Sectoral Integration, Comovement and Contagion

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Abstract

The recent Global Financial Crisis has rekindled research interests in diversification benefits and contagion in industry portfolios. Our paper studies time-varying comovements and contagion between thirty nine industry sectors from five regions: Europe, North America, Asia-Pacific, Latin America and Japan. We employ both world-local three-factor and four-factor asset pricing models with time-varying betas, and measure time-varying contagion as correlations between portfolio's idiosyncratic shocks. Our results show exposure on size and value risk factors are affected more than exposures on market and momentum factors. We capture more intra-industry contagion effects than intra-region contagion effects. We suggest that investors take extra caution when diversifying across region within an industry, as even some sectors that are not correlated in normal time do exhibit contagion signals in crisis periods.

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1. Introduction

There is an abundant amount of literature debating the role of an industry factor in asset pricing and diversification. Traditionally, researchers argue that industry effect is insignificant compared to any country effect in determining stock returns and a country's unique economic environment is the reason why markets do not move closely together, resulting in low correlations and subsequently risk reduction benefits for international diversification. Evidence of the importance of country effects in determining stock returns are documented by Lessard (1974, 1976), Heston and Rouwenhorst (1994), Griffin and Karolyi (1998), and Serra (2000). Consequently it is more efficient to diversify across countries rather than across industries. However, Roll (1992) challenges the traditional wisdom and argues that the low correlation between markets is due to the difference in industry composition of each country. Since a country is a mixture of different sectors, the country effect is essentially a combination of different industry effects. When correlations between industries are imperfect, portfolios with different industry compositions also have different movements, and subsequently low correlations with each other. For instance, if two markets concentrate in two different sectors, holding the two country portfolios is equivalent to holding portfolios of these two sectors. If the two sectors have an imperfect correlation, the two countries will also have low correlation. In short, an industry factor is the main reason that markets move differently from each other, implying that investors should diversify across industries.

Against the background of globalisation and contagious financial crises, a new wave of research supports the argument of Roll (1992), documenting the increasing importance of industry effects (notably Baca, Garbe and Weiss, 2000; Cavaglia, Brightman and Aked, 2000; Carrieri, Errunza and Sakissian, 2004; Ferreira and Gama, 2005; Campa and Fernandes, 2006; Carrieri, Errunza and Sakissian, 2012). The findings of these studies suggest that investors should seek to diversify both across countries as well as across industries to reap the maximum benefits. Furthermore, industry integration is documented even if the sector resides in a partially segmented country (Carrieri, Errunza and Sakissian, 2004), implying that sectors can act as shock propagation channels across borders. The global financial crisis is an example of how integrated sectors act as a shock transmission channel. This crisis originated in the US and spread to other countries via the integrated financial sector. Research that examines industry contagion have documented global contagion effects among industries during this period in different sectors (see Baur, 2012; Milunovich and Truck, 2013; Milunovich and Tan, 2012; and Dungey and Gajurel, 2014), while only detecting regional effects during the Mexican and the Asian crises (Phylaktis and Xia, 2009). The empirical findings suggest an increase in industry integration, which subsequently leads to higher shock transmission, and a more important role for industry effects in determining stock returns. Hence it is crucial that investors understand the nature of both industry integration and contagion.

We re-examine in depth the time-varying pattern of integration and contagion at the sectoral level for 39 industries across 31 countries over 5 regions (Asia-Pacific, Latin America, Europe, North America and Japan)to compare and contrast the effect of different crises over the period July 1981 to December 2011. Our study contributes to the literature that focuses on integration, contagion and diversification at the sectoral level. We extend the current literature in several ways. First, we employ both the world-regional three-Fama-French-factor and the world-regional four-Fama-French-factor models to study the integration and contagion of industry sectors. The six-factor model is documented by Bekaert, Hodrick and Zhang (2009) to capture very well the covariance between asset returns. We extend this model to examine whether introducing momentum factors improves model performance.

Additionally, utilising the long availability of our data, we are able to compare and contrast the difference in contagion effects of five different periods of financial turbulence. The episodes we examine in this study are the Mexican crisis, the Asian crisis, the Argentine Debt crisis, the Global Financial crisis and the European Debt crisis. Since each of these crises originate in different sectors and markets, it is interesting to compare their global and regional effects. Moreover we study the time-varying behaviour of both global and regional integration patterns of each industry sector during each financial crisis throughout our sample period. This sheds light on the question whether industries become more integrated over time. We also document the behaviour of the model betas separately for each risk factor. Finally we investigate cross-region contagion for all the industries in the world across the various crisis periods. Here, we extend the work of Baur (2012) who studies cross-region contagion only during the global financial crisis. In addition to integration, contagion effects are examined from two perspectives: intra-region and intra-industry. The intra-region test examines the contagion effects among industries within a specific region while the intra-industry test investigates the presence of contagion signals in the same sector that resides in different regions..

We adopt the approach of Bekaert, Hodrick and Zhang (2009) and employ the world-regional three and four-Fama-French-factor models to capture movements in asset returns. The model is re-estimated every six months to account for time varying betas. There are several appealing aspects of this model. Importantly, the beta coefficients are not restricted to either zero or unit as in the model of Heston and Rouwenhorst (1994). In addition, it is an extension of a standard benchmark asset pricing model, which has been well-tested empirically. Finally the model allows for decomposition of empirical covariance of asset returns into covariance between risk factors, which represents the fundamental comovements between assets, and covariance between idiosyncratic shocks, which captures the excess comovements beyond expectation.

The findings of our study indicate that most industry portfolios are more exposed to their regional rather than global risk factors. The pattern is particularly clear in the case of Japan, echoing the findings of Harvey (1991) that the Japanese stock market is more influenced by its own variance. Our findings on integration are also similar to Carrieri, Errunza and Sakissian (2004) in the sense that North American industries are more exposed to regional risk factors, while European industries are more exposed to global risk factors. In addition to the level of betas, we also investigate possible time trends and crisis structural breaks in time-varying integration. We find that none of the betas exhibit any time trend, which rejects the hypothesis that industries are becoming more integrated over time. On the other hand, we detect structural breaks in integration patterns especially during the global financial crisis and most of these crisis effects occur in SMB and HML betas rather than in MKT beta. Moreover, industries also exhibit decoupling with regional markets while increasing comovement with the global market during this period.

Preliminary analysis of residual correlation matrices between industries shows small but significant industry effects, consistent with most of the studies in literature. We take extra precaution to ensure the significantly positive correlations between industry residuals are not due to the sectors being concentrated in one specific country.[1] Our inter-industry contagion test results capture few contagion signals, most have small magnitudes except for Latin America region during the Mexican crisis. On the other hand, our intra-industry contagion test shows that certain groups of industries, for instance, the group of energy and industrial sectors such as oil & gas, alternative energy, chemicals, mining, construction materials, forestry & paper and industrial metals & mining, are more interdependent across regions than others. We hypothesise that many of these sectors comove with world business cycles. The test also identifies more contagion effects, implying that diversifying within one industry across regions is not very beneficial during the time of crises.

One interesting observation is that some of the sectors that are not normally globally connected tend to exhibit contagion effects during crises, e.g. the construction material, aerospace and defence and beverage sectors. Since such sectors do not normally have excess comovement with the same sector in another region, holding stocks from this sector in different regions could provide risk reduction benefits. However, during the global financial crisis, these sectors from different regions exhibit an increase in excess comovement, which reduces the diversification gain. We hypothesise that shocks are first transmitted via sectors that are highly connected across regions, for instance, the banking sector. These shocks are then spread to the relatively more domestic sectors, which normally are independent across regions. Investors therefore should take into account the potential contagion effects across industries and be cautious about holding stocks of one single sector across regions.

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[1] Sometimes an industry portfolio is dominated by firms from a particular country. For instance, nearly 69% of firms in the electronic & electric equipment and 59% of firms in the chemical sectors in Asia are in South Korea, and these two sectors exhibit significantly positive correlation at 5% level. This positive correlation could be due to the common country effect of South Korea. Therefore we conduct a simple test to determine if the significant correlation reflects the natural connectedness between industries or the common country effect. In order to do so, we regress the residual of industry i on the residual of industry j and on the product of residual of industry j and an indicator. The indicator is 1 if industry i and j shares a common dominant country.

The remainder of the study is structured as follows. Section 2 provides a detailed literature review on industry effects and industry integration. Section 3 presents the methodological approach adopted and the construction of the weekly Fama French risk factors for both developed and developing/hybrid regions. In-depth discussion of data and its construction are reported in section 4 while section 5 presents the main empirical results. Finally, section 6 concludes.

2. Literature Review

2.1. The role of industry effect in determining stock return

International finance theory predicts that diversifying across countries provide risk reduction benefits, which come from the low correlation between stock indices (Grubel, 1968; Levy and Sarnat, 1970). Traditionally, researchers believe that the low comovement between stock markets is due to the difference in the national economic environment of each country, such as growth rates and policies (Lessard, 1974, 1976). However, Roll (1992) suggests that the reason markets do not comove closely together is the difference in their industry compositions. Since each country has their own mixture of industry and each sector has its unique nature, each country return is then affected by a different mixture of industry factors, leading to low comovement. For instance if the Swiss market index is dominated by its banking sector, and the Dutch market index is dominated by its energy sector, then investing in a Swiss market index is essentially investing in banking, while holding a Dutch market index portfolio is equivalent to holding energy stocks. Since the banking and energy sectors have imperfect correlations, the correlation between the two indices should also be low. Therefore part of the gain of international diversification is from sectoral diversification.

