Introduction

Since the early 1990s, international investors showed an increasing interest in emerging stock markets given the great diversification potential they offer in portfolio investing[1]. A large body of research has since been dedicated to understanding and explaining the behavior of stock returns in these markets. But the extent to which foreign exchange risk affects the pricing of emerging markets securities has not received much attention in the international finance literature despite the greater uncertainty about exchange rate regimes and the frequent currency crises that characterize most of these countries. For example, in 1994, following the sharp devaluation of the Mexican peso and the various crises that swept the country, American investors converting their Mexican portfolios into dollars would have lost 42%, although the Mexican Bolsa fell only 8.6% in peso terms.

[1] This is due to their low correlations with developed markets which add to the attractive features of higher average returns and higher degree of predictability of those returns in most EMs.

More interestingly, the impact of exchange rate movements on foreign portfolio investments goes beyond the "pure translation" risk to affect stock prices through their more fundamental impacts on firms' expected cash flows. This is particularly relevant in the case of EMs whose economies are mostly dependent on exports/imports and short term foreign capital flows that are highly sensitive to exchange rate fluctuations. For instance, the recent fall of the Brazilian real in January 1999 and its negative impact on the Brazilian stock market is a good illustration of the sensitivity of equity values to exchange rate changes. Furthermore, Argentine firms exporting to Brazil were hurt by the fall in the real which caused the Argentine stock market to fall in its turn and cause other markets in Europe and the US to follow such a downturn shortly after.

Theoretically, the relation between exchange rates and stock prices has been clearly identified by early models such as Shapiro (1974) and Dumas (1978), based on the potential impacts of exchange rate movements on the firm's expected cash flows. In addition, stock markets and exchange rates might be correlated because they are both subject to the effects of similar macroeconomic variables.

In light of these facts, the question of whether foreign exchange risk is priced in the stock market seems very relevant in the context of emerging markets (EMs) which offer valuable diversification potential to international investors, but at the same time tend to be characterized by important exchange rate uncertainty, including the risk of devaluation for those countries with fixed or pegged exchange rate regimes. From a theoretical point of view, it is recognized that a non-zero exchange risk premium in stock returns may exist because of the repeated and persistent deviations from strict purchasing power parity (PPP)[1]. In addition, various legal and institutional barriers are still faced by investors in many countries and consumption preferences also differ

[1] PPP deviations are well documented in the economic literature for both developed and EMs: Roll (1979), Abuaf and Jorion (1990), Zhou (1997), Salehizadeh and Taylor (1999), Li (1999).

across countries. Under such conditions, investors may consider a foreign investment as more risky, perceiving exchange risk as a real currency risk, and hence require some compensation in terms of expected returns when investing in foreign stock markets.

In this paper, we conduct various empirical tests to investigate whether foreign exchange risk is priced in emerging stock markets. To our knowledge, with the exception of one study for Mexico by Bailey and Chung (1995) and a study for Pacific Basin countries by Phylaktis and Ravazzolo (2002) no previous research has investigated this issue in the context of a large number of emerging markets. In this paper, using data from nine countries encompassing different regions and different exchange rate regimes, we attempt to provide some answers to the following related questions: Is exchange risk priced in emerging stock markets, in the sense that it commands a significant non-zero risk premium in an international asset pricing model (IAPM)? If exchange risk is priced, is the currency risk premium different across countries/regions? And is the size of such risk premium similar to what has been evidenced for developed stock markets in previous studies? The answers to these questions have important implications for modeling and testing international asset pricing theories as well as for the determination of the cost of capital of firms operating in the international capital market. Moreover, this subject could bring some insight into the debate about the relevance of hedging policies for corporate managers and portfolio investors.

The rest of the paper is organized as follows. In section 2, we make a brief discussion of the existing empirical literature about the pricing of exchange risk in the stock market. Section 3 outlines the model and methodology followed in this study. Section 4 describes the data and presents some preliminary statistical analysis of emerging markets returns. The empirical results from tests of exchange risk pricing under alternative model specifications are presented in section 5. Finally, section 6 concludes the paper and suggests some guidelines for future research.

2. Previous Research

Theoretically, if the effects of currency risk do not vanish in a well-diversified portfolio, exposure to the exchange risk factor should yield a risk premium in an asset market in equilibrium. On the other hand, if PPP holds and if there are no barriers to international investments and no differences in consumption goods, the single-index APM should hold internationally and exchange risk should not be priced. Given the wide empirical evidence against such a perfect world, some early theoretical studies considered foreign exchange risk as a priced factor and proposed IAPMs that include exchange risk premia along with the traditional market risk premium [Solnik (1974), Sercu (1980), Adler and Dumas (1983)]. On the empirical side, there are only few studies that directly test for the existence and significance of such exchange risk premia in the stock market. In general, the evidence is quite mixed and fragmentary. Early tests, such as Hamao (1988) and Jorion (1991), were rather inconclusive and generally found no evidence that exchange risk is priced on the Japanese and US stock markets in an unconditional framework. On the other hand, more recent studies, based on conditional asset pricing models [Dumas and Solnik (1995), De Santis and Gerard(1998), Choi, Hiraki, and Takezawa (1998), Doukas, Hall and Lang (1999), Carrieri (2001)], tend to strongly support the hypothesis that foreign exchange risk is priced in stock markets of major developed countries.

Such evidence is not sufficient to allow one to make strong conclusions about whether exchange risk is generally priced in the stock market. In fact, some of the limitations of this literature that still need to be addressed can be summarized as follows. First, many of these studies use aggregate market data (stock market indices) to test for the existence and significance of an exchange risk premium in the stock market. This could be rather misleading because the exchange risk exposures of different firms may offset each other when those firms are grouped into an aggregate market index measure. Second, most previous studies are limited to the context of few major developed stock markets (US, UK, Japan and Germany), and derive their conclusions by testing models that implicitly assume full market integration. This is not very informative about the pricing of exchange risk in different market environments such as in emerging stock markets which are shown to be neither fully integrated nor completely segmented from global financial markets [Errunza, Losq and Padmanabhan (1992), Bekaert and Harvey (1995), Carrieri, Errunza and Hogan (2001)].

Moreover, many EMs have experienced some kinds of currency crises with overwhelming negative impacts on their economies and stock markets.[1] This may affect the perception of foreign investors with respect to the importance of exchange risk as an additional source of uncertainty in EMs. It is then interesting to see if such perception is reflected in more significant (and/or larger) foreign exchange risk premia in equity returns in emerging markets compared to what has been found by previous studies in developed markets.

3. Empirical Model and Methodology

The starting point of our empirical procedure is a standard multi-beta linear pricing relationship where we assume that expected asset returns are linear functions of factor risk premia and their corresponding betas:

$$r_{it} = \alpha_i + \sum_{j=1}^{k} \left(\beta_{ij} \cdot R_{jt}\right) + \varepsilon_{it} \qquad (i = 1, \cdots, N;\ t = 1, \ldots, T) \tag{1}$$

$$\text{and } E(r_{it}) = \lambda_0 + \sum_{j=1}^{k} \lambda_j \cdot \beta_{ij} \tag{1a}$$

where r_{it} is the excess return on asset i measured in a given currency (e.g. US\$); R_{1t} to R_{kt} are the (excess) returns on the risk factors in period t; β_{i1} to β_{ik} are the asset sensitivities to the risk factors; λ_1 to λ_k are the risk premia associated with the factors

[1] For an analysis of devaluations and stock market returns in emerging markets see Glen (2002).

and ε_{it} are random errors. Note that in this model specification, both the betas and the risk premia are assumed constant over time. This assumption could be relaxed later to test a conditional version of the model where we allow for time variation in the asset sensitivities to the risk factors and their risk premia.

We test two-factor and three-factor models with exchange risk as described below. Our objective is to determine, under alternative model specifications and hypotheses, the size and significance of the risk premium (λ) related to the exchange risk factor.

3.1. The pricing of exchange risk in a world CAPM framework

We first test an unconditional version of model (1) where the risk factors are the world market return (R_w) and the change in the selected exchange rate measure (R_s).

$$r_{it} = E(r_{it}) + \beta_{iw}[R_{wt} - E(R_{wt})] + \beta_{is}R_{st} + \varepsilon_{it} \quad (2)$$

$$\text{and } E(r_{it}) = \lambda_0 + \lambda_w\beta_{iw} + \lambda_s\beta_{is} \quad (2a)$$

where r_{it} is the excess return on the market index of country i measured in U\$; R_{wt} and R_{st} are the world market excess return and the change in the selected exchange rate measure; β_{iw} and β_{is} are the sensitivities to the world and exchange risk factors; λ_w and λ_s are the risk premia associated with the world and exchange risk factors respectively and ε_{it} are the factor model disturbances.

Substituting (2a) in (2) and given that the exchange factor is orthogonal[1] to the market factor, we can rewrite the above system of equations as:

[1] The exchange factor used in the model is the residual from the projection of exchange rate changes on the market factor. This is a common method used in the literature to avoid that one factor be priced simply because of its correlation with another priced factor.

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{is}R_{st} + \varepsilon_{it} \quad (3)$$

Equation (3) is the empirical two-factor model to be tested first using market level data and then at the less aggregated portfolio and firm level data. This set of tests can be related to the international CAPM framework of Adler and Dumas (1983). The original specification of Adler and Dumas (1983) includes all the currencies of the countries covered in the model. However, such a specification with multiple bilateral exchange rates is expensive to test empirically. For parsimony concern, previous studies have used aggregate proxies such as the trade-weighted exchange rate in Jorion (1991), Ferson and Harvey (1993, 1994) and Choi et al. (1998) or the SDR value of a given currency in Choi and Rajan (1997). In this study, given the large number of countries covered, we also use a single exchange rate, R_{st}, as a proxy for the exchange risk factor. However we test the robustness of our results across different exchange rate specifications that include bilateral exchange rates.

We should also note that in this theoretical framework, we are implicitly assuming that emerging markets are fully integrated to the world capital market. This assumption will be relaxed later and replaced by a 'partial segmentation' hypothesis, which seems more appropriate for the case of EMs. However, we start from model (3) since we are interested in comparing the results of a test of an international CAPM model applied to EMs with those obtained in previous studies for developed stock markets.

3.2. The pricing of exchange risk in an IAPM with segmentation hypothesis

There is a growing literature suggesting that capital markets are neither completely segmented nor fully integrated due to the existence of yet various barriers to international investments and capital flows. Some early studies proposed international asset pricing models under various forms of market segmentation [Stulz(1981b), Errunza and Losq (1985), Hietla (1989)]. More recent studies tested models of time-varying integration [Bekaert and Harvey (1995), Carrieri, Errunza and Hogan (2001)] providing further evidence in favor of a non-polar market structure such as the full integration framework assumed in the above two-factor model. Moreover, empirical evidence about the behavior of emerging markets returns provided by Harvey (1995) suggests that expected returns in these markets are more likely to be influenced by local rather than global factors. This motivates the need for testing the pricing of exchange risk in emerging stock markets within the context of a partial segmentation model. In the three-factor model described below, we use the domestic market return as an approximation for local risk factors and test for the pricing of exchange risk using cross-sections of returns from the same country. The following equation is estimated separately for each country:

$$r_{it} = E(r_{it}) + \beta_{iw}\left[R_{wt} - E(R_{wt})\right] + \beta_{id}R_{dt} + \beta_{is}R_{st} + \varepsilon_{it} \quad (4)$$

$$\text{and} \quad E(r_{it}) = \lambda_0 + \lambda_w\beta_{iw} + \lambda_d\beta_{id} + \lambda_s\beta_{is} \quad (4a)$$

where r_{it} is now the excess return on stock i in period t; R_{wt} is the world market excess return in period t; R_{dt} is the domestic market excess return; R_{st} is the change in the selected exchange rate measure (bilateral or trade weighted index); β_i's are the sensitivities to the risk factors and λ_w, λ_d and λ_s are the risk premia on the world market, domestic market and exchange risk factors respectively[1]. Each of the domestic factor and exchange risk factor is orthogonalized so that only the residuals from the projection on the world market return are included in the model[2]. The empirical model to be estimated in this three-factor framework is:

[1] This specification is consistent with the Arbitrage Pricing Theory with a choice of factors justified by existing literature as in the above discussion. The domestic return factor is treated as a general factor just like the exchange rate factor. Thus, only the world is a market portfolio factor in this model and has a risk premium $\lambda_w = E(R_w) - \lambda_0$ provided that all other factors are orthogonal to the world factor (see Shanken (1992)). Equation (5) is indeed derived based on this assumption.

[2] Some studies such as Jorion(1991) orthogonalize the exchange risk factor with respect to all other factors in the model. This is not the case in this study where the exchange factor is orthogonalized only to the world market factor as explained in the previous note. However given the generally low correlations between domestic markets returns and the alternative exchange rate measures used, it is unlikely that the exchange factor be priced in this model because of its correlation with a priced domestic factor.

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_d\beta_{id} + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{id}R_{dt} + \beta_{is}R_{st} + \varepsilon_{it} \quad (5)$$

Equations (3) and (5) are estimated by maximum likelihood where all risk premia parameters λ's and β's are jointly determined in a one-step estimation to avoid the errors in variables problem implied by a 2-step estimation procedure a la Fama and MacBeth (1973). Exchange risk is priced in these models if λ_s is significantly different from zero.

4. Data Description and Preliminary Analysis of EMs returns

The countries covered in this study are: Argentina, Brazil, Chile, Mexico, Greece, India, Korea, Thailand and Zimbabwe. These are the nine EMs for which we have the longest data series of returns (including firm level data) on a monthly basis from January 1976 to October 1999. Country returns are computed from national total return indices (adjusted for dividends) of the S&P/IFC's Emerging Market Database (EMDB). Individual stock returns are computed from price and dividend series available from the same database at the firm level. Only securities with data available for the whole sample period are selected. This has survivorship bias but, given the large number of parameters to be estimated, such restriction is necessary to enhance the power of the statistical tests by using longer data series. The world market return is computed from MSCI World index adjusted for dividends and available from DataStream. All returns used in the empirical tests are expressed in US$ and computed in excess of the 30-day eurodollar interest rate (used as a proxy for the risk-free rate) available from the Federal Reserve Economic Database (FRED).

Exchange rates are from the IMF's International Financial Statistics database and DataStream. We use the change in the trade weighted dollar index (TWXR$) as the aggregate exchange risk measure. A positive (negative) change in this rate represents an appreciation (depreciation) of the dollar. We also use bilateral rates of each country's local currency against the dollar (LC/U$) as well as the yen/U$ (JPYU$) and the Euro/U$ (EURU$) as proxies for the exchange risk factor[1]. Use of the yen/U$ rate is motivated by the fact that many East Asian economies, due to their de facto peg to the dollar, are quite sensitive to the yen/U$ exchange rate fluctuation. A strengthening of the yen against the dollar tends to be reflected in a depreciation of the local currency and vice versa. Moreover, considering the trade patterns of some EMs, mainly in East Asia where the volume of trade with Western Europe is comparable to their trade with the US and Japan, it seems quite natural to include a European currency measure in this study. The Euro/U$ rate offers a parsimonious approximation for the dollar's value against major European currencies. All bilateral rates are expressed in foreign currency units by US dollar so that a positive change in these rates also represents a dollar appreciation with respect to the foreign currency.

For portfolio level tests, we construct four size-based portfolios for each of the nine countries (for a total of 36 portfolios) from all listed securities over the sample period. We use both equally weighted and value weighted portfolios. In addition, we conduct some tests using industry portfolios in an attempt to compare our results to previous studies based on industry portfolios. For this purpose, we use the IFCG industry indices provided in the EMDB since January 1985 (see appendix 3 for a list of these industries). We should note that IFC computes industry indices at the aggregate level across all EMs. Further details about the interpretation of such portfolio-based tests are given below. The use of such portfolio level data in this study is motivated not only by the need for comparison with previous studies but also by the growing importance of industry investing across both emerging and developed markets. In addition, since each IFC industry index includes securities from all EMs, this offers the advantage of testing for the pricing of exchange risk in the context of well-diversified portfolios where only the component of currency exposure that cannot be diversified away should be priced.

[1] The rate used for EURU$ is the synthetic Euro to U$ exchange rate computed by DataStream.

Tables 1a and 1b report summary statistics and correlations between excess market returns and the world risk factors. Compared to the world return characteristics, EMs returns seem quite high and much more volatile, especially in the Latin American region. The correlations between domestic returns and world return are generally low compared to what is commonly observed for developed markets. Mexico, Korea and Thailand show the highest correlations to the world market (close to 0.3). Among the four Latin American countries in the sample, only Mexico shows a relatively high correlation with changes in the U$ trade weighted value (TWXR$). Korea and Thailand have very low correlations with TWXR$ but show higher negative correlations with changes in the dollar value against the Japanese yen (JPYU$). They also show higher correlation with EURU$ than with TWXR$. Mexico and Greece also have a relatively higher correlation with EURU$ than with TWXR$. This further justifies the use of the bilateral JPYU$ and EURU$ rates as alternative proxies for the exchange risk factor in the model. Finally, the relatively high correlation observed between the world return and the three dollar exchange rates motivates the need for orthogonalization of the exchange risk factor with respect to the world factor as described in the previous section.

4.1. Local currency versus US dollar returns

We first proceed to a preliminary statistical analysis in order to evaluate the extent of currency risk that an investor might face when investing in an emerging stock market index. More precisely, taken the US investor's perspective, we try to determine, how do exchange rate changes affect the dollar-denominated return and what component of this U$-return comes from currency fluctuations relative to the realized market return in the local currency.

Table 2 shows the means and standard deviations for the historical returns expressed in US dollar (U$) and local currencies (LC) for the nine EMs covered in the study. Few points are noteworthy.

First, historical returns in local currencies are on average much higher than the corresponding dollar returns for all countries. For some countries, mainly in Latin America, the mean return is reduced to less than half once translated in U$. This is due to the negative currency returns (depreciation of the LC against U$), which characterizes all countries over the sample period. Second, The variability of the dollar-denominated returns is also higher than the variability of returns when expressed in LC, for almost all countries (except Argentina and Brazil).

The first obvious explanation for this excess variability of returns expressed in dollar is the effect of exchange rate changes.[1] As shown in Table 2, the dollar has on average appreciated against all of the nine local currencies over the sample period. This seems consistent with the lower return observed when expressed in dollar terms since potential gains in LC return are reduced by the depreciation of EMs currencies. Although exchange rate variability is quite low on average compared to the volatility of market returns in LC, its impact on the dollar return is significant.

We should also note that the period covered in this analysis is quite long (25 years of monthly data), but the results are similar when computing average returns and volatility over shorter sub-periods (see appendix 1). For some periods, the impact of exchange risk on the dollar-denominated return and variance is very high, while for other periods it seems less important. For instance we can note the important time variation of the exchange rate effect on the dollar returns for Argentina and Brazil. The currency impact is also different across countries.

[1]The dollar-denominated return is merely the product of the return in LC by the exchange rate return, or $(1 + R_{US}) = (1 + R_{LC})*(1 + R_S)$, where S is the exchange rate expressed as LC/U$ and R_S is the percent appreciation/depreciation of the local currency.

4.2. Variance decomposition of the dollar denominated returns

It is clear from Table 2 that exchange rate variability affects both the realized return and the volatility of an investment in a foreign market. To determine the extent of the contribution of the exchange rate volatility in the total variance of the dollar denominated returns, we perform a simple variance decomposition analysis. Theoretically, we can decompose the variance of the dollar returns into three components: 1) the pure variance of the corresponding returns in LC terms, 2) the variance of the exchange rate return; and 3) a component related to the covariance of the LC returns and exchange rate changes[1]. As shown in Table 3, the variance of the return in U$ is higher than the variance of the return in LC for all countries except Argentina and Brazil. Exchange rate variability can be seen as affecting the dollar-realized return through both its own variance and its covariance with the local market return.

The total contribution of the exchange rate changes to the variance of the dollar returns can be calculated as the percent difference between the variance of the LC return and the dollar return variance. The results are shown in the last column of Table 3. We can see that exchange rate volatility has on average caused an increase of up to 25% in the variance of some market returns when translated in US$. The result is somehow different for Argentina and Brazil as the exchange rate variability have reduced the variation of the dollar denominated returns. Although the exchange risk component as calculated above seems to play a less important role in the total risk of some markets (e.g. Chile, Greece, India), a sub-period analysis reveals that the currency risk contribution for these countries can reach up to 40% in some periods. Appendix 2 shows the results of the variance decomposition analysis over sub-periods. The time variation of the exchange rate contribution is quite obvious for all countries in the sample.

5. Asset pricing tests results

5.1. Estimation of the two-factor model with portfolio returns

We start by running a regression analysis separately for each country excess returns on various risk factors in order to determine the sensitivity of market returns to those factors. Table 4 summarizes the results obtained for single-factor and multifactor regressions at the market level for the nine EMs. Greece and Mexico are the only countries with a significant exposure to both the world factor and the exchange risk factor regardless of the exchange rate measure included in the regression. Korea, Thailand and Zimbabwe show significant exposure to the world factor but insignificant exposure to changes in the trade weighted dollar value. However, Korea shows a significant exchange risk exposure when the JPYU$ and EURU$ rates are used instead of the TWXR$[2]. For Brazil, the world factor becomes significant only after including the exchange risk factor (with more significant exposure to the TWXR$). India shows an insignificant exposure to the world factor in all three regressions but has a significant negative exposure to the trade weighted dollar exchange rate. Finally, Argentina does not seem to have any significant exposure to either the world or the exchange risk factors over the sample period. Overall, we find that the country indices are more sensitive to the aggregate rather than the individual exchange rate measures.

We then estimate the assets sensitivities to the world and exchange risk factors jointly with the corresponding risk premia from equation (3) using maximum likelihood estimation as described in the methodology section. Table 5 reports the estimated risk premia parameters in the two-factor model using the change in the trade weighted dollar index (TWXR$) as the exchange risk factor. Overall, the two-factor model performs

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[1] We can write $R_{US} = R_{LC} + R_S + R_{LC}*R_S$. Therefore, the variance of the dollar return can be written as: $Var(R_{US}) = Var(R_{LC}) + Var(R_S) +2\ Cov(R_{LC}, R_S) +$ another term to account for the cross product $(R_{LC}*R_S)$.

[2] Note that in this preliminary analysis, we use JPYU$ and EURU$ rates together in the same regression as an alternative specification to using the aggregate TWXR$ to identify countries exchange rate exposures. However, for asset pricing tests, we use each rate separately for parsimony concern.

fairly well at the market level and both the world market and the exchange risk factor yield statistically significant risk premium coefficients of 1.54% and 1.01% respectively. Thus, while the market premium represents the largest component of expected returns, the exchange risk premium is of comparable size and economically significant. The sign of the coefficients implies that those countries with positive exposure are expected to have higher rates of returns.[1] To gain more insight on factors pricing in this model, we compute the Wald test statistics for the joint significance of the risk premia. Table 5 shows that over the whole sample period, the null hypothesis of the two parameters jointly equal to zero is rejected at any significance level.

This result is quite different from those obtained in previous studies testing unconditional asset pricing models with market level data for developed countries. For instance, the studies by Dumas and Solnik (1995) and Ferson and Harvey (1999) both found that exchange risk premia were insignificant within the unconditional version of their IAPMs. However, the results of the subperiod analysis reported in table 5 show that both the world and the exchange risk premia are unstable over time and are significant only in the period of steep dollar depreciation in the second part of the Eighties.

To check the robustness of these market level results with respect to the exchange risk measure, we test model (3) with less aggregated exchange rates. Results in panel B of table 5 show that over the whole sample period, the average estimated risk premia are in line with what is obtained with the TWXR$ and are still overall significant. Both bilateral rates yield a positive risk premium coefficient and the size and significance of the risk premium parameter appear to be robust to the exchange rate measure included. When we conduct the sub period analysis we confirm that the size of the exchange risk

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[1] Recall that all exchange rate changes used in testing equations (3) and (5) are computed such that a positive value means an appreciation of the U$. Thus, a negative exposure to this factor means that the asset return decreases with an appreciation of the U$ or that assets are hurt by such appreciation

premium varies overtime and its significance is mostly driven by the dollar depreciation of the Eighties.

For comparison with the evidence provided in Jorion (1991) who uses a similar unconditional framework with 20 industry portfolios constructed from all listed securities in NYSE, we estimate model (3) using 24 portfolio returns computed from the IFC's industry indices for emerging markets.[1] Recall that such indices are computed across all EMs in the Emerging Market Database. Table 6a reports the risk premia in the two-factor model for industry portfolios using alternative exchange risk measures. It is interesting to note that while Jorion (1991) failed to find any significance of the exchange risk premium using cross-sections from the same country, the exchange risk premium obtained in this study from the cross-sections of EMs industry portfolios is significant for the aggregate exchange rate measure. However, the world market risk premium is never significant. As for the size of the exchange risk premium, the estimate is much higher than what is obtained in Jorion (1991) where the exchange risk premium coefficient (using the TWXR$) for the overall period of 1971-1987 was estimated at 0.033% for the US market compared to 0.511% when it is estimated from the cross section of emerging markets. The Wald test also rejects that the prices are jointly zero for the case of the trade-weighted exchange rate. Thus, also in the case of portfolios diversified across countries we find that currency risk is priced, even though its size is reduced from the evidence presented in table 5.

We also test equation (3) using size portfolios constructed from all securities covered by the IFC's database for the previously mentioned nine EMs. Four portfolios are constructed for each country with quartile-size 1 including the smallest size firms and quartile-size 4 the largest size firms. Table 6b summarizes the risk premia obtained from estimating the two-factor model (3) with world return and TWXR$ across value-weighted portfolio returns over the period from January 1976 to October 1999. The

[1] The Emerging Market Database contains a large number of sector and industry indices. For comparison purposes we chose those ones that are similar to the US industries included in the Jorion (1991) study.

exchange risk factor is significantly priced for portfolios of size 2 through 4. Interestingly, the size of the exchange risk premium coefficient seems to increase consistently with portfolio size (from 0.84% for the smallest size 1 to 2.70% for the largest size 4). The beta coefficients of the exchange risk factor estimated from equation (3) are also more significant for larger size firms (fourth and third quartiles) than for smaller size firms (first and second quartiles). As for the world factor, it shows a similar pattern with respect to the size and significance of the estimated risk premium. Similar results are obtained by using equally weighted portfolio returns and alternative exchange rate measures.

This evidence suggests that investors command higher risk premia for larger size firms in EMs with respect to exchange risk. Although we have no information on the nature of operations of the firms included in each quartile nor on the extent of their foreign activities to explain such finding, we can still say that on average larger size firms are those that explain the pricing of foreign exchange risk.

5.2. Estimation of the two-factor model with firm returns

We estimate equation (3) separately for each country using firm level data to determine whether exchange risk premia vary across countries/regions. We should note that this firm level analysis is limited by the availability of return data on individual securities over a common long time period for a given country. Thus, to increase the number of cross-sections within a country, we had to shorten the sample period and test the model over the period starting from January 1985 to October 1999. Table 7 summarizes the risk premia for the world and exchange risk factors for each country using alternative exchange rates to test the robustness of our results with respect to the exchange rate measure[1]. The evidence is quite mixed and suggests an important variation of exchange risk premia across countries and regions.

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[1] Greece and Zimbabwe are excluded from this analysis for lack of individual firm return data.

In Latin America, Brazil, Chile and Mexico show significant positive exchange risk premia with respect to the TWXR$, JPYU$ and EURU$ but negative insignificant risk premia (except for Mexico) with respect to the change in the dollar against their respective local currencies. The failure to capture a significant exchange risk premium for Chile when the LC/U$ rate is used is not very surprising. In fact, over the 1985-99 period, Chile has switched between crawling pegs and crawling bands regimes where the local currency is rather pegged to a basket of foreign currencies. Moreover, the Chilean trade is more diversified rather than being dominated by the US, so the change in LC/U$ is unable to capture the effects of currency exposures of Chilean assets.

For Argentina, the exchange risk premium is never significant for any exchange rate measure in this two-factor asset pricing model. Such a different behavior compared to the other Latin American countries in the sample may be related to the fact that Argentina has the strongest fix, short to dollarization, through its currency board regime. This may influence the perception of international investors about the impact of exchange rate fluctuations on Argentine assets in a different way than what is the case for other Latin American countries. However given the low number of cross-sections used in this test, such results should be interpreted with caution.

For Asian countries, the currency factor yields mostly negative risk premia for Korea and Thailand that are only slightly significant for Korea when either TWXR$ or the JPYU$ rates are used in the model. The world market factor is never significant for Asian countries except for India when the LC/U$ rate is used. Latin American countries, however, show relatively large positive risk premia associated with the world factor, but their significance varies depending on the exchange rate included in the model. The low values for the Wald test statistics of the joint significance of the factor risk premia for most countries, except for Chile and Mexico, suggest that the two-factor full integration model is not well specified for the firm level analysis and further motivates the need for testing exchange risk pricing in the context of a partial segmentation model.

