Is Currency Factor Important for Global Portfolios?

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Abstract

We investigate whether cross-country diversification, particularly into emerging markets, has an impact on the pricing of exchange risk for globally diversified portfolios. Our empirical tests based on a conditional IAPM show that the price of exchange risk is highly significant in global sector portfolios that include only developed countries. In contrast, when we include emerging markets with the developed market assets, the hypothesis of zero price of exchange risk cannot be rejected. Also, global sector portfolios that include EM assets show lower currency beta and lower contribution of the currency premium on average. The reduction in the contribution of the currency premium is specifically important in periods of crises.

Keywords: International Asset Pricing; Currency risk; Emerging Markets; International diversification; Global sector investing.

JEL Classification: F21, F31, G12, G15

1. Introduction

In an International setting, the asset pricing models contain an exchange risk premium in addition to the traditional market risk premium. Thus, exchange risk constitutes an additional source of risk in international asset pricing models (IAPMs). Consequently, the issue of whether exchange risk is priced in the stock market has been of significant interest in the international finance literature. Although the early evidence was inconclusive, the work of Dumas and Solnik (1995) suggested that the previous evidence on currency risk may be due to the use of unconditional asset pricing models. Other studies that followed 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 international asset pricing model (IAPM) with time varying prices of risk and found strong evidence consistent with Dumas and Solnik (1995) that foreign exchange risk is priced in major developed stock markets. Other studies such as Carrieri (2001) found similar evidence using data on major European countries.

Since most of these studies implicitly assumed full market integration and focused on few major developed markets, Carrieri, Errunza and Majerbi (2006a, 2006b) looked at a number of emerging markets and investigated the pricing of exchange risk in the context of partially integrated models. 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. Based on a theoretical model that accounts for currency risk and partial segmentation, Chaieb and Errunza (2007) report similar results with regards to the significance and time variation of the global currency risk. Another study by Phylaktis and Ravazzolo (2004) applied a regime switching model for a number of Pacific Basin markets. Their results provide strong evidence that not only currency risk

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

is priced in both pre and post liberalization periods, but the model is superior to one which does not include currency risk.

Most of the available studies, however, are based on country-level data, i.e., using cross-sections of country indices expressed in the same reference currency.[2] Indeed, investors seeking to take advantage of the benefits of international diversification hold geographically diversified portfolios as evidenced by the increasing investments in portfolio indexing strategies to replicate global indices such as MSCI, S&P, DJ, and FTSE's regional and sector-based indexes. 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 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 is important to test whether exchange risk is priced for cross-sections of globally diversified portfolios, instead of single-country portfolios. In this study, we use global sector portfolios to examine the importance of currency risk with special emphasis on the role of emerging markets (EMs) in the pricing of currency risk. 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 to reduce the global portfolio risk because of beneficial cross-currency diversification effects. The implications of these perceptions on the expected returns of global assets are quite different. It is thus important to investigate the relevance of the exchange risk factor in pricing these global equity portfolios, in particular when they include emerging market assets. Further, we also investigate the time varying impact of cross-country diversification on currency risk exposure and the contribution of currency risk premium to total premium.

Based on data from global sector indexes constructed across developed and emerging markets, we estimate an IAPM to investigate the significance of the price of

[2]There are also few studies that use industry-level data but in a single-country (single-currency) setting such as Jorion (1991) and Francis et al. (2008) for the US; Choi, Hiraki, and Takezawa (1998), and Doukas, Hall and Lang (2001) for Japan; and Bailey and Chang (1995) for Mexico.

[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.

exchange risk and the economic magnitude of the currency premium given that at least a part of the currency risk should be eliminated through cross-currency diversification within the portfolios. To our knowledge, there is no study that tests whether exchange risk is priced and estimates the premium for currency risk using cross-sections of globally diversified portfolios. Cross-currency diversification should reduce the exchange risk exposure of the global portfolio returns because the exposure to various exchange rates would cancel out when these currencies are grouped together in the same portfolio. For this reason, some have argued that exchange risk hedging is irrelevant because exchange risk can be diversified away by holding multi-currency asset portfolios. Nonetheless, there is no empirical evidence in support of such an argument except that the price of exchange risk is significant and that exchange risk premia represent an important component of equity returns at the individual country level. 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 sector portfolios.

To this end, we use the DataStream global sector indices, which are a basket of the world's largest companies representing a substantial proportion of world equity value. The regional global equity indices are segmented into 10 different global sectors. We consider three regional sets of these sector-level indices; the “DS-EMU” that is diversified across European developed markets, the “DS-DM” encompasses the same countries included in the DS-EMU portfolio as well as other developed markets, and the “DS-WRD” that includes developed and emerging countries sectors.[4] These three global equity indices differ in the countries and currencies represented and hence the extent of cross-country and cross-currency diversification, allowing us to investigate the role of EM assets in the pricing of currency risk.

The main results of this study can be summarized as follows. The price of exchange risk is significantly different from zero for global sector portfolios diversified across only the developed markets. However, using global sector portfolios that include both developed and emerging market assets, the hypothesis of a zero price of exchange

[4] A complete list of the countries composing each regional group is provided in appendix A.

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 include emerging markets. Indeed, while the price of exchange risk is consistently found to be significant for developed and emerging markets at the country level, this result does not hold when we consider global portfolios that include both developed and emerging market assets. In addition, global sector portfolios that include EM assets show lower currency beta and lower contribution of the currency premium on average. The reduction in the contribution of the currency premium is specifically important in periods of crises.

The rest of the paper is organized as follows. Section 2 outlines the model and empirical methodology used in the study. Section 3 describes the data and presents some preliminary analysis of global sector returns. In section 4, we report the empirical results from tests of exchange risk pricing using global sector returns. Section 5 concludes the paper and suggests some guidelines for future research.

2. Model and Methodology

2.1. The model

We use 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 excess returns can be written as:

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

where $r_{i,t}$ and $r_{w,t}$ are excess returns on asset *i* and the world market portfolio in period *t*, $\pi^{\$}_{j}$ is the rate of inflation of country *j* expressed in the reference currency , *E* is the expectations operator, δ_w is the price of world market risk and δ_j 's are the prices of inflation risks. The term cov (r_i , $\pi_j^{\$}$) measures the exposure of asset *i* to both inflation risk and exchange rate risk associated with country *j*. Since in this study we focus on exchange risk related to developed and emerging currencies, we follow Carrieri, Errunza and Majerbi (2006a) and simplify the model by assuming that US inflation is non-stochastic so that the only random component in $\pi_j^{\$}$ comes from the relative change in the real 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* and we can re-write equation (1) as follows:

$$E(r_{i,t}) = \sum_{j=1}^{L} \delta_{j,t-1} \operatorname{cov}_{t-1}(r_{i,t}, e_{j,t}) + \delta_{w,t-1} \operatorname{cov}_{t-1}(r_{i,t}, r_{w,t}) \qquad (2)$$

where e_j is the change in real exchange rate on currency *j* and δ_j is the price of real exchange risk related to currency *j*.