According to Roll (1992)'s argument, a country's return is largely determined by its mixture of industry effects rather than its unique economic environment, or country effects. This argument has implications for both diversification and asset pricing. In terms of diversification, if stock returns are determined mainly by industry effects, diversification across industries will be more efficient than diversification across countries. On the other hand, if country effects dominate industry effects in explaining stock returns, cross-country diversification will be more beneficial. In term of asset pricing, it is important to determine whether an industry factor should be priced. As a result, Roll (1992)'s argument has sparked a long debate about the role of industry effect in determining stock returns, and the empirical studies provide mixed results regarding the importance of industry factors.

On one side, we have studies supporting the traditional view that an industry effect, albeit present, is insignificant compared to a country effect in determining stock return. Lessard (1974) employs principal component analysis on returns on country and industry indices to capture country and industry effects. He finds that the impact of an industry factor on stock returns is significantly smaller than that of a country factor. The finding is echoed by Lessard (1976), where he uses different measures of country and industry factors. Specifically, he finds evidence of significant country and industry factors but that the country factor explains a higher proportion of the variance in stock returns than the industry factor whether the factors are computes by value weighted or equally weighted portfolios.

The approach of Lessard (1974, 1976) is criticised by Heston and Rouwenhorst (1994) however, as the use of country and industry indices as factors does not properly disentangle country and industry effects. Since, if countries have a different industrial mix, the industry index will contain a country effect while the country index will contain an industry effect. Adopting Roll (1992)'s approach, Heston and Rouwenhorst (1994) separate country and industry effects using dummies, and address the role of the industry factor on both diversification and asset pricing. Due to its intuitiveness and simplicity, the Heston and Rouwenhorst (1994) model is widely used in the country-industry debate literature. The model has the following specification:

$$R_i = \alpha + \sum_{j=1}^{n_{ind}} \beta_j I_{ij} + \sum_{k=1}^{n_{country}} \gamma_k C_{ik} + e_i \qquad (1)$$

where stock return R_i is regressed on a set of industry dummies I_{ij} ($I_{ij} = 1$ if stock i belong to industry j, $I_{ij} = 0$ otherwise) and a set of country dummies C_{ik} ($C_{ik} = 1$ if stock i belong to country k, $C_{ik} = 0$ otherwise). The pure industry effect is computed as $(\alpha + \beta_j)$ and the pure country effect is $(\alpha + \gamma_k)$. Studying European countries and sectors, Heston and Rouwenhorst (1994) find that country effects on industry index returns are larger than industry effects on country index returns. Hence, similar to Lessard (1974, 1976)'s findings, the presence of industry effects cannot be rejected, but since they are much smaller than country effects, diversification across countries is still more beneficial.

The findings of Heston and Rouwenhorst (1994) are robust in emerging markets. Using the same model, Serra (2000) documents that country effects explain an even larger proportion of the variance of country indices in emerging markets. Furthermore, industry effects in emerging markets explain a smaller proportion of industry indices' variances than in developed markets. The finding confirms the insignificant effect of industry factor, and implies that industry indices in emerging markets are controlled by country effects to a higher extent than in developed markets. Consequently, diversifying within the same industry across different geographical locations is equivalent to diversifying across countries. As a result, investors still obtain risk reduction benefits. Different from Heston and Rouwenhorst (1994), and Serra (2000), Griffin and Karolyi (1998) study a finer industry classification and uncover the heterogeneity in the effects of industry factors on industry returns. For sectors that do not produce traded goods, the variances of their indices are explained more by country effects than by industry effects. In contrast, sectors that produce internationally traded goods have their variance explained more by industry effects. The result implies that certain industries are able to provide better diversification gain than others.

2.2. Globalisation and the increasing role of industry effects

The globalisation process has challenged the traditional view of the dominance of country effects. With many markets adopting liberalisation policies and the creation of many regional agreements and associations such as the North American Free Trade Agreement (NAFTA) and the European Union, countries have become more connected to each other. Evidence of such increases in country correlations is documented by Longin and Solnik (1995), Beckers, Connor and Curds (1996), and Berben and Jansen (2005). In addition, negative events that originate in one market have been felt across the world, such as the global financial crisis. Moreover, with the removal of barriers to trade and capital flows, companies are able to extend their activities outside their home countries, and industries become more integrated as well as markets. Consequently industry shocks in different countries have higher correlationand industry effects become more important in explaining international stock returns (Campa and Fernandes, 2006). These issues suggest that the roles of country and industry effects on diversification are changing, with industry effects becoming more important, emphasising the importance of industry diversification.

A number of studies toward the end of the 20th century challenged the traditional wisdom regarding the dominance of country effects and documented the increasing importance of industry effects. Using Heston and Rouwenhorst (1994) approach, Baca, Garbe and Weiss (2000) and Cavaglia, Brightman and Aked (2000) both find the increasing effect of industry factors on stock returns. The empirical results of these studies document the decline in country effects and the rise in industry effects on stock returns. By the end of their sample, the difference between these two effects becomes statistically insignificant. Similar to Griffin and Karolyi (1998), Cavaglia, Brightman and Aked (2000) document higher industry effects with finer industry classifications. However, unlike Griffin and Karolyi (1998), they report strong results supporting industry diversification. By comparing the Sharpe ratios of three investing strategies: taking positions in industries only, taking position in countries only and taking position in both industries and countries, Cavaglia, Brightman and Aked (2000) find that the Sharpe ratio of industry-factor portfolios are greater than those of country-factor portfolios.

Since Baca, Garbe and Weiss (2000) and Cavaglia, Brightman and Aked (2000) use the same sample period up to the Dot com crisis, Brooks and Del Negro (2004) argue that their result of the dominance of industry effects is due to the IT bubble. By excluding the Technology, Media and Telecommunication (TMT) sector from the sample, Brooks and Del Negro (2004) document that the sharp rise in the industry effect is non-existent and therefore conclude that the rise in the importance of industry effect is only temporary. This study is challenged by Ferreira and Gama (2005) and Campa and Fernandes (2006), who also exclude the TMT sector from their samples but still find an increase in industry effects. Employing a volatility decomposition model, Ferreira and Gama (2005) report that the rise in industry volatility documented in previous studies is still present even when the TMT sector are not included. Since correlations between industries fall when industry volatility rises, the study supports diversification across industries at least during the period 1995-2000.

The findings of Campa and Fernandes (2006) are partly consistent the findings of both Brooks and Del Negro (2004) and Ferreira and Gama (2005) that the rise of industry factors toward the end of the year 1999 is due mainly to the temporal TMT bubble, and that the variance of industry shocks decrease after the Dot com bubble bursts. However they document that the size of industry shocks compared to country shocks has increased over time. Furthermore, they also find that financial integration increases industry effects and decreases country effects. This is consistent with the argument that when an industry becomes more globally integrated, it is subject more to global industry shocks and less to country idiosyncratic shocks. When a country becomes more integrated, its return is determined more by global factors and the effect of idiosyncratic country shocks reduces. The decreasing effect of country idiosyncratic shocks on both industry and country returns and the increasing exposure of industries to global shocks indicate that industry shocks become more important when a country becomes more integrated. Carrieri, Errunza and Sakissian (2012) also report that the average correlation between countries has increased compared to average correlation between industries, especially in the large OECD countries. They conclude that investors should also consider diversifying across industries, especially if they take positions in the few largest OECD countries.

Baele and Inghelbrecht (2009) and Bekaert, Hodrick and Zhang (2009) employ an asset pricing framework and report that the rise in industry effects is temporal. They argue that the results supporting the increase of industry effects are mainly due to short sample period, from early 1990s to the end of 2000. During this period, both studies find that correlation between industries falls below that of countries, and there is a significant trend in the difference between the two correlations. However, Baele and Inghelbrecht (2009) find that after 2003, the correlation between industries increases again and continues to exceed country correlations until the end of their sample. Similarly, Bekaert, Hodrick and Zhang (2009) examine a longer period of time and document that the average correlation between industries is larger than that between countries. Moreover, they do not find any evidence of increasing country correlations and decreasing industry correlations. Overall, the literature still supports the view of the limited influence of industry factors compared to country factors, and criticises that the increasing importance of industry effects is largely due to the chosen sample period before the dot com crisis.

2.3. Industry contagion

Prior to the global financial crisis, Phylaktis and Xia (2009) is one of the very few studies that examines contagion at the industry level. Employing the asset pricing approach and contagion definition of Bekaert, Harvey and Ng (2005), they detect heterogeneous contagion signals across industries during the Mexican and Latin American crises. For instance, contagion in European and Asian industries are from the US, the region and the equivalent sector while industries in Latin America mainly exhibit contagion from the US. Furthermore, sectors also exhibit different contagion patterns during different crises. One of those examples is the financial sector. During the Mexican crisis, only the financial sector in Latin America exhibits excess comovement with the US, while the same sector in Asia displays contagion signals from the US only during the Asian crisis. Overall, the empirical results of Phylaktis and Xia (2009) indicate that both the Mexican and the Asian crises are contained within their region, and the difference in contagion patterns provides diversification opportunity for investors.