5.3. Estimation of the three-factor model

As mentioned in section 3, we test for the pricing of exchange risk in an asset pricing model that allows for partial segmentation by estimating equation (5) for each country using the same firm level dataset. Table 8 summarizes the risk premia obtained for the world, domestic and exchange risk factors across alternative exchange rate measures. In general, the three-factor model seems to provide a more appropriate specification for all countries (except Thailand) as we can see from the highly significant levels of the Wald test statistics compared to what was previously obtained in the two-factor model in table 7. The residual domestic factor coefficient is always significant for all countries (except India and Thailand) and for all exchange rate measures. The world market risk premium remains marginally significant for Mexico. As for the exchange risk premia, the evidence is puzzling. Both the TWXR$ and the LC/U$ rates are never significant in the presence of the domestic market risk factor. The bilateral JPYU$ exchange rate still yields a significant risk premium for Brazil while the EURU$ exchange rate yields a significant negative risk premium only for India.

In sum, almost in all cases where the exchange risk factor was significant in the two-factor model (table 7), this factor is subsumed by the local market index in the three-factor model. Table 8 confirms that it is hard to detect an unconditional exchange risk premium at firm level when using data from one country only. On the other hand, the cross-sectional data from one country yields a domestic risk premium that is robust to all exchange rate specifications.

The evidence from firm level tests seems also in contrast to the common belief that exchange exposure is better detected by the use of firm level information than through aggregate portfolios. For example Choi and Prasad (1995) showed that exchange rate changes do affect firm prices for a sample of 409 multinational firms in the US over the period 1978-89. However, when these firms were grouped into 20 SIC-based industry portfolios, the authors found limited support for exchange rate sensitivity.[1]

We believe that the limited number of firms included in these tests makes it hard to make strong conclusions at this level. An explanation could be that this limited data do not provide enough information to price either the world or the exchange risk factors. The evidence provided shows that they are in fact subsumed by the domestic factor whose impact on domestic assets is more likely to show through a limited number of firms. Moreover, by imposing constant prices of risk in this unconditional framework, which is in contrast to the growing evidence of time varying risk premia, the impact of exchange rate fluctuations may be underestimated in this setting where we estimate the average unconditional risk premia over a relatively long time period.

6. Conclusions and future research

In this paper, we provide preliminary empirical evidence on the pricing of exchange risk in emerging stock markets. To our knowledge, there is no previous study that investigates this issue for a large number of countries across different regions. Moreover, our tests are conducted at the market, portfolio and firm level data and use different exchange rate measures. This provides the basis for appropriate comparisons with a variety of previous studies for developed markets.

Tests based on market and portfolio level data support the hypothesis that exchange risk is unconditionally priced and commands a non-zero significant risk premium. This finding is different from what has been shown in similar unconditional studies for major developed stock markets where the hypothesis of a zero exchange risk premium could not be rejected.

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[1] We should recall though that Choi and Prasad (1995) study is about exchange rate sensitivity and not about pricing.

When using cross-sectional data at firm level there is some indication that bilateral exchange rates perform better than aggregate exchange rates in capturing the model's exchange risk factor. The results of the country-by-country analysis suggest that there is some variation in the size and sign of exchange risk premia across countries and regions. The sensitivity of the test results to the exchange rate measure suggests that a careful choice of the exchange rates is necessary to make sure that the exposures of a given country/region assets to certain foreign currencies are not overlooked by the use of a broad aggregate exchange rate measure. Finally, the significance of the exchange risk factor is highly affected by the model specification and motivates the need for using an appropriate asset pricing model that takes into account the extent of the integration or segmentation for the countries included. In fact, at the firm level, we find evidence that the most relevant factor is the domestic factor that subsumes the exchange risk factor.

Overall these results have important implications for the investment and risk management decisions of corporations. Pricing of exchange rate risk in the stock market implies that foreign exchange exposure is non-diversifiable and investors require compensation for taking on this type of risk. In this case, hedging by companies will be rewarded with a lower cost of capital.

Although these tests yield interestingly different results compared to similar unconditional studies for developed markets, additional evidence on the pricing of exchange risk in EMs is necessary. In particular, given the growing evidence about time variation of expected assets returns and the prices of risk, it would be more relevant to investigate whether exchange risk is priced in EMs using a conditional asset pricing model. Previous research for developed markets has shown that the conclusions are very different depending on whether we test a conditional or unconditional version of the same asset pricing model to test for exchange risk pricing. Indeed, some of the tests in this study conducted over shorter sub-periods show different results over different sub-periods and further motivates the need for using a time varying conditional framework.

Another potential improvement can be achieved by constructing an "EM currency index", that is, an exchange rate measure that takes into account only the currencies that are relevant for EMs, based on an analysis of the trade patterns and the extent of exposure of firms in each country/region with respect to those currencies. There is also the issue of inflation risk that should be addressed when we deal with EMs as inflation rates can be particularly high and volatile in many of these countries. We leave these issues to be investigated in a separate paper.

TABLE 1a
Summary Statistics for Stock Market Excess Returns[a]
- Monthly Data from January 1976 to October 1999 -

COUNTRY	Minimum	Maximum	Mean	Standard Deviation	Coeficient of Variation	Skewness	Kurtosis
Argentina	-65.675	177.359	3.821	25.940	6.789	2.281	10.654
Brazil	-57.560	56.920	1.325	16.165	12.203	0.477	1.435
Chile	-28.743	62.295	1.797	10.586	5.890	0.896	3.635
Mexico	-59.876	39.047	1.377	12.354	8.972	-0.845	3.489
Greece	-31.364	57.907	0.601	10.050	16.717	1.536	6.268
India	-24.691	34.925	0.747	8.104	10.850	0.578	1.422
Korea	-34.033	70.468	0.909	11.111	12.223	1.331	6.287
Thailand	-34.428	46.470	0.650	10.109	15.543	0.347	3.558
Zimbabwe	-41.097	45.342	0.370	10.480	28.347	-0.168	2.238
MSCI World	-17.731	11.072	0.354	4.006	11.323	-0.548	1.895

a: all returns are expressed in US$ and in percentage terms.

TABLE 1b
Correlation Matrix of Monthly Excess Returns and Risk Factors (1976.01–1999.10)

	Arg	Bra	Chl	Mex	Gre	Ind	Kor	Tha	Zim	MSCI	TWXR$	JPYU$	EURU$
Argentina	1.000												
Brazil	0.018	1.000											
Chile	0.137	0.098	1.000										
Mexico	0.192	0.087	0.209	1.000									
Greece	0.072	0.028	0.176	0.090	1.000								
India	0.115	0.066	0.138	0.076	0.139	1.000							
Korea	-0.047	0.046	0.094	0.128	0.014	0.032	1.000						
Thailand	0.058	0.062	0.195	0.263	0.174	0.095	0.322	1.000					
Zimbabwe	-0.029	0.040	0.175	0.084	0.133	0.170	0.096	0.086	1.000				
MSCI World	0.031	0.158	0.111	0.299	0.210	0.022	0.278	0.293	0.144	1.000			
TWXR$	0.065	0.086	-0.038	0.146	-0.185	-0.129	0.003	0.000	-0.120	-0.282	1.000		
JPYU$	0.033	0.027	-0.003	0.094	-0.081	-0.099	-0.154	-0.053	-0.085	-0.320	0.692	1.000	
EURU$	0.044	0.082	-0.013	0.210	-0.202	-0.083	0.056	0.075	-0.081	-0.210	0.069	0.567	1.000

TWXR$ is the change in the trade weighted exchange rate of the U$. JPYU$ and EURU$ are the changes in the JPY/US$ and EUR/U$ rates respectively. A positive change in all these rates means an appreciation of U$.

TABLE 2

LC versus U$-denominated Returns (1976.01-1999.10)

	Returns in LC		Returns in U$		App/dep. of LC vs U$	
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Argentina	12.41%	36.47%	4.44%	25.93%	-6.09%	2.11%
Brazil	11.98	22.69	1.94	16.16	-8.50	9.54
Chile	3.87	10.34	2.42	10.56	-1.39	3.14
Mexico	4.15	11.27	1.99	12.32	-2.06	5.99
Greece	1.96	9.82	1.22	10.01	-0.71	2.95
India	1.93	8.23	1.36	8.09	-0.53	1.99
Korea	1.73	9.94	1.53	11.09	-0.27	3.03
Thailand	1.44	9.66	1.27	10.08	-0.18	2.76
Zimbabwe	2.33	9.57	0.99	10.46	-1.35	3.82

TABLE 3

Variance Decomposition of the U$-denominated Returns

	Var($R_{u\$}$)	Var(R_{LC})	Var(R_S)	Cov(R_{LC},R_S)	R_s contrib.
Argentina	672.14	1329.80	146.64	-203.48	-49%
Brazil	261.11	514.62	90.92	- 91.60	-49%
Chile	111.48	106.82	9.87	- 1.51	4%
Mexico	151.78	126.99	35.94	- 0.43	20%
Greece	100.17	96.36	8.71	- 1.59	4%
India	65.61	67.79	3.95	- 2.32	-3%
Korea	123.21	98.86	9.21	6.31	25%
Thailand	101.71	93.23	7.59	1.10	9%
Zimbabwe	109.37	91.57	14.57	3.88	19%

TABLE 4

Regression of Country Excess Returns against World Risk Factors

	Regression 1			Regression 2				Regression 3				
Country	Const.	World Return	Adj. R-sqr	Const.	World Return	TWXR$	Adj. R-sqr	Const.	World Return	JPYU$	EURU$	Adj. R-sqr
Argentina	3.770*	0.157	-0.003	0.037*	0.331	0.779	-0.001	3.675*	0.310	0.154	0.415	-0.006
	(2.446)	(0.405)		(2.352)	(0.807)	(1.260)		(2.350)	(0.762)	(0.281)	(0.671)	
Brazil	1.125	0.613	0.019	0.013	0.778**	0.862*	0.035	0.959	0.762**	0.096	0.621	0.030
	(1.185)	(2.571)		(1.074)	(3.151)	(2.316)		(1.002)	(3.063)	(0.287)	(1.639)	
Chile	1.705*	0.283	0.008	0.017**	0.279	-0.031	0.004	1.752**	0.321*	0.156	-0.096	0.003
	(2.726)	(1.802)		(2.658)	(1.673)	(-0.125)		(2.758)	(1.947)	(0.699)	(-0.381)	
Mexico	1.083	0.903*	0.081	0.009	1.130**	1.172**	0.138	0.920	1.148**	0.359	0.795**	0.146
	(1.542)	(5.120)		(1.318)	(6.261)	(4.311)		(1.341)	(6.438)	(1.489)	(2.928)	
Greece	0.425	0.542*	0.043	0.027	0.458**	-0.511*	0.059	0.660	0.498**	0.294	-0.703**	0.065
	(0.728)	(3.704)		(0.456)	(3.001)	(-2.220)		(1.130)	3.281)	(1.435)	(-3.041)	
India	0.721	0.079	-0.002	0.006	-0.012	-0.402*	0.010	0.751	-0.026	-0.143	-0.192	0.003
	(1.498)	(0.657)		(1.273)	(-0.100)	(-2.147)		(1.543)	(-0.204)	(-0.839)	(-0.998)	
Korea	0.686	0.685	0.057	0.005	0.779**	0.348	0.069	0.291	0.726**	-0.621**	0.820**	0.106
	(1.072)	(4.263)		(0.733)	(4.739)	(1.404)		(0.462)	(4.425)	(-2.803)	(3.281)	
Thailand	0.438	0.652**	0.063	0.003	0.747**	0.321	0.079	0.275	0.785**	-0.057	0.390	0.087
	(0.755)	(4.473)		(0.601)	(5.062)	(1.444)		(0.474)	(5.204)	(-0.282)	(1.697)	
Zimbabwe	0.242	0.392*	0.019	0.016	0.320*	-0.340	0.022	0.293	0.337*	-0.016	-0.231	0.015
	(0.393)	(2.534)		(0.025)	(1.981)	(-1.397)		(0.468)	(2.075)	(-0.073)	(-0.932)	

* Significant at 5%; ** Significant at 1%; t-statistics are in parentheses.

TABLE 5

Risk Premia in the Two-Factor Model at the Market Level using TWXR$

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{is}R_{st} + \varepsilon_{it}$$

Period	λ_0	λ_s	Wald. Stat
1976.01 - 1999.10	1.536**	1.010**	13.80
	(3.556)	(2.827)	[0.001]
1976.01-1980.12	19.049	26.116	0.447
	(0.350)	(0.344)	[0.799]
1981.01-1985.12	0.740	2.687	4.066
	(0.876)	(1.905)	[0.130]
1986.01-1990.12	3.179**	1.677**	74.54
	(8.366)	(4.511)	[0.000]
1991.01-1999.10	-0.024	0.247	1.324
	(-0.049)	(0.762)	[0.515]

Panel B: Risk Premia for Alternative Exchange Rate Measures

Exchange rate	λ_0	λ_s	Wald. Stat
JPYUS$	1.501**	1.772*	9.446
	(2.969)	(2.031)	[0.008]
1976.01-1980.12	15.173	52.162	0.096
	(0.291)	(0.273)	[0.952]
1981.01-1985.12	1.929	7.969	3.369
	(1.465)	(1.773)	[0.186]
1986.01-1990.12	3.356**	2.361**	70.15
	(5.752)	(3.323)	[0.000]
1991.01-1999.10	-0.063	0.814	0.626
	(-0.087)	(0.773)	[0.731]
EURUS$	1.445**	1.0478*	13.63
	(3.691)	(-2.053)	[0.001]
1976.01-1980.12	N/A	N/A	N/A
1981.01-1985.12	0.168	2.182	7.371
	(0.786)	(1.756)	[0.025]
1986.01-1990.12	3.182**	1.931*	33.87
	(4.053)	(3.044)	[0.000]
1991.01-1999.10	-0.1547	0.044	0.074
	(-0.234)	(0.013)	[0.963]

* significant at 5%; ** significant at 1%. t-statistics of the parameter estimates are in parentheses. *P-values* of the Wald-statistics are in brackets.

TABLE 6a
Risk Premia in the Two-Factor Model using Industry Portfolios
(1985.01-1999.10)

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{is}R_{st} + \varepsilon_{it}$$

	λ_0	λ_s	Wald. Stat
R_s = TWXR$	0.0350	0.5111*	7.266
	(0.202)	(2.322)	[0.026]
R_s = JYPU$	-0.0862	1.3842	2.652
	(-0.298)	(1.624)	[0.265]
R_s = EURU$	0.0160	0.433	4.390
	(0.092)	(1.947)	[0.111]

* significant at 5%; ** significant at 1%. t-statistics of the parameter estimates are in parentheses. *P-values* of the Wald-statistics are in brackets.

TABLE 6b
Risk Premia in the Two-Factor Model using Size-Based Portfolios
(1976.01-1999.10)

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{is}R_{st} + \varepsilon_{it}$$

	λ_0	λ_s	Wald. Stat
VWP quartile 1	0.3861	0.8366	2.3391
	(0.523)	(1.529)	[0.310]
VWP quartile 2	2.3379**	1.5867**	15.1958
	(3.841)	(2.334)	[0.000]
VWP quartile 3	2.8954**	1.7464**	15.8683
	(3.949)	(2.459)	[0.000]
VWP quartile 4	3.4099**	2.6983**	19.5877
	(3.590)	(3.190)	[0.000]

VWP: value-weighted portfolio. Quartile 1 includes the smallest size firms and quartile 4 the largest size firms. Each set contains nine portfolios (one for each country in the study).
* Significant at 1%; t-statistics of the parameter estimates are in parentheses. P-values of the Wald-statistics are in brackets.

TABLE 7
Risk Premia in the two-factor Model using Firm Level Data

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{is}R_{st} + \varepsilon_{it}$$

	R_s = change in $TWXR			R_s = change in LC/$			R_s = change in Yen/$			R_s = change in EUR/$		
	λ_0	λ_s	W-stat	λ_0	λ_s	W-stat	λ_0	λ_s	W-stat	λ_0	λ_s	W-stat
Argentina	3.0391	0.4824	2.834	3.6128	-1.6552	2.823	2.6671	0.8855	3.7010	3.3667*	0.4070	2.926
14 assets	(1.633)	(0.525)	[0.242]	(1.511)	(-0.104)	[0.244]	(1.578)	(1.003)	[0.157]	(1.684)	(0.388)	[0.231]
85.01-99.10												
Brazil	1.1985	0.9504	2.999	1.6286	-2.5191	2.152	1.895	1.2544	2.266	1.3954	1.2519	2.923
16 assets	(1.042)	(1.480)	[0.223]	(1.439)	(-0.662)	[0.341]	(1.045)	(1.290)	[0.322]	(1.157)	(1.524)	[0.232]
85.01-99.10												
Chile	1.4971*	1.1318*	8.583	1.8448*	-0.5758	6.323	0.7364	3.3342*	6.410	1.5300*	0.9480	7.060
17 assets	(1.885)	(1.636)	[0.014]	(2.214)	(-0.509)	[0.042]	(0.684)	(1.849)	[0.040]	(1.969)	(1.296)	[0.029]
85.01-99.10												
Mexico	1.8403*	1.2776**	9.368	0.773	-3.3278*	5.592	1.6513	1.2843	2.758	2.0225*	1.4228**	7.393
14 assets	(1.654)	(2.906)	[0.009]	(0.711)	(-2.092)	[0.061]	(1.297)	(1.308)	[0.252]	(2.083)	(2.380)	[0.025]
85.01-99.10												
India	0.8453	0.6298	3.361	1.1708*	-0.4577	3.294	1.1284	-0.0741	2.707	0.9015	0.8858	3.573
26 assets	(1.157)	(0.798)	[0.186]	(1.742)	(0.675)	[0.193]	(1.557)	(-0.070)	[0.258]	(1.244)	(0.828)	[0.167]
86.05-99.10												
Korea	0.0381	-1.2997	2.009	-0.8658	-0.6268	0.504	0.0836	-1.776	2.294	-0.0112	-0.5304	0.304
16 assets	(0.028)	(-1.418)	[0.366]	(-0.490)	(-0.698)	[0.777]	(0.063)	(-1.510)	[0.318]	(-0.009)	(-0.540)	[0.859]
85.01-99.10												
Thailand	-0.7801	-0.2169	0.478	-0.6522	0.0866	0.299	-0.6956	-0.6036	1.023	-0.8516	-0.4228	0.599
14 assets	(-0.633)	(-0.333)	[0.787]	(-0.517)	(0.147)	[0.861]	(-0.564)	(-0.816)	[0.599]	(-0.666)	(-0.533)	[0.741]
89.01-99.10												

* significant at 5%; ** significant at 1%. t-statistics of the parameter estimates are in parentheses. P-values of the Wald-statistics are in brackets. LC/U$ refers to the bilateral exchange rate between the country's local currency and the US dollar. Consistent with all other exchange risk factor measures, a positive value for the change in this rate is interpreted as an appreciation of the US$ with respect to the local currency.

TABLE 8

Risk Premia in the three-factor Model (Partial Segmentation) using Firm Level Data

$$r_{it} = \lambda_0(1-\beta_{iw}) + \lambda_d\beta_{id} + \lambda_s\beta_{is} + \beta_{iw}R_{wt} + \beta_{id}R_{dt} + \beta_{is}R_{st} + \varepsilon_{it}$$

	R_s = change in TWXR$				R_s = change in LC/US$				R_s = change in JPYUS$				R_s = change in EURUS$			
	λ_0	λ_d	λ_s	W-stat	λ_0	λ_d	λ_s	W-stat	λ_0	λ_d	λ_s	W-stat	λ_0	λ_d	λ_s	W-stat
Argentina	-2.8598	6.9203*	-1.2674	61.240	-1.9348	5.6086*	20.4875	42.089	-1.3346	5.4259*	0.2698	117.640	-2.6414	6.7442*	-1.4333	63.066
14 assets	(-0.716)	(1.829)	(-0.857)	[0.000]	(-0.574)	(1.887)	(0.834)	[0.000]	(-0.534)	(2.320)	(0.255)	[0.000]	(-0.690)	(1.851)	(-0.877)	[0.000]
Brazil	1.1622	2.8457**	0.5511	27.739	1.1082	2.8594**	3.193	30.383	1.3969	2.4651**	-3.4540*	18.527	1.1387	2.8536**	0.6789	26.968
16 assets	(0.954)	(5.203)	(0.821)	[0.000]	(0.874)	(5.410)	(0.676)	[0.000]	(0.867)	(2.946)	(-1.698)	[0.000]	(0.908)	(5.067)	(0.826)	[0.000]
Chile	0.7234	1.5457**	0.8436	74.257	0.7957	1.5191**	0.1994	79.178	0.8011	1.5093**	0.9069	71.166	0.7656	1.5194**	0.6466	70.975
17 assets	(0.699)	(2.608)	(1.097)	[0.000]	(0.821)	(2.701)	(0.165)	[0.000]	(0.842)	(2.675)	(0.847)	[0.000]	(0.753)	(2.578)	(0.808)	[0.000]
Mexico	1.5505*	2.3230**	0.8567	96.845	0.9756	2.5007**	-2.0640	62.219	1.3472	2.4208**	-0.3072	97.079	1.6478*	2.3163**	0.8691	90.839
14 assets	(1.585)	(8.337)	(1.053)	[0.000]	(0.926)	(7.141)	(-1.034)	[0.000]	(1.423)	(9.537)	(-0.270)	[0.000]	(1.608)	(8.242)	(0.913)	[0.000]
India	0.6621	0.2689	0.7197	22.622	1.1460	-0.2723	0.8111	23.732	2.1133	-1.1399	-2.0052	13.371	-1.6548	0.5162	-5.6965*	4.677
26 assets	(0.605)	(0.230)	(0.714)	[0.000]	(1.078)	(-0.232)	(0.832)	[0.000]	(1.453)	(-0.778)	(-1.240)	[0.004]	(-0.821)	(0.886)	(-1.871)	[0.197]
Korea	0.3059	0.8323**	-1.3612	9.068	-0.0469	0.8643**	0.2452	10.203	0.0615	0.8674**	-1.7764	10.473	0.3907	0.8413**	-1.2054	10.065
16 assets	(0.183)	(2.732)	(-1.111)	[0.028]	(-0.031)	(2.732)	(0.255)	[0.017]	(0.040)	(2.977)	(-1.339)	[0.015]	(0.256)	(2.954)	(-0.963)	[0.018]
Thailand	-0.4343	0.5393	-0.3497	1.698	-0.5104	0.5416	-0.0619	1.459	-0.3904	0.5278	-0.6429	2.466	-0.5076	0.5345	-0.6365	1.903
14 assets	(-0.312)	(0.767)	(-0.429)	[0.637]	(-0.325)	(0.732)	(-0.196)	[0.692]	(-0.267)	(0.747)	(-0.751)	[0.481]	(-0.360)	(0.724)	(-0.661)	[0.593]

* significant at 5%; ** significant at 1%. t-statistics of the parameter estimates are in parentheses. P-values of the Wald-statistics are in brackets. LC/US$ refers to the bilateral exchange rate between the country's local currency and the US dollar. Consistent with all other exchange risk factor measures, a positive value for the change in this rate is interpreted as an appreciation of the US$ with respect to the local currency.

Appendix 1

Period	Returns in U$		Returns in LC		App/dep. of LC vs U$	
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Argentina						
1976-80	9.31	31.06	10.24	29.76	-4.72	11.60
1981-85	1.88	28.97	17.08	34.22	-12.05	11.36
1986-90	4.93	31.87	25.59	59.70	-11.50	17.05
1991-95	4.07	17.65	5.27	19.34	-0.75	5.33
1996-99	1.28	10.01	1.28	10.00	0.00	0.08
Brazil						
1976-80	-0.71	9.94	2.59	9.82	-3.18	3.18
1981-85	3.86	14.94	12.95	16.12	-8.05	3.37
1986-90	0.65	23.00	18.75	30.06	-14.17	10.56
1991-95	4.56	16.31	20.91	29.13	-14.20	11.53
1996-99	1.17	12.77	2.48	10.80	-1.20	6.97
Chile						
1976-80	6.83	14.90	9.47	14.51	-2.45	3.32
1981-85	-2.16	9.41	0.37	9.38	-2.43	4.68
1986-90	4.18	8.23	5.22	8.17	-0.99	1.94
1991-95	2.86	8.12	3.13	7.44	-0.29	2.21
1996-99	-0.25	7.63	0.36	7.17	-0.64	1.60
Greece						
1976-80	-0.11	4.68	0.30	3.97	-0.43	1.70
1981-85	-1.83	6.89	-0.01	5.76	-1.83	3.75
1986-90	4.70	15.27	4.81	15.05	-0.08	2.98
1991-95	-0.03	8.27	0.64	8.50	-0.61	3.01
1996-99	4.01	10.35	4.71	11.17	-0.58	2.67
India						
1976-80	2.07	4.73	1.85	4.30	0.22	2.23
1981-85	1.77	6.47	2.47	5.91	-0.70	1.45
1986-90	0.93	8.91	1.62	9.09	-0.66	1.29
1991-95	0.85	10.47	2.07	11.67	-1.06	2.76
1996-99	1.14	9.06	1.56	8.48	-0.44	1.55

Appendix 1

Period	Returns in U$		Returns in LC		App/dep. of LC vs U$	
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Korea						
1976-80	1.53	10.27	2.03	10.05	-0.49	2.20
1981-85	1.71	8.67	2.22	8.74	-0.50	0.57
1986-90	2.85	8.93	2.46	8.79	0.37	0.84
1991-95	0.54	7.67	0.67	7.57	-0.13	0.66
1996-99	0.86	18.91	1.16	14.64	-0.68	7.01
Mexico						
1976-80	2.58	9.68	3.42	7.41	-0.80	6.22
1981-85	-0.82	13.33	3.51	11.74	-4.07	7.98
1986-90	5.16	15.84	8.67	16.34	-3.26	4.83
1991-95	1.47	10.87	2.84	8.77	-1.41	5.67
1996-99	1.46	9.84	1.77	8.00	-0.44	2.83
Thailand						
1976-80	1.48	7.43	1.50	7.40	-0.02	0.18
1981-85	0.56	4.49	0.97	3.97	-0.40	2.33
1986-90	3.31	9.34	3.22	9.40	0.09	0.65
1991-95	2.19	8.79	2.19	8.87	0.01	0.54
1996-99	-1.94	17.66	-1.30	16.31	-0.73	6.28
Zimbabwe						
1976-80	1.60	8.95	1.59	8.69	0.00	1.63
1981-85	-0.53	12.91	1.03	12.85	-1.53	3.27
1986-90	3.66	5.72	4.46	4.97	-0.78	2.02
1991-95	-0.10	10.12	1.99	10.02	-1.96	4.41
1996-99	0.09	13.28	2.64	9.55	-2.81	6.19

Appendix 2

Country	$Var(R_{US})$	$Var(R_{LC})$	$Var(R_S)$	$Cov(R_{LC},R_S)$	R_S contribution in % of $Var(R_{US})$
Argentina					
1976-80	964.98	885.92	134.51	-5.34	9
1981-85	839.00	1170.72	129.06	-104.86	-28
1986-90	1015.86	3564.44	290.69	-626.43	-72
1991-95	311.56	374.05	28.40	-41.15	-17
1996-99	100.21	100.08	0.01	0.05	0
Brazil					
1976-80	98.72	96.46	10.12	-0.70	2
1981-85	223.12	259.93	11.33	-3.74	-14
1986-90	528.89	903.37	111.47	-128.15	-41
1991-95	266.09	848.42	132.93	-134.37	-69
1996-99	163.12	116.65	48.53	-8.15	40
Chile					
1976-80	221.96	210.42	11.02	4.04	5
1981-85	88.48	87.94	21.94	-10.03	1
1986-90	67.75	66.77	3.78	-1.28	1
1991-95	65.97	55.38	4.87	2.70	19
1996-99	58.25	51.35	2.57	2.56	13
Greece					
1976-80	21.90	15.78	2.88	1.68	39
1981-85	47.48	33.12	14.03	0.90	43
1986-90	233.19	226.42	8.87	-1.79	3
1991-95	68.31	72.28	9.08	-4.84	-5
1996-99	107.17	124.82	7.13	-9.38	-14
India					
1976-80	22.39	18.47	4.98	-0.59	21
1981-85	41.83	34.90	2.11	2.28	20
1986-90	79.38	82.60	1.65	-1.87	-4
1991-95	109.52	136.13	7.59	-13.60	-20
1996-99	82.11	71.88	2.41	3.84	14
Korea					
1976-80	105.54	100.93	4.85	-0.09	5
1981-85	75.23	76.33	0.32	-0.35	-1
1986-90	79.80	77.31	0.70	0.69	3
1991-95	58.81	57.31	0.43	0.62	3
1996-99	357.43	214.24	49.18	37.70	67

Country	$Var(R_{US})$	$Var(R_{LC})$	$Var(R_S)$	$Cov(R_{LC},R_S)$	R_S contribution in % of $Var(R_{US})$
Mexico					
1976-80	93.72	54.93	38.70	-1.84	71
1981-85	177.58	137.85	63.64	-12.03	29
1986-90	250.75	266.96	23.38	2.50	-6
1991-95	118.19	76.96	32.12	6.99	54
1996-99	96.88	64.08	8.01	14.57	51
Thailand					
1976-80	55.21	54.82	0.03	0.19	1
1981-85	20.14	15.77	5.45	-0.68	28
1986-90	87.21	88.40	0.42	-1.18	-1
1991-95	77.30	78.72	0.29	-0.74	-2
1996-99	311.72	265.88	39.43	7.51	17
Zimbabwe					
1976-80	80.04	75.57	2.66	0.64	6
1981-85	166.68	165.09	10.71	-2.10	1
1986-90	32.75	24.73	4.07	1.87	32
1991-95	102.50	100.34	19.47	-7.88	2
1996-99	176.42	91.14	38.33	33.47	94

Appendix 3

List of IFC industry indices used in portfolio level tests

Code	Name
100	Mining
320	Food & Kindred Products
321	Tobacco Manufactures
322	Textile Mill Products
323	Apparel & Other Textile Products
324	Lumber & Wood Products
325	Furniture & Fixtures
326	Paper & Allied Products
328	Chemicals & Allied Products
329	Petroleum Refining & Related Products
330	Rubber & Misc. Plastics Products
331	Leather Goods & Products
332	Cement & Glass Products
333	Primary Metal industries
334	Fabricated Metal Products
335	Machinery Except Electrical
336	Electric & Electronic Equipment
337	Transportation Equipment
339	Miscellaneous Manufacturing
400	Transportation/communication/utilities
500	Wholesale/retail trade
600	Finance/Insurance/Real Estate
700	Services
800	Other/diversified

CHAPTER III

Testing a Conditional IAPM with Joint Hypotheses of Currency Risk and Partial Integration for Emerging Stock Markets

Abstract

In this paper, we provide new evidence on the global pricing of exchange risk using data on the US and nine emerging stock markets (EMs. We conduct empirical tests using a multivariate GARCH-in-Mean specification and time varying prices of risk to determine whether exchange risk is priced under alternative model specifications and exchange rate measures. Since inflation rates in EMs are high and volatile, we argue that the use of real exchange rates offer a better proxy for both inflation risk and nominal exchange risk. In addition to using real exchange rates, the empirical model allows for partial integration by including a time-varying price of local market risk. Our main results support the hypothesis of significant exchange risk premia in emerging stock 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..