Given that it is very complicated to test the ICAPM model with many foreign currency variables, we simplify the model using two exchange rate indices (see for example Ferson and Harvey (1993, 1994), Carrieri, Errunza and Majerbi (2006a, 2006b)). The pricing equation is then

$$E(r_{i,t}) = \sum_{j=MJ,EM} \delta_{j,t-1} \operatorname{cov}_{t-1}(r_{i,t}, e_{j,t}) + \delta_{w,t-1} \operatorname{cov}_{t-1}(r_{i,t}, r_{w,t}) \qquad (3)$$

$\sum_{j=MJ,EM} \delta_{j,t-1} \operatorname{cov}_{t-1}(r_{i,t}, e_{j,t})$ measures the global currency risk premium which includes the currency premium for the major index and the currency premium for the EM index. These two currency indices are trade-weighted and a full description of them is provided in the data section.

2. 2. Empirical Methodology

We test the significance of exchange risk in the context of cross-country diversified portfolios. The intuition is that currency risk may be less significant in explaining globally diversified portfolio returns, such as global sectors, with expectation that emerging market assets will play an important role in diversifying away such risk.

We test the ICAPM described in Eq. (3) using different cross-sections of diversified sector portfolios that cover different groups of countries such as developed markets only or both developed and emerging markets.

DataStream provides total return indexes for global sectors both at the country level and at the regional level, with various regions encompassing different groups of countries. Based on data availability, we identify the following regions:

1. Europe (EMU only) DS-EMU
2. Developed Markets ex-North America DS-DM
3. World DS-WRD

We then use EMU, DM, and World global sector portfolios as our test assets. We start with the EMU group as this represents a globally diversified portfolio across 14 developed countries using major currencies that have been shown to be significantly priced in previous international asset pricing literature. The DM region of DataStream covers 22 developed countries except the US and Canada. Although this region extends the previous one to cover more countries, we are only diversifying the sector portfolios across developed markets.[5] To include the emerging markets effect, and in the absence of a specific smaller region in DataStream that includes a combination of both developed and emerging markets, we use the "world" region. This can be thought of as the ultimate diversified portfolio on a value weighted basis. This region covers 53 countries. Appendix A provides the detailed list of countries included in each region.

We estimate the model in equation (3) for each of the three groups using a cross-section of ten sectors returns plus the two currency indexes. For robustness, we also run our model with a cross-section of internationally diversified portfolios represented by the G7 global sectors and the G7EM global sectors. The first one can be considered as a well diversified portfolio that includes developed markets across Europe, Asia and

[5] We also use the most widely benchmarked international index, the MSCI Europe, Australia and Far East index also known as the EAFE index. It tracks a basket of 31 well-developed stock markets outside America. These global sector portfolios include mainly developed markets and provide similar results to what we obtain with the DM set. Hence we do not report the results for this set but they are available upon request.

America. The G7EM includes the G7 countries plus 8 emerging markets for which we have data at the sectoral level as outlined in more details in section 3.

The following system of equations is estimated for each set:

$$r_{it} = \delta_{w,t-1} h_{w,t} + \delta_{MJ,t-1} h_{MJ,t} + \delta_{EM,t-1} h_{EM,t} + \varepsilon_{it} \qquad i=1,\dots,N \qquad (4)$$

$$\varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t)$$

where r_{it} is the excess return on sector i expressed in US dollar; $\delta_{w,t-1}$ is the price of world market risk; $\delta_{MJ,t-1}$ is the price of major currency risk; $\delta_{EM,t-1}$ is the price of emerging markets currency 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; $h_{MJ,t}$ and $h_{EM,t}$ are the $(N\text{-}2)^{th}$ and $(N\text{-}1)^{th}$ columns of the covariance matrix H_t which give the covariances of the N assets with the major and the EM currency index returns respectively; and Ω_{t-1} is a set of information variables available to investors at time t.

In each system for estimation, the pricing restriction (2) has to hold for all N assets that include 10 sector portfolios, the change in exchange rates for the two real currency indices, and the world market return.[6]

We model the prices of world market risk and exchange rate risks ($\delta_{w,t-1}$, $\delta_{MJ,t-1}$ and $\delta_{EM,t-1}$) to depend on a set of global information variables Z_{t-1}, drawn from previous literature.[7] 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.[8]

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

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

[8] 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 Dumas and Solnik (1995), De Santis and Gerard (1998), Carrieri, Errunza and Majerbi (2006a, 2006b), and Chaieb and Errunza (2007) use the same functional specification proposed above for the prices of market and currency risk.

$$\delta_{w,t-1} = \exp\,(k_w' Z_{t-1}) \qquad (5)$$

$$\delta_{j,t-1} = k_j' Z_{t-1}, \qquad \textit{where } j=MJ, EM \qquad (6)$$

We follow the fully parametric approach used in De Santis and Gerard (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[9]:

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

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)).

3. 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 our focus is on sectors. These are Oil and Gaz, Basic Materials, Industrials, Consumer Goods, Healthcare, Consumer Services, Telecommunications, Utilities, Financials, and Technology. We compute monthly returns for each sector in a given country/region from January 1976 until December 2006.

[9] 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.

At each point in time, each DataStream EMU/Developed/World global sector index may include stocks from all EMU/Developed/World countries or just from a subset of those, and the particular stocks may also vary as DataStream revises its indices annually.

We also construct two 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 national sectors returns across the G7 countries (Canada, Germany, France, Italy, Japan, UK and US). The second set of global sectors, referred to as *G7EM Global Sectors*, spans a larger number of countries that include the G7 plus eight emerging markets for which we have data at the sectoral level. These are Argentina, Chile, Mexico, Malaysia, Korea, Philippines, Taiwan and Thailand. The portfolios for these 2 groups are constructed on a value-weighted basis from the constituent countries national sectors.

The world market return is computed from MSCI World index inclusive of dividends and available from DataStream. All returns for global sectors are expressed in US dollars and computed in excess of the one-month eurodollar deposit rate, used as a proxy for the risk-free rate and available from DataStream. We use two trade-weighted currency indices as the exchange risk factors in the estimations across the different sets of global sector portfolios. These are the real major currency index and the real emerging market currency index (or OITP) provided by the Federal Reserve Board (FRB). Both indices are computed as the time-varying trade-weighted average of the bilateral exchange rate changes for each sub-group of currencies.

Table 1 reports summary statistics for the three groups of global sectors, the world market portfolio, and the two currency indices. The excess returns display some interesting properties. For example, there is considerable cross-sectional variation in both mean excess returns and volatilities. Average volatility is highest in the Technology, Telecom, and Consumer goods sectors and lowest in the Healthcare and the Utilities sectors. As expected the volatilities of the global sectors are reduced as we move from the EMU region to the World because of risk reduction through portfolio diversification. The reduction in volatilities ranges from 0.3% for Basic Materials to 3.2% for the Technology sector. In addition, the data shows clear departure from normality. The hypothesis of normally distributed returns is rejected by the Bera-Jarque test for almost all global sectors.