A potential reason for the lack of interest in industry contagion is the documented dominance of country effects compared to industry effects. If country effects are the main determinant of the variation in stock returns, and if diversification across countries provides substantially higher risk reduction than diversifying between industries, then investors need only worry about abnormal increases in cross-country correlations during crisis periods. However recent studies report that industries have become integrated globally over time, and that global industry effects have become more important. As industries become more integrated, they are more likely to facilitate global shocks to propagate across countries. The global financial crisis is a clear example of a few sectors acting like a shock transmission channel. It started in the subprime loan sector, which accounts for a small proportion of the US economy, and spilled over into the banking sector then to the whole world. This contagious nature of the global financial crisis has re-kindled the interest in sectoral contagion.

Recent research on sectoral contagion has been focusing solely on global financial crisis period and on the sectors that may have propagated shocks across countries: the banking sector, the financial services sector and the real estate sector. Boyson, Stahel and Stulz (2010) use quantile and logit regressions to test for excess correlation in monthly hedge fund index returns. They find very strong contagion evidence among hedge fund indices, and that contagion effects are associated with large liquidity shocks. On the other hand, Milunovich and Truck (2013) examine contagion between Real Estate Investment Trusts (REITS) within and across North America, Europe and Asia-Pacific during the global financial crisis. Employing Bekaert, Harvey and Ng (2005)'s framework, they find significant contagion effects between REITS indices in Asia-Pacific and their region, and between REITS indices in US, Belgium, Australia and Japan and the global equity index.

Similar to Milunovich and Truck (2013), Baur (2012) also adopts Bekaert, Harvey and Ng (2005)'s approach and focus on the global financial crisis period. Rather than concentrate on a particular sector, Baur (2012) studies a wide set of sectors to examine three channels of contagion: contagion of the financial sector across countries, contagion from the financial sector to the real economy of other countries and contagion to the real economy within a country. Similar to Phylaktis and Xia (2009), Baur (2012) finds heterogeneous contagion results across the real economy sectors, with some sectors exhibiting stronger contagion effects while others show weaker contagion effects such as Healthcare and Telecommunications and Technology sectors. He also finds that the contagion effect of the global financial crisis is present in all financial sectors across regions, and that none of the sectors or countries are immune from contagion.

In contrast to previous studies, Bekaert *et al.* (2011) study country-industry portfolios and find little evidence of cross-region contagion during the global financial crisis. Focusing on three sources of contagion: global, US and domestic contagion, they find contagion effects from the world and from the US have smaller magnitudes compared to domestic contagion. Moreover, contagion is documented to spread mainly via macro-fundamentals (foreign exchange reserves, the current account deficit and the sovereign rating). Milunovich and Tan (2012) use a four-Fama-French-factor asset pricing model to test for the presence of contagion among

12 US industries during the global financial crisis. They however do not account for time-varying integration like previous studies. Similar to Bekaert, Harvey and Ng (2005) and Baur (2012), they define contagion as positive excess correlations between model's standardized residuals. They find that 14 out of 66 pairs of industries exhibit excess comovement during the crisis period. In contrast to Baur (2012), Milunovich and Tan (2012) find that the financial sector has the least contagion effects and the healthcare sector has the most contagion effects. The difference in results probably stems from the difference in the sample coverage. Baur (2012)'s study has a wide international setting while Milunovich and Tan (2012) only examine domestic US sectors. Within the US, since the global financial crisis started in the financial sector of the US, the sector's volatility rises sharply, hence temporarily reduces the sector's correlation with other sectors in the same market. These studies however do not account for time-varying integration of industry portfolios, except from Phylaktis and Xia (2009) and Bekaert *et al.* (2011).

2.4. Testable hypothesis

Overall, the empirical results in the literature support the presence of industry contagion during the global financial crisis, while little has been done to compare this contagion effect between different crises. Although Phylaktis and Xia (2009) document that industry contagion during the Mexican and the Asian crisis is more contained within the region, evidence from Baur (2012), Milunovich and Truck (2013), and Milunovich and Tan (2012) suggests that industry contagion has become more widespread. The findings suggest that industry shocks have more impact than before, supporting the view that industry factors have become more important. Another implication from the findings in the literature is that industries have become more integrated, and subsequently facilitated shock transmission across countries. Therefore we add to the literature by examining industry integration and contagion with a wider set of data and sample period, and address the following hypotheses:

H1: Do industries become more integrated over time?

H2: How do the different crises affect the integration process of industry portfolios?

H3: Is there any evidence of cross-industry contagion during the five studied crisis periods?

H4: Is cross-region contagion present in any sector during the five studied crisis periods?

The first two hypotheses focus on the model's betas, which are the measures of integration. Against the background of globalisation and the two consecutive crises: global financial crisis and European debt crises, we re-examine the pattern of time-varying global and regional integration of all 39 industry sectors. This is related to the argument of Campa and Fernandes (2006) that integrated industries can propagate shocks across regions, leading to the spreading of crises. Furthermore we also examine the effect of each crisis on the integration patterns of industries. Similar to Phylaktis and Xia (2009), we compare and contrast the effect of different crises on a sector's global and regional integration. The final two hypotheses focus on the excess correlation between sectors, within regions and cross-regions, which are related to the debate over sectoral diversification opportunities. By separating fundamental comovement and excess comovement, we examine if contagion plagues different sectors and regions differently, and if certain sectors exhibit more contagion signals than others.

3. Methodology

3.1. Main model

Our main model is adopted from the approach of Bekaert, Hodrick and Zhang (2009) and has the following general form:

$$R_{i,t} = E(R_{i,t}) + (\beta_{i,t}^{w})' F_t^{w} + (\beta_{i,t}^{reg})' F_t^{reg} + e_{i,t} \quad (3)$$

where $R_{i,t}$ is the excess return on portfolio i at time t and $E(R_{i,t})$ is the expected excess return on portfolio i. F_t^{w} is a (n x k_w) matrix of zero-mean world factors that have impact on excess return $R_{i,t}$ where k_w is the number of world factors included in the model. The exposure of asset i to the set of global factors F_t^{w} is measured by the vector loading $\beta_{i,t}^{w}$. Similarly, F_t^{reg} is a n x k_{reg} matrix of zero-mean regional factors included in the model where k_{reg} is the number of regional factors.

The regional factors are computed using only data from a particular regional market and are orthogonal to all of the global factors. The orthogonalisation helps decompose the impact of global shocks and regional shocks on asset returns. In this chapter we consider two sets of risk factors. The first set is the global and regional Fama French three factors: the market (MKT), size (SMB) and value (HML) factors. In other words, the set of common factors is specified as $F_t = \{MKT_t^w, SMB_t^w, HML_t^w, MKT_t^{reg}, SMB_t^{reg}, HML_t^{reg}\}'$. We refer to this model as the six-factor model. The second set contains global and regional Fama French four factors: the three previous factors and the momentum (WML) factor. In this model, $F_t = \{MKT_t^w, SMB_t^w, HML_t^w, WML_t^w, MKT_t^{reg}, SMB_t^{reg}, HML_t^{reg}, WML_t^{reg}\}'$ and we refer to this model as the eight-factor model.

The factor model incorporates both global and regional integration of asset i with $\beta_{i,t}^w$ and $\beta_{i,t}^{reg}$ capturing the degree of global and regional integration respectively. In one extreme, if portfolio i is completely globally integrated, the return on asset i is determined only by world shocks. In that case, $\beta_{i,t}^{reg}$ is a vector of zero coefficients. On the other, if portfolio i is completely segmented from the world market, its return is only explained by its regional factors. $\beta_{i,t}^w$ will then be a vector of zero loadings. In order to account for time-varying integration, the model is re-estimated every six months, assuming that $\beta_{i,t}^w$ and $\beta_{i,t}^{reg}$ are constant within each six-month period.

The factor model allows for decomposition of the comovement between assets into fundamental comovements and non-fundamental comovements as follows:

$$\text{cov}_\tau(R_i, R_j) = \beta'_{i,\tau} \Sigma_{F,\tau} \beta_{j,\tau} + \text{cov}_\tau(e_i, e_j) \quad (4)$$

where $\text{cov}_\tau(R_i, R_j)$ is the covariance between returns on portfolio i and portfolio j during the τ th six-month period and $\Sigma_{F,\tau} = \text{cov}_\tau(F_t, F_t)$ is the $(k_w + k_{reg})$ x $(k_w + k_{reg})$ factor covariance matrix during the τ th six-month period, where $F_t = \{(F_t^w)', (F_t^{reg})'\}'$ is the $(k_w + k_{reg})$ x 1 factor vector for week t. $\beta_{i,\tau}$ and $\beta_{j,\tau}$ are the $(k_w + k_{reg})$ x 1 vectors of factor loadings of portfolio i and portfolio j

respectively with $\beta_{i,\tau} = \{(\beta^{w}_{i,\tau})', (\beta^{reg}_{i,\tau})'\}'$ and $\beta_{j,\tau} = \{(\beta^{w}_{j,\tau})', (\beta^{reg}_{j,\tau})'\}'$. The term $\beta'_{i,\tau}\Sigma_{F,\tau}\beta_{j,\tau}$ captures fundamental comovements as covariance of risk factors while $\text{cov}_{\tau}(e_i, e_j)$ is the covariance of model residuals during the τ th six-month period, capturing the non-fundamental comovements between portfolios.