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 (1981a), and Adler and Dumas (1983)].[1] These international asset pricing models (IAPMs) include covariance 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. 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. Since most previous results are based on models that implicitly assume full market integration and study a few major developed stock markets (US, UK, Japan

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

and Germany), 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 relevance of exchange risk as an additional source of uncertainty in EMs.

It is then interesting to empirically see if such perception is reflected in more significant (and/or larger) foreign exchange risk premia in equity returns in emerging markets. Indeed, the issue of whether foreign exchange risk is priced for securities in these markets remains to a large extent an open question.[2] For example, the Bailey and Chung (1995) study finds evidence that Mexico's equity market premia are related to premia in the currency market. However they conclude that some risk premia can be detected only if time variation is allowed. Another study by Carrieri and Majerbi (2003) where they conduct unconditional tests for nine EMs suggests that while the world market and the exchange risk premia are significant over a 25 year period, both premia become insignificant and unstable over certain specifications of exchange risk and time periods. Further, in their test of a model that admits partial integration, the exchange risk factor is subsumed by the domestic risk factor.

Hence, we use a conditional framework to investigate whether foreign exchange risk is priced in emerging stock markets under different model specifications and exchange risk measures. Based on data from the US and nine EMs encompassing different regions and different exchange rate regimes, we attempt to provide some answers to the following related questions:

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[2] This is surprising in light of the exchange rate uncertainty that characterizes most EMs and the impact of exchange rate movements that goes beyond the "pure translation" risk to affect stock prices through their impact on expected cash flows. As reported by Carrieri and Majerbi (2003), historical returns in local currencies are on average much higher and less volatile than the corresponding dollar returns for all countries. For a majority of EMs, the variability of the dollar-denominated returns is also higher than the variability of LC returns.

- Does exchange risk command a significant time varying risk premium in equity returns?
- Does the price of exchange risk remain significant once we account for local market risk in a model that assumes partial integration?
- If exchange risk is priced, is the exchange premium different across countries/regions? and how does this compare to what has been reported for developed stock markets?

Our base model uses the IAPM of Adler and Dumas (1983). The base case assumes that 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 EMs.

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 inflation risks are priced. Previous empirical tests based on this model have assumed inflation as negligible and simplified the model by estimating the prices of covariance risk of the assets returns with nominal exchange rate changes. Although this can be considered a reasonable assumption in the case of major developed markets, one cannot simply ignore inflation by assuming that it is nonrandom when we deal with relatively more inflationary and volatile economies such is the case in most EMs. In the absence of such simplifying assumption, we derive our empirical model where the covariance terms of asset returns with inflation rates are replaced by the covariance of asset returns with the 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.

Furthermore, it is well accepted that EMs are neither fully integrated nor completely segmented [see, Errunza, Losq and Padmanabhan (1992), Bekaert and Harvey (1995)][3]. 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 an asset pricing model that allows for partial integration by including a time varying price of local market risk. The addition of this domestic risk factor to capture the effects of potential country-specific risk can also be related to the mild segmentation model of Errunza and Losq (1985), which is a limiting case of the more general model of Stulz (1981b).[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 of failure to account for the domestic risk 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 EMs show larger premia linked to the exchange risk factor. 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 across all global assets they represent 14 percent of the total premium in absolute terms. This number increases to about 17% when we consider the average among EMs only. Over subperiods, we find that the contribution from

[3] These studies, however, ignore the exchange risk factor and focus on global versus local risk premia in pricing EM assets.
[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), Hardouvelis, Malliaropulos and Priestley (1999), Carrieri, Errunza and Sarkissian (2002).

emerging markets currency risk can be as high as 40 percent for some EM assets. When we allow for partial segmentation, we find that local market risk is often priced and at times it subsumes the statistical importance of currency risk. For some countries, the significance of the price of currency risk is quite sensitive to the choice of the exchange risk measure used. 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 18 percent of the total premium across all EM assets. Thus, currency risk is an important economic risk factor in pricing global assets, not only in major stock markets as shown in previous studies, but also in less mature markets that are partially segmented.

The rest of the paper is organized as follows. In section 2, we briefly discuss the existing empirical literature on the pricing of exchange risk. Section 3 outlines the model and methodology. Section 4 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 those based on a partial integration specification are presented in section 5. Section 6 concludes the paper.

2. Past Research

Early theoretical studies considered foreign exchange risk as a priced factor and proposed IAPMs that include exchange risk premia along with the traditional market risk premium [Solnik (1974), Stulz (1981a), Adler and Dumas (1983)]. On the empirical side, there are only few studies that directly test for the existence and significance of such exchange risk premia in stock markets. In general, the evidence is quite mixed and fragmentary. Early unconditional tests, such as Hamao (1988) and Jorion (1991), were rather inconclusive and generally found no evidence that exchange risk is priced on the Japanese and US stock markets in an unconditional framework. On the other hand, more recent studies, based on a conditional setting [Dumas and Solnik

(1995), De Santis and Gerard(1998), Choi et al. (1998), Doukas, Hall and Lang (1999), Carrieri (2001)], tend to strongly support the hypothesis that foreign exchange risk is priced in stock markets of major developed countries.

The literature on foreign exchange risk premia as they relate to EMs is very sparse. With the exception of the Bailey and Chung (1995) study of the Mexican market, the unconditional tests of Carrieri and Majerbi (2003) for a sample of nine EMs and the Phylaktis and Ravazzolo (2002) analysis of Pacific Basin financial markets, we are not aware of any other work that focuses on estimating exchange risk premia in emerging stock markets.

The conclusions in Carrieri and Majerbi (2003) provide initial evidence that exchange risk is unconditionally priced in EMs using aggregate market data, although with firm level data both the world market and the exchange risk factor become insignificant and are subsumed by the domestic market risk factor. However, given the growing evidence about time variation of expected assets returns and the prices of risk, it would be more relevant to investigate whether exchange risk is priced in EMs using a conditional asset pricing model. Previous research for developed markets has shown that the conclusions are very different depending on whether we test a conditional or an unconditional version of the same asset pricing model. Indeed, further investigation of this important issue is called for.

3. Model and Methodology

3.1. 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,

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

where r_i and r_w are excess returns on the asset i and the world market portfolio, $\pi^{\$}_c$ is the rate of inflation of country c expressed in the reference currency , E is the expectations operator, δ_w is the price of world market risk and δ_c 's are the prices of inflation risks. The term cov(r_i , $\pi^{\$}_c$) measures the exposure of asset i to both the inflation risk and the exchange risk associated with country c.

Dumas and Solnik (1995) and De Santis and Gerard (1998) simplified the model by assuming that domestic inflation is non-stochastic. Since $\pi^{\$}_c \approx \pi_c + e_c$,[5] where π_c is the inflation in local currency terms and e_c is the change in the nominal exchange rate , they assume that the only random component in $\pi^{\$}_c$ is the relative change in the exchange rate between the reference currency and the currency of country c. Therefore, cov (r_i , $\pi^{\$}_c$), is a pure measure of the exposure of asset i to the currency risk of country c and δ_c can be interpreted as the price of exchange risk related to currency c. 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 EMs where inflation is volatile, we cannot substitute the change in the nominal exchange rate for the inflation rate $\pi^{\$}_c$. In addition, using nominal exchange rates to proxy for inflation in the reference currency would cause misspecification of the estimated risk premium as it would not account for the adjustment from local inflation.

[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$

Therefore, when inflation cannot be assumed non stochastic, we should have two covariance terms for each currency. Not only this is too difficult to estimate, but the separation between local inflation and nominal currency value for a given country to estimate inflation and exchange risk premia may not have a relevant economic meaning. This is because, especially in EMs, the changes in these two factors tend to be closely related.

One way to overcome the difficulty in empirical testing of IAPMs for the case of high inflation countries is to proxy the inflation rate $\pi_c^{\$}$ by the change in the real exchange rate of currency c instead of the nominal exchange rate (see proof in appendix 1). As explained in the appendix, this would still require an assumption about inflation to be non stochastic, but only for the reference currency (the US dollar) which is a reasonable assumption. 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 c and the US) and changes in the nominal currency value. In addition, using changes in the real exchange rates also helps overcome possible complications due to fixed exchange rate regimes or large discrete changes in nominal exchange rates due to devaluations or peg removals that often occur in EMs[6].

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:

$$E(r_{i,t}) = \delta_{w,t-1} \operatorname{cov}_{t-1}(r_{i,t}, r_{w,t}) + \sum_{c=1}^{L} \delta_{c,t-1} \operatorname{cov}_{t-t}(r_{i,t}, r_{c,t}) \tag{1a}$$

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] Another advantage of using real exchange rates is that it makes it more appropriate to use the same model for countries with different exchange rate regimes.

where $r_{c,t}$ is a real currency return represented by the change in the real exchange rate of currency c vis-à-vis the US dollar. δ_c can now be interpreted as the price of exchange risk after adjusting for inflation changes.

Next, we modify this simplification to depict a more realistic global market environment. We test for the pricing of exchange risk within the framework of an asset pricing model that allows for partial integration by adding a time varying price of local market risk:

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

where, δ_d, the price of domestic risk for each EM equity portfolio, is incorporated to measure factors such as legal barriers to portfolio flows or differential tax treatment across countries that are not captured by the full integration model. In this, we follow Bekaert and Harvey (1995) and De Santis and Gerard (1998) who add a constant price of local risk in a model with global covariance risk. This extension is important from an empirical perspective since we want to avoid a spurious significance of the currency risk due to missing relevant factors[7].

Our empirical specification with time-varying prices of world and domestic risks has the advantage of accommodating periods of various degrees of integration or segmentation without being subject to the rigidity inherent to the choice of a liberalization date in regime switching models such as De Santis and Imrohoroglu (1997) and Phylaktis and Ravazzollo (2002).[8] This is because some countries may be integrated even in the presence of barriers as shown in Bekaert and Harvey (1995) who

[7] At present there is no theoretical model that accounts for both PPP deviations and barriers to investment that result in market segmentation.
[8] These models typically assume that markets are segmented during the pre-liberalization date (including only local risk) and integrated thereafter (including only world market risk).

found that integration was substantial also in countries presenting extensive foreign ownership restrictions such as Korea and Taiwan.[9]

3.2. 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. In the system for estimation, the pricing restriction (1a) has to hold for all N assets that include n equity portfolios ($1<n<L+1$), L real currency portfolios and the world market portfolio:

$$
\begin{aligned}
r_{1t} &= \delta_{w,t-1}\operatorname{cov}(r_{1t}, r_{wt} \mid \Omega_{t-1}) + \sum_{c=1}^{L}\delta_{c,t-1}\operatorname{cov}(r_{1t}, r_{n+c,t} \mid \Omega_{t-1}) + \varepsilon_{1t} \\
&\vdots \\
r_{nt} &= \delta_{w,t-1}\operatorname{cov}(r_{nt}, r_{wt} \mid \Omega_{t-1}) + \sum_{c=1}^{L}\delta_{c,t-1}\operatorname{cov}(r_{nt}, r_{n+c,t} \mid \Omega_{t-1}) + \varepsilon_{nt} \\
r_{n+1,t} &= \delta_{w,t-1}\operatorname{cov}(r_{n+1,t}, r_{wt} \mid \Omega_{t-1}) + \sum_{c=1}^{L}\delta_{c,t-1}\operatorname{cov}(r_{n+1,t}, r_{n+c,t} \mid \Omega_{t-1}) + \varepsilon_{n+1,t} \qquad (2) \\
&\vdots \\
r_{n+L,t} &= \delta_{w,t-1}\operatorname{cov}(r_{n+L,t}, r_{wt} \mid \Omega_{t-1}) + \sum_{c=1}^{L}\delta_{c,t-1}\operatorname{cov}(r_{n+L,t}, r_{n+c,t} \mid \Omega_{t-1}) + \varepsilon_{n+L,t} \\
r_{wt} &= \delta_{w,t-1}\operatorname{var}(r_{wt} \mid \Omega_{t-1}) + \sum_{c=1}^{L}\delta_{c,t-1}\operatorname{cov}(r_{wt}, r_{n+c,t} \mid \Omega_{t-1}) + \varepsilon_{wt}
\end{aligned}
$$

where:

r_{it} ($i=1 \ldots n$) is the excess return on equity portfolio i measured in a common currency

$r_{n+c,t}$ ($c=1 \ldots L$) are the real currency returns;

r_{wt} is the excess return on the world market portfolio;

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

$\delta_{c,t-1}$ are the prices of currency risk;

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

[9] Bekaert and Harvey (1995) also use a regime switching model but without fixing the regime switching date.

$\varepsilon_t \sim N(0, H_t)$ are the error terms

Grouping all assets into one vector, we can rewrite system (2) as follows:

$$r_t = \delta_{w,t-1} h_{w,t} + \sum_{c=1}^{L} \delta_{c,t-1} h_{n+c,t} + \varepsilon_t \qquad \varepsilon_t / \Omega_{t-1} \sim N(0, H_t) \qquad (2)'$$

where r_t is a vector of excess returns of N assets (N=n+L+1) measured in a common currency, $h_{w,t}$ is the last column of the *(NxN)* covariance matrix H_t. which gives the covariances of the N assets with the world portfolio return, and $h_{n+c,t}$ is the $(n+c)^{th}$ column of H_t. which gives the covariances of the N assets with the real currency portfolio c=1...L.

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 these uncovered currency deposits. We start from the same uncovered interest rate condition and substitute domestic Fisher relationships for the nominal interest rate.[10] The pricing equation for currency portfolios can now be expressed in terms of changes in the real exchange rates. This implies that, together with the assumption of real interest rate parity, real exchange rate changes 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).

[10] From uncovered interest parity, using the domestic Fisher relationship for the nominal interest rates and regrouping terms we have that $i_j + e_j - i = (a_j - a_\$) + (e_j + \pi_j - \pi_\$) = (a_j - a_\$) + e_j^r$ where i_j is the nominal interest rate, a_j is the real interest rate and e^r_j is the change in the real exchange rate for currency j.

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 returns includes a time varying price of domestic market risk, $\delta_{d,t-1}$, in addition to a time varying price of world market risk and time varying prices of real exchange rate risk:

$$r_{it} = \delta_{w,t-1} h_{i,w,t} + \sum_{c=1}^{L} \delta_{c,t-1} h_{i,n+c,t} + \delta_{di,t-1} h_{i,i,t} + \varepsilon_{it} \qquad (3)$$

where $\delta_{di,t-1}$ is the price of local market risk. The expected return of the other assets in the system (i.e., the currency returns and the world return) will depend only on world market risk and real currency risk, in line with the original model of equation (1a).

We model the prices of world market risk and exchange rate risk ($\delta_{w,t-1}$ and $\delta_{c,t-1}$) to depend only on a set of global information variables $Z_{G,t-1}$, while the price of local risk $\delta_{di,t-1}$ is dependent on a set of local information variables, $Z_{L,t-1}$, which is country-specific.[11] 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[12]. The same linear specification is also used for the price of the domestic risk factor.

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

$$\delta_{c,t-1} = k_c' Z_{G,t-1}, \quad c = 1 \text{ to } M \qquad (5)$$

[11] Dumas and Solnik (1995) and De Santis and Gerard (1998) use the same set of global instruments for the price of world risk and the prices of currency risk.

$$\delta_{d,t-1} = k_d' Z_{L,t-1} \quad (6)$$

We use a linear specification for the price of domestic 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 EMs assets, we propose to follow the fully parametric approach with a multivariate GARCH-in-Mean specification 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 the first term of H_t as a function of the unconditional covariance matrix of the residuals H_0 and a reduced number of parameter vectors[13]:

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

where i is a $(Nx1)$ vector of ones, a and b are $(Nx1)$ vectors of unknown parameters to be estimated jointly with the risk premia parameters and * denotes the Hadamard (element-by-element) matrix product.[14]

---

[12] 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. The empirical models of De Santis and Gerard (1998) and Hardouvelis, Malliaropulos and Priestly (1999) use the same functional specification proposed above for the prices of market and currency risk.

[13] 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.

[14] 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.

In summary, equations (2)' for the full integration model and (3) for the partial integration model are estimated under the specifications in Eqs. (4) to (7). Under the assumption of conditional normality, the log-likelihood function can be written as follows:

$$\ln L(\theta) = -\frac{TN}{2}\ln 2\pi - \frac{1}{2}\sum_{t=1}^{T}\ln\left|H_t(\theta)\right| - \frac{1}{2}\sum_{t=1}^{T}\varepsilon_t(\theta)' H_t \varepsilon_t(\theta) \qquad (8)$$

Each 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 to misspecification of the model (see White (1982)).

Even with this parsimonious specification, a joint multi-country estimation of such model is computationally very difficult since it would include a large number of currency premia and domestic premia. That is why previous studies with similar methodologies were limited to using few countries at a time.[15] To reduce the dimensionality of the model, a common way used in the literature is to replace the different currencies exchange rates by a single exchange rate measure such as a trade weighted exchange rate index [Jorion (1991), Fang and Loo (1996), Choi, Hiraki and Takezawa (1998)]. To include a large cross section of countries, other studies, such as Hardouvelis et al. (1999) estimated similar models in two steps [16].

Clearly there are shortcomings to both approaches. By using a single currency index, we lose information regarding the relative pricing of some currencies with

[15] Four countries in the case of DeSantis and Gerard (1998) with three currency premia.

[16] In Hardouvelis, Malliaropulos and Priestly (1999), which use a similar empirical framework but with a time-varying degree of integration for the EMU countries, the 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 countries 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 simultaneous estimation procedure suggested by De Santis and Gerard (1997,1998).

respect to others, while a 2-step estimation procedure results in errors in variables problem and may affect the significance of the parameter estimates. In our study, we find a compromise by investigating various versions of the model both on a multi-country and individual country basis. In the multi-country joint estimation, we reduce the dimensionality of the model by using two exchange rate indices to separate the effects of EMs currencies fluctuations from those of major currencies. In the individual country estimations where we test for the relative pricing of exchange risk after we account for both world and local market risks, we use real bilateral exchange rates as an alternative measure for the exchange risk factor.

4. Data and Summary Statistics

This study covers 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 (adjusted for dividends) of the S&P/IFC's Emerging Market Database (EMDB). The world market return is computed from MSCI World index adjusted for dividends and available from DataStream. All returns are expressed in US$ and computed in excess of the 30-day eurodollar deposit rate, used as a proxy for the risk-free rate, available from DataStream.

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

As mentioned in section 3 above, we use two trade-weighted exchange rate indices computed by the Federal Reserve Board to separate the effects of EMs currencies fluctuations from those of major currencies. The first group of currencies is included in the "other important trading partner" (*OITP)* index. We will refer to this as *EM currency index*. This group includes the currencies of important trading partners, but these currencies are not heavily traded outside their respective home markets. The currencies of nineteen countries among EMs are in this subset. The second group is summarized in the "major partners" index, which we will refer to as *Major currency index*. This group comprises the major international currencies. It includes sixteen currencies until the introduction of the euro and seven currencies after that event. These two currency indices are also computed on a price-adjusted basis (real exchange rate indices) and provide fairly good measures to approximate for the sum of the various real exchange rates that should be included in the model (see proof in appendix 2). 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.

We use the *Major currency index* in our estimation since according to the full integration model, there should be as many currency premia as there are countries. Furthermore, given previous evidence on the pricing of the exchange risk related to major currencies in developed stock markets, it is interesting to investigate the pricing effect of such risk factor in the case of EMs. In addition, 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 major European currencies due to their trade patterns or currency regimes.[17]

Table 1 reports summary statistics and correlations between excess market returns and the world risk factors (world return and real exchange rate indices). Compared to the world return characteristics, EMs returns are large on average and show 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, EMs 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 (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 EMs. 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 Colombia, 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 in international asset pricing. More precisely, we use similar instruments as in the studies of De Santis and Gerard (1998) and Dumas and Solnik (1995) to compare our results. 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

[17] 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.

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 notes, 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 markets dividend yields 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 IFS database.

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.

We start by estimating a system for six country returns (Brazil, Chile, Korea, Mexico, Thailand and the US), two exchange rate indices (EM and Major currencies) and the world market where the prices of risk are constant.[18] We find that neither global market nor currency risk is priced. The findings of Dumas and Solnik (1995) and De

[18] For the multicountry estimation we use a subset of countries with the longest data series available.

Santis and Gerard (1998) on the importance of conditioning information are thus confirmed also within 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 obtained for DMs [De Santis and Gerard (1998), Dumas and Solnik (1995)] we find that the prices of both EM and Major currencies risks are statistically different from zero and significantly time-varying. The hypothesis of constant prices of the two currency risk factors is rejected at the 1% level. The price of *EM currency* risk is relatively more significant than the price of *Major currency* risk within this sample that includes a larger number of EM countries. On the other hand, there is no strong evidence on the time-variation of the price of global market risk. Diagnostics for residuals 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 report the graphs of the estimated prices of risk and the corresponding risk premia computed for each country in figure 1 and 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 for DM markets. 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 EMs show larger premia linked to the exchange risk factor, particularly with respect to the *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.[19] Interestingly, over the Nineties, the EMs currency premium is positive for all assets.

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

This might be indication that in this period characterized by persistent depreciations, the hedging component is not 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. Looking only at EMs, 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 EMs the largest portion is represented by the *EM currency* premium component, while the *Major currency* premium component represents the largest 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 EMs 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. We do not report summary statistics of the five-year period in between the two subsamples. This time is characterized by the large depreciation of the dollar in real terms. Remarkably for this subsample, we find that the major currency premium component is significantly larger than its sample average since it represents 17 percent of the total. This implies that at times EM assets provide sizable compensation for currency risk also to DM investors.

We also estimate a multicountry model with the four largest financial markets plus Mexico and Korea.[20] The evidence that we obtained is qualitatively similar.[21] Total currency premia are priced at any statistical level and represent on average over the whole period 14.5 percent of total absolute premium. Interestingly, even for DM assets, the premium attached to emerging market currencies is of significant size when we compute it over subperiods. Overall, there is initial evidence that, financial assets worldwide provide compensation not only for the risk of major currencies but also for currency risk attached to the assets 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 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 to 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 plus a local market risk factor. Although this specification is not based on an explicit theoretical model, the factors are motivated by widely used IAPMs and past empirical findings such as Harvey (1995). 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. The results are in table 6. The evidence on the significance of currency risk is unchanged. Overall, currency risk is the most relevant source of risk since global risk is still marginally

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

[21] For this set of countries, we also conducted a likelihood ratio test between the unrestricted model with two currency premia and the one that excludes the currency premium from the emerging market currencies. The restricted model is rejected in favor of the unrestricted model. However, we do not report this analysis since the likelihood ratio test, differently from the Wald test, is not robust to mis-specification.

significant. Both currency groups are priced, with the emerging market currencies being a relatively more important source of variation than the other group of currencies for the countries included in the system. However, we find that none of the individual prices of domestic risk are significant and we cannot reject the hypothesis that local risk is jointly equal to zero.

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.

Besides the world and domestic risk factors, we keep both currency indices as a measure of changes in PPP deviations. We conduct separate estimations for all nine countries in our sample within a reduced system that includes five assets: the EM country, the US, the world and the two currency indices.[22] Table 7 reports the results of this partial integration model. Unlike the results in table 6, we find that the time-varying price of domestic risk is highly significant for five countries. The price of exchange risk remains highly significant for Brazil, Chile and India and marginally significant for all the other six countries. When we look at the relative statistical importance of the two currency groups, the major currency group is always priced at the 10% significance level or better, while the emerging market currency group is priced for Brazil, Chile, India, Mexico and Thailand and not priced in the case of Colombia, Korea, Malaysia and Philippines. The price of world market risk is also significant for all countries.

[22] For the last four assets, the pricing equation is the same as in (2).

Table 8 contains estimated risk premia as percentages of the absolute total premium for the partial integration model. The most important result is that, although local market risk is on average the largest component, total currency premia still represent about 18 percent of total premium. Interestingly, in the full integration model, total currency premia reported in table 5 for emerging markets also account for about 17 percent of the total premium. One might assume that in the absence of local risk, 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 over 40 percent of the total premium, such as in the case of Colombia, Malaysia, Philippines and Thailand in the Nineties.

In figure 3, we report graphs of the risk premia associated with the two currency factors estimated from the model in table 7. Since we want to focus on the relative importance overtime of the currency factors and the local market risk factor, we omit the world risk premium. Some points are noteworthy. First, for most countries, the size of the domestic market risk premium is much higher than both the world (not shown on graphs) and the currency risk premia. Second, we can clearly see that the pattern of both currency risk premia is consistent to that obtained for the same countries in the full integration model as shown in figure 2. There is only a small difference for Korea where the negative part of the large swing in the *EM currency* premium during the 1997-99 period is now depicted by the local risk factor. Third, we note that in some cases, periods of large swings in the risk premia are mostly captured by the domestic risk factor but we can still identify periods of crisis that are characterized by an increase in *EM currency* premia. This is the case of Brazil, Chile and Mexico during the Latin American debt crisis of 1982-83 and of Korea, Thailand and Malaysia during the Asian crisis of 1997-99.

In summary, the evidence reported in this section suggests that currency risk is statistically and economically significant, even after accounting for local risk.

5.3. Robustness Checks

Besides the computational advantage, the previous estimation within the smaller system has the additional benefit of allowing a test for the pricing of exchange risk using less aggregated currency risk measures. To investigate whether the results on the relative importance of exchange risk and local risk are sensitive to the choice of the exchange rate measure, we re-estimate the nine systems in the previous test substituting for the *EM currency index*, the change in the real bilateral exchange rate with respect to the reference currency (US$). Table 9 shows the results of the partial integration model that includes the world factor, a local currency factor (using the real bilateral exchange rate), a major currency risk factor (using *Major currency index*), and the domestic risk factor.

First, we note that the significance of the domestic risk factor seems to be largely unaffected by the use of the bilateral exchange rate in place of the *EM currency index* for most countries. It is still significantly different from zero and time-varying for Chile, Colombia, Korea and Philippines, but not significant for Brazil, India and Thailand. However, in the case of Mexico, local market risk is now significant, while we find no evidence of exchange risk using the bilateral rate measure. In the case of Malaysia we observe the opposite result. The local market risk becomes insignificant while the bilateral exchange rate risk is now important. The local currency risk is now significant also for Chile, Colombia, Korea and Philippines and for these countries it is not subsumed by the significance of the domestic 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.