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), Dumas and Solnik (1995), and De Santis, Gerard, and Hillion (2003) to facilitate comparison of 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 (USTP), the US default premium spread (USDP), and the change in the risk free rate (Euro$). 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 bonds in excess of the yield on the three-month bills, 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.

4. Empirical Results

4.1. Exchange risk pricing across global sector portfolios

We estimate model (4) using cross-sections of the global sector portfolios that are diversified across countries and currencies. Three estimations are performed with the three sets of global sectors (DS-EMU, DS-DM, and DS-WRD) as shown in Table 3. First, using DS-EMU sectors, we can see in Panel A that both major currency and EM currency risks are significantly priced, and jointly time varying. Nonetheless, we could not reject the hypothesis of constant price of risk for the EM currency risk. When we use a cross section of sector portfolios that include more developed countries, the price of EM currency risk becomes insignificant, while the price of major currency risk is still highly significant and time varying. Exposure to both major and EM currency risks is not significantly priced when emerging market assets are included as shown for global sectors at the world level, i.e. using DS-WRD. Although the emerging markets comprise a small fraction of any global sector's market capitalization, their inclusion makes exchange risk not significantly priced. Notice that for all the estimations the world market risk is significantly priced and is time-varying.

Our results are unchanged if we use the G7 global sectors vs. G7EM global sectors. As shown in Panel B, with a cross-section of G7-diversified sector portfolios, the prices of both currency risks are significant and time varying, although the major currency component of the exchange risk factor is marginally significant. However, we cannot reject the hypothesis of zero price of risk for both exchange rate indexes at any significant level when our global sector portfolios are diversified across both the G7 and emerging markets.

Figure 1 reports the graphs for the estimated prices of world market, MJ, and EM exchange risks for the three groups of global sectors. The estimations from the different sets of global sectors provide very similar patterns for the price of world market risk and the same average of 0.8. However, the prices of MJ currency risk and EM currency risk differ across the three estimations. If we only consider the period 1989-2006 where most of the EM sectors became available, we notice that the average price of EM currency risk decreases from 9 (EMU) to -1.4 (World). As for the MJ currency risk, though there is a slight increase in the average price of risk, the change is statistically insignificant.

4.2. Exchange risk premiums across global sector portfolios

We investigate the impact of cross-country diversification on the exposure to currency risk and the premium to currency risk. We measure the exposure to the MJ or EM currency index as follows,

$$\beta_{ij,t} = \frac{\operatorname{cov}_{t-1}(R_{it}, e_{j,t})}{\operatorname{var}_{t-1}(e_{j,t})}, \quad j = MJ, EM, \quad i = 1,\ldots 10$$

Figure 2 plots the average MJ and EM currency betas for the ten sectors and different sets (EMU, DM, and World) over the period sample (1976-2006). For all global sectors, the average exposure to the MJ currency risk is positive. The cross sectors average is equal to 0.8, 0.9, and 0.6 respectively for EMU, DM, and the World regions. Except for Basic Materials sector, the MJ currency beta is reduced for the World global sectors compared to the EMU global sectors. The decrease in the MJ currency beta is especially striking for the Technology sector where the exposure is reduced by half. On the other hand, the MJ currency exposure increases for all sectors, except for Technology and Consumer Goods, as we diversify the EMU global sectors by adding other developed markets. Hence it is not the diversification into different countries and currencies per se that reduces the currency risk exposure but rather the EM assets play an important role as a hedge against the currency risk. The average exposure to the EM currency risk is positive across all sectors. The average across the ten sectors is equal to 0.8, 0.78, and 0.67 respectively for EMU, DM, and the World regions. For most sectors, we see a decrease in the EM currency beta especially for Telecom, Utilities, and Technology sectors.

Figure 3 reports, for each of the ten sectors of each group, the average contribution of the global currency risk premium in absolute terms. The global currency risk premium is the sum of the MJ currency risk premium and the EM currency risk premium. We can see that global currency risk premiums are reduced for all sectors. Though the currency premium decrease is not economically important on average over the entire period, this reduction is striking over the crises periods of 1995-99 that encompass the Tequila crisis, the Asian crisis, and the LTCM default. On average across all sectors, the global currency premium decreases from 70% to 40% of the total premium in absolute value. The global currency risk premium decreases significantly during the Asian crisis in 1997. The average contribution across all sectors decreases from 80% to 36%.

Thus, the evidence suggests that the significance of exchange risk in pricing global assets is reduced in the context of global portfolios that include not only developed countries but also emerging market assets. Investing in globally diversified portfolios that include EM assets provide them with a hedge against currency risk.

5. Conclusions

Recent empirical evidence for both developed and emerging markets at the individual country level have established that the price of exchange risk is significant and economically important in explaining expected equity returns. The 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 risks using cross sections of globally diversified portfolios that include both developed and emerging market assets and currencies. We focus on global sector portfolios because of the growing interest in sector investing as a valuable source of diversification in the increasingly integrated capital markets.

Our results offer evidence that the significance of the exchange risk factor in pricing global assets is significantly reduced when we include emerging market assets in global portfolios. In addition, the exposure to currency risk as well as the relative contribution of the currency risk premium decreases when diversifying across developed and emerging markets. The reduction in the contribution of the currency premium is specifically important during periods of crisis. Hence, the inclusion of EM assets seems to not only reduce the volatility and boost the return of the overall portfolio but it also impacts its currency exposure and the relative contribution of the currency premium. This is consistent with previous evidence suggesting that emerging markets play a key role in achieving the benefits of international diversification of investment portfolios.

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Table 1- Summary statistics of asset returns

DS-EMU, DS-DM, and DS-World global sector returns are from DataStream, expressed in US dollar, and in percent per month. The returns are computed in continuous time and in excess of the one-month eurodollar interest rate. each DS-EMU, DS-DM, and DS-World global sector index may include stocks from all EMU, Developed, World countries or just from a subset of those, and the particular stocks may also vary as DataStream revises its indices annually.
The MJ and EM currency indices are in real terms, these are trade-weighted averages of the major trading partners for MJ and other important trading partners for the EM. 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. p-values are reported under each test statistic.
The regions constituents lists are detailed in Appendix A

DS-EMU	Oil and Gaz	Basic Materials	Industrials	Consumer Goods	Healthcare	Consumer Services	Telecom	Utilities	Financials	Technology
Mean	0.84	0.52	0.44	0.29	0.58	0.37	0.37	0.63	0.52	0.73
Std. Dev.	5.52	5.18	5.56	6.11	4.57	5.28	6.58	4.71	5.37	9.53
Min.	-24.43	-19.61	-21.55	-26.94	-19.88	-25.52	-25.27	-17.26	-24.59	-33.94
Max.	16.60	15.44	15.87	19.89	12.56	19.56	22.38	18.03	17.24	38.12
B-J	72.32	74.77	84.31	77.28	44.46	119.11	37.61	15.14	126.44	32.70
p-value	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.004*	*0.001*	*0.001*
Q	12.87	5.57	15.94	21.02	4.27	21.81	26.94	22.12	11.83	11.42
p-value	*0.379*	*0.936*	*0.194*	*0.050*	*0.978*	*0.040*	*0.008*	*0.036*	*0.460*	*0.494*