Equation (4) also demonstrates that any increase in the covariance of asset returns can occur via any one of three channels: an increase in the asset's integration (increase in factor loadings), an increase in common factors' volatility (Σ_F) and an increase in covariance of the residuals. If the increase in asset covariance is due to an increase in integration, the effects should be persistent as an increase in integration is usually due to government policies (Bekaert, Hodrick and Zhang, 2009). Covariance between assets also rises during turbulent episodes when factor volatility heightens. Since there is no long-term trend in the pattern of market volatility (Schwert, 1989), an increase in asset covariance via this channel is more short-lived. Yet it is crucial to account for any such increase in factor volatility in the model since it may lead to a spurious interpretation of contagion, highlighted by Forbes and Rigobon (2002). Our main model is able to capture changes in factor volatility since the empirical factor covariance is re-estimated every six months.

The final channel that affects asset comovement is the covariance/correlation of residuals. This is the measure of contagion in an asset pricing framework proposed by Bekaert, Harvey and Ng (2005). If the model specification correctly identifies and captures the linkages and comovements between markets that are driven by fundamentals, any comovements in the model residuals represent non-fundamental and/or irrational behaviour. We expect this contagion effect to be very short-lived and coincide with documented contagious crisis episodes.

3.2. Fama French risk factors

All factors for developed regions (Europe, North America and Japan) are computed using the approach of Fama and French as detailed on Kenneth French's website.[2] The market premium MKT is the value weighted return of the whole region minus the weekly risk-free rate, which is also obtained from Kenneth

[2] Computation method of Fama-French factors is detailed on Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_developed.html

French's website. In order to compute SMB and HML, we only include stocks that have valid book-to-market ratios. We form two size portfolios and three B/M portfolios. All portfolios are rebalanced at the end of June each year. The breakpoint for the size portfolios is at 10% of June market cap of the region, with small stocks are those in the bottom 10% of the total regional market cap.

Since the book-to-market (B/M) ratios are made available at the end of December each year, we first match the B/M ratio of each stock at December of year t-1 to returns from July of year t to June of year t+1. Breakpoints for the B/M portfolios are at the 30^{th} and 70^{th} percentile of the B/M ratio of large stocks only. The stocks in the bottom 30% are classified as growth stocks, the top 30% are classified as value stocks with the middle 40% being neutral stocks. The two size portfolios and the three B/M portfolios are then intersected to create six size-B/M portfolios: Small-Growth (SG), Small-Neutral (SN), Small-Value (SV), Big-Growth (BG), Big-Neutral (BN) and Big-Value (BV). The SMB and HML factors are then computed as:

$$\begin{aligned} SMB &= \frac{1}{3}(SG + SN + SV) - \frac{1}{3}(BG + BN + BV) \\ HML &= \frac{1}{2}(SV + BV) - \frac{1}{2}(SG + BG) \end{aligned} \tag{5}$$

While Fama and French only include developed market data in their computation of SMB and HML, our sample consists of the Latin America region which contains only developing markets and the Asia-Pacific which contains both developing and developed markets (e.g. Hong Kong, Singapore, Australia and New Zealand). For these regions, we first adopt the approach suggested by Barry *et al* (2002) and sort stocks based on their relative sizes and relative B/M ratios for comparability. The relative size (B/M ratio) of a firm is obtained by dividing the firm's size (B/M ratio) by the average size (B/M ratio) of the market the firm belongs to in a particular year. Barry *et al.* (2002) argues that using relative size prevents the bias of allocating mainly stocks from large countries to big portfolio and mainly stocks from small countries to small portfolios, which subsequently mask the size effect in emerging markets. Additionally, the relative B/M ratios make stocks across countries comparable due to large differences in accounting standards in emerging markets. Aside from the use of relative instead of absolute size and B/M ratio, the rest of the computation for SMB and HML is then similar to the case of developed regions.

In order to compute the momentum factor, we only include stocks that have valid price information necessary to compute prior returns. The prior return of each stock is the cumulative return over 11 months from month t-12 to t-2. Stocks are then sorted every month into winner, neutral and loser portfolios, using the breakpoints at the 30^{th} and 70^{th} percentile of large stocks' prior returns. The WML factor is formed on the intersection of two size portfolios and three momentum portfolios with size obtained as outlined previously. The intersection creates six size-momentum portfolios: Small-Loser (SL), Small-Neutral (SN), Small-Winner(SW), Big-Loser (BL), Big-Neutral (BN) and Big-Winner (BW) from which the momentum factor is computed as:

$$WML = \frac{1}{2}(SW + BW) - \frac{1}{2}(SL + BL) \tag{6}$$

The global market premium MKT is the value weighted returns of all the stocks in the sample minus the one-week US T-bill rate. The global SMB, HML and WML are computed from the intersection of two global size portfolios and three global B/M portfolios or three global momentum portfolios. To create the global size portfolios, the global size breakpoint is first obtained from the sample of all developed markets in the sample. Similar to the regional portfolios, the breakpoint for the global size portfolios is at 10% of June global market cap. Stocks in Europe, North America and Japan are allocated into the global size portfolio using the global breakpoint while stocks in Asia-Pacific and Latin America are allocated based on their local breakpoints. For the global B/M and global momentum portfolios, we employ regional breakpoints to allocate stocks. In other words, the global growth/neutral/value portfolio contains growth/neutral/value stocks from all regions. The same approach is applied to the global momentum portfolios. The global SMB, HML and WML are then computed using (5) and (6) as in the case of the regional factors.

In order to separate regional effects from global effects, regional risk factors are orthogonalised against demeaned global factors. Each regional factor is regressed on all global factors in the model. For instance, in case of a six-factor model, each regional factor MKT_t^{reg}, SMB_t^{reg}, and HML_t^{reg} is regressed on all of the three global factors MKT_t^{w}, SMB_t^{w}, and HML_t^{w}. The same principle applies for the eight-factor model. The residuals obtained after orthogonalisation are the pure regional risk factors. We do not orthogonalise between global factors or between regional factors.

3.3. Contagion test

We employ two contagion tests to examine contagion among industry portfolios. The first test studies contagion across industries within a region. The objective is to examine whether different sectors in the same region comove more excessively during a crisis episode. We call this the intra-region contagion test, which has the following form:

$$\begin{aligned} e_{i,t} &= c + v_{i,t} z_t + u_{i,t} \\ v_{i,t} &= \lambda_0 + \lambda_1 D \end{aligned} \tag{7}$$

where $e_{i,t}$ is the residual of industry i, and z_t is the sum of the residuals of all other portfolios that are in the same region with portfolio i. The coefficient $v_{i,t}$ is conditioned on a constant λ_0 and a crisis dummy D. While the coefficient λ_0 captures the excess comovements that are always present, the coefficient λ_1 accounts for additional contagion effect during crisis period D. We examine five crisis periods, which are the Mexican crisis, the Asian flu, the Argentine Debt crisis, the Global Financial Crisis and the European Debt crisis.

In addition, we also examine the contagion between portfolios that belong to the same sector but reside in different regions. We refer to this type of contagion as intra-industry contagion. The purpose of the test is to examine whether stocks that belong to the same industry exhibit excess comovement even though they are located in different regions. This test provides useful information to compare the degree of contagiousness between sectors. We expect to find greater contagion signals in more internationalised sectors such as bank, oil & gas, and automobiles. The intra-industry contagion test is formulated as follows:

$$\begin{aligned} e_{i,t} &= c + (\gamma_{reg})' F_t^{reg} + v_{i,t} z_t + u_{i,t} \\ v_{i,t} &= \lambda_0 + \lambda_1 D \end{aligned} \tag{8}$$

Similar to the intra-region contagion test, $e_{i,t}$ is the residual of industry i, and the coefficient $v_{i,t}$ is also conditioned on a constant λ_0 and a dummy variable, representing each crisis. In this case, z_t is the sum of the residuals of all portfolios in other regions that are in the same industry with portfolio i. In order to capture this contagion effect, we control for the possible comovement between different regions that are not accounted for by world factors by including the term $(\gamma_{reg})' F_t^{reg}$. Due to the construction of our main model, we account for the comovement of portfolio i with the world and its regional market, but not with other regions. If we regress the residual of portfolio i on another portfolio of another region, the coefficient may pick up the correlations between regions. For instance, returns on North America and Japan may comove with each other since North America is dominated by the US, and Japanese and US stocks are documented to comove together (Karolyi and Stulz, 1996). Therefore in order to observe the pure comovement between sectors, we control for comovement between regions. The set of factors F_t^{reg} here contains the three regional Fama French factors (MKT, SMB and HML) of all regions for portfolios estimated by the six-factor model, and the four regional Fama French factors (MKT, SMB, HML and WML) of all regions for portfolios estimated by the eight-factor model. γ_{reg} is a vector of coefficients which measures the exposure of portfolio i to the regional Fama French factors. For both contagion tests, we run a panel regression for each crisis period. The hypothesis test for contagion is $H_0 : \lambda_1 = 0$. Contagion signals are detected if λ_1 is significantly positive.

4. Data

4.1. *Stock returns*

Our sample consists of firm-level data of both dead and alive publicly traded stocks on the main exchanges of thirty one countries around the world.[3] Among these countries are all the developed markets listed in the MSCI Developed Market Index and representative developing markets listed in the MSCI Developing Market index. These markets cover five regions of the world: Asia-Pacific, Europe, North America, Latin America and Japan. Due to its size and different economic

[3] The lists of dead and alive stocks on each market are maintained by Datastream.

environment, Japan is treated as a separate region. The list of the countries included in the sample is reported in table 1. Our sample period starts from 1981 and runs to the end of 2011, covering five significant crises: the Mexican crisis, the Asian crisis, the Argentine Debt crisis, the Global Financial crisis and the European Debt crisis.