Table 10 contains the estimated risk premia as percentages of the absolute total premium from the model in table 9. In this setting using bilateral exchange rates, total currency premia represent on average, among emerging markets, 21 percent of total premium, with the local currency factor as the largest element. Similar to the evidence in tables 5 and 8, we find that the risk premium related to EMs currencies is larger over subsamples. The *Major currency* premium is similar in percentage terms to the numbers reported in tables 5 and 8. 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.

For further investigation of the sensitivity of the results to the exchange rate measure, we exclude the *Major currency index* from the previous systems and re-estimate the partial integration model using EM currencies (either bilateral exchange rates or *EM currency index*) as the only currency risk factor besides the world and domestic risk factors. Table 11 reports the results of the three-factor model using real bilateral exchange rates. 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. The price of world market risk is also significant for all countries.

Table 12 shows the results of the partial integration model that includes the world market risk factor, the exchange risk factor linked to the *EM currency index*, and the domestic market risk factor. Interestingly, for Brazil, unlike the results in tables 9 and 11, we find that exchange risk is significant. This suggests that this country's assets may be more sensitive to the fluctuations of EMs currencies and explains the failure to find significant price of exchange risk when the *EM currency index* is missing from the model. The price of *EM currency* risk is also significant for most other countries where the bilateral exchange rate was significant in the previous tests, except for Malaysia where local risk is instead more significant when we use the *EM currency index*. This switch in the relative significance of exchange versus local risk in Malaysia when we change the exchange rate measure is also noticed for Mexico. Indeed, in the case of Malaysia, when we use the bilateral exchange rate measure (alone or with the *Major currency index*), the local risk disappears, while in Mexico the domestic risk factor becomes insignificant when we include the *EM currency index* in the model.

These results suggest that, for some countries, the significance of currency risk is 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 overall local market risk and exchange rate risk are priced separately, although in some cases it is hard to disentangle the two risk factors. Therefore, using an asset pricing model with only exchange risk or only local risk may lead to misspecification. The implications for investors of such misspecification are important. In fact, if currency risk is found significantly priced in a model that assumes full integration, investors are rewarded for such risk in terms of expected returns and should consider hedging this risk. However, this model ignores domestic risk. Therefore if the relevance of exchange risk pricing is largely spurious in the sense that it may account for the missing domestic factor, the latter should be priced, while exchange rate risk may be diversifiable.

6. Conclusions

The objective of this paper was to investigate the 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 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 risk factor due to the missing local risk factor.

Since inflation rates are high and volatile in EMs, our tests are based on real exchange rates, which provide a better proxy for both inflation risk and exchange risk. Previous studies testing for exchange risk pricing focus only on nominal exchange rate changes because they assume non-random inflation. Such assumption is obviously not appropriate in the case of EMs. We argue that real exchange rates provide a better proxy for PPP deviations since they capture both inflation and nominal exchange rate risks. Thus, in addition to using an empirical model that allows for partial integration, we also use real exchange rates.

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 currencies. The price of exchange risk is also significantly time-varying, which is consistent with previous evidence for major developed stock markets. When we include local market risk, currency risk still represents a significant portion of total premium. While on average total currency premia represent almost 18 percent of the total premium in absolute terms, over subperiods the risk premium of emerging market currencies increases for all global assets and it can be as large as 40 percent for some emerging market assets.

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.

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 Columbia, 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**
Columbia	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											
Columbia	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 Columbia, 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
Columbia	-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	Columbia	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.	Min.	Max.	Pairwise correlations		
XWDY	-0.4023	0.2349	-1.3030	-0.0403	1.0000	0.0870	-0.5330
ΔUSTP	-0.0098	0.4689	-2.3700	3.5600		1.0000	0.1370
USDP	1.0986	0.4616	0.5500	2.6900			1.0000

Panel B: Local information variables

	Mean	Std.Dev.	Min.	Max.	Pairwise correlations	
XLDY					with LagRet	with ΔLCinf.
Brazil	-0.1929	0.2621	-0.9097	1.2009	-0.2759	-0.0830
Chile	-0.2485	0.2938	-1.4063	0.2291	0.0905	-0.0180
Columbia	-0.1325	0.2167	-0.5506	0.6859	0.1497	0.0252
India	-0.4376	0.2384	-1.3573	-0.0311	0.0011	-0.0181
Korea	-0.3489	0.2351	-1.2200	0.3752	-0.0043	0.0235
Malaysia	-0.3313	0.1446	-0.6808	0.0512	-0.0129	-0.0346
Mexico	-0.3102	0.3315	-1.3872	1.0888	-0.0319	0.0547
Philippines	-0.3781	0.1320	-0.6945	0.0898	0.1234	-0.0118
Thailand	-0.2296	0.2275	-1.1084	0.3519	0.0202	0.0296
ΔLCinf.						
Brazil	0.0010	3.9901	-45.6656	10.0694	-0.2081	
Chile	-0.0218	2.0718	-13.1781	25.3608	-0.0412	
Columbia	-0.0087	0.8282	-3.4140	2.2467	0.0752	
India	0.0104	0.9196	-3.6977	2.4323	-0.0840	
Korea	-0.0014	0.7780	-3.4822	2.5887	-0.0649	
Malaysia	0.0031	0.4242	-1.3107	1.2673	0.1041	
Mexico	0.0002	1.1950	-6.3756	6.1403	-0.1834	
Philippines	-0.0139	0.9800	-7.2424	5.3201	0.0489	
Thailand	0.0007	0.7826	-3.3012	2.8685	0.0167	

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

The estimated model is:

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

$$\text{where} \begin{cases} \delta_{w,t-1} = \exp(k_w' z_{t-1}) \\ \delta_{em,t-1} = k_{em}' z_{t-1} \\ \delta_{mj,t-1} = k_{mj}' z_{t-1} \\ \varepsilon_t | \Im_{t-1} \sim N(0, H_t) \end{cases}$$

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 (element by element) 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: Parameter 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
Mexico	-1.44**	4.76**	23.46*	13.33
Korea	0.22	1.65**	12.45	12.54
Thailand	-0.47**	2.74**	40.97**	29.47**
USA	-0.79**	3.59**	10.20	5.37
EM curr. index	-1.27**	4.38**	24.76*	8.23
Major curr. index	0.32*	0.43	33.22**	7.11
World	-0.70**	2.30**	14.82	5.36

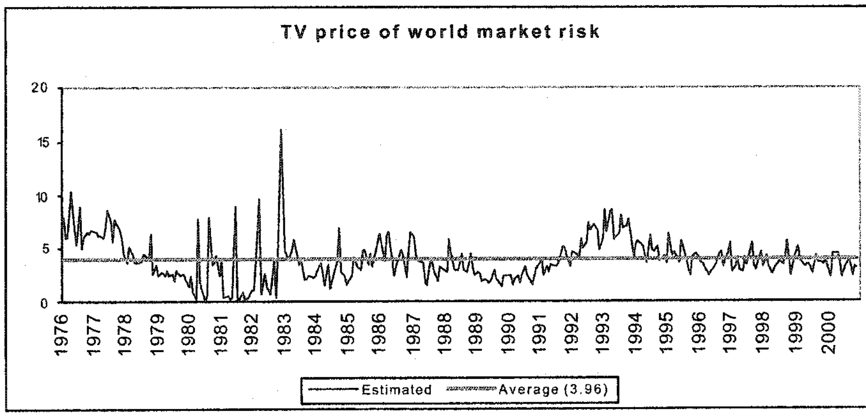
[a] Ljung-Box test statistic for returns and returns squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

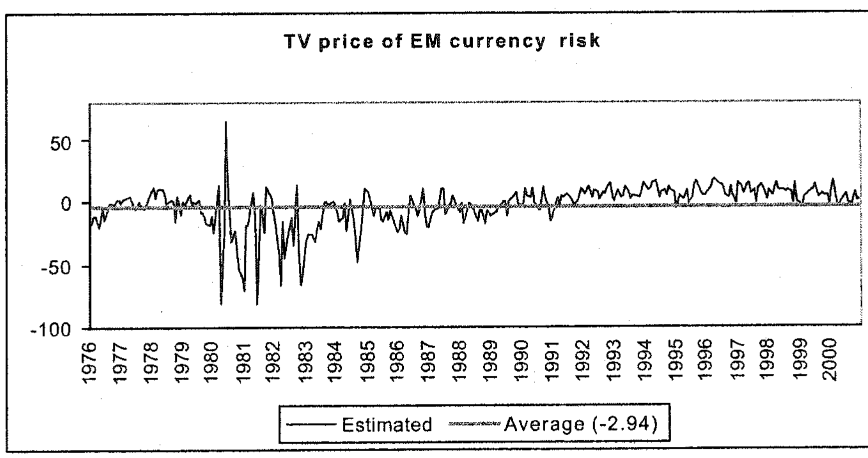
Table 5. Summary Statistics for Equity Premia

This table contains averages for the risk premia estimated for 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 markets currency 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

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





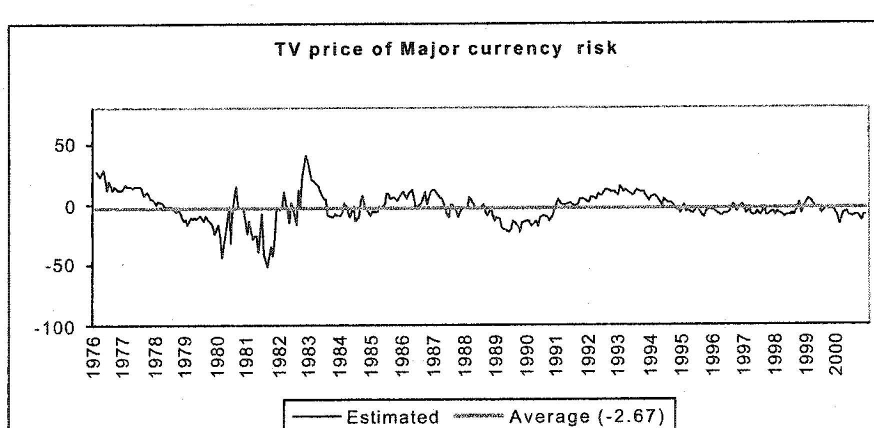
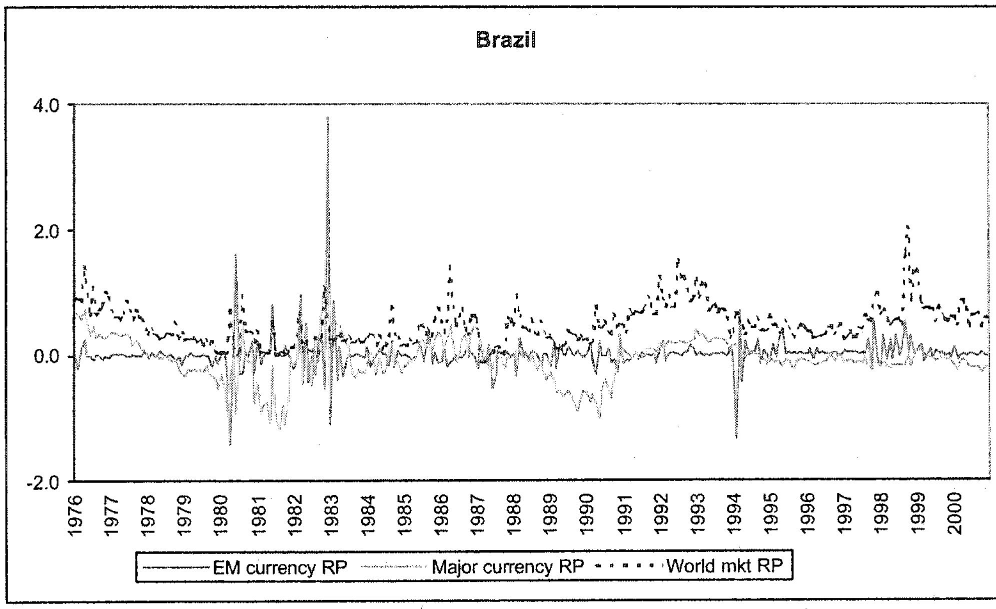
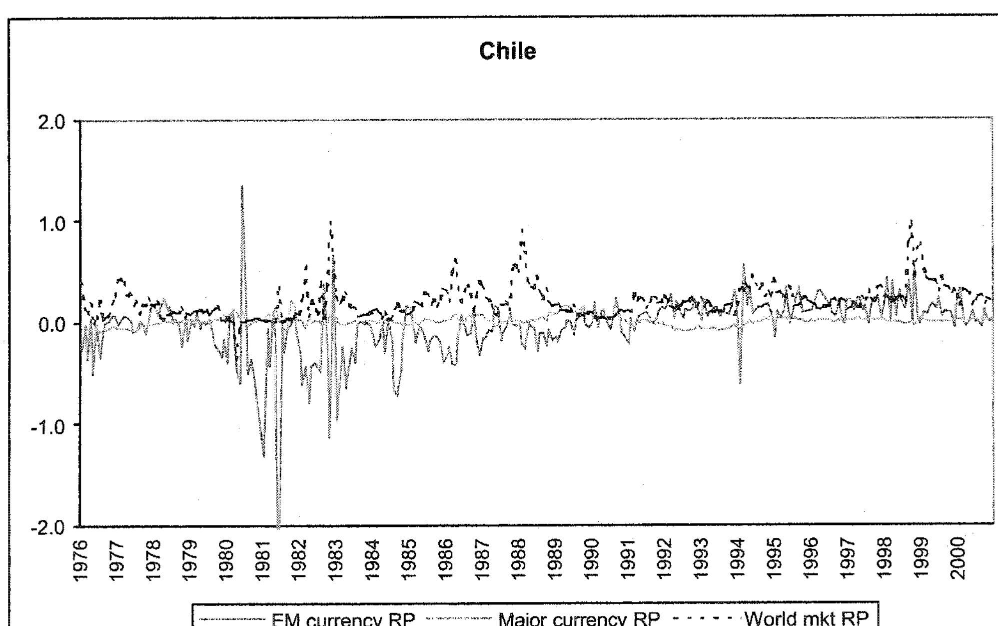
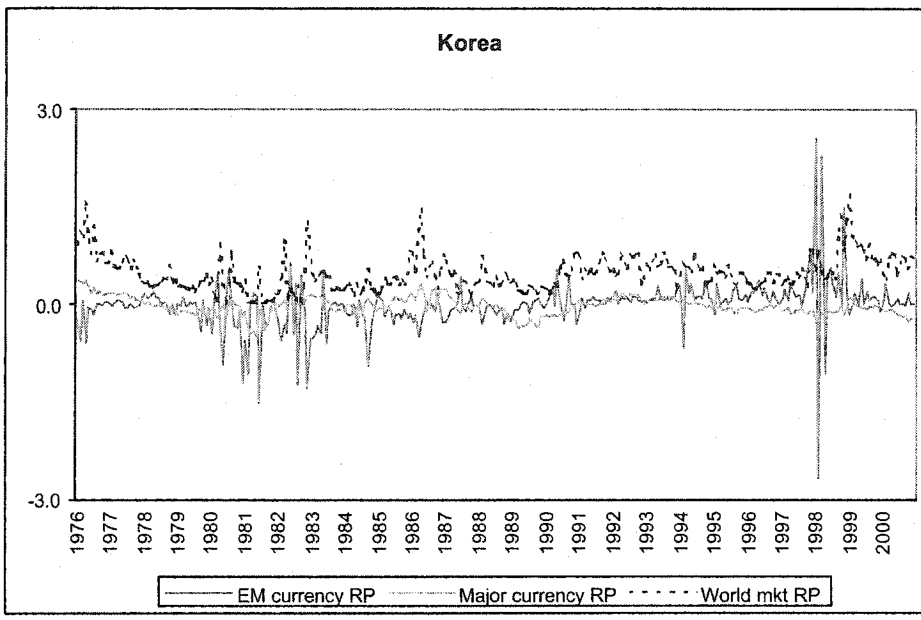


Figure 2. Estimated Risk Premia for Country Returns from Full Integration Model







Korea
3.0
0.0
-3.0
1976
1977
1978
1979
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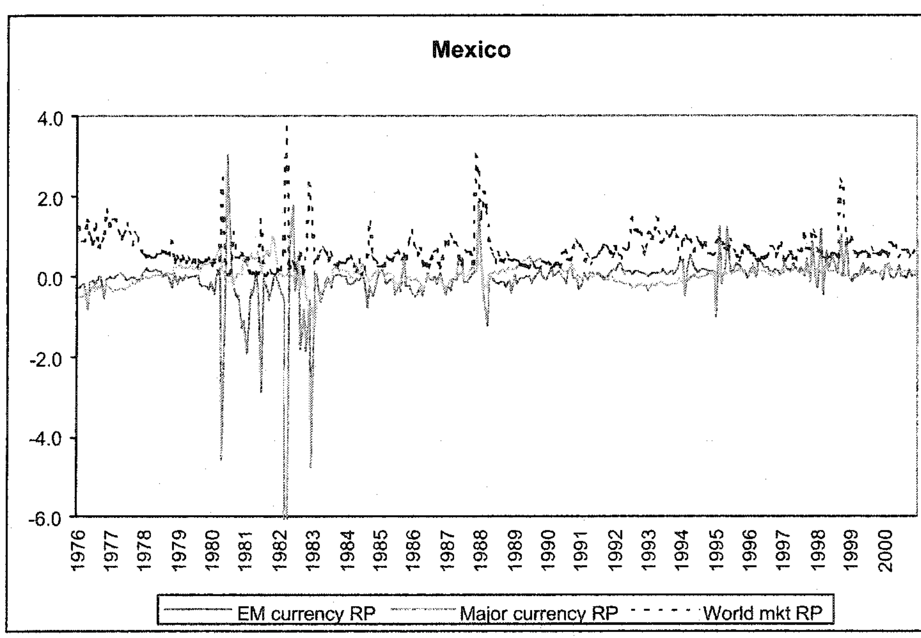
EM currency RP
Major currency RP
World mkt RP



Mexico
4.0
2.0
0.0
-2.0
-4.0
-6.0
1976
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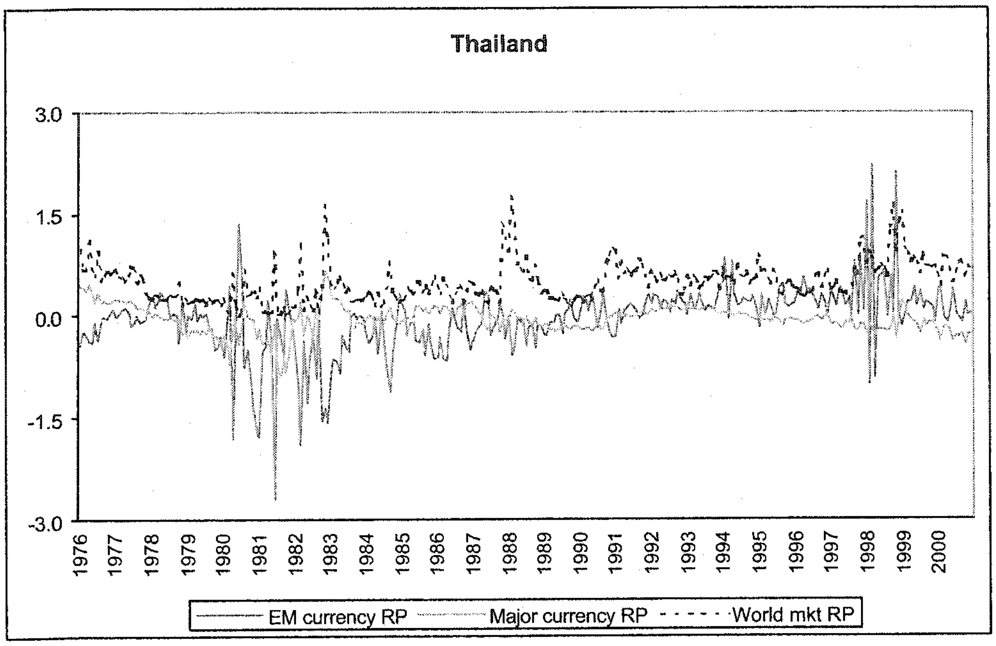
EM currency RP
Major currency RP
World mkt RP


Thailand
3.0
1.5
0.0
-1.5
-3.0
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
EM currency RP
Major currency RP
World mkt RP

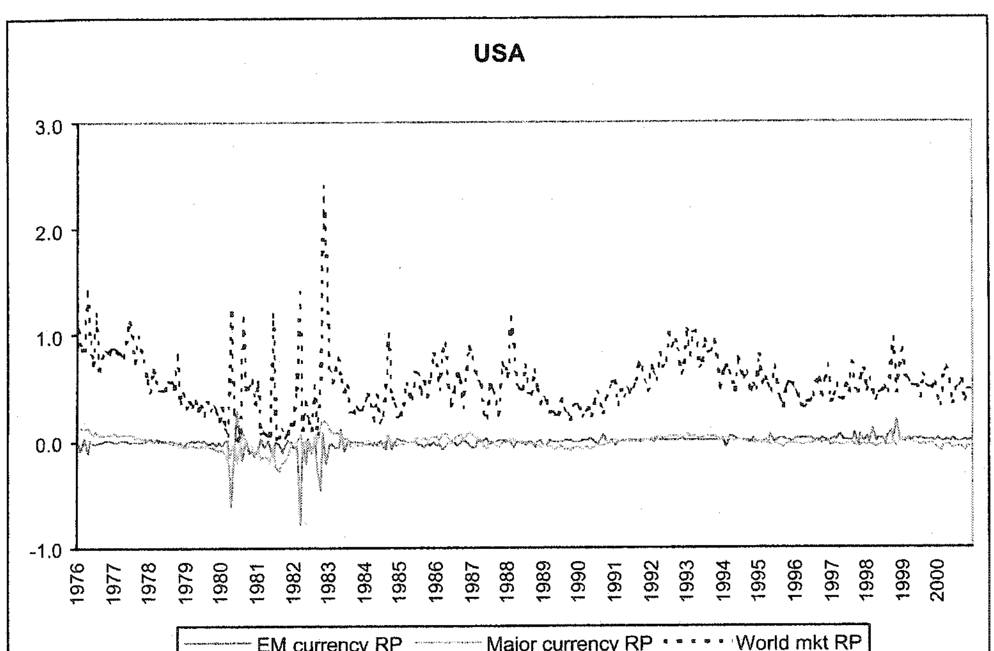

USA
3.0
2.0
1.0
0.0
-1.0
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
EM currency RP
Major currency RP
World mkt RP

Table 6. QML Estimates of the Partial Integration Model with T.V. Prices of World and Currency Risk and Constant Price of Domestic Risk

The estimated model is:

$$r_{it} = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{em,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{emt}) + \delta_{mj,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{mjt}) + \delta_{di}\,\mathrm{var}_{t-1}(r_{it}) + \varepsilon_{it}$$

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

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; δ_i is a constant price of domestic risk added only in the pricing equations of EMs equity portfolios (i=1...5); 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:

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

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

Panel A: Parameter estimates

	k_w			k_{em}			k_{mj}		
	estim.	std.err.	*p*-value	estim.	std.err.	*p*-value	estim.	std.err.	*p*-value
Const	-2.8514	1.0531	0.0068	0.2735	0.1404	0.0514	-0.0193	0.0953	0.8398
XWDY	2.3838	1.1173	0.0329	0.1078	0.3856	0.7798	0.5903	0.1926	0.0022
ΔUSTP	-1.1519	1.1055	0.2975	0.2618	0.1738	0.1320	-0.1218	0.0853	0.1534
USDP	0.3538	1.1794	0.7642	-0.2373	0.1694	0.1613	0.2064	0.1153	0.0734

All GARCH parameters are significant and satisfy the stationarity condition.

Prices of domestic risk:

	Brazil	Chile	Mexico	Korea	Thailand
δ_d	-0.0020	0.0058	-0.0009	0.0065	-0.0003
std.err.	0.0037	0.0043	0.0040	0.0063	0.0060
p-value	0.5983	0.1782	0.8199	0.2997	0.9614

Panel B: Specification Tests

Null hypothesis	χ^2	df	p-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0\ \forall j > 1$	6.3080	3	0.0975
(2) Is the price of real *EM currency* risk equal to zero? $H_0 : k_{em,j} = 0\ \forall j$	12.0024	4	0.0173
(3) Is the price of real *EM currency* risk constant? $H_0 : k_{em,j} = 0\ \forall j > 1$	11.9972	3	0.0074
(4) Is the price of real *Major currency* risk equal to zero? $H_0 : k_{mj,j} = 0\ \forall j$	10.1423	4	0.0381
(5)) Is the price of real *Major currency* risk constant? $H_0 : k_{mj,j} = 0\ \forall j > 1$	9.7154	3	0.0211
(6) Are the prices of all currencies risk equal to zero? $H_0 : k_{em,j} = k_{mj,j} = 0\ \forall j$	19.5653	8	0.0121
(7) Are the prices of all currencies risk constant? $H_0 : k_{em,j} = k_{mj,j} = 0\ \forall j > 1$	19.2776	6	0.0037
(8) Are the prices of domestic risk jointly equal to zero? $H_0 : \delta_i = 0\ \forall i$	3.7128	5	0.5915
Likelihood function		-8145.12	

Panel C: Diagnostics Tests For Residuals

	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Brazil	-0.32*	1.60**	9.26	13.42
Chile	-0.09	1.55**	36.84**	15.38
Mexico	-1.44**	4.76**	23.35*	13.00
Korea	0.21	1.60**	13.22	15.82
Thailand	-0.47**	2.74**	40.89**	29.90**
USA	-0.78**	3.58**	10.15	5.36
EM curr. index	-1.27**	4.41**	24.74*	8.65
Major curr. index	0.32*	0.44	3.36**	7.65
World	-0.70**	2.31**	14.80	5.38

[a] Ljung-Box test statistic for returns and returns squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

Table 7. Hypotheses Testing of the Partial Integration Model with T.V. Prices of World, Currency and Domestic Risk - using real *EM currency index* and *Major currency index* -

The estimated model is:

$$r_{it} = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{em,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{emt}) + \delta_{mj,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{mjt}) + \delta_{di,t-1}\,\mathrm{var}_{t-1}(r_{it}) + \varepsilon_{it}$$

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

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 (same as in previous model); Z_{di} 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).

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

Panel A: Specification Tests

	BRAZIL			CHILE			COLUMBIA		
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? $H_0: k_{w,j} = 0\ \forall j > 1$	12.7324	3	0.0053	21.3999	3	0.0001	7.4908	3	0.0578
(2) Is the price of real EM currency risk equal zero? $H_0: k_{c1,j} = 0\ \forall j$	12.5524	4	0.0137	9.2025	4	0.0562	5.7706	4	0.2169
(3) Is the price of real EM currency risk constant? $H_0: k_{c1,j} = 0\ \forall j > 1$	12.1583	3	0.0069	9.0209	3	0.0290	1.5534	3	0.6700
(4) Is the price of real Major currency risk equal zero? $H_0: k_{c2,j} = 0\ \forall j$	9.1361	4	0.0578	7.6894	4	0.1036	9.8990	4	0.0422
(5) Is the price of real Major currency risk constant? $H_0: k_{c2,j} = 0\ \forall j > 1$	7.7168	3	0.0522	7.3730	3	0.0609	9.2209	3	0.0265
(6) Are the prices of all currencies risk equal to zero? $H_0: \sum k_{c,j} = 0\ \forall c, j$	21.4754	8	0.0060	16.4334	8	0.0366	14.6846	8	0.0656
(7) Are the prices of all currencies risk constant? $H_0: \sum k_{c,j} = 0\ \forall c, \forall j > 1$	18.9325	6	0.0043	15.4659	6	0.0169	11.2455	6	0.0811
(8) Is the price of domestic market risk equal to zero? $H_0: k_{d,j} = 0\ \forall j$	0.3858	3	0.9432	14.3701	4	0.0062	37.1137	4	0.0000
(9) Is the price of domestic market risk constant? $H_0: k_{d,j} = 0\ \forall j > 1$	0.3733	2	0.8297	13.5238	3	0.0036	36.9880	3	0.0000

Table 7. cont.

Null hypothesis	INDIA			KOREA			MALAYSIA		
	χ^2	df	p-value	χ^2	df	p-value	χ^2	df	p-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0\ \forall j > 1$	16.1402	3	0.0011	13.9439	3	0.0030	7.2156	3	0.0653
(2) Is the price of real EM currency risk equal zero? $H_0 : k_{c1,j} = 0\ \forall j$	10.0757	4	0.0392	5.6865	4	0.2238	5.2342	4	0.2641
(3) Is the price of real EM currency risk constant? $H_0 : k_{c1,j} = 0\ \forall j > 1$	10.0416	3	0.0182	5.6410	3	0.1304	0.4785	3	0.9236
(4) Is the price of real Major currency risk equal zero? $H_0 : k_{c2,j} = 0\ \forall j$	9.1656	4	0.0571	7.9425	4	0.0937	9.6107	4	0.0475
(5) Is the price of real Major currency risk constant? $H_0 : k_{c2,j} = 0\ \forall j > 1$	8.5807	3	0.0354	7.3725	3	0.0609	7.4263	3	0.0595
(6) Are the prices of all currencies risk equal to zero? $H_0 : \sum k_{c,j} = 0\ \forall c, j$	17.1419	8	0.0287	12.8172	8	0.1183	15.2832	8	0.0539
(7) Are the prices of all currencies risk constant? $H_0 : \sum k_{c,j} = 0\ \forall c, \forall j > 1$	16.3047	6	0.0122	12.3621	6	0.0544	8.6862	6	0.1920
(8) Is the price of domestic market risk equal to zero? $H_0 : k_{d,j} = 0\ \forall j$	1.3150	3	0.7256	10.6806	4	0.0304	11.9337	4	0.0179
(9) Is the price of domestic market risk constant? $H_0 : k_{d,j} = 0\ \forall j > 1$	0.7132	2	0.7001	9.6642	3	0.0216	10.1526	3	0.0173

Table 7. cont.