	World market	MJ curreny index	EM currency index
Mean	0.40	0.04	-0.04
Std. Dev.	4.03	1.72	1.08
Min.	-19.23	-5.15	-5.24
Max.	10.58	5.52	4.05
B-J	91.26	5.84	550.70
p-value	*0.001*	*0.050*	*0.001*
Q	12.56	55.25	55.50
p-value	*0.402*	*0.000*	*0.000*

Unconditional correlation between the different sectors

Oil and Gaz	1.000	0.612	0.573	0.506	0.620	0.524	0.344	0.514	0.551	0.401
Basic Materials		1.000	0.868	0.810	0.775	0.824	0.610	0.683	0.820	0.574
Industrials			1.000	0.792	0.738	0.864	0.706	0.668	0.841	0.659
Consumer Goods				1.000	0.680	0.756	0.613	0.582	0.770	0.568
Healthcare					1.000	0.736	0.495	0.671	0.766	0.513
Consumer Services						1.000	0.729	0.669	0.789	0.648
Telecom.							1.000	0.556	0.665	0.586
Utilities								1.000	0.681	0.395
Financials									1.000	0.594
Technology										1.000

DS-DM

	Oil and Gaz	Basic Materials	Industrials	Consumer Goods	Healthcare	Consumer Services	Telecom.	Utilities	Financials	Technology
Mean	0.71	0.41	0.41	0.36	0.57	0.40	0.30	0.74	0.54	0.48
Std. Dev.	5.46	5.44	5.31	5.58	4.29	4.95	6.82	6.16	5.64	7.78
Max.	-24.01	-18.96	-20.36	-20.88	-18.15	-16.02	-20.11	-20.92	-17.84	-27.56
Min.	15.35	19.07	18.40	17.48	16.09	16.93	36.74	39.94	22.79	24.86
B-J	39.90	6.39	55.44	28.62	40.34	12.02	234.50	525.22	21.55	15.13
p-value	*0.001*	*0.040*	*0.001*	*0.001*	*0.001*	*0.008*	*0.001*	*0.001*	*0.001*	*0.004*
Q	10.59	10.23	3.92	10.59	13.50	16.75	21.88	24.53	18.88	12.07
p-value	*0.564*	*0.596*	*0.985*	*0.564*	*0.333*	*0.159*	*0.039*	*0.017*	*0.091*	*0.440*
Unconditional correlation between the different sectors										
Oil and Gaz	1.000	0.626	0.621	0.542	0.603	0.607	0.400	0.328	0.568	0.407
Basic Materials		1.000	0.857	0.745	0.796	0.891	0.590	0.648	0.824	0.595
Industrials			1.000	0.876	0.724	0.867	0.598	0.490	0.750	0.829
Consumer Goods				1.000	0.652	0.760	0.503	0.436	0.652	0.770
Healthcare					1.000	0.808	0.555	0.589	0.754	0.468
Consumer Services						1.000	0.663	0.677	0.838	0.676
Telecom.							1.000	0.426	0.604	0.553
Utilities								1.000	0.683	0.295
Financials									1.000	0.552
Technology										1.000

DS-EAFE

	Oil and Gaz	Basic Materials	Industrials	Consumer Goods	Healthcare	Consumer Services	Telecom.	Utilities	Financials	Technology
Mean	0.79	0.43	0.44	0.37	0.57	0.39	0.32	0.74	0.54	0.57
Std. Dev.	5.52	5.37	5.37	5.53	4.31	5.01	6.88	6.11	5.68	8.00
Max.	-19.57	-18.60	-19.94	-20.62	-17.06	-16.25	-20.57	-19.93	-18.23	-25.72
Min.	15.32	18.96	18.40	17.59	16.35	17.59	36.74	39.99	22.72	23.35
B-J	11.72	6.76	53.24	30.22	32.34	11.23	219.91	547.12	22.50	8.75
p-value	*0.009*	*0.035*	*0.001*	*0.001*	*0.001*	*0.010*	*0.001*	*0.001*	*0.001*	*0.019*
Q	11.39	11.32	3.80	10.68	13.88	17.99	21.77	25.72	18.80	9.23
p-value	*0.496*	*0.502*	*0.987*	*0.556*	*0.308*	*0.116*	*0.040*	*0.012*	*0.094*	*0.683*

Unconditional correlation between the different sectors

Oil and Gaz	1.000	0.610	0.600	0.532	0.598	0.601	0.407	0.341	0.560	0.361
Basic Materials		1.000	0.853	0.744	0.793	0.892	0.591	0.646	0.821	0.596
Industrials			1.000	0.876	0.710	0.854	0.599	0.480	0.745	0.832
Consumer Goods				1.000	0.647	0.755	0.507	0.432	0.650	0.789
Healthcare					1.000	0.808	0.557	0.585	0.745	0.463
Consumer Services						1.000	0.663	0.683	0.836	0.658
Telecom.							1.000	0.425	0.606	0.536
Utilities								1.000	0.678	0.302
Financials									1.000	0.547
Technology										1.000

DS-WRD

	Oil and Gaz	Basic Materials	Industrials	Consumer Goods	Healthcare	Consumer Services	Telecom.	Utilities	Financials	Technology
Mean	0.63	0.36	0.46	0.31	0.55	0.36	0.36	0.54	0.58	0.40
Std. Dev.	5.01	4.84	4.68	4.77	3.65	4.32	5.08	3.87	4.88	6.63
Max.	-24.02	-18.54	-24.12	-21.35	-19.33	-19.02	-16.96	-11.84	-21.23	-31.54
Min.	14.29	13.60	12.65	12.27	11.81	11.22	26.32	21.92	20.36	19.46
B-J	79.32	24.16	163.56	103.67	126.14	54.34	114.85	104.08	67.46	115.83
p-value	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
Q	8.74	5.35	3.21	9.50	14.49	13.91	24.08	21.71	18.43	11.64
p-value	*0.725*	*0.945*	*0.994*	*0.660*	*0.271*	*0.306*	*0.020*	*0.041*	*0.103*	*0.475*
Unconditional correlation between the different sectors										
Oil and Gaz	1.000	0.652	0.626	0.554	0.496	0.548	0.348	0.416	0.544	0.425
Basic Materials		1.000	0.871	0.807	0.677	0.847	0.523	0.596	0.817	0.574
Industrials			1.000	0.887	0.678	0.886	0.579	0.492	0.765	0.787
Consumer Goods				1.000	0.620	0.829	0.523	0.473	0.719	0.679
Healthcare					1.000	0.761	0.486	0.561	0.703	0.468
Consumer Services						1.000	0.648	0.573	0.810	0.726
Telecom.							1.000	0.410	0.559	0.602
Utilities								1.000	0.702	0.269
Financials									1.000	0.538
Technology										1.000