Stock returns are computed in US dollars from Wednesday to Wednesday to avoid market microstructure effects such as nonsynchronous trading or the Monday effect of stock prices. Since data from Datastream suffers from various data errors, we employ a series of data screens and filters suggested by Ince and Porter (2006), Hou, Karolyi and Kho (2011) and Griffin, Kelly and Nardari (2010). First, we only include stocks that have valid observations for price, return index and market value and at least one accounting ratio. We then select only the stocks that are primary listed, major and traded on the main stock exchanges in each country. Most countries have only one main exchange, which is the one with the largest number of stocks, with the exception of Japan and US. For Japan we collect stocks traded on both Tokyo and Osaka exchanges. For US stocks that are traded on NYSE, AMEX and NASDAQ are included in the sample.

Only common stocks are included in our analysis. Since the dead and alive stock list of Datastream includes a mixture of common stocks, preferred stocks, warrants, REITs, closed-end funds, exchange-traded funds, and depositary receipts, we screen the data using three criteria. First, we filter stocks by the types assigned to them by Datastream. We only include stocks with type “EQ” in the sample. However Ince and Porter (2006) demonstrate that this filter alone is not enough to exclude all non-common stocks from the sample. The second filter we employ is industry code of a stock (Datastream Datatype INDC and INDG). Griffin, Kelly and Nardari (2010) provide a list of industry codes which indicates that a particular stock is an Investment Vehicle rather than a common stock. Finally, we check the name of each stock for abbreviations which may indicate that the security is a non-common equity. For example, if the security’s name contains abbreviations such as PREF or PREFF then it is a preferred stock rather than a common one. We then manually screen each of the stock names that contain the abbreviations for false positives. For example, the abbreviation IT may mean investment trust, but MITSUBISHI is a valid company. Details of abbreviations that signal non-common stock are provided by Griffin, Kelly and Nardari (2010) for a wide list of countries.

Finally we follow the screening procedures suggested by Ince and Porter (2006) and Hou *et al* (2011) to the remaining sample of stocks. First, as Ince and Porter (2006) document, Datastream sometimes repeatedly reports the final price of a stock even after the stock has stopped trading, inflating the number of zero return observations in the sample. Therefore we set to missing the trailing zero returns at the end of each series, as Ince and Porter suggest.[4] Second, we set to missing any returns that are greater than 200% and revert within one period. In other words, if $R_t > 200\%$ or $R_{t-1} > 200\%$ and $(1+R_{t-1})(1+R_t)-1 < 50\%$, then both R_{t-1} and R_t are set to missing. Third, we set to missing any returns that fall outside the 0.1% and 99.9% quantile of the whole sample, eliminating extreme outliers which are caused by mergers or stock splits. Finally a stock is required to have at least 52 valid weekly return observations to be included in the final sample.

4.2. Industry portfolios

From our final sample of 30,838 stocks, we create industry portfolios using Datastream level 4 industry classification, which equates to the ICB sector level classification, similar to Bekaert *et al.* (2011). At this level, industry classifications are neither too fine nor too coarse.[5] The use of level 4 classification results in 39 global industries. The mnemonic code names and the corresponding full names of each industry are detailed in table 3. Four out of five regions cover all 39 global industries. Since we do not have sufficient data for the Real Estate Investment Trust sector in Latin America, this region only has 38 global industries. In order to avoid having too few stocks in any particular portfolio, we form our industry portfolios by grouping stocks within regions. Subsequently, the return on any industry portfolio is the value-weighted return of all the stocks in that particular industry. Table 2 reports

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[4] We are aware that some meaningful zero returns at the end of the sample may be lost. Ince and Porter (2006) mention the first reaction to this problem is to use the stock end dates to pinpoint the exact time a stock stops trading. However they also point out that the stock end dates reported by Datastream are not reliable.

[5] Griffin and Karolyi (1998) argue that using too broad industry categories masks the heterogenous industry effects. Meanwhile, Brooks and Del Negro (2006) study global, country and industry effects on stock returns and find that using finer industry classification gives qualitatively similar results as those obtained at level 4. Too fine aggregation of industries could lead to too few stocks in one portfolio.

the descriptive statistics of our industry portfolios. For each sector, we report the start date, the average return over the whole available period, standard deviation of returns and the average market value. While majority of industry portfolios in all five regions start in 1981, we can see that industry portfolios in Latin America tend to have a shorter availability of data. Some portfolios do not even cover all five crisis periods, such as the oil equipment and services sector, the life insurance sector, the real estate investment and services sector and the alternative energy sector of Latin America. For these portfolios, the analysis examines which ever crisis periods are covered by the data.

The average industry returns are more diverse in developing regions (Latin America and Asia-Pacific) than in developed regions. For instance, mean returns in Asia-Pacific vary from the low of -0.07% on forestry & paper to the high of 0.65% on the alternative energy sector. Similarly, sectors in Latin America also exhibit large differences in mean returns, from the low of -1% (alternative energy) to 0.73% (aerospace and defence). Meanwhile, average industry returns in Europe, North America and Japan are more uniform, vary from -0.05% to 0.34% in Europe, from 0.09% to 0.31% in North America and from -0.06% to 0.35% in Japan. Tobacco sector has the highest average return in Europe and America while alternative energy has the highest mean return in Japan.[6]

Figure 1 panel A to E present the pie charts of the industry structure of each region. While the industry compositions are more evenly distributed in the more developed regions, they are much less uniform in developing regions. In Asia-Pacific and Latin America, the industry structure consists of a few large dominated sectors and many small ones. For instance, Latin America is dominated by the oil & gas sector, whose market cap is 15.11% of the region, with Brazil accounts for 78.29% of the whole sector market cap. Meanwhile, the banking sector accounts for 19.51% of the Asia-Pacific market, with 31.14% of the sector situates in Hong Kong and 23.72% in Australia. The banking sector also holds a significant market share in other regions, account for 14.33%, 10.64% and 8.44% of Europe, Japan and North

[6] The alternative energy sector is booming in Asia-Pacific and Japan due to both government policies and natural geographic locations. For instance, Australia introduced the Mandatory Renewable Energy Target schemes in 2001 to increase renewable energy usage. Japan and the Philippines, whose natural fuel resources are unsustainable, turned to renewable energy sources to cope with national energy demand. The strong growth in this sector is reflected by the high average return.

America markets respectively. The UK accounts for the largest share of the banking sector in Europe region (26.32%) while the US accounts for 90.79% of the banking sector in North America.

5. Empirical results

5.1. Model performance

Following Bekaert, Hodrick and Zhang (2009), comovement of portfolio excess returns can be decomposed into comovement between risk factors and comovement between residuals as follows:

$$\begin{aligned}\gamma_{sample,\tau}^{CORR} &= \frac{1}{\overline{W}_\tau}\sum_{i=1}^{n_{PORT}}\sum_{j>i}^{n_{PORT}} w_{i,\tau}w_{j,\tau}corr_\tau(R_{i,t},R_{j,t}) \\ &= \frac{1}{\overline{W}_\tau}\sum_{i=1}^{n_{PORT}}\sum_{j>i}^{n_{PORT}} w_{i,\tau}w_{j,\tau}corr_\tau(F_t\beta_i,F_t\beta_j) \\ &+\frac{1}{\overline{W}_\tau}\sum_{i=1}^{n_{PORT}}\sum_{j>i}^{n_{PORT}} w_{i,\tau}w_{j,\tau}corr_\tau(e_{i,t},e_{j,t}) \\ &= \gamma_{risk,\tau}^{CORR}+\gamma_{idio,\tau}^{CORR} \\ &\gamma^{CORR} \\ &\tau\end{aligned} \tag{9}$$

where $\gamma_{sample,\tau}^{CORR}$ is the average correlation of stock returns in a six-month window τ, computed by weighted correlations of all industry portfolios using the previous month-end weight $w_{i,\tau}$ and $w_{j,\tau}$ of industry portfolio i and j respectively. Since $\gamma_{sample,\tau}^{CORR}$ is a weighted measure, a scalar $\overline{W}_\tau = \sum_{i=1}^{n_{PORT}}\sum_{j=1,j>i}^{n_{PORT}} w_{i,\tau}w_{j,\tau}$ is needed to ensure all the weights add up to one. $\gamma_{risk,\tau}^{CORR}$ is the measure of comovement between risk factors, while $\gamma_{idio,\tau}^{CORR}$ is capture the excess comovement of asset returns. These correlation measures are computed by dividing the average covariance in period τ by the square root of the product of return variance $[\text{var}_\tau(R_{i,t})\,\text{var}(R_{j,t})]^{\frac{1}{2}}$. Over the whole sample, we obtain three vectors of γ_{sample}^{CORR}, γ_{risk}^{CORR} and γ_{idio}^{CORR}, which can be interpreted as time-varying unconditional comovement of portfolio returns, of fundamentals and of portfolio idiosyncratic shocks respectively.

Since we focus on the second moment, we examine how well the empirical time-varying comovement of returns is captured by the comovement in factors. The model performs well if γ_{risk}^{CORR} is able to match γ_{sample}^{CORR} closely or in other words, if γ_{idio}^{CORR} is small. Figures 2 and 3 panels A to E present the plots of the time-varying comovement, γ^{CORR}, of the return data, the risk factors and the residuals for the whole sample period for Asia-Pacific, Latin America, Europe, North America and Japan respectively. We can see that the comovement computed by both the six-factor and the eight-factor model trace the empirical comovement very closely, except for the period of 1990 to mid-1994 in Latin America. During this time, the Latin America region has many illiquid stocks and missing data, causing difficulty in fitting the model. However, from the latter half of 1994 onwards, the performance of the model improves. This is evidence that our main model captures the dynamics of fundamentals in our data sufficiently, consistent with the results from Bekaert, Hodrick and Zhang (2009). Baele and Inghelbrecht (2010) employ a different approach but also document small excess correlation when the model is rich enough to capture fundamental comovement between markets.