Null hypothesis	MEXICO χ^2	df	p-value	PHILIPPINES χ^2	df	p-value	THAILAND χ^2	df	p-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0\ \forall j > 1$	16.1457	3	0.0011	20.0744	3	0.0002	16.6152	3	0.0008
(2) Is the price of real EM currency risk equal to zero? $H_0 : k_{c1,j} = 0\ \forall j$	9.1780	4	0.0568	3.3605	4	0.4994	8.8963	4	0.0637
(3) Is the price of real EM currency risk constant? $H_0 : k_{c1,j} = 0\ \forall j > 1$	9.0394	3	0.0288	1.5500	3	0.6708	8.8824	3	0.0309
(4) Is the price of real Major currency risk equal zero? $H_0 : k_{c2,j} = 0\ \forall j$	9.1735	4	0.0569	11.3538	4	0.0229	8.0310	4	0.0904
(5) Is the price of real Major currency risk constant? $H_0 : k_{c2,j} = 0\ \forall j > 1$	8.5254	3	0.0363	9.7993	3	0.0204	7.7683	3	0.0511
(6) Are the prices of all currencies risk equal to zero? $H_0 : \sum k_{c,j} = 0\ \forall c, j$	15.1881	8	0.0556	15.5095	8	0.0500	15.2485	8	0.0545
(7) Are the prices of all currencies risk constant? $H_0 : \sum k_{c,j} = 0\ \forall c, \forall j > 1$	14.3077	6	0.0264	11.3925	6	0.0770	14.9343	6	0.0208
(8) Is the price of domestic market risk equal to zero? $H_0 : k_{d,j} = 0\ \forall j$	4.7360	4	0.3155	15.9648	4	0.0031	5.0450	4	0.2827
(9)) Is the price of domestic market risk constant? $H_0 : k_{d,j} = 0\ \forall j > 1$	3.6351	3	0.3037	15.4537	3	0.0015	4.6612	3	0.1984

Panel B: Diagnostics Tests For Residuals

	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Brazil	-0.33*	1.53**	9.18	12.84
Chile	-0.02	2.19**	12.94	12.55
Columbia	0.15	1.44**	8.67	16.00
India	0.35*	0.56	7.20	19.29
Korea	0.09	0.82**	25.57*	12.03
Malaysia	-1.00**	3.31**	23.18*	8.02
Mexico	-1.62**	5.91**	20.88*	15.02
Philippines	0.25	1.61**	8.52	10.39
Thailand	-0.22	2.27**	43.05**	20.25

[a] Ljung-Box test statistic for residuals and residuals squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

Table 8. Summary Statistics for Equity Premia

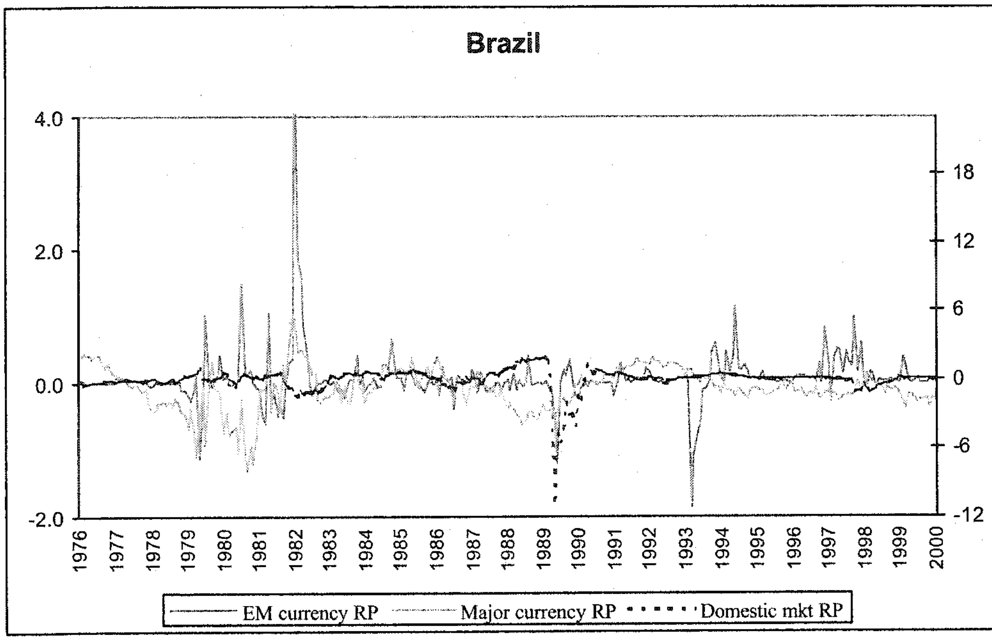
This table contains averages for the risk premia estimated for the partial integration model in table 7. The averages are percentages of the total absolute premium. We report the world market risk premium (WMP), the emerg ing markets currency risk premium (EMCP), the major currencies premium (MJCP) and the local market risk premium (LP).

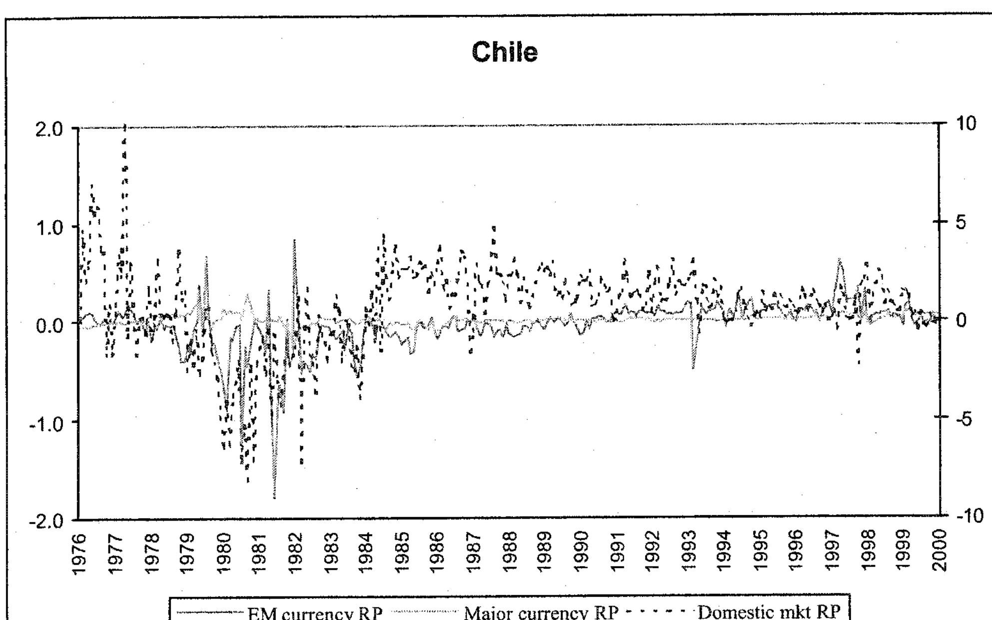
	WMP	EMCP	MJCP	LP	WMP	EMCP	MJCP	LP	WMP	EMCP	MJCP	LP
	All sample				Dec 76 - Dec 85				Jan 91 - Dec 00			
Brazil	62.3%	10.2%	14.6%	12.9%	49.5%	19.4%	22.6%	8.5%	82.0%	10.7%	4.7%	2.7%
Chile	25.0	3.8	1.4	69.8	27.9	18.3	1.9	51.9	18.0	6.2	1.4	74.3
Columbia [a]	13.2	10.0	3.9	72.9	--	--	--	--	27.3	23.8	23.9	25.0
India	1.8	1.5	5.8	90.9	16.7	32.1	10.9	40.3	2.5	13.5	1.3	82.7
Korea	27.6	14.0	3.6	54.8	41.0	7.1	6.8	45.1	15.9	22.2	1.0	60.9
Malaysia [a]	42.4	25.2	1.0	31.4	--	--	--	--	48.3	38.3	8.3	5.1
Mexico	55.7	4.8	4.8	34.7	43.2	16.2	5.4	35.2	52.5	10.2	3.3	34.1
Philippines [a]	53.5	23.6	8.2	14.7	--	--	--	--	48.8	19.6	29.6	2.0
Thailand	55.5	15.2	8.5	13.3	45.9	30.1	9.5	14.5	42.6	39.0	5.6	12.7
USA [b]	96.2	0.7	3.0	--	93.3	3.1	3.6		96.7	2.2	1.1	--
World [b]	88.4	1.9	9.7	--	81.3	7.3	11.4		92.3	4.3	3.5	--
avg. among EMs	37.5	12.0	5.8	43.9	37.4	20.6	9.5	32.6	37.5	20.4	8.8	33.3

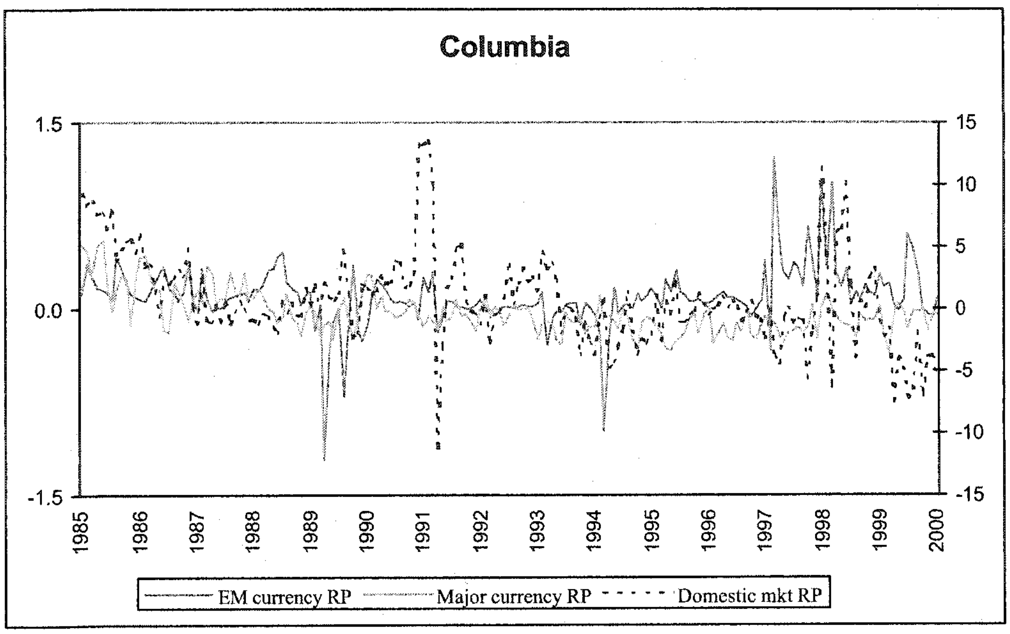
[a] sample available from Jan 85 - Dec 00

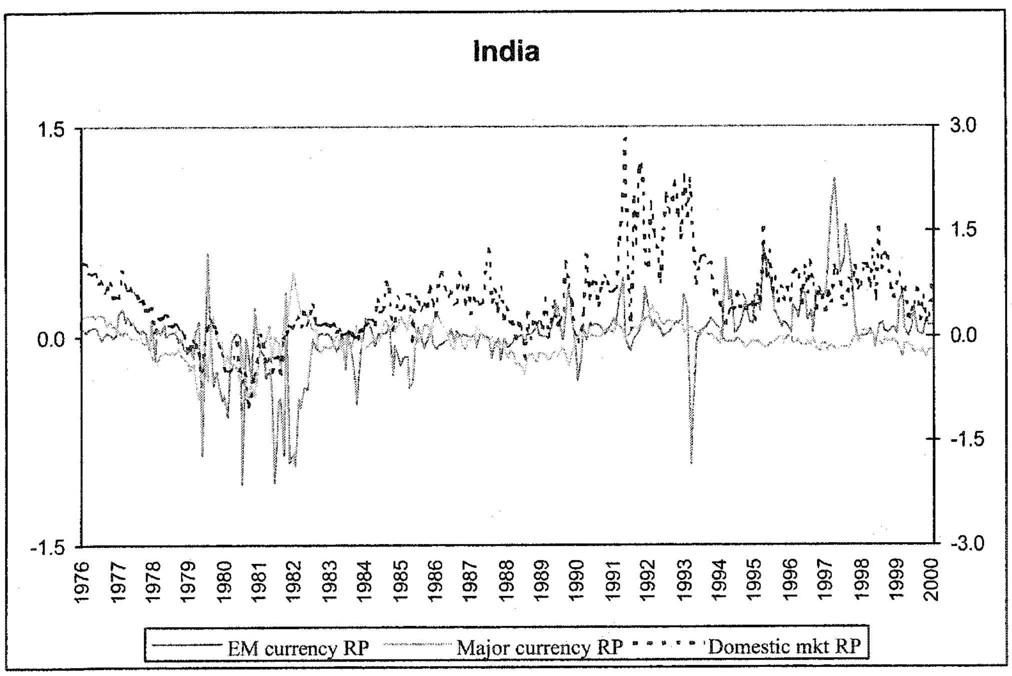
[b] as average across all nine estimated systems

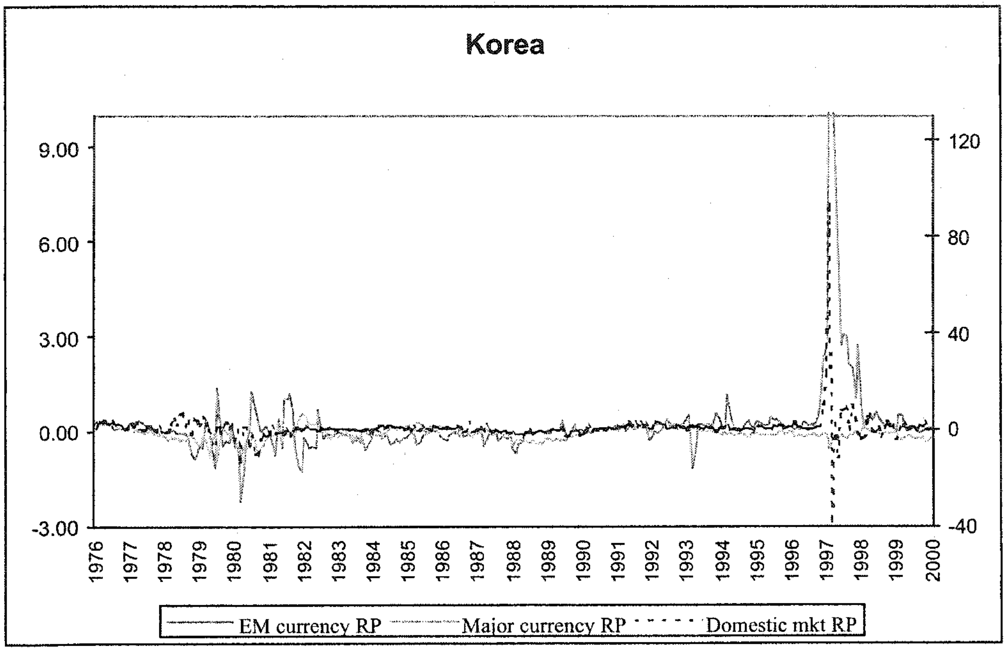
Figure 3. Estimated Risk Premia from the Partial Integration Model with Real *EM* and *Major Currency Indexes* (table 7)



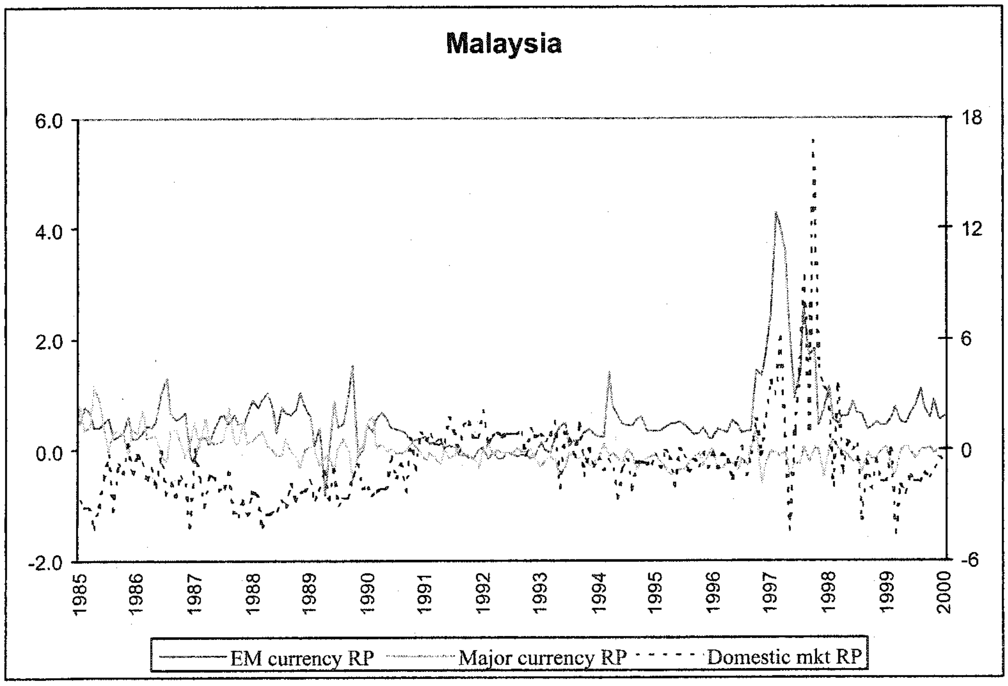



Columbia
1.5
0.0
-1.5
15
10
5
0
-5
-10
-15
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP

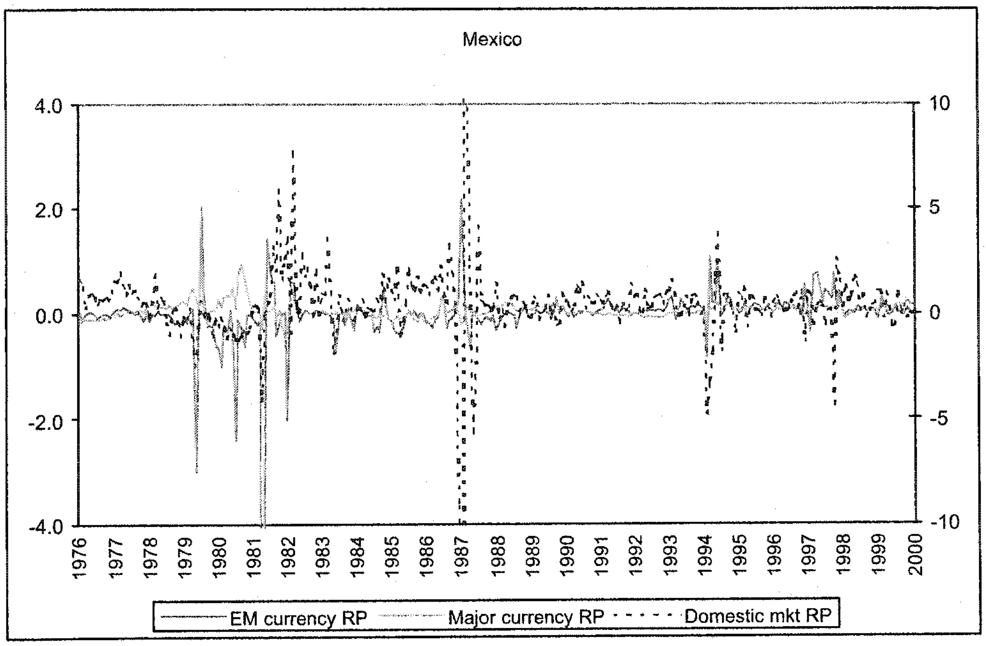

India
1.5
0.0
-1.5
3.0
1.5
0.0
-1.5
-3.0
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP

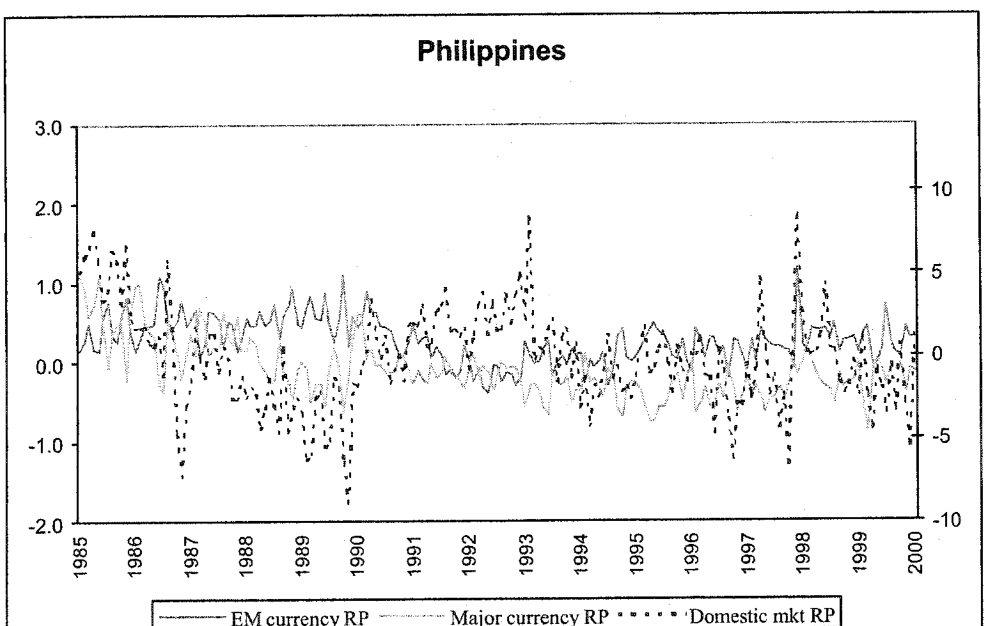


Korea
9.00
6.00
3.00
0.00
-3.00
120
80
40
0
-40
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP



Malaysia
6.0
4.0
2.0
0.0
-2.0
18
12
6
0
-6
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP


Mexico
4.0
2.0
0.0
-2.0
-4.0
10
5
0
-5
-10
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP


Philippines
3.0
2.0
1.0
0.0
-1.0
-2.0
10
5
0
-5
-10
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP

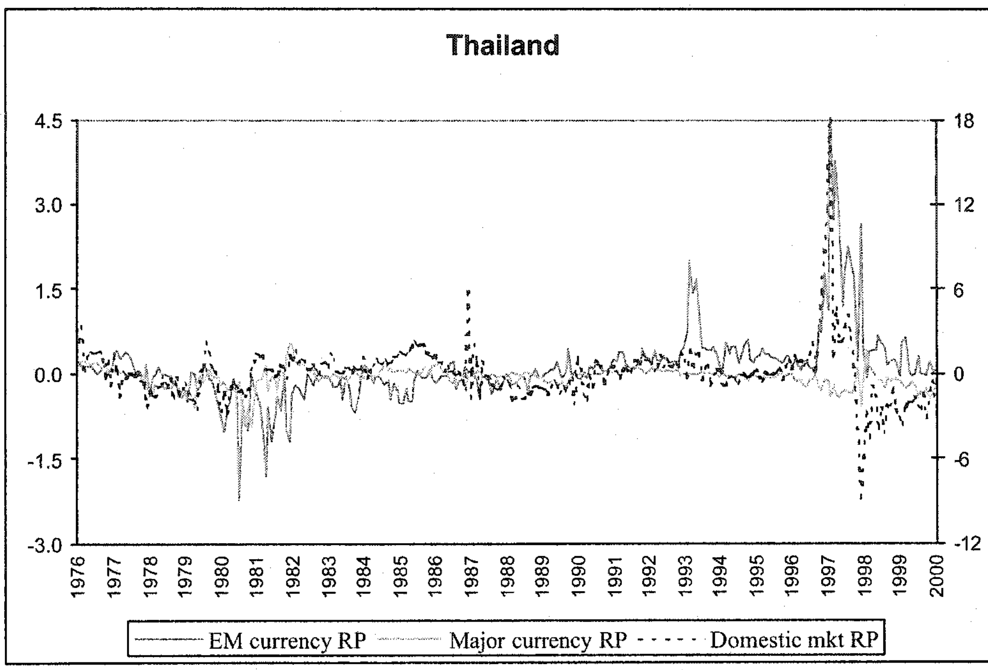

Thailand
4.5
3.0
1.5
0.0
-1.5
-3.0
18
12
6
0
-6
-12
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EM currency RP
Major currency RP
Domestic mkt RP

Table 9. 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:

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

$$\text{where } \begin{cases} \delta_{w,t-1} = \exp(k_w' Z_{t-1}) \\ \delta_{c,t-1} = k_{c1}' Z_{t-1} \\ \delta_{mj,t-1} = k_{c2}' Z_{t-1} \\ \delta_{di,t-1} = k_d' Z_{di,t-1} \\ \varepsilon_t | \Im_{t-1} \sim N(0, H_t) \end{cases}$$

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_{di} 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			COLUMBIA		
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? $H_0 : \Sigma k_{c,j} = 0\ \forall c, j$	6.8257	8	0.5555	14.7971	8	0.0632	209.8522	8	0.0000
(7) Are the prices of all currencies risk constant? $H_0 : \Sigma k_{c,j} = 0\ \forall c, \forall j > 1$	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 9. cont.

Null hypothesis	INDIA χ^2	df	p-value	KOREA χ^2	df	p-value	MALAYSIA 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 9. cont.

Null hypothesis	MEXICO χ^2	df	p-value	PHILIPPINES χ^2	df	p-value	THAILAND 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
Columbia	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 10. Summary Statistics for Equity Premia

This table contains averages for the risk premia estimated for the partial integration model in table 9. The averages are percentages of the total absolute premium. We report the world market risk premium (WMP), the emerging markets 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 (LP).

	WMP	EMCP	MJCP	LP	WMP	EMCP	MJCP	LP	WMP	EMCP	MJCP	LP
	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
Columbia [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

Table 11. Hypotheses Testing of the Partial Integration Model with T.V. Prices of World, Currency and Domestic Risk - using real bilateral exchange rates only -

The estimated model is:

$$r_{it} = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{c,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{cit}) + \delta_{di,t-1}\,\mathrm{var}_{t-1}(r_{it}) + \varepsilon_{it}$$

$$\text{where } \begin{cases} \delta_{w,t-1} = \exp(k_w' Z_{t-1}) \\ \delta_{c,t-1} = k_c' Z_{t-1} \\ \delta_{di,t-1} = k_d' Z_{di,t-1} \\ \varepsilon_t | \Im_{t-1} \sim N(0, H_t) \end{cases}$$

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_w is the excess return on the world market portfolio; Z is a set of global information variables (same as in previous model); Z_{di} 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 4×1 vectors of unknown parameters.

Panel A: Specification Tests

Null Hypothesis	BRAZIL χ^2	df	p-value	CHILE χ^2	df	p-value	COLUMBIA χ^2	df	p-value
(1) Is the price of world market risk constant? $H_0 : k_{w,j} = 0\ \forall j > 1$	26.6953	3	0.0000	26.5471	3	0.0000	17.4186	3	0.0006
(2) Is the price of real bilateral XR risk equal to zero? $H_0 : k_{c,j} = 0\ \forall j$	1.4662	4	0.8326	7.8481	4	0.0973	6.6600	4	0.1550
(3) Is the price of real bilateral XR risk constant? $H_0 : k_{c,j} = 0\ \forall j > 0$	1.4654	3	0.6903	5.7319	3	0.1254	4.5650	3	0.2066
(4) Is the price of domestic market risk equal to zero? $H_0 : k_{d,j} = 0\ \forall j$	0.3737	4	0.9846	12.3944	4	0.0146	29.9442	4	0.0000
(5)) Is the price of domestic market risk constant? $H_0 : k_{d,j} = 0\ \forall j > 1$	0.3358	3	0.9532	11.8025	3	0.0081	29.1094	3	0.0000

Table 11. cont.