G7

	Gaz	Materials	Industrials	Goods	Healthcare	Services	Telecom.	Utilities	Financials	Technology
Mean	0.58	0.31	0.42	0.28	0.53	0.33	0.23	0.49	0.55	0.36
Std. Dev.	5.10	4.99	4.65	4.84	3.77	4.38	5.14	4.06	5.07	6.68
Max.	-22.16	-16.50	-22.59	-20.98	-18.57	-17.33	-17.59	-13.26	-21.00	-32.09
Min.	14.52	15.59	13.80	12.52	12.13	11.88	26.92	22.47	21.54	19.02
B-J	35.89	12.42	110.47	93.70	79.85	30.00	147.89	96.98	51.87	125.84
p-value	*0.001*	*0.007*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
Q	12.44	5.20	3.74	9.55	15.10	14.20	27.99	17.21	20.51	11.91
p-value	*0.411*	*0.951*	*0.988*	*0.655*	*0.236*	*0.288*	*0.006*	*0.142*	*0.058*	*0.453*

Unconditional correlation between the different sectors

Oil and Gaz	1.000	0.585	0.564	0.498	0.452	0.493	0.309	0.376	0.480	0.384
Basic Materials		1.000	0.859	0.797	0.647	0.836	0.488	0.573	0.798	0.548
Industrials			1.000	0.883	0.654	0.871	0.554	0.453	0.732	0.768
Consumer Goods				1.000	0.590	0.817	0.499	0.430	0.692	0.666
Healthcare					1.000	0.738	0.452	0.517	0.678	0.451
Consumer Services						1.000	0.619	0.526	0.789	0.708
Telecom.							1.000	0.375	0.538	0.578
Utilities								1.000	0.676	0.208
Financials									1.000	0.498
Technology										1.000

G7-EM

	Oil and Gaz	Basic Materials	Industrials	Consumer Goods	Healthcare	Consumer Services	Telecom.	Utilities	Financials	Technology
Mean	0.58	0.32	0.43	0.29	0.53	0.33	0.26	0.48	0.54	0.36
Std. Dev.	5.09	4.93	4.66	4.81	3.76	4.36	5.06	4.01	5.01	6.65
Max.	-22.09	-16.27	-22.34	-20.64	-18.55	-17.44	-16.97	-12.99	-21.08	-31.43
Min.	14.48	15.34	13.77	12.46	12.17	11.76	26.91	22.47	21.52	19.01
B-J	36.90	14.39	107.94	94.00	80.60	32.33	136.70	105.14	60.00	119.81
p-value	*0.001*	*0.005*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
Q	12.45	5.41	3.34	9.57	14.97	14.02	25.95	19.24	19.59	11.34
p-value	*0.410*	*0.943*	*0.993*	*0.654*	*0.243*	*0.300*	*0.011*	*0.083*	*0.075*	*0.500*
Unconditional correlation between the different sectors										
Oil and Gaz	1.000	0.591	0.565	0.502	0.455	0.499	0.325	0.383	0.485	0.391
Basic Materials		1.000	0.863	0.802	0.646	0.839	0.506	0.579	0.803	0.563
Industrials			1.000	0.884	0.652	0.873	0.565	0.460	0.735	0.779
Consumer Goods				1.000	0.592	0.819	0.511	0.442	0.698	0.673
Healthcare					1.000	0.740	0.463	0.528	0.676	0.453
Consumer Services						1.000	0.629	0.541	0.791	0.711
Telecom.							1.000	0.394	0.546	0.584
Utilities								1.000	0.681	0.231
Financials									1.000	0.507
Technology										1.000

Table 2: Summary statistics of the information variables

The information set includes the world dividend yield in excess of the one-month eurodollar rate (XWDY), the US term premium (USTP), the US default premium (USDP), the change in the one-month eurodollar deposit rate (ΔEuro$). The world dividend yield is the dollar denominated dividend yield on the MSCI world index. The US term premium is the yield difference between the 10 year T-bond and the three-month T-bill. The US default premium is the yield difference between Moody's Baa and Aaa rated bonds. All variables are in percent per month and are used with one month lag with respect to the returns series.

	Mean	Std. Dev.	Pairwise Correlations			
XWDY	-0.34	0.26	1	0.577	-0.471	-0.097
USTP	1.72	1.30		1	0.075	-0.040
USDP	1.07	0.43			1	-0.101
ΔEuro$	0.00	0.07				1

Table 3. Specification tests

The estimated model is:

$$r_{i,t} = \delta_{W,t-1}\, cov\,(r_{it}, r_{Wt}) + \delta_{mj,t-1}\, cov\,(r_{it}, e^r_{mj,t}) + \delta_{em,t-1}\, cov\,(r_{it}, e^r_{em,t}) + \varepsilon_{it}, \quad i=1,...10$$

$$r_{W,t} = \delta_{W,t-1}\, var\,(r_{W,t}) + \delta_{mj,t-1}\, cov\,(r_{W,t}, e^r_{mj,t}) + \delta_{em,t-1}\, cov\,(r_{W,t}, e^r_{em,t}) + \varepsilon_{W,t}$$

$$e^r_{j,t} = \delta_{W,t-1}\, cov\,(e^r_{j,t}, r_{Wt}) + \delta_{mj,t-1}\, cov\,(e^r_{j,t}, e^r_{mj,t}) + \delta_{em,t-1}\, cov\,(e^r_{j,t}, e^r_{em,t}) + \varepsilon_{j,t} \qquad j = mj,\ em$$

where r_{it} is the excess return on the global sector, $r_{W,t}$ is the world index excess return, δ_W is the price of world covariance risk, δ_{mj}, δ_{em} are respectively the prices of MJ and EM real currency risks, and $\varepsilon_t | \vartheta_{t-1} \sim N\,(0, H_t)$. Price of risk specifications are given by:

$$\delta_{W,t-1} = exp\,(\kappa_W' \mathbf{Z}_{G,t-1})$$

$$\delta_{j,t-1} = \kappa_j' \mathbf{Z}_{G,t-1} \qquad j = mj,\ em$$

where $\mathbf{Z}_G$ is a set of global information variables which includes a constant, the U.S. default spread, the U.S. term structure spread, the world dividend yield in excess of the risk free rate, and the change in the eurodollar rate.