In order to determine which model between the six-factor and the eight-factor performs better, we employ the root mean square error criterion as suggested by Bekaert, Hodrick and Zhang (2009):

$$RMSE_{CORR} = \left[\frac{1}{n_\tau} \sum_{\tau=1}^{n_\tau} \left\{ \frac{1}{\overline{W}_\tau} \sum_{i=1}^{n_{PORT}} \sum_{j>i}^{n_{PORT}} w_{i,\tau} w_{j,\tau} [corr_\tau(e_{i,t}, e_{j,t})]^2 \right\} \right]^{1/2} \tag{10}$$

where $RMSE_{CORR}$ is the square root of the time-series mean of the weighted average of all the elements in the upper triangular correlation matrix of the model residuals. Basically, $RMSE_{CORR}$ measures the average difference between correlation matrices of the sample and of the model. Therefore a lower $RMSE_{CORR}$ indicates a better model performance. For each six-month window τ, the weighted average of residual correlations is computed for each region, with the weights $w_{i,\tau}$, $w_{j,\tau}$, and the scalar $\overline{W}_\tau$ as specified previously. The $RMSE_{CORR}$ is then the mean of these weighted average values over n_τ periods. Latin America has lower n_τ (43) than other regions (61) due to a shorter availability of data.

The computed $RMSE_{CORR}$ for each region are presented in table 4. According to the result, the $RMSE_{CORR}$ of the eight-factor model are always slightly smaller than that of the six-factor model. For instance, the $RMSE_{CORR}$ of Europe is 0.078 and 0.068 for the six- and the eight-factor model respectively, with the difference of 0.01 while the difference between the two $RMSE_{CORR}$ of Latin America is 0.005. Since the estimated results are qualitatively similar in both cases, and the eight-factor model has a slightly better performance measure, we will focus on the results estimated from the eight-factor model, and refer to the six-factor model for comparison when necessary.

5.2. Time-varying integration

Tables 5 and 6 present the time-series means of the difference between the global and regional beta of each risk factor for the five regions. Overall, the results suggest that in more developed regions, the majority of sectors have higher exposure to global risk factors than sectors in developing regions. Yet there remains clear evidence that the majority of sectors in all regions are still highly determined by their regional risk factors. To our knowledge, this is the first study that documents the difference between global and regional exposure of industry portfolios to Fama-French risk factors. Although Bekaert, Hodrick and Zhang (2009) use the same approach, they do not focus on this pattern in integration.

Among the five regions, Asia-Pacific is the most regionally oriented, with majority of the sectors exhibiting higher sensitivity to regional risk factors. In fact, the exposures to regional MKT, SMB, HML and WML are higher than the respective global factors in 77%, 100%, 64% and 75% of the Asia-Pacific industries. Similarly, sectors in Latin America are also more integrated with the region than with the world, with 55%, 92%, 37% and 47% of sectors having higher MKT, SMB, HML and WML regional betas. On the other hand, Europe is the region with the highest number of sectors that have higher global betas than regional betas, with

59%, 26%, 97% and 46% of the sectors exhibiting higher global MKT, SMB, HML and WML betas.

Our results on the integration of industries in North America and Japan are consistent with previous literature. In the case of America, we find that roughly half of the sectors have higher exposure to the regional MKT, and about two third of the sectors have higher betas on regional than global SMB, HML and WML. These findings extend the results of Carrieri, Errunza and Sakissian (2004) to other risk factors and to a larger geographical scale. While these authors document that the US price of risk is significant in a large proportion of US industries, we confirm that the effects persist on a regional scale. This is not surprising as the US accounts for a sizeable portion of North America. In addition, we also confirm the importance of other regional risk factors, such as the SMB, HML and WML, in a large number of the North American sectors. In the case of Japan, we find that most Japanese sectors (87%) have higher sensitivity to the regional MKT, echoing the results of Harvey (1991) that Japanese stock market return is heavily influenced by its own variance.

In addition to the levels of betas discussed previously, we also examine betas' time-varying patterns, specifically if they exhibit any trend over time and/or structural breaks during the crises. In other words, we investigate if portfolios' sensitivity on the eight (six) global and local factors increase or decrease over time, and if the aforementioned crisis periods significantly alter these sensitivity measures. In order to do so, we regress each beta vector on a time trend and on a set of crisis dummies as follows:

$$\beta_{\tau}^{risk} = c + \delta^{risk} TR + \sum_{d=1}^{5} \gamma_{d}^{risk} D_{d} + \xi_{\tau} \qquad (11)$$

where β_{τ}^{risk} is the estimated time-varying factor loadings of global and regional MKT, SMB, HML, and WML. We perform a panel regression for each β_{τ}^{risk} across industries in each region. For each risk factor, β_{τ}^{risk} is regressed on a linear time trend TR, and a set of five crisis dummies D_d with $d = 1...5$. We then test for the null hypothesis of no linear trend $H_0 : \delta^{risk} = 0$ against the alternative: $H_1 : \delta^{risk} \neq 0$.

In addition, the hypothesis for structural break in β_{τ}^{risk} during crisis period d is $H_0 : \gamma_d^{risk} = 0$, and $H_1 : \gamma_d^{risk} \neq 0$.

The results for linear time trend and structural break test of β_{τ}^{risk} obtained by the six-factor model are presented table 7 while the same results of β_{τ}^{risk} from the eight-factor model are detailed in table 8. In each table, panels A and B detail the results of global and regional β_{τ}^{risk} respectively. Our key results are consistent with the previous literature. Overall, we do not detect any linear time trend in all β_{τ}^{risk}, implying that sectors do not become more integrated over time, consistent with Bekaert, Hodrick and Zhang (2009). Although industry integration does not have a long term trend, we detect short term crisis effects on β_{τ}^{risk}, mostly during the global financial crisis, similar to Bekaert *et al.* (2011). However our result is different in the sense that most of our significant crisis effects are detected in SMB and HML rather than in MKT. Another difference is that there is more decoupling, when δ^{risk} is significantly negative, with regional markets than with global markets during the five crisis periods. For instance, while β^{WSMB} of North America rises significantly during the global financial crisis, both β_{τ}^{RSMB} and β_{τ}^{RHML} of the region fall during the same period. The findings indicate that during the global financial crisis, industry portfolios increase their comovement with the world market, which could have significant impact on diversification benefit and asset allocation.

5.3. *Contagion results*

5.3.1. *Preliminary results*

In order to get an overview of the connectedness as well as the excess correlations between industry portfolios, we first study the unconditional correlation matrices of the model's residuals in five regions. Consistent with Bekaert, Hodrick and Zhang (2009), the unconditional excess correlations between industry portfolios are small. In fact, none of them has a magnitude larger than 0.5. On the other hand, despite the small magnitudes, we still detect significantly positive correlations between residuals of industry portfolios, reflecting the connectivity between these sectors due to their nature.

However one may argue that such positive correlations are due to country effects since firms in some industries can be highly concentrated in a particular country. For instance, the oil & gas producer and mining sectors in Asia-Pacific have a significantly positive correlation of 0.13 at a 1% significant level. Closer examination reveals that a sizeable number of firms from both sectors are in Australia.[7] If country effects are indeed more important than industry effects, sectors that have majority of the firms from one country can be correlated to each. Therefore it could be that these two sectors are subjected to a common Australia country effect, resulting in their positive correlations. In order to determine if our industry portfolios in each region are characterised by country effect, we conduct the following test. First, we determine the country that has highest number of firms in each industry. We then regress the residuals of a portfolio on the residuals of another portfolio and on an indicator term $I_{\{same\_country\}}$ as follows:

$$e_{i,t} = \alpha + \gamma_i e_{j,t} + \theta_i I_{\{same\_country\}} e_{j,t} + u_{i,t}$$
$$\{i = 1, 2, ..., n_{port}\} \qquad j > i \tag{12}$$

where the indicator term $I_{\{same\_country\}}$ is equal to 1 if the two sector i and j share a common dominant country, and 0 otherwise.

Equation (12) basically captures the comovement between the idiosyncratic risk of industry i, $e_{i,t}$, with that of industry j, $e_{j,t}$ ($j \neq i$). The total comovement is measured as $(\gamma_i + \theta_i)$, which is the sum of industry comovement γ_i and the additional comovement if the two industries share the same dominant country θ_i. If country effects are more important than industry effects, we expect θ_i to be significantly positive. We employ a panel regression for equation (12) for each of the four regions: Asia-Pacific, Latin America, Europe and North America. Naturally portfolios in Japan are free of this problem because Japan is both a country and a region, and the country risk factors of Japan are already accounted for in F_t^{reg}. Our estimated results are presented in table 9, and the key finding is that the positive correlations between the industry portfolios are not characterised by country effects. Since none of the θ coefficients are significantly positive, we can conclude that the

[7] 52 over 89 firms in the oil & gas producer sector and 273 over 304 firms in mining sector are in Australia.

positive correlations in the correlation matrices reflect the connectedness between different industries in a region.