Null Hypothesis	INDIA χ^2	df	p-value	KOREA χ^2	df	p-value	MALAYSIA χ^2	Df	p-value
(1) Is the price of world market risk constant?									
$H_0 : k_{w,j} = 0 \; \forall j > 1$	16.2415	3	0.0010	31.5876	3	0.0000	15.4654	3	0.0015
(2) Is the price of real bilateral XR risk equal to zero?									
$H_0 : k_{c,j} = 0 \; \forall j$	11.9251	4	0.0179	15.7004	4	0.0034	21.6419	4	0.0002
(3) Is the price of real bilateral XR risk constant?									
$H_0 : k_{c,j} = 0 \; \forall j > 0$	3.7161	3	0.2938	11.6326	3	0.0088	21.5464	3	0.0001
(4) Is the price of domestic market risk equal to zero?									
$H_0 : k_{d,j} = 0 \; \forall j$	3.2630	4	0.5148	16.8426	4	0.0021	8.6000	4	0.0719
(5)) Is the price of domestic market risk constant?									
$H_0 : k_{d,j} = 0 \; \forall j > 1$	2.6658	3	0.4461	15.4980	3	0.0014	2.3233	3	0.5081

Null Hypothesis	MEXICO χ^2	df	p-value	PHILIPPINES* χ^2	df	p-value	THAILAND χ^2	Df	p-value
(1) Is the price of world market risk constant?									
$H_0 : k_{w,j} = 0 \; \forall j > 1$	37.3046	3	0.0000	9.1258	3	0.0277	20.3256	3	0.0001
(2) Is the price of real bilateral XR risk equal to zero?									
$H_0 : k_{c,j} = 0 \; \forall j$	208.7988	4	0.0000	3.1398	4	0.5347	3.3136	4	0.5068
(3) Is the price of real bilateral XR risk constant?									
$H_0 : k_{c,j} = 0 \; \forall j > 0$	77.9503	3	0.0000	1.6062	3	0.6580	3.3136	3	0.3458
(4) Is the price of domestic market risk equal to zero?									
$H_0 : k_{d,j} = 0 \; \forall j$	15.1540	4	0.0044	13.9540	4	0.0074	8.7403	4	0.0679
(5)) Is the price of domestic market risk constant?									
$H_0 : k_{d,j} = 0 \; \forall j > 1$	13.6786	3	0.0034	13.4025	3	0.0038	8.1599	3	0.0428

* for Philippines, we report the estimates obtained using the *EM currency index* due to a difficulty encountered in estimating the system with the bilateral exchange rate only.

Panel B: Diagnostics Tests For Residuals

	Skewness	Kurtosis	$Q(z)_{12}$ [a]	$Q(z^2)_{12}$ [a]
Brazil	-0.42**	1.71**	7.98	12.61
Chile	-0.07	1.49**	16.11	9.63
Columbia	0.18	1.43**	9.45	17.16
India	0.39**	0.64*	6.36	17.21
Korea	0.06	1.15**	29.15**	28.14**
Malaysia	-0.89**	3.47**	18.33	5.71
Mexico	-1.03**	3.45**	22.09*	6.27
Philippines	0.24	1.65**	8.42	11.31
Thailand	-0.12	2.27**	37.27**	14..89

[a] Ljung-Box test statistic for residuals and residuals squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

Table 12. Hypotheses Testing of the Partial Integration Model with T.V. Prices of World, Currency and Domestic Risk

- using real *EM currency Index* only h-

The estimated model is:

$$r_{it} = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{em,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{emt}) + \delta_{di,t-1}\,\mathrm{var}_{t-1}(r_{it}) + \varepsilon_{it}$$

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

where r_i is the excess return on asset i, r_{emt} is the change in the real *EM 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_{di} 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 4×1 vectors of unknown parameters.

Panel A: Specification Tests

	BRAZIL			CHILE			COLUMBIA		
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?									
$H_0 : k_{w,j} = 0\ \forall j > 1$	31.256	3	0.0000	29.911	3	0.0000	17.809	3	0.0005
(2) Is the price of real *EM currency* risk equal to zero?									
$H_0 : k_{c,j} = 0\ \forall j$	10.009	4	0.0403	7.7103	4	0.1028	15.892	4	0.0032
(3) Is the price of *EM currency* risk constant?									
$H_0 : k_{c,j} = 0\ \forall j > 0$	9.5499	3	0.0228	7.1244	3	0.0680	3.7945	3	0.2845
(4) Is the price of domestic market risk equal to zero?									
$H_0 : k_{d,j} = 0\ \forall j$	0.5810	3	0.9008	10.497	4	0.0328	40.278	4	0.0000
(5)) Is the price of domestic market risk constant?									
$H_0 : k_{d,j} = 0\ \forall j > 1$	0.5120	2	0.7741	9.7270	3	0.0210	40.031	3	0.0000

Table 12. cont.

Null Hypothesis	INDIA χ^2	df	*p*-value	KOREA χ^2	df	*p*-value	MALAYSIA χ^2	df	*p*-value
(1) Is the price of world market risk constant?									
$H_0: k_{w,j} = 0\ \forall j > 1$	22.3668	3	0.0001	20.7864	3	0.0001	19.3551	3	0.0002
(2) Is the price of real *EM currency* risk equal to zero?									
$H_0: k_{c,j} = 0\ \forall j$	9.0349	4	0.0602	7.2575	4	0.1229	5.6477	4	0.2271
(3) Is the price of *EM currency* risk constant?									
$H_0: k_{c,j} = 0\ \forall j > 0$	9.0263	3	0.0289	5.7206	3	0.1260	0.2977	3	0.9605
(4) Is the price of domestic market risk equal to zero?									
$H_0: k_{d,j} = 0\ \forall j$	2.5506	4	0.6356	11.8566	4	0.0184	12.1086	4	0.0166
(5)) Is the price of domestic market risk constant?									
$H_0: k_{d,j} = 0\ \forall j > 1$	1.9302	3	0.5870	11.6974	3	0.0085	11.9956	3	0.0074

Null Hypothesis	MEXICO χ^2	df	*p*-value	PHILIPPINES χ^2	df	*p*-value	THAILAND χ^2	df	*p*-value
(1) Is the price of world market risk constant?									
$H_0: k_{w,j} = 0\ \forall j > 1$	24.6382	3	0.0000	9.1258	3	0.0277	25.2022	3	0.0000
(2) Is the price of real *EM currency* risk equal to zero?									
$H_0: k_{c,j} = 0\ \forall j$	7.9901	4	0.0919	3.1398	4	0.5347	7.8719	4	0.0964
(3) Is the price of *EM currency* risk constant?									
$H_0: k_{c,j} = 0\ \forall j > 0$	7.9859	3	0.0463	1.6062	3	0.6580	7.8237	3	0.0498
(4) Is the price of domestic market risk equal to zero?									
$H_0: k_{d,j} = 0\ \forall j$	3.9065	4	0.4188	13.9540	4	0.0074	10.5678	4	0.0319
(5)) Is the price of domestic market risk constant?									
$H_0: k_{d,j} = 0\ \forall j > 1$	3.1444	3	0.3699	13.4025	3	0.0038	10.3934	3	0.0155

Panel B: Diagnostics Tests For Residuals

	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Brazil	-0.31	1.53**	9.15	12.67
Chile	-0.03	2.12**	12.79	11.97
Columbia	0.09	1.50**	9.31	22.18*
India	0.39**	0.53	7.04	19.73
Korea	0.14	0.73*	24.74*	11.48
Malaysia	-0.99**	3.14**	23.61*	6.29
Mexico	-1.61**	5.92**	19.95	14.19
Philippines	0.24	1.65**	8.42	11.31
Thailand	-0.15	2.15**	45.23**	18.61

[a] Ljung-Box test statistic for residuals and residuals squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

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$. According to this formulation, an increase in the index gives the appreciation / depreciation of the US$:

$\log\left(\frac{I_t}{I_{t-1}}\right) = \sum_j w_{jt} \log\left(\frac{e_{jt}}{e_{jt-1}}\right) \rightarrow$ weighted average of the appreciation/depreciation of the US$ against all other FCs 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\$.

Appendix 3

What pricing equation to use for the currency factor when real exchange rates are used instead of nominal exchange rates?

A common way of testing the IAPM with currency risk has been to define the return on currencies as: $r_c = i_c + \Delta S - i_\$$

where i_c is the currency deposit rate in country c, ΔS is the change in the nominal exchange rate (expressed as the appreciation/ depreciation of the foreign currency c against the reference currency (US$), and $i_\$$ is the currency deposit rate in the country of reference (US).

In this framework, the pricing equation used for the currency return r_c is the same as the pricing equation used for the countries equity returns included in the model. This is interpreted as the pricing of deviations from uncovered interest rate parity (UIP) since in the absence of such deviations, the change in the nominal exchange rate is approximately equal to the interest differential so that r_c as defined above should be equal to zero.

When real exchange rates are used in the IAPM instead of nominal exchange rates (for the reasons mentioned in the previous appendix), the question that remains to be solved is how to define the pricing equation for the currency factors in the model?

In our framework, we define r_c as the change in the real exchange rate (S_R) of currency c with respect to the $: $r_c = \Delta S_R$.

By definition of the real exchange rate, we can write:

$$\Delta S_R = \Delta S + \pi^c - \pi^\$ \qquad (1)$$

where π^c and $\pi^\$$ are respectively the inflation rates in country c and the country of reference. If UIP holds, then

$$\Delta S = i_\$ - i_c \qquad (2)$$

We also know that by *Fisher Effect*, the nominal interest rate in a given country is equal to the real interest rate plus the expected inflation, and that real interest rates are approximately the same across countries so that differences in the nominal interest rate levels between countries indicate changes in inflation rate levels between the same countries. We can then write:

$$i_\$ - i_c = \pi^\$ - \pi^c \qquad (3)$$

Substituting *(2)* and *(3)* in *(1)*, we get:

$$\Delta S_R = \pi^\$ - \pi^c + \pi^c - \pi^\$ = 0$$

Therefore, if the change in the real exchange rate is used as the currency return r_c in the IAPM, we can specify the same pricing equation for this 'asset return' as in the case where $r_c = i_c + \Delta S - i_\$$, i.e., the same equation used to price excess equity returns. This would be equivalent to pricing both the deviations from Fisher Effect and the deviations from UIP, since according to the two interest parity relations, the change in the real exchange rate should be zero[1].

[1] A much simpler argument can be based on PPP. In fact, we know that if PPP holds, the real exchange rate should be constant so that if the currency return in the model is defined as the change in the real exchange rate, it should be equal to zero. Thus, by using the same equation as for the equity returns, we are pricing deviations from PPP (which is the underlying assumption for the APM).

CHAPTER IV

The Impact of Diversification on the Price of Foreign Exchange Risk: A Global Sector Analysis

Abstract
The purpose of this paper is to investigate whether cross-currency diversification has an impact on the pricing of exchange risk. We conduct empirical tests in a conditional setting for the G7 countries using sector portfolios for each country (single currency) and global sector portfolios that are diversified across developed and emerging markets (multi-currency). Previous studies testing for the pricing of exchange risk are mostly based on cross-sections of country indices. We use global sector portfolios given the increasing popularity of sector investing as shown by the growing number of global sector index funds on the ETFs market. Our tests based on globally diversified portfolios offer new evidence on the significance of the price of exchange risk after we take away the diversifiable component of exchange risk through cross-currency diversification. Our results show that while the price of exchange risk is highly significant in single-currency portfolio returns represented by national sectors, the hypothesis of zero price of exchange risk cannot be rejected for globally diversified sector portfolios that include G7 countries and emerging markets assets. We take this as initial evidence that exchange risk is less significant in pricing global assets that are diversified across both developed and emerging markets. Further investigation of this issue is needed because the implications for global investors are important.

1. Introduction

The issue of whether exchange risk is priced in the stock market has recently regained interest in the international finance literature, especially since the Dumas and Solnik (1995) study has shown that previous inconclusive evidence on the subject may be due to the use of unconditional asset pricing models. Other studies have then followed in an attempt to test various conditional versions of the Adler and Dumas (1983) model derived under deviations from purchasing power parity (PPP) and stochastic inflation.[1] For instance, De Santis and Gerard (1998) tested a conditional ICAPM with time varying prices of risk and found strong evidence that foreign exchange risk is priced in major developed stock markets, which is consistent with the evidence in Dumas and

[1] Early theoretical models derived under PPP deviations also include Solnik (1974) and Stulz (1981). See Karolyi and Stulz (2002) for a review of APMs in the international finance literature.

Solnik (1995). Other studies such as Carrieri (2001) found similar evidence using data on major European countries.

Since most of these studies implicitly assume full market integration and focus on few major developed markets, Carrieri, Errunza and Majerbi (2003) look at nine emerging markets and test for the pricing of exchange risk in the context of a partial integration model. Their results suggest that the global price of exchange risk is significantly different from zero and significantly time varying regardless of the exchange risk measure used and even after accounting for inflation risk and local market risk.

Most of these studies, however, are based on country-level data, i.e., using cross-sections of country indices expressed in the same reference currency. There are also few studies that use industry-level data but in a single-country (single-currency) setting [Jorion (1991) for the US; Choi, Hiraki, and Takezawa (1998) and Doukas, Hall and Lang (2001) for Japan; Bailey and Chang (1995) for Mexico].

In reality though, investors seeking to take advantage of the benefits of international diversification into global equity markets, hold geographically diversified portfolios that also involve a certain level of cross-currency diversification. This is shown by the increasing investment amounts involved in portfolio indexing strategies to replicate global indices such as MSCI, S&P, DJ, and FTSE's regional and sector indexes. Moreover, geographically diversified portfolios in the form of regional or sector/industry indexes can be considered as an important class of the traded assets in the global capital market.[2] Most of the major index providers cited above have recently licensed many of their global sector indexes to be traded as ETFs.[3] Some exchanges

[2] For instance, on February 2001, FTSE launched the first tradable Global Sector indices on 11 sectors. The indices aim to reflect the performance of the largest and most liquid global blue-chip stocks by sector.

[3] Example: FTSE Global Sector Index Series, the Dow Jones Global Sector Titans Indexes, MSCI Global Sector Indexes, etc. Most of these indexes are also licensed for ETFs in exchanges in the US and Europe.

have also begun to offer sector-based derivatives to cope with the new hedging needs following the introduction of global sector index funds.

Hence, it will be interesting to estimate an international asset pricing model using cross-sections of globally diversified portfolios, instead of country indices or single-country portfolios, to investigate whether exchange risk is priced. In this study, we propose to use global sector portfolios for the following two reasons. First, global sector investing can be considered as one of the most important changes in global equity investing since the surge in emerging markets in the early 1990s. As countries become more interdependent, global sectors have recently emerged as an attractive alternative to the traditional country-based approach to asset allocation. Second, the impact of the currency component of global sector investing is not clear yet. Because each sector has exposure to multiple currencies, this could be perceived by investors as either creating an additional source of risk or rather helping reduce the global portfolio risk because of beneficial cross-currency diversification effects. The implications of these perceptions on the expected returns of such global assets are different. It would then be interesting to investigate the relevance of the exchange risk factor in pricing this new class of global assets since most previous evidence on the pricing of exchange risk in stock returns relies on single-currency country indexes.

Based on data from G7 countries sectors as well as global sector indexes constructed across developed and emerging markets, we estimate an IAPM to investigate the significance of the price of exchange risk after taking away the diversifiable component of this risk through cross-currency diversification within the portfolios. To our knowledge, there is no study that estimates the price of exchange risk in the stock market using cross-sections of globally diversified portfolios. This is surprising because intuitively, cross-currency diversification is likely to reduce the exchange risk exposure of the global portfolio returns because the exposure to various exchange rates may cancel out when these currencies are grouped together in the same portfolio. For this reason, some have argued that hedging is irrelevant because exchange risk can be diversified away by holding multi-currency assets portfolio. Nonetheless, there is no empirical evidence in support of such argument since previous tests mostly show that the price of exchange risk is significant and that exchange risk premia represent an important component of equity returns, although relatively different across countries and over time. A natural way to extend this literature is to test for the significance of the price of exchange risk in the context of internationally diversified portfolios such as global sectors portfolios.

The main results of this study can be summarized as follows. First, using cross-sections of national sectors portfolios, we find that the price of exchange risk is significant for all G7 countries except Canada. This finding is consistent with previous evidence based on country-level data for developed markets. With global sector portfolios, the evidence is mixed. When we estimate our IAPM using global sectors constructed across G7 markets only, the price of exchange risk remains significantly different from zero. However, with cross-sections of global sector portfolios that include both G7 countries and emerging markets assets, the hypothesis of a zero price of exchange risk cannot be rejected at any statistically significant level. These results suggest that cross-currency diversification decreases the significance of exchange risk in pricing global assets particularly when we diversify into emerging markets. Indeed, as shown by previous studies, while the price of exchange risk is consistently found to be significant for developed and emerging markets assets when considered separately, this result does not hold when we consider 'truly' global portfolios that include both DMs and EMs assets.

The rest of the paper is organized as follows. In section 2, we briefly discuss the related literature on sector versus country diversification. Section 3 outlines the model and methodology. Section 4 describes the data and presents some preliminary analysis of global sectors returns. The empirical results from tests of exchange risk pricing in global sectors returns are presented in section 5 and section 6 concludes the paper.

2. Sector versus country diversification

The debate on country versus sector/industry diversification is not new. In an early study, Solnik (1974) showed that diversification across countries led to greater risk reduction than diversification across industries. Lessard (1976), Drummen and Zimmermann (1992) and Heston and Rouwenhorst (1994), henceforth HR, also found that country effects dominate over industry effects which suggests that country diversification is a more effective tool for achieving risk reduction than industry diversification. Griffin and Karolyi (1997), using the same model as Heston and Rouwenhort (1994), also found that variation in returns was little explained by industrial structure, although for some industries that produce internationally traded goods, the variance of industry factors is relatively large.

More recent studies however suggest that sector effects now dominate. For instance, Cavaglia et al. (2000a) reconsider HR's model and show that since early 1997, industry effects have been dominating country effects. They conclude that industrial diversification provides greater risk reduction than diversification across countries. In another study, Cavaglia et al. (2000b) show that cross-country cross-industry asset allocation dominates country diversification strategies. Another extension of the HR's model can be found in L'Her, Sy and Tnani (2001). The authors incorporate a third global risk factor, measured on the basis of size, book-to-market ratio and performance, in addition to country and sector factors. They found that sectors have become more important than countries since the end of 1999.

Finally, Carrieri, Errunza and Sarkissian (2002) follow a different approach and test an international asset pricing model where industry risk is priced along with world and country risks. Their results indicate that global industry risk is important in the pricing of certain industries and suggest that a country that is fully integrated with (segmented from) the world capital market only if her industries are integrated (segmented). More interestingly, it is shown that country level segmentation does not preclude industry level integration. The study concludes that industries that are priced differently represent additional sources of diversification gains.

In sum, there is growing evidence supporting the emergence of global sectors and this motivates our choice to focus on this type of diversified portfolios in the current study. Indeed, an investigation of the relevant risk factors in pricing such global assets is important for both practitioners and academicians.

3. Model and Methodology

3.1. The model

We begin with the econometric specification based on Adler and Dumas (1983) model derived under PPP deviations and stochastic inflation. In a world with L+1 countries, the expected return of an asset can be written as:

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

where r_i and r_m are excess returns on asset i and the world market portfolio, $\pi^{\$}_j$ is the rate of inflation of country j expressed in the reference currency , E is the expectations operator, δ_m 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 both inflation risk and exchange rate risk associated with country j. Since in this study we focus on developed countries, we follow previous tests of Dumas and Solnik (1995) and De Santis and Gerard (1998) and simplify the model by assuming that domestic inflation is non-stochastic so that the only random component in $\pi^{\$}_j$ comes from the relative change in the exchange rate between the reference currency and the currency of country j. 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.

3. 2. Empirical Methodology

We first estimate the model in equation (1) for each individual country using a cross-section of national sectors returns. Then, we use cross-sections of internationally diversified portfolios represented by the G7 global sectors and the G7EM global sectors (including G7 countries and emerging markets) as explained in section 4 below.

$$r_{it} = \delta_{w,t-1} h_{w,t} + \delta_{c,t-1} h_{c,t} + \varepsilon_{it} \qquad i=1 \ldots N \qquad (2)$$

where r_{it} is the excess return on sector i expressed in US$; $\delta_{w,t-1}$ is the price of world market risk; $\delta_{c,t-1}$ is the price of exchange risk; $h_{w,t}$ is the last column of the *(NxN)* covariance matrix H_t which gives the covariances of the N assets with the world portfolio return; $h_{c,t}$ is the $(N-1)^{th}$ column of the covariance matrix H_t which gives the covariances of the N assets with the currency portfolio return represented by the uncovered currency deposit rate; and $\varepsilon_t \sim N(0, H_t)$ is a vector of errors.

In each system for estimation, the pricing restriction (2) has to hold for all N assets that include up to 10 sector portfolios, the uncovered currency deposit rate, and the world market return[4]. The general IAPM in (1) 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 (UIP) and estimate the exchange premia in (1) through uncovered currency

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[4] The expected return on the world market portfolio also depend on world market risk and exchange risk, in line with the original model of equation (1).

deposits. We follow the same approach and use uncovered currency deposits between each country's currency and the US dollar in the individual countries estimations. This is computed as the foreign currency deposit rate in excess of the US dollar deposit rate plus the appreciation or depreciation of the foreign currency. As for the estimations across global sectors, we use a trade-weighted index of the uncovered currency deposit rates of the *G7* countries, which we refer to as the *G7 currency index*. In this, we follow Harvey (1995b) where a trade-weighted currency index is constructed to take into account both exchange rate changes and interest rate differentials between the US and trading partners[5].

We model the prices of world market risk and exchange rate risk ($\delta_{w,t-1}$ and $\delta_{c,t-1}$) to depend on a set of global information variables Z_{t-1}, drawn from previous literature.[6] 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 price of exchange risk can be modeled using a linear functional form as there is no restriction on the price of exchange risk to be positive in the model.[7]

$$\delta_{w,t-1} = \exp\,(k_w' Z_{t-1}) \qquad (3)$$

$$\delta_{c,t-1} = k_c' Z_{t-1}, \qquad (4)$$

We propose to follow the fully parametric approach used in De Santis and Gerard (1997, 1998). We impose a diagonal structure on the matrices of coefficients and

[5] Harvey, C.R., Global risk Exposure to a Trade-Weighted Foreign Currency Index, WP, Duke University. As explained by Harvey in this paper, it is very complicated to test Adler and Dumas (1983) model that includes many foreign currency variables. To simplify the model, many empirical studies have used a single exchange rate index (for example Ferson and Harvey (1993, 1994)). However, the exchange rate index used often ignores the interest rate component, and as such, cannot be considered as a true currency excess return.

[6] Dumas and Solnik (1995) and De Santis and Gerard (1998) use the same set of global instruments.

[7] 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 1. The empirical models of De Santis and Gerard (1998) and Hardouvelis, Malliaropulos and Priestly (1999) use the same functional specification proposed above for the prices of market and currency risk.

assume that the system is covariance-stationary so that we can rewrite the first term of H_t as a function of the unconditional covariance matrix of the residuals H_0 and a reduced number of parameter vectors[8]:

$$H_t = H_0 * (ii' - aa' - bb') + aa' * \varepsilon_{t-1}\varepsilon_{t-1}^{'} + bb' * H_{t-1} \qquad (5)$$

where i is a $(Nx1)$ vector of ones, a and b are $(Nx1)$ vectors of unknown parameters and * denotes the Hadamard (element by element) matrix product. 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)).

4. Data and Summary Statistics

We use sector indices provided by DataStream. The database covers 10 sectors, further subdivided into industries, which in turn are divided into sub-industries. In this study we focus on the level of sectors. These are: Resources, Basic Industries, General Industrials, Cyclical Consumer Goods, Non-Cyclical Consumer Goods, Cyclical Services, Non-Cyclical Services, Utilities, Information Technology, and Financials. We compute monthly returns for each sector in a given country from January 1975 until December 2001. The countries covered in this study are the G7 (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States). Because data on some sectors is missing for our sample period, we cover 63 (out of 70) portfolios of national sectors.

We construct three sets of global sectors portfolios. In the first set, referred to as the *G7 Global Sectors*, each sector return is obtained from a value-weighted index of

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8 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.

national sectors returns across the G7 countries. The second set of global sectors, referred to as *G7EM1 Global Sectors,* spans a larger number of countries that include the G7 and 12 countries in Asia (mostly EMs), using DataStream 'Asia except Japan' sector indices[9]. The portfolios in this group are also obtained on a value-weighted basis of the constituents groups of countries sectors. Finally, the third set of global sectors, referred to as the *G7EM2 Global Sectors*, covers the same countries as in the second set plus Chile and Mexico. Due to data limitations, we could not include more countries from Latin America, but we believe that the last two groups of global sectors are sufficiently well diversified across both developed and emerging markets.

The world market return is computed from MSCI World index adjusted for dividends and available from DataStream. All returns for both national and global sectors are expressed in US dollar and computed in excess of the one-month eurodollar deposit, used as a proxy for the risk-free rate and available from DataStream.

We compute uncovered currency deposit rates using one-month euro-currency rates (euro-CAD, euro-FRF, euro-DEM, euro-ITL, euro-JPY and Euro-GBP) in excess of the eurodollar one-month rate plus the appreciation/depreciation of each currency with respect to the dollar. Nominal bilateral exchange rates with respect to the dollar and euro-currency interest rates are all available from DataStream. For France, Germany and Italy, uncovered currency deposits are computed using the Euro/US$ exchange rate starting from January 1999. We also construct a trade-weighted *G7 currency deposit index* to be used as the exchange risk factor in the estimations across the three sets of global sectors portfolios. For this, we use the time-varying trade weights (on a yearly basis) computed by the Federal Reserve Board and used in their computation of the dollar trade weighted exchange rate indexes. The weights corresponding to the six trading partners of the US in the G7 group are normalized to one and applied to the previously computed national uncovered currency deposit rates

[9] The countries in Datastream 'Asia-ex-Japan' group of global sectors are: China, Hong Kong, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan and, Thailand.

to obtain the *G7 currency deposit index*. This is similar to the methodology proposed in Harvey (1995b) where a currency index of the 10 major currencies is computed as the trade-weighted average of the exchange rate changes plus the trade-weighted average of the local interest rates minus the eurodollar rate[10].

Table 1 reports summary statistics for each country excess sector returns and currency deposit rates as well as for the three groups of global sectors and the *G7 currency deposit index*. In general, the data shows high levels of skewness and kurtosis and the hypothesis of normally distributed returns is clearly rejected by the Bera-Jarque test for almost all sectors/countries.

Table 2 contains summary statistics for the instruments used to describe the conditioning information set of the investor. The choice of the global information variables is drawn from previous empirical literature in international asset pricing. More precisely, we use similar instruments as in the studies of De Santis and Gerard (1998) and Dumas and Solnik (1995) to compare our results. 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 notes, both available from the Federal Reserve Board (FRB) database. The default spread is measured by the difference between Moody's Baa-rated and Aaa-rated corporate bonds also available from the FRB database. All variables are used with one-month lag relative to the sectors excess returns and the risk factors.

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[10] Harvey (1995b) used time-varying weights that reflect five-year moving average of trade. This was an improvement over the fixed trade weights used in the calculation of the Federal Reserve Index of the dollar value at that time. However, in the new Fed index methodology, the trade weights are time-varying on a yearly basis. We use those same time-varying weights computed by the Fed in our calculation of the G7 currency deposit index.

5. Empirical Results

5.1. Exchange Risk Pricing across single-currency sector portfolios

We first estimate model (2) separately for each country using cross-sections of national sectors portfolios. In each system for estimation we have a maximum of 12 assets, which include the available sectors for the country over the sample period, the uncovered currency deposit rate for the country and the world market return. This represents a sufficiently large number of assets for each country to make the estimation of the parameters involved in each system computationally hard to achieve even with the restrictive parameterization of the covariance matrix H_t followed in this study.

Since there are no previous studies that estimate such IAPM using cross-sections of sectors returns in a single-country setting[11], we need to perform this individual country estimation in order to make sure that any differences in the results based on our global sectors portfolios is not due to the use of such specific dataset and the underlying sector classification. Table 3 summarizes the results of this test for each country. Consistent with previous evidence, we find that the price of exchange risk is statistically different from zero and significantly time-varying (at the 1% level) for most countries, except Canada and, to a lesser extent, the US.

The price of world market risk is highly significant for all countries (though to a lesser extent for Japan) and suggest that world market risk is important in explaining national sectors returns in the G7 countries. Figure 1 shows the time varying prices of both market risk and exchange risk estimated for each country cross-section of sectors returns. While the price of world market risk follows a similar pattern over time from the various countries estimations, the price of exchange risk is relatively different since we use different currency specification for each country. But overall, we note similar

[11] Except the few studies using cross sections of industry portfolios indicated in section 1.

variation (mainly with a negative sign) in the price of exchange risk for the three euro-zone countries and the US while for Japan and the UK there are more swings between periods of positive and negative prices of exchange risk.