H_t is the time-varying conditional covariance parameterized as:

$$H_t = H_0 * (\iota\iota' - \boldsymbol{aa}' - \boldsymbol{bb}') + \boldsymbol{aa}' * \Sigma_{t-1} + \boldsymbol{bb}' * H_{t-1},$$

where * denotes the Hadamard product, **a** and **b** are (13 x 1) vector of constants, ι is (13 x 1) unit vector, and Σ_{t-1} is the matrix of cross error terms, $\varepsilon_{t-1}\varepsilon'_{t-1}$.
DS-EMU, DS-DM, and DS-World global sector returns are from DataStream, and the world equity index is from MSCI. The risk free rate is the one-month Eurodollar rate from DataStream. All returns are denominated in USD. The model is estimated by Quasi-Maximum Likelihood. P-values for robust Wald test for the hypothesis are reported for each region. The regions constituents lists are detailed in Appendix A

Panel A: using datastream regions

		ds-EMU	ds-DM	ds-WRD
Null Hypothesis	df	*p* -value	*p* -value	*p* -value
for time-varying market risk				
$k_{W,j} = 0$, for j>1	4	0.0020	0.0000	0.0000
for significant MJ real currency risk				
$k_{mj,j} = 0$, for j>0	5	0.0351	0.0284	0.2082
for time-varying MJ real currency risk				
$k_{mj,j} = 0$, for j>1	4	0.0175	0.0139	0.1272
for significant EM real currency risk				
$k_{em,j} = 0$, for j>0	5	0.0002	0.9859	0.7417
for time-varying EM real currency risk				
$k_{em,j} = 0$, for j>1	4	0.2179	0.9683	0.9157
for significant global real currency risk				
$k_{mj,j} = 0$ and $k_{em,j} = 0$ for j>0	8	0.0132	0.1123	0.3753

Panel B: using G7 and G7EM sector indices

		G7	G7EM
Null Hypothesis	df	*p* -value	*p* -value
for time-varying market risk			
$\kappa_{W,j} = 0$, for j>1	3	0	0
for significant MJ real currency risk			
$\kappa_{mj,j} = 0$, for j>0	4	0.0925	0.1517
for time-varying MJ real currency risk			
$\kappa_{mj,j} = 0$, for j>1	3	0.0777	0.1262
for significant EM real currency risk			
$\kappa_{em,j} = 0$, for j>0	4	0.0057	0.7126
for time-varying EM real currency risk			
$\kappa_{em,j} = 0$, for j>1	3	0.0371	0.8951
for significant global real currency risk			
$\kappa_{mj,j} = 0$ and $\kappa_{em,j} = 0$ for j>0	6	0.011	0.3758

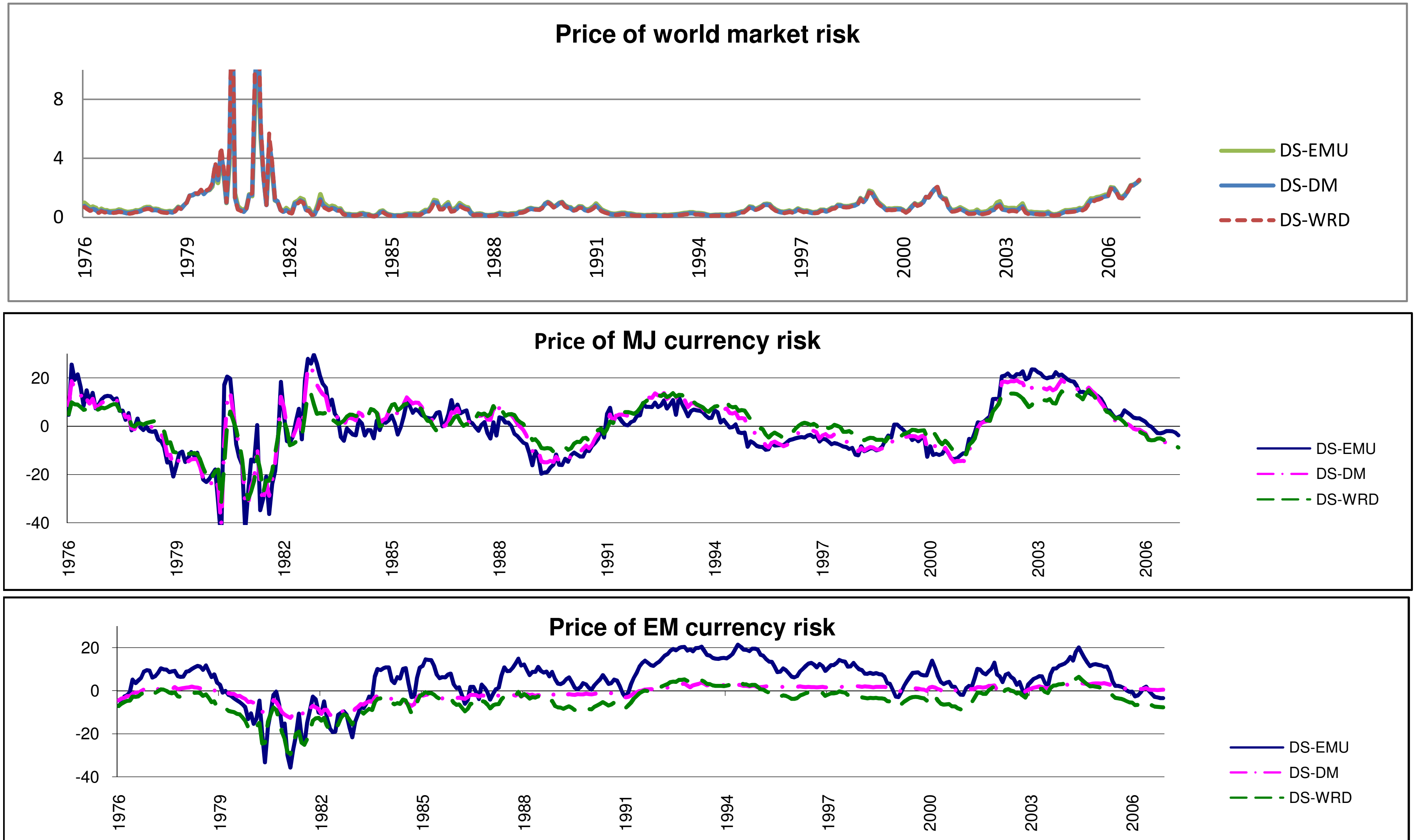


Fig.1 Prices of risk.
The figure plots the prices of wrold market risk, MJ currency risk and EM currency risk obatained from the three estimations; 1) DS-EMU set of global sectors, 2) DS-DM set of global sectors, and 3) DS-WRD set of global sectors. The system of equations is presented in Table