5.3.2. Formal contagion test

Since our preliminary results detect significant excess correlation among industry portfolios, we examine the presence of contagion across industries in the same region, and contagion across regions of the same industry. We refer to these two tests as the inter-industry (equation (7)) and the intra-industry (equation (8)) contagion tests respectively. Our estimated results of the inter-regional contagion test are presented in table 10, and highlight several key findings. First, similar to the measure γ_{idio}^{CORR} of Bekaert, Hodrick and Zhang (2009), the coefficient v_0, which captures the time-varying average contagion across all sectors in each region, are very close to zero. Second, we detect mostly economically small (magnitude is less than 1%) and scattered contagion effects, echoing the results of Bekaert *et al.* (2011). The largest contagion signal is detected in the Latin America region during the Mexican crisis (magnitude 2.1% and 2.4% in table 10 panels A and B respectively), but it is only significant at 10% level. The lack of sizeable contagion effects is good news for investors as the comovement between different industry portfolios does not increase abnormally during crises.

While there are not many contagion effects among industries in the same region, we detect more contagion signals of the same industry residing across different regions using the intra-industry contagion test. Tables 11 and 12 present the estimated λ_0 and λ_1 of the intra-industry contagion test, employing the sets of regional risk factors $F_t^{reg} = \{MKT_t^{reg}, SMB_t^{reg}, HML_t^{reg}\}$ and $F_t^{reg} = \{MKT_t^{reg}, SMB_t^{reg}, HML_t^{reg}, WML_t^{reg}\}$ respectively. These sets of F_t^{reg} control for the comovement between regions that is not captured by common world factors. As a result, the coefficient v_0 in this case reflects the excess correlation of a sector between regions. Although v_0 also captures the excess correlation, we interpret it as the industry effect of each sector rather than contagion. Most of the estimated v_0 are significantly positive, which suggests the presence of industry effects. Consistent with Karolyi and Stulz (1998), most of the sectors that exhibit positive v_0 are those with international traded goods, such as oil & gas, foods and automobiles. One explanation for this finding is that sectors that trade internationally are more exposed to changes in economic condition of other countries/ regions. Analogously, the sectors with insignificant v_0 are more domestic in nature, such as gas, water & multi-utilities or food & drug retailers.

While v_0 accounts for the industry effect, the coefficient v_1 captures the intra-industry contagion signals during a particular crisis. Our findings of contagion during the global financial crisis are consistent with Baur (2012) and Dungey and Gajurel (2014), in the sense that we detect contagion in both the banking and financial services sectors during this period. However, unlike Baur (2012), contagion is only detected in 10 sectors. We do not detect any signals during the Mexican crisis, consistent with the findings of Bekaert, Harvey and Ng (2005) that the Mexican crisis is not contagious. The key finding that has not been documented in the literature is that sectors that are not ordinarily connected tend to increase their comovement across borders during crises. These industries normally exhibit insignificant v_0 and therefore appear to be attractive opportunities for diversification. For instance, the construction material sector in different regions are not connected to each other (v_0 is insignificantly different from zero). Hence investors may gain diversification benefits by holding construction material stocks from different regions. However, during the global financial crisis, this sector exhibits a rise in correlation across regions, reducing the diversification benefits. Therefore investors should be cautious about holding stocks of the same industry across regions.

6. Conclusion

We revisit the widely debated issues in the international finance literature of industry effects on diversification and industry integration. Since the 1990s, many countries have adopted liberalisation policies resulting in markets becoming more interdependent on each other. At the same time, industries are also reported to have become more integrated. This increase in global integration results in shocks being transmitted across borders, potentially leading to contagion effects during different crises. Comparing five recent popular crises, we attempt to answer the following questions: have industries become more globally integrated over time? Are these patterns of integration affected significantly during crises? Is contagion present across sectors in any region during the five studied crisis periods? Is cross-region contagion present in any sector during the five studied crisis periods?

Our study contributes to the literature in several ways. First, we extend the world-regional Fama-French three-factor model of Bekaert, Hodrick and Zhang (2009) by including global and regional WML factor. This model captures the covariance between asset returns slightly better than the Bekaert, Hodrick and Zhang (2009)'s model, which is reflected in a smaller $RMSE_{CORR}$ in all regions. Our estimated results indicate that most of the industry portfolios in all regions are more exposed to their regional risk factors than global risk factors. Among all of the portfolios, Asia-Pacific sectors are most regionally oriented, with a sizeable proportion exhibiting higher exposure to all regional risks. In contrast, European sectors are the most globally integrated compared to other regions, with the highest number of sectors displaying higher global betas than regional betas. The domination of regional factors in North America and Japan are consistent with the findings of Carrieri, Errunza and Sakissian (2004) and Harvey (1991) that the US and Japan stock markets are influenced by their own variances.

Another contribution of our study is the examination of the patterns of time-varying beta of each risk factor. Specifically, we investigate if each of the beta increases over time and exhibits structural breaks during the five key crises. Our empirical results indicate that none of the betas exhibit any time trend, which does not support the perceived notion that industries have become more integrated over time. On the other hand, we detect structural breaks in betas, mostly during the global financial crisis, confirming the distinct contagious characteristic of the global financial crises compared to all the other episodes. While our results are similar to Bekaert *et al.* (2011) in that we detect crisis effects in betas during this period, most of the crisis effects are detected in SMB and HML betas rather than MKT betas. An implication of the finding is that portfolios could increase their exposure to other global risk factors alongside the global market. Our results also detect a shift from regional integration toward global integration during the global financial crisis, indicating an increase in comovement of industries with the world market, and a potential reduction in diversification benefits.

The finding that industry portfolios increase their comovement with the world market during crises is re-confirmed in our contagion test results. Extending the work of Baur (2012) who only studies intra-industry contagion for the financial sector during the global financial crisis, we investigate both inter-industry and intra-industry contagion for all sectors in the world across various crisis periods. The inter-industry test identifies contagion signals across different industries in the same region while the intra-industry test examines contagion signals of one particular sector in different regions. In other words, the first test examines if contagion spreads across different industries in the same location while the second test determines if contagion is observed across borders in the same industry. Consistent with Bekaert, Hodrick and Zhang (2009) we detect evidence of a few small excess comovement between industries in the first test, indicating that our model captures well the comovement of returns on industry portfolios. This is good news for investors as they do not have to be concerned about abnormal increases in comovement between industries in the same region, even during the global financial crisis.

In contrast, we detect higher excess comovement in the same sector but situated in different regions, indicating the presence of global industry effects. Consistent with Karolyi and Stulz (1998), the connectedness is stronger in sectors that involve heavily in international trade such as oil & gas, food and automobiles. An explanation is that sectors that trade internationally are more exposed to the economic cycles of their trading partners, who situate in other geographical regions. Following this line of argument, sectors that are more domestic in nature are expected to exhibit less connectivity across regions. Indeed, we also find that sectors such as gas, water and multi-utilities in different regions are not highly connected to each other. Therefore it may be beneficial to hold stocks from these sectors across regions due to their low correlations. However, our key finding is that the sectors that are usually not connected tend to increase their comovement with each other during crises. A few examples are the support services during the Asian crisis, the aerospace & defence sector during the Argentine debt crisis, and the construction material sectors during the global financial crisis. We hypothesise that shocks during a crisis are transmitted to these sectors via the more interdependent sectors, such as the banking sector. Therefore, even though investors are usually advised to diversify across regions, they should take into account the potential for contagion effects and be cautious about holding stocks of the same industry across regions.

References

Baca, S. P., Garbe, B. L. & Weiss, R. A. 2000. The rise of sector effects in major equity markets. Financial Analysts Journal, 56, 34-40.

Baele, L. & Inghelbrecht, K. 2009. Time-varying integration and international diversification strategies. Journal of Empirical Finance, 16, 368-387.

Baele, L. & Inghelbrecht, K. 2010. Time-varying integration, interdependence and contagion. Journal of International Money and Finance, 29, 791-818.

Barry, C. B., Goldreyer, E., Lockwood, L. & Rodriguez, M. 2002. Robustness of size and value effects in emerging equity markets, 1985–2000. Emerging Markets Review, 3, 1-30.

Baur, D. G. 2012. Financial contagion and the real economy. Journal of Banking & Finance, 36, 2680-2692.

Beckers, S., Connor, G. & Curds, R. 1996. National versus global influences on equity returns. Financial Analysts Journal, 52, 31-39.

Bekaert, G., Ehrmann, M., Fratzscher, M. & Mehl, A. J. 2011. Global crises and equity market contagion. National Bureau of Economic Research Working Paper Series, No. 17121.

Bekaert, G. & Harvey, C. R. 1995. Time-varying world market integration. Journal of Finance, 50, 403-444.

Bekaert, G., Harvey, C. R. & Ng, A. 2005. Market integration and contagion. The Journal of Business, 78, 39-69.

Bekaert, G., Hodrick, R. J. & Zhang, X. 2009. International stock return comovements. Journal of Finance, 64, 2591-2626.

Berben, R.-P. & Jansen, W. J. 2005. Comovement in international equity markets: a sectoral view. Journal of International Money and Finance, 24, 832-857.

Boyson, N. M., Stahel, C. W. & Stulz, R. M. 2010. Hedge fund contagion and liquidity shocks. Journal of Finance, 65, 1789-1816.

Brooks, R. & Del Negro, M. 2004. The rise in comovement across national stock markets: market integration or IT bubble? Journal of Empirical Finance, 11, 659-680.