5.2. Exchange Risk Pricing across global sectors portfolios

Next, we estimate model (2) using cross-sections of global sector portfolios that are diversified across countries (and currencies). Three estimations are performed with the three sets of global sectors as shown in table 4. First, using G7 sectors, we find that the price of exchange risk is still significantly different from zero, but the hypothesis of a constant price of exchange risk cannot be rejected. Interestingly, when we use the other two sets of global sectors that include emerging markets in addition to G7 countries, the hypothesis of zero price of exchange risk cannot be rejected at any statistical level. Only the world market risk remains highly significant across the two groups of global sectors (G7EM1 and G7EM1). Figure 2 reports the graphs for the estimated prices of exchange risk for the three groups of global sectors. The price of exchange risk is negative on average in all three estimations. However, it is clear that there is a large decrease in the average price of risk as we move from G7 to G7EM global sectors. In figure 3, we report the average risk premia computed across all 10 sectors in each group. We can see that while the size of the market premium remains on average the same for all three global sectors groups, exchange risk premia are reduced to almost half of the their value when we use global sectors that include emerging markets. Indeed, for the G7 sectors group, the exchange risk prmium represents on average 30 percent of total absolute premium. This number decreases to 16 and 17 percent for the G7EM1 and G7EM2 global sectors respectively.

This evidence suggests that the significance of exchange risk in pricing global assets is mostly reduced in the context of global portfolios that include not only developed countries but also emerging markets assets. Intuitively, this result is not very surprising to the extent that global diversification, particularly when including emerging market assets, is more likely to reduce the impact of foreign exchange risk on the global portfolios returns because of the beneficial effect of cross-currency diversification. We should note though, that due to data limitations, further investigation of this question is required before we can draw any robust conclusions. In fact, our tests for the two groups of global sectors that include developed and emerging markets are based on a shorter sample period as constrained by data availability. Moreover, as shown by previous studies using country level data, the results about the significance of the exchange risk factor in international asset pricing models may be sensitive to the choice of the exchange rate measure. In this study, we used an index of uncovered currency deposit rates for the G7 countries only. It would then be interesting to check the robustness of these results by including emerging market currencies into the currency deposit index used for estimation across global sectors. This, again, is limited by the availability of data on emerging markets interest rates over sufficiently long sample periods.

6. Conclusions

Recent empirical evidence for both developed and emerging markets have established that the price of exchange risk is significant in explaining expected equity returns. The statistical significance of the price of exchange risk and the size of the currency risk premia could be due to the failure to account for diversified portfolios in the cross-sections of assets included in empirical testing. To shed light on this issue we estimate a conditional IAPM with time-varying prices of world market and foreign exchange risk using cross sections of globally diversified portfolios that have a certain level of cross-currency diversification. We focus on global sector portfolios because of the growing interest into sector investing as a valuable source of diversification in the globally integrated capital markets. Our results offer initial evidence that as we increase the number of countries/currencies in the portfolios, i.e., with global diversification, the significance of the exchange risk factor in pricing global assets may vanish, particularly when we include emerging markets into such global portfolios. This new evidence seems in contrast to the conclusions of most recent studies where exchange risk is found to be a significant determinant of stock returns. Further investigation of this issue using different datasets and other exchange rate measures is necessary.

Table 1. Summary Statistics of Excess Sectors Returns

All sector 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 excess currency deposit for each country is computed as the country's one-month euro-currency interest rate minus the eurodollar interest rate plus the appreciation/depreciation of the country's currency with respect to the US dollar (uncovered currency deposit). The *G7 currency index* is a trade-weighted average of the G7 countries excess currency deposit rates. The sample period is from January 1975 to December 2001 for Canada, France, Germany, UK and US, and from January 1978 to December 2001 for Italy, Japan, and G7 global sectors. Data on G7EM1 and G7EM2 global sectors is from January 1986 to December 2001. 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 1% and 5% levels respectively.

Canada	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.086	7.03	-0.35**	2.98**	121.6**	17.74	24.42*
Basic Industries	-0.029	6.84	-0.42**	2.61**	97.17**	6.17	14.53
Gen. Industrials	0.417	7.33	-0.39**	1.37**	32.34**	14.46	21.88*
Cyc. Cons. Goods	-0.055	12.60	-2.28**	19.38**	5187**	15.53	0.74
Non Cyc. Cons. Goods	0.751	5.81	-0.35**	1.96**	56.20**	7.69	8.74
Cyclical Sevices	0.065	5.71	-0.53**	2.81**	116.9**	16.59	5.96
Non Cyc Sevices	0.528	5.21	-0.38**	2.61**	95.41**	32.02**	18.23
Utilities	0.232	4.60	-0.54**	1.74**	54.53**	8.85	12.69
Info. Technology	0.198	8.75	-1.72**	12.90**	2332**	38.95**	104.50**
Financials	0.427	5.69	-0.79**	4.02**	243.2**	8.63	8.15
Excess Currency Deposit	-0.067	1.38	-0.40**	1.22**	27.79**	16.42	13.07

France	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.842	8.33	-0.17	2.32**	70.78**	24.49*	43.65**
Basic Industries	0.508	6.60	-0.29*	0.78**	12.13**	7.22	14.17
Gen. Industrials	0.545	7.55	-0.63**	4.11**	239.97**	13.67	5.87
Cyc. Cons. Goods	0.162	8.30	-0.13	1.85**	44.68**	9.21	15.80
Non Cyc. Cons. Goods	0.641	6.68	-0.25	0.38	5.14	6.06	17.74
Cyclical Sevices	0.346	7.30	0.05	2.37**	72.44**	8.06	20.02
Non Cyc Sevices	0.758	7.56	-0.22	0.89**	12.72*	28.09**	20.72
Info. Technology	0.692	10.12	-0.16	1.34**	24.17**	17.03	28.00
Financials	0.479	6.43	-0.60**	2.07**	74.37**	13.77	61.02**
Excess Currency Deposit	-0.790	3.46	-0.28*	0.94**	15.28**	15.09	5.03

Germany	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Basic Industries	0.033	5.72	-0.33**	1.11**	21.54**	6.93	18.45
Gen. Industrials	0.041	5.66	-0.46**	1.20**	29.31**	17.33	24.98**
Cyc. Cons. Goods	0.002	7.48	0.51**	6.83**	620.86**	8.43	4.15
Non Cyc. Cons. Goods	-0.016	5.03	-0.35**	0.87**	16.26**	9.53	4.38
Cyclical Sevices	-0.243	6.13	-0.18	0.71**	7.89*	23.79*	18.54
Non Cyc Sevices	-0.203	7.94	-0.41**	2.67**	101.29**	21.07*	77.42**
Utilities	0.097	4.71	-0.06	1.11**	15.73**	12.29	14.47
Financials	0.107	6.57	-0.39**	1.56**	38.99**	9.07	25.00**
Excess Currency Deposit	-0.628	3.53	-0.16	0.91**	11.73**	14.92	9.72

Italy	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Basic Industries	0.169	8.36	-0.15	0.45	3.17	7.67	11.44
Gen. Industrials	0.143	8.81	0.17	1.48**	25.95**	11.15	8.25
Cyc. Cons. Goods	0.455	9.48	-0.28*	4.85**	273.8**	13.48	23.24*
Cyclical Sevices	0.526	9.11	0.64**	2.85**	112.2**	19.14	19.32
Non Cyc Sevices	0.794	8.69	0.24	0.49	5.32	16.34	16.92
Utilities	0.807	7.76	0.26	0.72**	8.84**	7.17	16.20
Financials	0.672	7.66	0.03	0.55*	3.35	28.94**	65.30**
Excess Currency Deposit	-0.946	3.39	-0.31*	0.85**	12.64**	20.19	11.95

Japan	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	-0.104	9.52	-0.03	0.97**	10.46**	16.82	19.35
Basic Industries	-0.083	7.51	0.06	0.70*	5.58	17.42	41.74**
Gen. Industrials	0.091	7.03	-0.17	0.75**	7.61*	6.94	34.92**
Cyc. Cons. Goods	0131	6.65	-0.10	0.53	3.50	9.78	15.04
Non Cyc. Cons. Goods	0.166	6.46	0.20	0.93**	11.60**	13.30	30.94**
Cyclical Sevices	0.065	6.47	0.10	0.72**	6.18*	20.16	67.72**
Non Cyc Sevices	0.447	9.77	0.89**	2.42**	104.00**	25.33**	31.55**
Utilities	0.129	8.47	0.88**	3.45**	173.32**	11.51	46.06*
Info. Technology	0.346	8.98	-0.07	0.26	0.88	13.12	53.39**
Financials	0.009	8.49	0.47**	1.34**	30.66**	19.95	23.60*
Excess Currency Deposit	-0.091	3.62	0.33*	1.00**	19.11	16.42	9.44

UK	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.886	7.53	0.55**	4.77**	311.63**	10.84	33.46**
Basic Industries	0.565	7.10	0.11	2.96**	114.13**	9.23	17.62
Gen. Industrials	0.628	7.67	0.19	3.36**	147.74**	9.52	13.55
Cyc. Cons. Goods	0.285	8.69	-0.03	2.22**	63.24**	9.42	18.94
Non Cyc. Cons. Goods	0.881	6.33	0.49**	6.26**	523.15**	7.49	18.82
Cyclical Sevices	0.657	7.20	0.46**	5.04**	341.65**	8.61	20.53
Non Cyc Sevices	0.981	7.95	0.32*	3.63**	175.89**	11.52**	34.71**
Info. Technology	0.529	10.46	-0.38**	2.07**	62.92**	32.18**	131.21**
Financials	0.846	6.93	0.53**	5.99**	480.95**	7.58	18.04
Excess Currency Deposit	0.051	3.16	0.00	1.67**	35.62**	9.99	21.14*

US	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.456	5.29	-0.15	1.35**	24.29**	12.10	56.34*
Basic Industries	0.324	5.88	-0.33**	3.05**	126.30**	3.77	17.45
Gen. Industrials	0.651	5.35	-0.62**	3.65**	192.85**	6.51	2.57
Cyc. Cons. Goods	0.384	5.82	-0.62**	2.93**	131.42**	17.96	10.16
Non Cyc. Cons. Goods	0.656	4.59	-0.45**	1.46**	37.76**	18.74	9.27
Cyclical Sevices	0.535	5.63	-0.65**	3.53**	184.60**	14.62	5.46
Non Cyc Sevices	0.497	4.45	-0.41**	0.81**	17.17**	12.20	59.45**
Utilities	0.464	4.07	0.23	0.91**	13.21**	15.85	35.15**
Info. Technology	0524	7.22	-0.57**	2.15**	76.84**	14.13	156.49**
Financials	0.717	5.44	-0.55**	2.05**	69.91**	19.40	3.96
G7 currency deposit index	-0.181	1.86	-0.20	0.88**	10.60**	12.70	18.52

G7 global sectors	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.398	5.23	-0.26	1.63**	33.20**	13.25	39.33**
Basic Industries	0.117	5.11	-0.23	0.82**	9.83**	7.45	25.79*
Gen. Industrials	0.326	4.79	-0.79**	2.37**	93.47**	6.04	10.27
Cyc. Cons. Goods	0.077	5.04	-0.75**	2.08**	75.71**	11.43	8.08
Non Cyc. Cons. Goods	0.630	3.99	-0.52**	2.14**	64.70**	18.50	5.62
Cyclical Sevices	0.361	4.56	-0.41**	1.18**	23.64**	13.24	15.45
Non Cyc Sevices	0.286	4.70	0.39**	2.74**	93.17**	19.72	24.22*
Utilities	0.278	4.24	0.59**	2.52**	88.62**	11.52	27.30**
Info. Technology	0.435	6.80	-0.80**	2.79**	118.83**	15.25	181.05**
Financials	0.454	5.43	-0.08	1.63**	30.18**	19.88	20.38
G7 currency deposit index	-0.181	1.86	-0.20	0.88**	10.60**	12.70	18.52
MSCI World	0.369	4.19	-0.75**	1.90**	67.86**	13.99	6.94

G7EM1 global sectors	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.469	4.79	-0.17	2.93**	64.58**	7.07	25.95**
Basic Industries	0.078	5.27	-0.18	0.92**	7.02*	4.40	18.98
Gen. Industrials	0.358	5.18	-0.92**	2.83**	85.96**	7.02	6.08
Cyc. Cons. Goods	0.127	5.20	-0.89**	2.58**	74.15**	9.84	5.74
Non Cyc. Cons. Goods	0.728	4.19	-0.65**	2.76**	69.67**	16.17	3.87
Cyclical Sevices	0.335	4.82	-0.57**	1.59**	28.84**	12.88	10.56
Non Cyc Sevices	0.199	5.31	0.40*	2.17**	39.70**	12.17	9.92
Utilities	0.269	4.43	0.73**	2.88**	78.29**	7.67	17.04
Info. Technology	0.504	7.54	-0.87**	2.34**	64.49**	13.32	114.27**
Financials	0.338	5.75	-0.04	1.58**	18.36**	11.79	14.69
G7 currency deposit index	-0.035	1.74	-0.13	0.89*	6.18*	18.12	10.22

G7EM2 global sectors	Mean	Std.Dev.	Skewness	Kurtosis	B-J	$Q(z)_{12}$	$Q(z^2)_{12}$
Resources	0.468	4.79	-0.18	2.95**	65.56**	7.11	26.14**
Basic Industries	0.085	5.26	-0.20	0.96**	7.80*	4.56	18.74
Gen. Industrials	0.358	5.17	-0.93**	2.86**	87.47**	7.05	6.03
Cyc. Cons. Goods	0.127	5.20	-0.89**	2.58**	74.20**	9.85	5.73
Non Cyc. Cons. Goods	0.726	4.19	-0.65**	2.78**	70.53**	16.28	3.86
Cyclical Sevices	0.336	4.81	-0.58**	1.61**	29.44**	13.04	10.32
Non Cyc Sevices	0.204	5.30	0.40*	2.16**	39.60**	12.02	9.66
Utilities	0.277	4.39	0.74**	2.98**	83.38**	8.01	17.55
Info. Technology	0.504	7.54	-0.87**	2.34**	64.49**	13.32	114.28**
Financials	0.337	5.74	-0.05	1.59**	18.59**	11.84	14.74
G7 currency deposit index	-0.035	1.74	-0.13	0.89*	6.18*	18.12	10.22

Table 2. 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). All variables are in percent per month and are used with one month lag with respect to the returns series (December 1974-November 2001).

Panel A: Global information variables

	Mean	Std.Dev.	Min.	Max.
XWDY	-0.3874	0.2333	-1.3030	-0.0243
ΔUSTP	0.0077	0.4652	-2.3700	3.5600
USDP	1.1138	0.4666	0.5500	2.6900

Panel B: Correlations

	XWDY	ΔUSTP	ΔUSTP
XWDY	1.000		
ΔUSTP	0.112	1.000	
ΔUSTP	-0.464	0.141	1.000

Table 3. QML Estimates of the Conditional IAPM for Individual Country Sectors

For each country, we estimate the following model:

$$r_{it} = \delta_{w,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{c,t-1}\,\mathrm{cov}_{t-1}(r_{it}, r_{ct}) + \varepsilon_{it} \qquad i=1..N\ (N=12)$$

$$\text{where} \begin{cases} \delta_{w,t-1} = \exp(k_w' Z_{t-1}) \\ \delta_{ct-1} = k_c Z_{t-1} \\ \varepsilon_t \mid \Im_{t-1} \sim N(0, H_t) \end{cases}$$

r_{it} is the excess return on sector i, r_w is the world market excess return and r_c is the country's excess currency deposit rate. 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:

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

where * denotes the Hadamard matrix product, a and b are $N \times 1$ vectors of unknown parameters.

Parameters k_w, k_c, plus the GARCH vectors a and b are estimated jointly with QML using BHHH algorithm. Robust standard errors are reported between parentheses.

Panel A: Parameter estimates

	Canada		France		Germany		Italy	
	k_w	k_c	k_w	k_c	k_w	k_c	k_w	k_c
Const.	-3.774	-0.182	-3.573	0.050	-4.399	0.036	-3.498	0.022
	(1.492)	*(0.140)*	*(0.461)*	*(0.048)*	*(0.738)*	*(0.042)*	*(0.550)*	*(0.045)*
XWDY	2.917	-0.139	2.275	0.125	3.205	0.171	4.420	0.178
	(1.858)	*(0.406)*	*(1.063)*	*(0.094)*	*(1.303)*	*(0.090)*	*(1.462)*	*(0.113)*
ΔUSTP	-0.286	0.008	0.027	-0.064	0.107	-0.073	-0.170	-0.064
	(1.804)	*(0.354)*	*(0.692)*	*(0.047)*	*(0.263)*	*(0.044)*	*(0.735)*	*(0.043)*
USDP	1.263	0.043	1.194	-0.076	1.678	-0.032	1.517	-0.044
	(1.139)	*(0.163)*	*(0.345)*	*(0.043)*	*(0.465)*	*(0.039)*	*(0.468)*	*(0.049)*

Panel A cont.

	Japan		UK		US	
	k_w	k_c	k_w	k_c	k_w	k_c
Const.	-4.970	0.002	-4.546	0.087	-4.376	0.040
	(2.203)	*(0.040)*	*(0.850)*	*(0.050)*	*(0.802)*	*(0.087)*
XWDY	1.960	0.233	3.157	-0.043	3.406	0.038
	(0.955)	*(0.081)*	*(1.430)*	*(0.095)*	*(1.208)*	*(0.213)*
ΔUSTP	-0.264	-0.082	0.030	-0.051	-0.101	-0.042
	(0.493)	*(0.042)*	*(0.130)*	*(0.045)*	*(0.326)*	*(0.093)*
USDP	1.552	0.072	1.768	-0.102	1.767	-0.110
	(1.127)	*(0.046)*	*(0.512)*	*(0.039)*	*(0.461)*	*(0.071)*

GARCH parameters for all assets in all countries are significant and satisfy the stationarity condition.

Panel B: Specification Tests

Null Hypothesis	*df*	**Canada**	**France**	**Germany**	**Italy**	**Japan**	**UK**	**US**
(1) Is the price of market risk constant?	3	8.389	13.154	13.612	23.716	7.046	13.365	18.439
$H_0 : k_{w,j} = 0 \ \forall j > 1$		*[0.039]*	*[0.004]*	*[0.004]*	*[0.000]*	*[0.071]*	*[0.004]*	*[0.000]*
(2) Is the price of XR risk equal to zero?	4	3.806	34.830	29.092	52.917	10.115	11.635	13.995
$H_0 : k_{c,j} = 0 \ \forall j$		*[0.433]*	*[0.000]*	*[0.000]*	*[0.000]*	*[0.039]*	*[0.020]*	*[0.007]*
(3) Is the price of XR risk constant?	3	1.327	12.023	13.015	14.188	10.022	11.143	4.029
$H_0 : k_{c,j} = 0 \ \forall j > 0$		*[0.723]*	*[0.007]*	*[0.005]*	*[0.003]*	*[0.018]*	*[0.011]*	*[0.258]*

The table reports Chi^2 test statistics and *[p-values]*.

Table 4. QML Estimates of the Conditional IAPM for Global Sectors

For each of the three groups of global sectors we estimate the following model:

$$r_{it} = \delta_{w,t-1} \operatorname{cov}_{t-1}(r_{it}, r_{wt}) + \delta_{c,t-1} \operatorname{cov}_{t-1}(r_{it}, r_{ct}) + \varepsilon_{it} \quad i=1..N \; (N=12)$$

$$\text{where } \begin{cases} \delta_{w,t-1} = \exp(k_w' Z_{t-1}) \\ \delta_{ct-1} = k_c Z_{t-1} \\ \varepsilon_t | \Im_{t-1} \sim N(0, H_t) \end{cases}$$

r_{it} is the excess return on global sector i, r_w is the world market excess return and r_c is the *G7 currency deposit index.*
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:

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

where * denotes the Hadamard matrix product, a and b are *12x1* vectors of unknown parameters.

Parameters k_w, k_c, plus the GARCH vectors *a* and *b* are estimated jointly with QML using BHHH algorithm.
Robust standard errors are reported between parentheses.

Panel A: Parameter estimates

	G7 global sectors		G7EM1 global sectors		G7EM2 global sectors	
	k_w	k_c	k_w	k_c	k_w	k_c
Const.	-3.813	0.019	-9.230	-0.184	-9.398	-0.179
	(0.748)	*(0.067)*	*(4.389)*	*(0.222)*	*(4.201)*	*(0.236)*
XWDY	4.923	0.159	-1.599	-0.041	-1.861	-0.063
	(2.336)	*(0.203)*	*(8.811)*	*(0.506)*	*(8.505)*	*(0.273)*
ΔUSTP	-0.143	-0.074	-5.386	-0.323	-5.453	-0.324
	(0.407)	*(0.085)*	*(3.152)*	*(0.178)*	*(3.236)*	*(0.174)*
USDP	1.842	-0.040	3.890	0.141	3.907	0.124
	(0.634)	*(0.019)*	*(1.898)*	*(0.358)*	*(1.884)*	*(0.334)*

All GARCH parameters are significant and satisfy the stationarity condition.

Panel B: Specification Tests

	G7 global sec.			G7EM1 global sec.			G7EM2 global sec.		
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? $H_0 : k_{w,j} = 0\ \forall j > 1$	15.064	3	0.002	20.527	3	0.000	21.263	3	0.000
(2) Is the price of XR risk equal to zero? $H_0 : k_{c,j} = 0\ \forall j$	11.809	4	0.019	6.146	4	0.189	6.104	4	0.192
(3) Is the price of XR risk constant? $H_0 : k_{c,j} = 0\ \forall j > 0$	3.958	3	0.266	4.057	3	0.255	4.014	3	0.260

Panel C: Diagnostics Tests For Residuals

Using G7 sectors	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Resources	-0.18	1.31**	13.33	25.59*
Basic Industries	-0.22	0.68*	9.83	9.58
Gen. Industrials	-0.92**	2.99**	9.22	4.12
Cyc. Cons. Goods	-0.94**	2.81**	13.29	3.90
Non Cyc. Cons. Goods	-0.43**	1.61**	19.10	4.18
Cyclical Sevices	-0.46**	1.28**	14.51	2.08
Non Cyc Sevices	0.54**	2.53**	14.89	12.76
Utilities	0.43**	0.89**	10.06	12.46
Info. Technology	-0.58**	1.59**	7.82	13.02
Financials	-0.20	1.98**	20.43	3.71
G7 currency deposit index	-0.14	0.88**	12.17	15.82
World	-0.74**	2.06**	19.45	5.16

[a] Ljung-Box test statistic for returns and returns squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

Panel C: Diagnostics Tests For Residuals *(cont).*

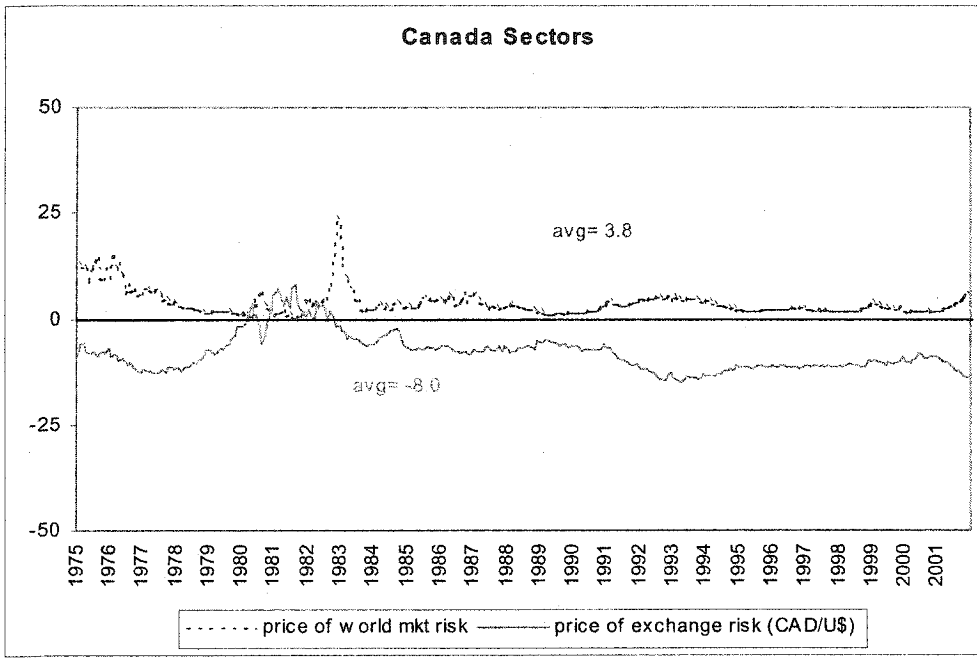
Using G7EM1 sectors	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Resources	-0.21	2.34**	5.84	24.49*
Basic Industries	-0.36*	1.09	7.37	9.98
Gen. Industrials	-0.95**	2.72**	7.06	4.35
Cyc. Cons. Goods	0.90**	2.59**	14.16	4.13
Non Cyc. Cons. Goods	-0.71**	2.67**	17.32	3.12
Cyclical Sevices	-0.87**	2.30**	12.60	4.44
Non Cyc Sevices	0.21	1.28**	13.20	14.43
Utilities	0.01	0.75*	9.37	9.10
Info. Technology	-0.71**	1.35**	14.55	46.80**
Financials	-0.60**	1.79**	9.59	7.74
G7 currency deposit index	-0.37*	1.20**	6.40	5.52
World	-1.03**	2.60**	11.14	2.20

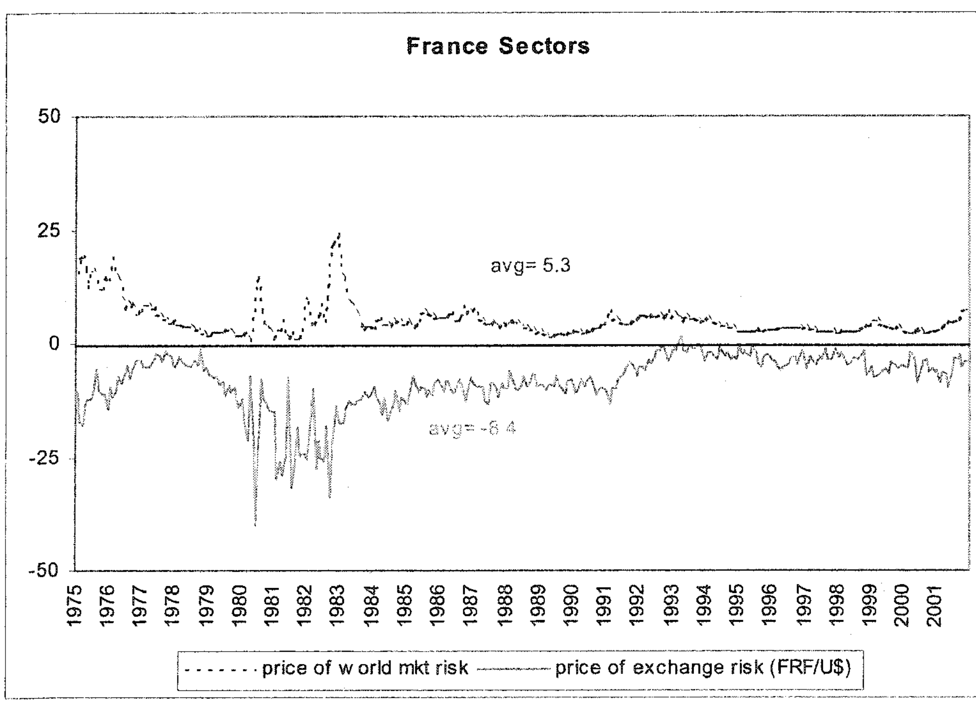
[a] Ljung-Box test statistic for returns and returns squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