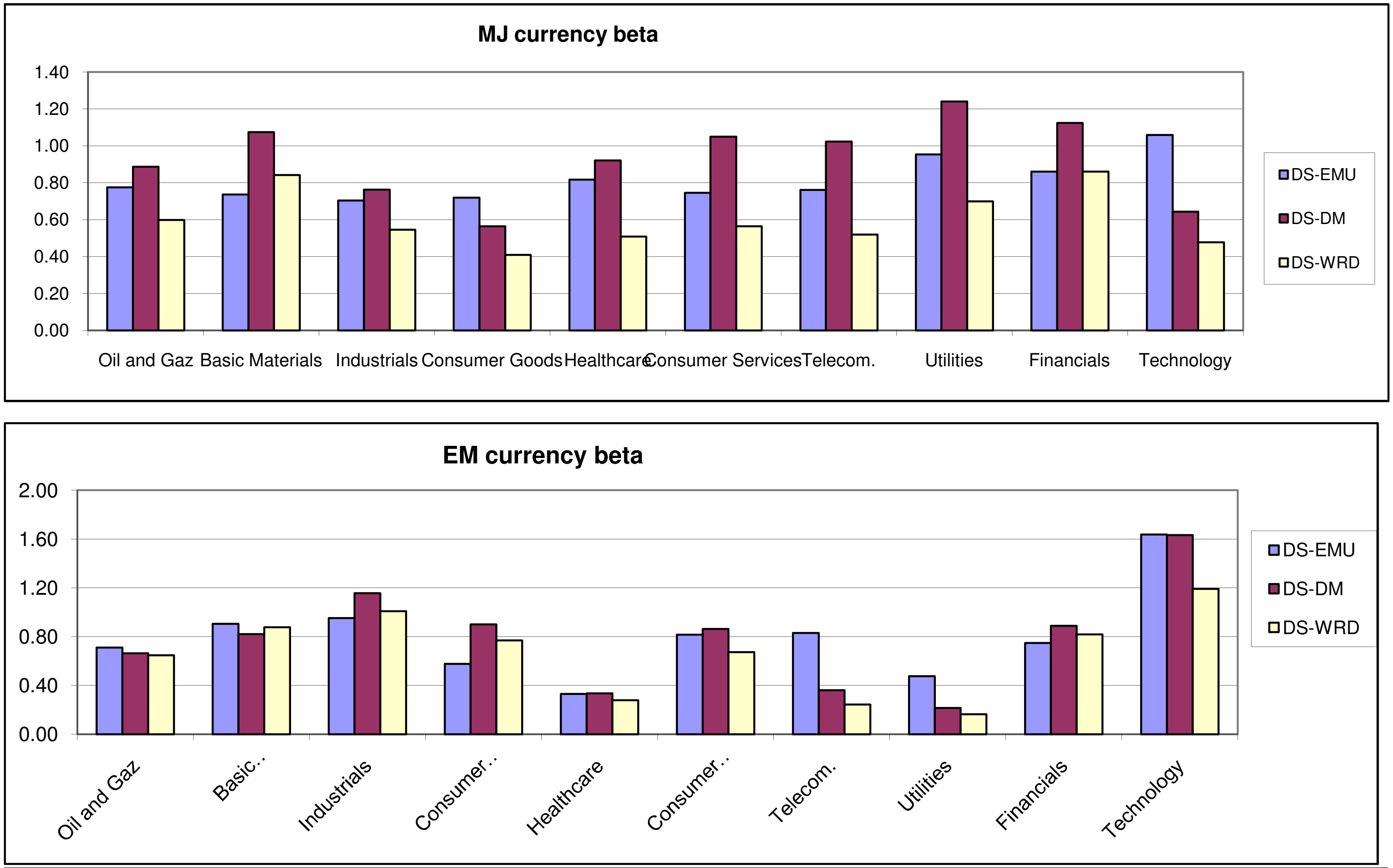
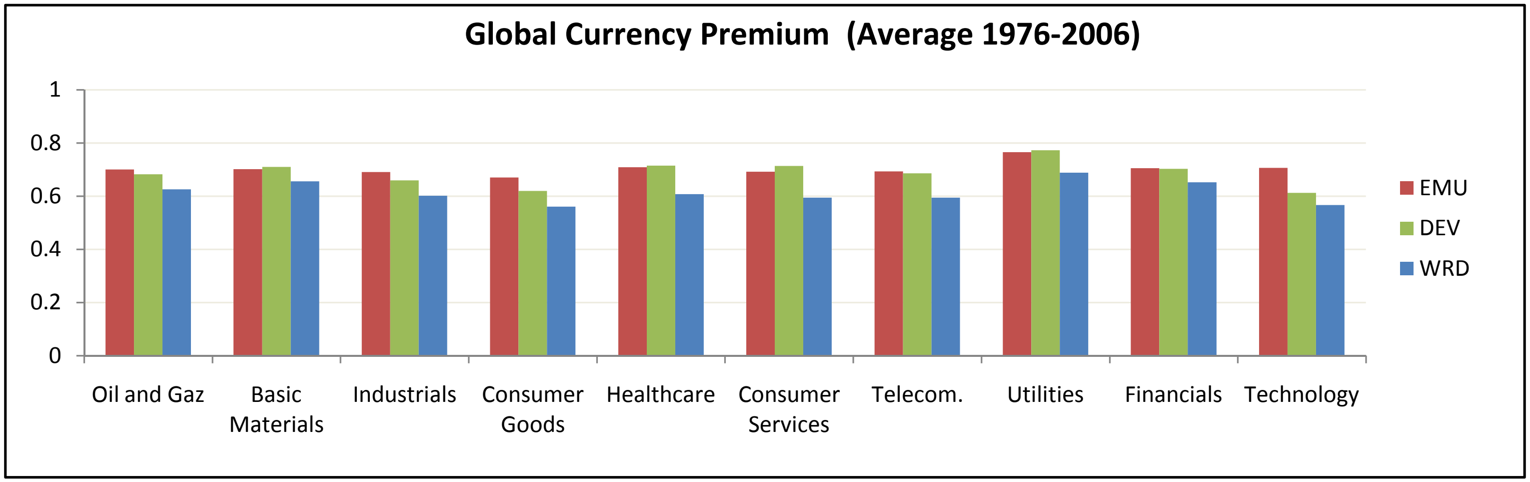
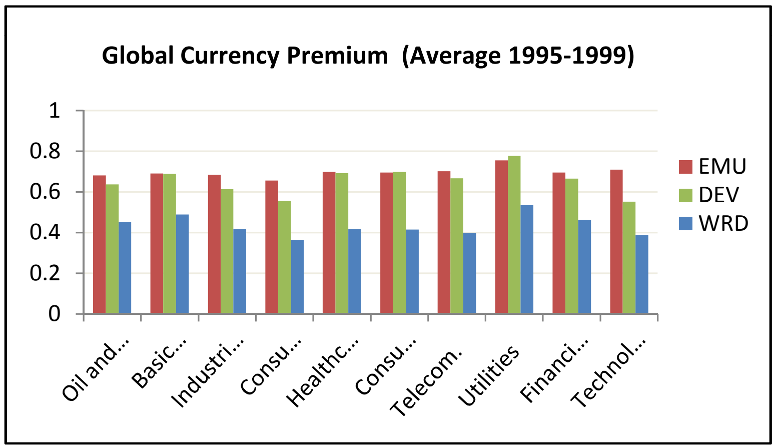


Fig.2 Estimated currency risk exposures. For each global sector index return, we plot the average MJ and EM currency risk betas. The average is computed over the period 1976-2006. The MJ (EM) currency betas are computed as the ratios of the covariance between each DS-EMU/DS-DM/DS-WRD global sector return with the change in the MJ (EM) real currency index and the variance of the changes in the MJ (EM) real currency index.