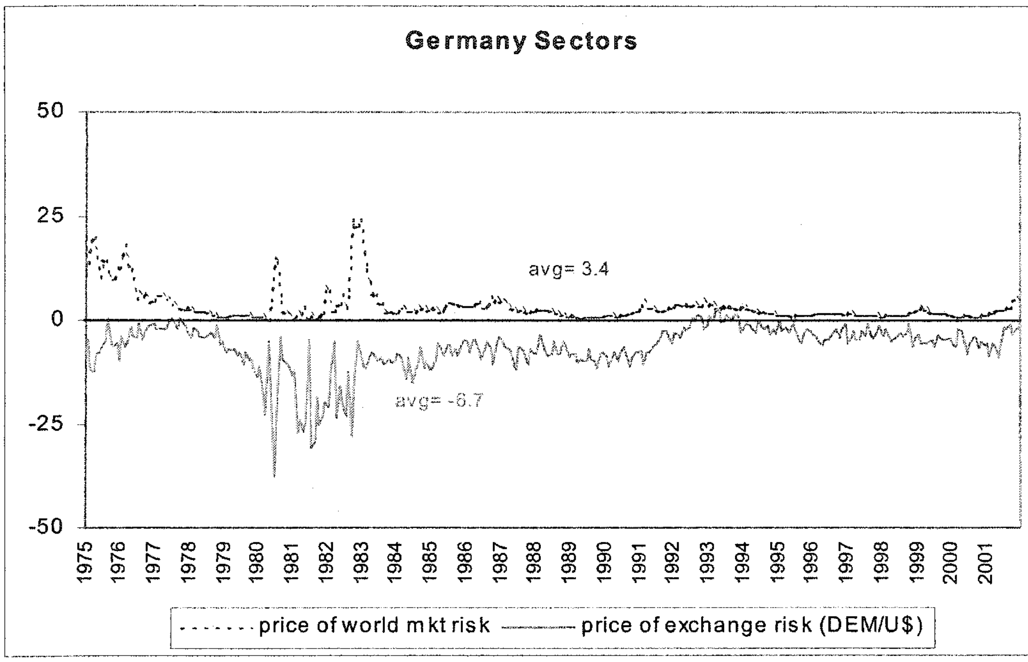
Using G7EM2 sectors	Skewness	Kurtosis	$Q(z)_{12}$[a]	$Q(z^2)_{12}$[a]
Resources	-0.21	2.37**	5.88	24.93*
Basic Industries	-0.37*	1.12**	7.62	10.16
Gen. Industrials	-0.96**	2.76**	6.99	4.26
Cyc. Cons. Goods	-0.91**	2.61**	14.00	4.10
Non Cyc. Cons. Goods	-0.71**	2.66**	17.42	3.17
Cyclical Sevices	-0.88**	2.31**	12.68	4.34
Non Cyc Sevices	0.21	1.27**	13.52	14.02
Utilities	-0.01	0.78*	9.83	9.49
Info. Technology	-0.71**	1.34**	14.31	45.63**
Financials	-0.60**	1.80**	9.54	7.92
G7 currency deposit index	-0.36*	1.19**	6.35	5.56
World	-1.03**	2.60**	10.99	2.24

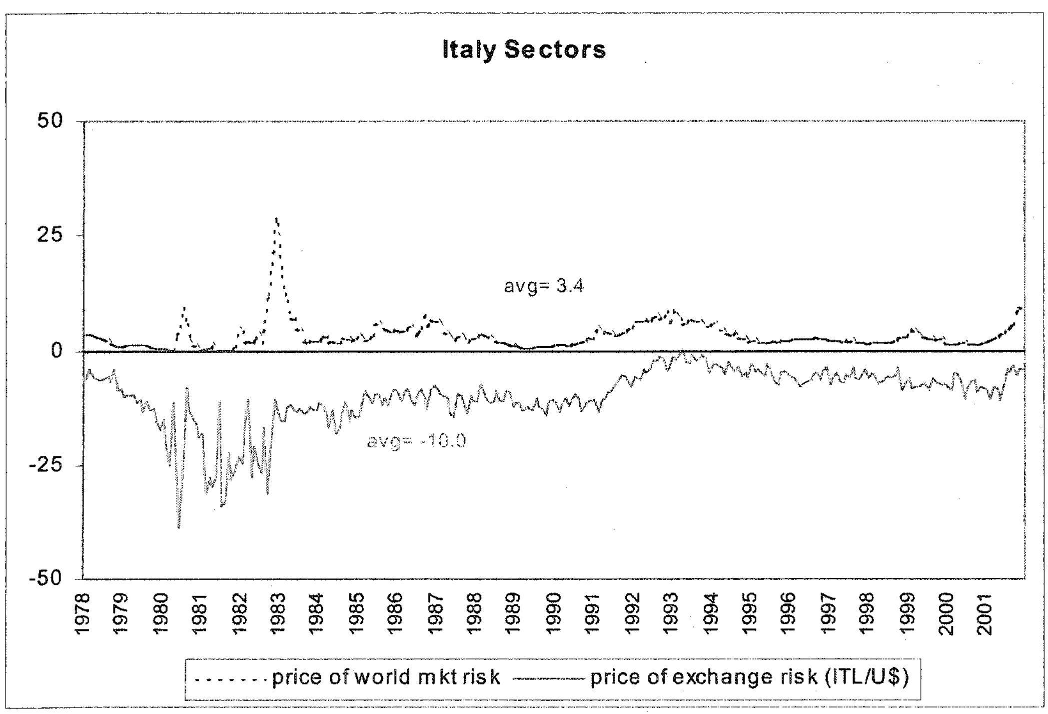
[a] Ljung-Box test statistic for returns and returns squared.
** and * denote statistical significance at the 1% and 5% levels respectively.

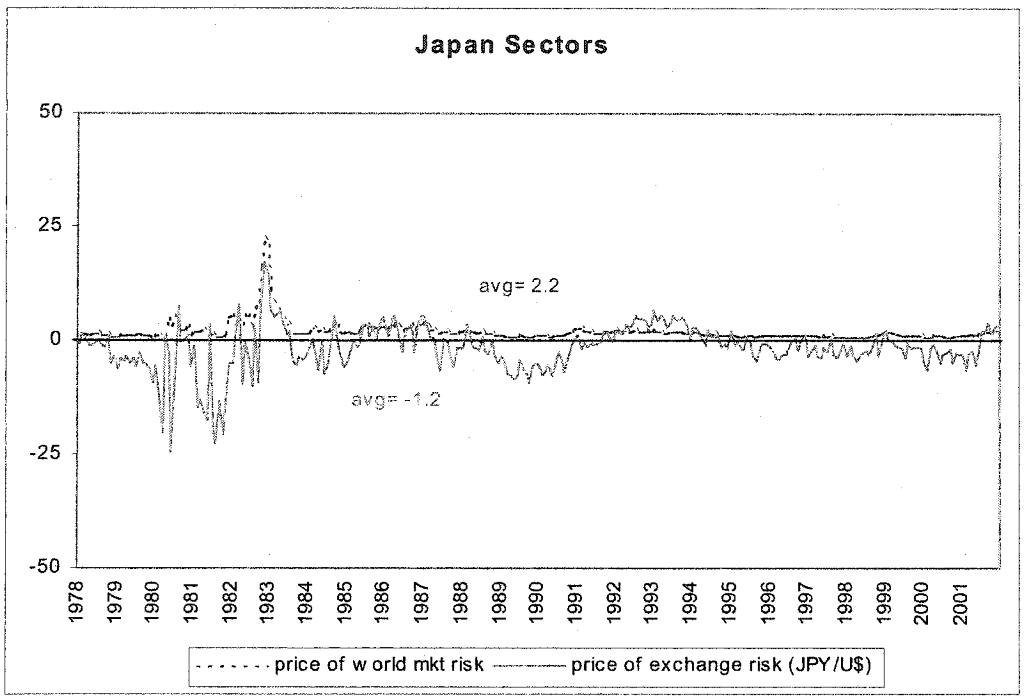
Figure 1. Prices of Risk Estimated from Single Country Sectors Returns



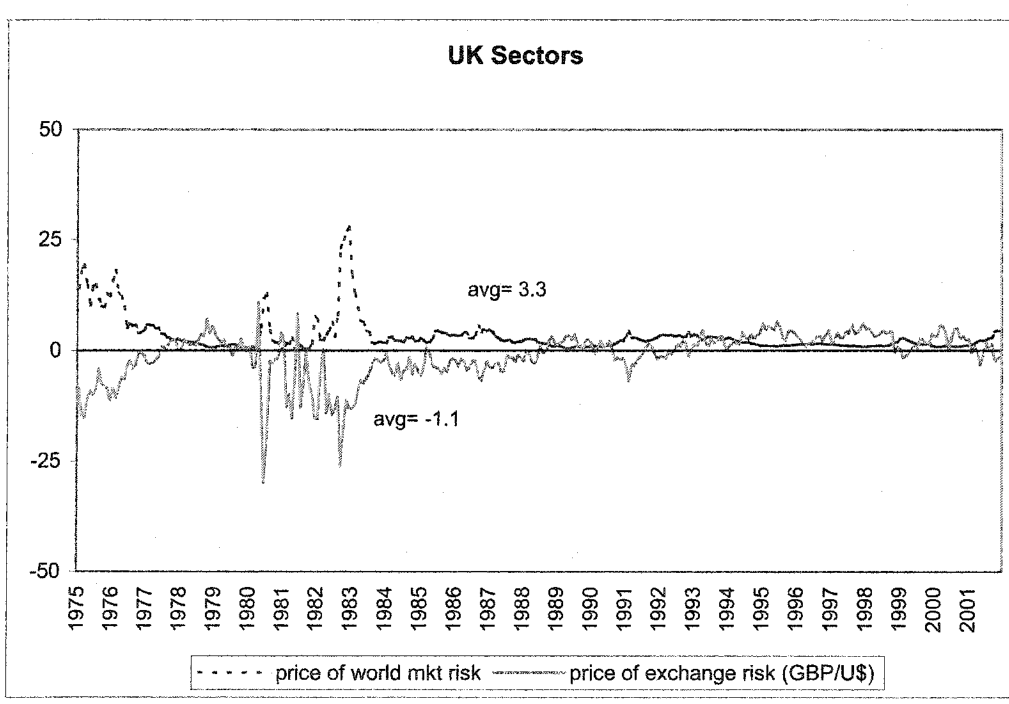



Germany Sectors
50
25
0
-25
-50
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
avg= 3.4
avg= -6.7
price of world mkt risk
price of exchange risk (DEM/U$)


Italy Sectors
50
25
0
-25
-50
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
avg= 3.4
avg= -10.0
price of world mkt risk
price of exchange risk (ITL/U$)



Japan Sectors
50
25
0
-25
-50
avg= 2.2
avg= -1.2
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
price of w orld mkt risk
price of exchange risk (JPY/U$)



UK Sectors
50
25
0
-25
-50
avg= 3.3
avg= -1.1
1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
price of world mkt risk
price of exchange risk (GBP/U$)

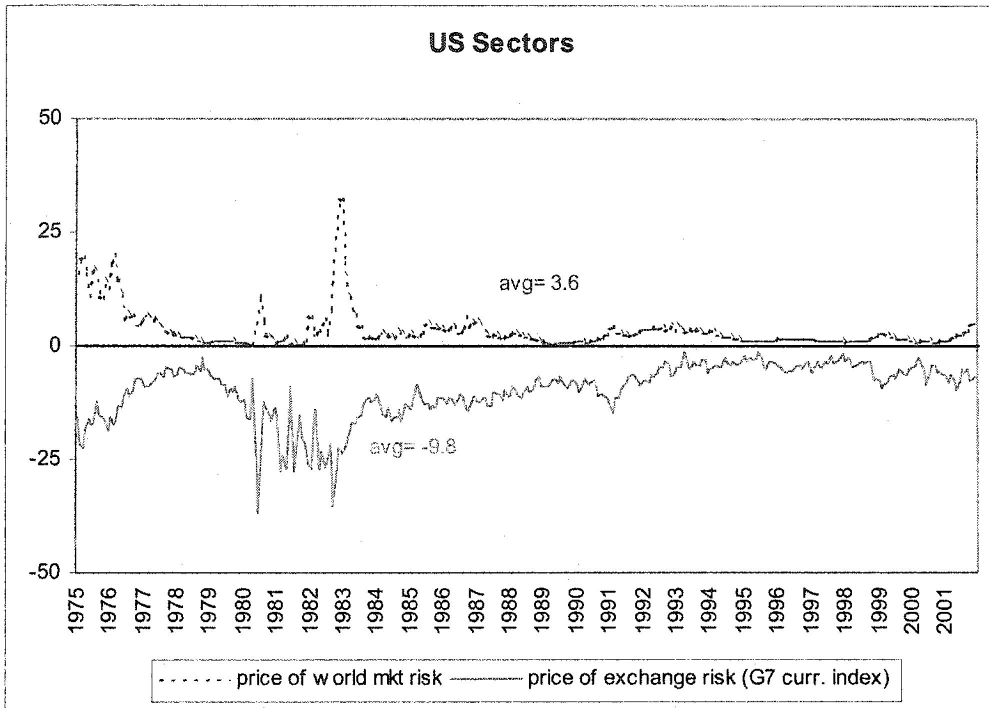
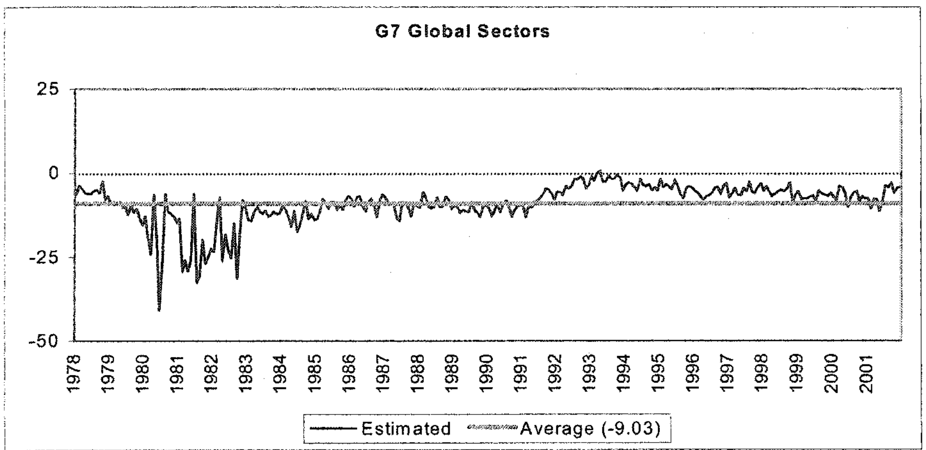
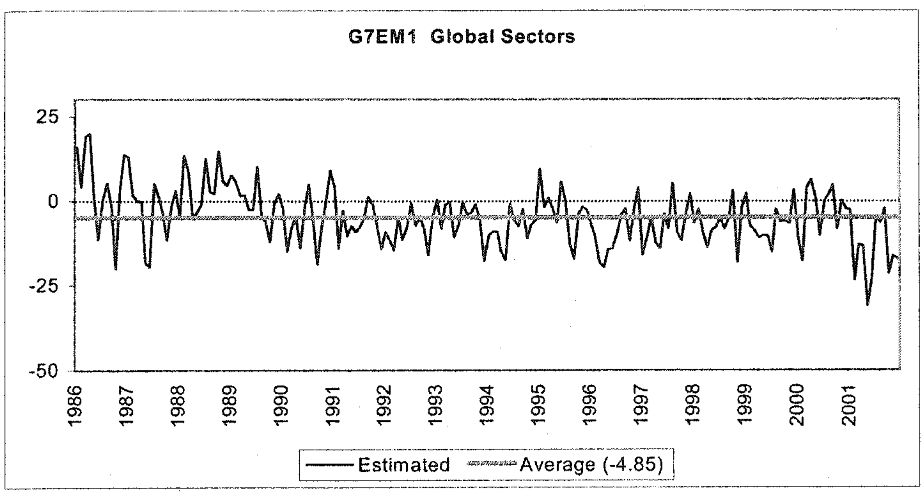

US Sectors
50
25
0
-25
-50
avg= 3.6
avg= -9.8
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
price of w orld mkt risk
price of exchange risk (G7 curr. index)

Figure 2. Prices of Exchange Risk Estimated from Global Sectors





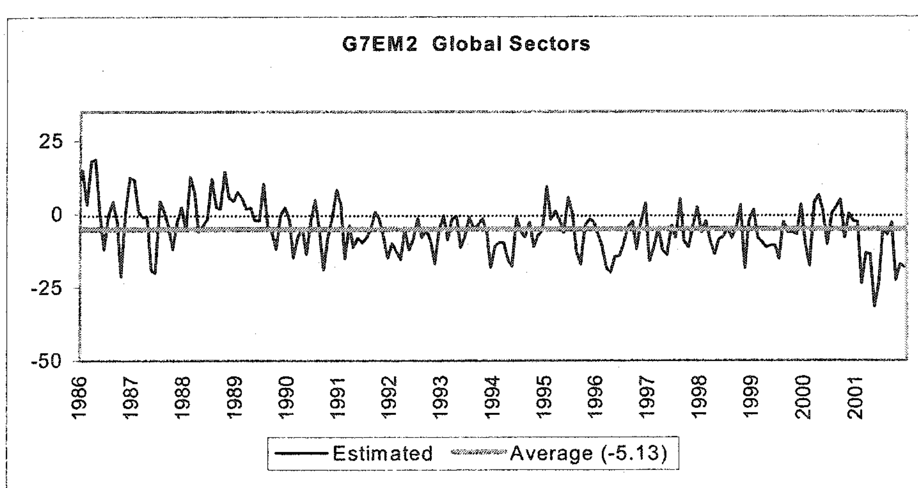
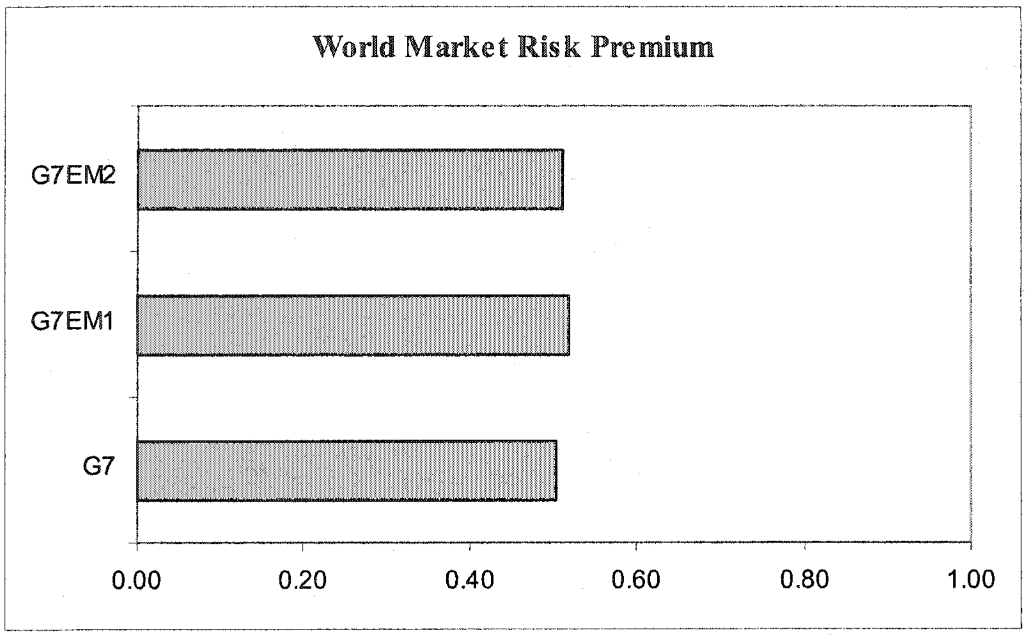
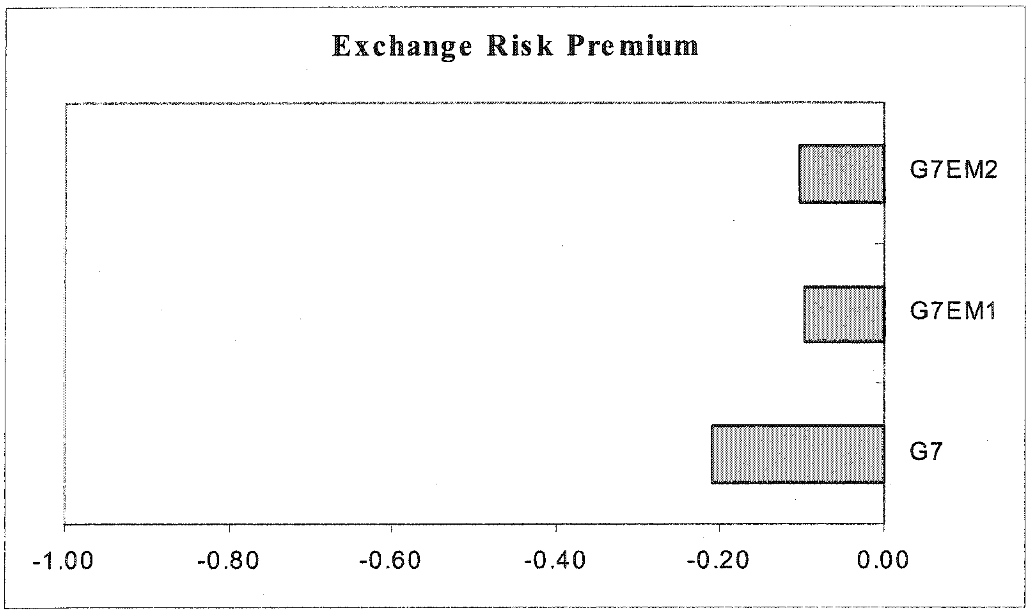


Figure 3. Average Estimated Risk Premia for Global Sectors





CHAPTER V

Summary and Conclusion

In this chapter, we summarize the main results of the thesis and emphasize the contribution of our study to the international asset pricing literature. We also discuss the implications of our findings and propose guidelines for future research in this field.

The purpose of this thesis was to investigate whether exchange risk is priced in the stock market, i.e., whether exchange rate variations are reflected in a significant risk premium in stock returns. For this, we test international asset pricing models (IAPMs) under varying market structures and using different exchange risk measures. Our analysis shows that exchange rate risk is one of the important determinants in the pricing of assets in both fully integrated and partially segmented capital market structures. Considering globally diversified assets, however, mitigates this result.

As discussed in the literature review in chapter I, the impact of exchange rate changes on stock returns remains to a large extent an open question. In fact, to the exception of few studies that clearly showed that the price of exchange risk is significant in the stock markets of major developed markets, we do not know much about the impact of exchange rate uncertainty on asset pricing in other less mature markets such as EMs. In addition, these studies often rely on restrictive assumptions that are not always appropriate to depict the reality of investing in international financial markets. For instance, most studies have assumed full integration of the world capital market and inflation is often assumed non random so that PPP deviations could be simply expressed in terms of nominal exchange rate changes. This motivates the need for further research on this issue in the context of different market environments where such simplifying assumptions do not hold.

In this thesis, we contribute to extending the literature by testing asset pricing models with exchange risk using more realistic specifications and covering a broader set of countries encompassing many regions and various exchange rate regimes.

In chapter II, we test for the existence and significance of exchange risk premia in nine emerging markets using alternative model specifications in an unconditional setting. Since this question has not been studied before for such a large number of EMs, the objective of this preliminary unconditional analysis is to find initial evidence on this issue and offer guidelines for conducting further investigations. Our empirical tests are performed using market indices, size and industry portfolios as well as firm level data. The main results show that unlike the case for developed markets where unconditional tests failed to detect a significant exchange risk premium in stock returns, exchange risk is unconditionally priced in EMs. However, this result does not hold when local market risk is introduced in the model to take into account potential segmentation effects, especially when we use cross-sections of returns at firm level. Exchange risk premia are indeed totally subsumed by local risk premia for almost all countries.

Besides providing new evidence on the pricing of exchange risk for a large number of emerging stock markets, the main contribution of this study is to show that the choice of the asset pricing model is critical in shaping the results about the significance of the exchange risk factor. In a model that assumes full integration, exchange risk appears as a significant pricing factor while in a partial segmentation model only local risk is priced. This suggests that using a full integration asset pricing model may result in a spurious significance of the exchange risk factor because it may capture country-specific shocks which would otherwise show in a local risk premium. However this study has some limitations. First, we used a limited dataset on individual firm returns to test the partial integration model. Second, the estimated risk premia are assumed constant over time, which is against the evidence on time varying risk premia in both stock markets and foreign exchange markets. Indeed, a subsample analysis in this study indicates that the significance of the exchange risk premium is different over subsamples.

The study conducted in chapter III tries to address these limitations by testing IAPMs in a conditional setting using multivariate GARCH-in-Mean specification and time varying prices of risk. We start with a model that assumes full market integration to compare our results with previous studies for major developed markets. Then this assumption is relaxed and we test a model that assumes partial segmentation by including a time varying price of local market risk. To our knowledge, this is the first study for EMs that uses a model that includes at the time exchange risk, global risk and local risk, all with time-varying prices. Another contribution of this study is to use real exchange rates in order to account for both inflation risk and nominal exchange risk. Previous studies have often neglected the inflation dimension and assumed that nominal exchange rate fluctuations are the major source of PPP deviations. While such assumption could be acceptable for some major developed markets, it would be unrealistic to ignore inflation risk when we deal with emerging markets.

The main empirical results presented in chapter III support the hypothesis of significant real exchange risk premia in emerging stock markets even after accounting for local market risk premia. This is different from the results obtained in the previous chapter and further justifies the importance of allowing for time variation in the risk premia in asset pricing relations. Another contribution of this study is that it clearly shows that the exchange risk premium is also economically significant as it represents a substantial component of stock returns in EMs reaching up to 45 percent for some countries over some time periods. For some countries, the exchange risk premium can be as large as the local market risk premium. Therefore, disentangling those two types of risk in asset pricing relations is important, not only from a theoretical point of view, but also for investors decisions regarding global asset allocation and hedging of portfolio risks.

Looking at the results of these two studies on EMs along with the evidence found in previous studies for developed markets, we note that an important aspect of foreign exchange risk pricing have been ignored in previous research. That is, we still do not have empirical evidence with respect to the relevance of exchange risk premia in the context of globally diversified portfolios. Intuitively, we may think that exchange risk can be diversified away, at least partially, by holding a portfolio of multi-currency assets. A natural extension of the literature is to examine the effect of such cross-currency diversification on the significance of exchange risk in pricing global assets. To shed light on this issue, the study in chapter IV tests for the significance of exchange risk in IAPMs using cross-sections of global sector portfolios. The choice of sector indexes rather than other types of global indexes that are available to investors is motivated by the increasing interest in global sector investing seen as a more attractive way to reap the benefits of international diversification when countries are becoming more interdependent.

To our knowledge, there is no previous evidence from testing IAPMs using this type of globally diversified portfolios. For this reason, we start our analysis using data on developed markets, precisely the G7 countries. Then in constructing our global sector portfolios, we extend the dataset to include emerging markets sectors. Using single country sector portfolios and global sector portfolios for the G7, we find that exchange risk is a significant pricing factor. However, using global sector portfolios that include G7 and EMs, we cannot reject the hypothesis that the price of exchange is zero. This suggests that exchange risk may be less significant in pricing global assets that include both developed and emerging markets securities and currencies.

The results of this study are interesting as they contribute to our understanding of the significance of foreign exchange risk in asset pricing. In fact, those who believe that exchange risk is nothing but a money illusion, would find in these results strong evidence that exchange risk should not be a priced factor since it can be diversified away at the portfolio level. However, this does not mean that in reality investors do not require compensation in terms of expected returns for taking on currency risk. Indeed as shown by our results in the first two essays, when we consider only a subset of assets in the global market, for instance the EMs region, exchange risk premia account for a substantial component of stock returns. Both EMs currencies and major currencies risks are priced. Similarly, previous research has shown that when we consider major stock markets such as the US, UK, Germany and Japan, currency premia are also significant in explaining the cross-sectional variation of stock returns. The results of the country level estimations in our third essay also confirm this finding since we strongly reject the hypothesis of a zero price of exchange risk using national and global sector portfolios for the G7.

In other words, all the existing evidence suggests that when we consider only a subset of assets in the world, either DMs or EMs separately, exchange rate will arise as an important pricing factor. However, when we consider 'truly' global assets that are diversified across both DMs and EMs securities and currencies, exchange risk becomes an insignificant pricing factor.

Given the widespread evidence on home bias in the international finance literature, and given that EMs assets still account for a small portion of the portfolios held by global investors, we can expect exchange risk to remain significantly priced in the stock markets of both developed and emerging countries. This is because investors that do not hold fully diversified global portfolios cannot completely diversify away their exchange risk exposure and therefore require compensation for taking on such risk in terms of expected returns in domestic and foreign stock markets.

Clearly, more research is needed in this field and improvements can be achieved both at the theoretical and empirical levels. Indeed, one of the major limitations of our tests of the partial integration model is the absence of an underlying theoretical pricing model derived under both PPP deviations and barriers to investment (or segmentation). The challenge is then to try to develop a model that takes into account these two important dimensions at the same time and see if the resulting pricing equation contains premia for hedging both exchange rate risk and local risk. Until such a model is developed, empirical testing will be based on ad-hoc models that rely on the implications of other theoretical models taking into account either PPP deviations or barriers, since none of these dimensions can be ignored in empirical investigations.

Improving the econometric methodology followed in empirical testing could also result in new evidence and significantly contribute to the literature. For instance, in many studies including those conducted in this thesis, the conditional covariance matrix is modeled using GARCH-type specification. Although this has been successfully applied to data in both developed and emerging markets, alternative specifications such as regime-switching models could better accommodate the returns variation in some countries, particularly emerging markets where periods of liberalization, increasing capital controls or episodes of crises may affect the assets returns behaviour. Finally, by extending the empirical testing to cover larger datasets including diversified portfolios that reflect the holdings of global investors will certainly provide insightful evidence on the significance of exchange risk in international asset pricing.

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