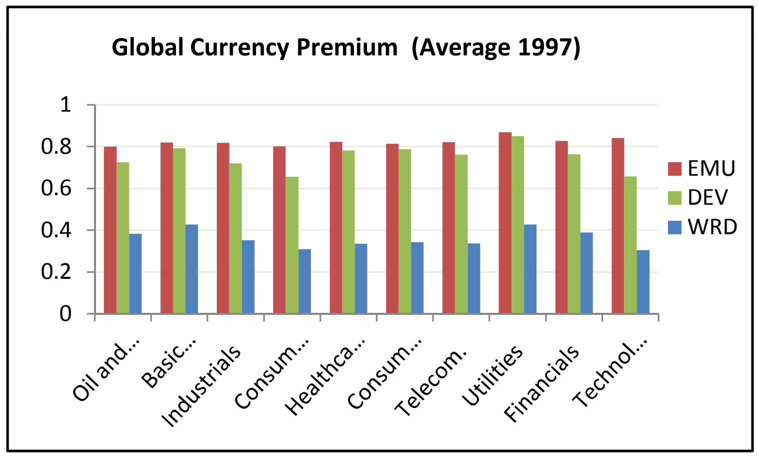


Fig.3 Estimated Risk premiums. For each global sector index return, we plot the percentage contribution in absolute terms of the global currency premium that includes the MJ and EM currency premiums. The global currency premium is the sum of the MJ currency risk premium and the EM currency risk premium.

Appendix A

ds-EMU group		ds-DM group		ds-EAFE		Ds-World	
	Europe (EMU only)	Developed Markets (22 countries)		Europe & Far East (31 countries)		World (52 countries including EMs)	
S43224	GERMANY-DS Market	S53424	AUSTRALIA-DS Market	S43224	GERMANY-DS Market	S51324	ARGENTINA-DS Market
S51924	BELGIUM-DS Market	S43224	GERMANY-DS Market	S51924	BELGIUM-DS Market	S53424	AUSTRALIA-DS Market
L12424	CYPRUS-DS Market	S51924	BELGIUM-DS Market	L13224	BULGARIA-DS Market	S43224	GERMANY-DS Market
S50824	SPAIN-DS Market	S50024	DENMARK-DS Market	L09624	CHINA-DS Market	S51924	BELGIUM-DS Market
S50224	FINLAND-DS Market	S50824	SPAIN-DS Market	L12424	CYPRUS-DS Market	L13224	BULGARIA-DS Market
S42824	FRANCE-DS Market	S50224	FINLAND-DS Market	L08224	CZECH REP.-DS Market	S59224	BRAZIL-DS Market
S53224	GREECE-DS Market	S42824	FRANCE-DS Market	S50024	DENMARK-DS Market	S58224	COLOMBIA-DS Market
S52924	IRELAND-DS Market	S53224	GREECE-DS Market	S50824	SPAIN-DS Market	L09624	CHINA-DS Market
S47824	ITALY-DS Market	S41224	HONG KONG-DS Market	S50224	FINLAND-DS Market	S58024	CHILE-DS Market
S41024	LUXEMBURG-DS Market	S52924	IRELAND-DS Market	S42824	FRANCE-DS Market	S52324	CANADA-DS Market
S42424	NETHERLAND-DS Market	S47824	ITALY-DS Market	S53224	GREECE-DS Market	L12424	CYPRUS-DS Market
S51724	AUSTRIA-DS Market	S42024	JAPAN-DS Market	S41224	HONG KONG-DS Market	L11424	SRI LANKA-DS Market
S55024	PORTUGAL-DS Market	S41024	LUXEMBURG-DS Market	L08424	HUNGARY-DS Market	L08224	CZECH REP.-DS Market
L13424	SLOVENIA-DS Market	S42424	NETHERLAND-DS Market	S52924	IRELAND-DS Market	S50024	DENMARK-DS Market
		S52124	NORWAY-DS Market	S47824	ITALY-DS Market	S50824	SPAIN-DS Market
		S54024	NEW ZEALAN-DS Market	S42024	JAPAN-DS Market	S50224	FINLAND-DS Market
		S51724	AUSTRIA-DS Market	S51124	KOREA-DS Market	S42824	FRANCE-DS Market
		S55024	PORTUGAL-DS Market	S41024	LUXEMBURG-DS Market	S53224	GREECE-DS Market
		S52724	SWEDEN-DS Market	S42424	NETHERLAND-DS Market	S41224	HONG KONG-DS Market
		S54424	SINGAPORE-DS Market	S52124	NORWAY-DS Market	L08424	HUNGARY-DS Market
		S91824	SWITZ-DS Market	S51724	AUSTRIA-DS Market	S53624	INDONESIA-DS Market
		S19824	UK-DS Market	S59624	POLAND-DS Market	S41424	INDIA-DS Market
				S55024	PORTUGAL-DS Market	S52924	IRELAND-DS Market
				L11224	ROMANIA-DS Market	L09024	ISRAEL-DS Market
				L08624	RUSSIA-DS Market	S47824	ITALY-DS Market
				S52724	SWEDEN-DS Market	S42024	JAPAN-DS Market
				L13424	SLOVENIA-DS Market	S51124	KOREA-DS Market
				S91824	SWITZ-DS Market	S41024	LUXEMBURG-DS Market
				S54624	TAIWAN-DS Market	S50624	MEXICO-DS Market
				S55224	TURKEY-DS Market	S53824	MALAYSIA-DS Market
				S19824	UK-DS Market	S42424	NETHERLAND-DS Market

	Ds-World (continue)	
	World (52 countries including EMs)	
	S52124	NORWAY-DS Market
	S54024	NEW ZEALAN-DS Market
	S51724	AUSTRIA-DS Market
	S58624	PERU-DS Market
	S54224	PHILIPPINE-DS Market
	L11024	PAKISTAN-DS Market
	S59624	POLAND-DS Market
	S55024	PORTUGAL-DS Market
	L11224	ROMANIA-DS Market
	L08624	RUSSIA-DS Market
	S51524	SOUTH AFRI-DS Market
	S52724	SWEDEN-DS Market
	S54424	SINGAPORE-DS Market
	L13424	SLOVENIA-DS Market
	S91824	SWITZ-DS Market
	S54624	TAIWAN-DS Market
	S54824	THAILAND-DS Market
	S55224	TURKEY-DS Market
	S19824	UK-DS Market
	S41624	US-DS Market
	L12624	VENEZUELA-DS Market