Brooks, R. & Negro, M. D. 2006. Firm-level evidence on international stock market comovement. Review of Finance, 10, 69-98.

Campa, J. M. & Fernandes, N. 2006. Sources of gains from international portfolio diversification. Journal of Empirical Finance, 13, 417-443.

Carrieri, F., Errunza, V. & Sarkissian, S. 2004. Industry risk and market integration. Management Science, 50, 207-221.

Carrieri, F., Errunza, V. & Sarkissian, S. 2012. The dynamics of geographic versus sectoral diversification: is there a link to the real economy? Quarterly Journal of Finance, 02, 1-41.

Dungey, M. & Gajurel, D. 2014. Equity market contagion during the global financial crisis: evidence from the world's eight largest economies. Economic Systems, 38, 161-177.

Ferreira, M. A. & Gama, P. M. 2005. Have world, country, and industry risks changed over time? An investigation of the volatility of developed stock markets. Journal of Financial and Quantitative Analysis, 40, 195-222.

Forbes, K. J. & Rigobon, R. 2002. No contagion, only interdependence: measuring stock market comovements. Journal of Finance, 57, 2223-2261.

Griffin, J. M. & Karolyi, A. G. 1998. Another look at the role of the industrial structure of markets for international diversification strategies. Journal of Financial Economics, 50, 351-373.

Griffin, J. M., Kelly, P. J. & Nardari, F. 2010. Do market efficiency measures yield correct inferences? A comparison of developed and emerging markets. Review of Financial Studies, 23, 3225-3277.

Grubel, H. G. 1968. Internationally diversified portfolios: welfare gains and capital flows. The American Economic Review, 58, 1299-1314.

Harvey, C. R. 1991. The world price of covariance risk. Journal of Finance, 46, 111-157.

Heston, S. L. & Rouwenhorst, K. G. 1994. Does industrial structure explain the benefits of international diversification? Journal of Financial Economics, 36, 3-27.

Hou, K., Karolyi, G. A. & Kho, B.-C. 2011. What factors drive global stock returns? Review of Financial Studies, 24**,** 2527-2574.

Ince, O. S. & Porter, R. B. 2006. Individual equity return data from thomson datastream: handle with care! Journal of Financial Research, 29, 463-479.

Karolyi, G. A. & Stulz, R. M. 1996. Why do markets move together? An investigation of U.S.-Japan stock return comovements. Journal of Finance, 51, 951-986.

Lessard, D. R. 1974. World, national, and industry factors in equity returns. Journal of Finance, 29, 379-391.

Lessard, D. R. 1976. World, country, and industry relationships in equity returns: implications for risk reduction through international diversification. Financial Analysts Journal, 32, 32-38.

Levy, H. & Sarnat, M. 1970. International diversification of investment portfolios. The American Economic Review, 60, 668-675.

Longin, F. & Solnik, B. 1995. Is the correlation in international equity returns constant: 1960–1990? Journal of International Money and Finance, 14, 3-26.

Milunovich, G. & Tan, A. 2012. Testing for contagion in US industry portfolios – a four-factor pricing approach. Applied Financial Economics, 23, 15-26.

Milunovich, G. & Trück, S. 2013. Regional and global contagion in real estate investment trusts. Journal of Property Investment & Finance, 31, 53-77.

Phylaktis, K. & Xia, L. 2009. Equity market comovement and contagion: a sectoral perspective. Financial Management, 38, 381-409.

Roll, R. 1992. Industrial structure and the comparative behavior of international stock market indices. Journal of Finance, 47, 3-41.

Schwert, G. W. 1989. Why does stock market volatility change over time? Journal of Finance, 44, 1115-1153.

Serra, A. P. 2000. Country and industry factors in returns: evidence from emerging markets' stocks. Emerging Markets Review, 1, 127-151.

Tables

Table 1. List of 31 countries and 5 regions covered in our sample. Europe, North America and Japan are developed regions. Latin America is a developing region. Asia-Pacific is a hybrid region, containing both developed and developing markets.

Asia-Pacific region	Latin America region	Europe region	North America region	Japan
Australia	Argentine	Austria	Canada	Japan
Hong Kong	Brazil	Belgium	United States	
Indonesia	Mexico	Denmark		
South Korea		Finland		
Malaysia		France		
New Zealand		Germany		
Philippines		Greece		
Singapore		Ireland		
Thailand		Italy		
		Netherland		
		Norway		
		Portugal		
		Spain		
		Sweden		
		Switzerland		
		United Kingdom		

Table 2. Descriptive statistics of industry portfolios formed across regions. This table presents the start dates, average weekly returns, standard deviations of returns, and average market capitalisations of 39 industries in 5 regions.

Asia-Pacific									
	Start date	Return (%)	Std Dev (%)	Market cap (million USD)		Start date	Return (%)	Std Dev (%)	Market cap (million USD)
Oil & Gas Producers	01/07/1981	0.07	3.05	40508.80	Tobacco	01/07/1981	0.21	3.28	7479.41
Oil Equipment & Services	01/07/1981	0.09	4.02	9266.19	Healthcare & Equipment	01/07/1981	0.06	2.70	6809.01
Alternative Energy	01/11/2000	0.65	7.48	5344.51	Pharmaceuticals & Biotechnology	01/07/1981	0.07	3.06	8526.75
Chemicals	01/07/1981	0.13	3.01	16887.17	Food & Drug Retailers	22/05/1996	-0.01	3.23	680.85
Forestry & Paper	01/07/1981	-0.07	2.70	3942.25	General Retailers	01/07/1981	0.11	2.48	27644.90
Industrial Metals & Mining	01/07/1981	0.10	3.80	27337.40	Media	01/07/1981	0.09	2.33	13287.08
Mining	01/07/1981	0.16	3.70	54741.32	Travel & Leisures	01/07/1981	0.01	2.42	39726.58
Construction & materials	01/07/1981	0.02	2.89	35094.13	Fixed Line Telecommunication	01/07/1981	0.28	3.61	30147.70
Aerospace & Defense	05/12/1984	0.22	4.26	2714.66	Mobile Telecommunication	15/01/1986	0.16	4.13	127894.10
General Industrials	01/07/1981	0.13	3.21	55664.32	Electricity	01/07/1981	0.06	2.82	28377.88
Electronic & Electric Equipment	01/07/1981	0.05	3.41	12868.72	Gas, Water & Multiutilities	01/07/1981	0.12	2.52	13774.85
Industrial Engineering	01/07/1981	-0.02	3.70	14478.29	Banks	01/07/1981	0.09	2.60	202078.51
Industrial Transportation	01/07/1981	0.00	2.23	21848.10	Nonlife Insurance	01/07/1981	0.15	2.91	11077.02
Support Services	01/07/1981	0.03	3.14	9174.72	Life Insurance	12/01/1983	0.17	3.53	14123.77
Auromobiles & Parts	01/07/1981	0.22	4.12	18227.66	Real Estate Investment & Services	01/07/1981	0.10	3.30	2873.94
Beverages	01/07/1981	0.15	2.35	8876.55	Real Estate Investment Trust	01/07/1981	0.08	2.54	18510.12
Food Producers	01/07/1981	0.04	2.03	25854.66	Financia Services	01/07/1981	0.05	3.26	30337.14
Household Goods & Home Construction	01/07/1981	-0.06	2.60	3577.38	Software & Computer Services	16/05/1984	0.12	3.68	11531.44
Leisure Goods	01/07/1981	0.06	3.64	5014.54	Technology Hardware & Equipment	11/07/1984	0.21	4.28	54849.40
Personal Goods	01/07/1981	0.07	2.50	14690.01					

Table 2. Continued

Latin America									
	Start date	Return (%)	Std Dev (%)	Market cap (million USD)		Start date	Return (%)	Std Dev (%)	Market cap (million USD)
Oil & Gas Producers	04/07/1990	0.34	5.08	47059.24	Tobacco	04/07/1990	0.47	4.67	3881.15
Oil Equipment & Services	11/01/1995	-0.07	5.53	1152.76	Healthcare & Equipment	24/03/1999	0.23	3.95	3037.30
Alternative Energy	29/11/2006	-1.00	8.28	427.53	Pharmaceuticals & Biotechnology	11/06/1997	0.27	5.85	379.59
Chemicals	04/07/1990	0.12	3.14	3436.94	Food & Drug Retailers	05/05/1993	0.03	3.48	1164.85
Forestry & Paper	11/08/1993	-0.24	3.50	1202.15	General Retailers	04/07/1990	0.21	3.73	25509.27
Industrial Metals & Mining	04/07/1990	0.32	4.47	19709.05	Media	14/07/1993	0.15	5.27	7261.30
Mining	16/02/1994	0.24	8.08	572.50	Travel & Leisures	04/07/1990	-0.15	2.23	870.75
Construction & materials	04/07/1990	0.16	4.44	12179.01	Fixed Line Telecommunication	22/05/1991	0.22	4.32	21815.02
Aerospace & Defense	20/07/1994	0.73	8.30	2475.94	Mobile Telecommunication	08/04/1992	0.27	5.38	23796.47
General Industrials	04/07/1990	0.35	5.27	7985.95	Electricity	01/12/1993	0.19	5.26	7123.76
Electronic & Electric Equipment	12/01/1994	0.49	7.07	3332.98	Gas, Water & Multiutilities	30/11/1994	0.14	5.91	5891.74
Industrial Engineering	07/04/1993	0.00	4.83	658.99	Banks	18/09/1991	0.13	3.89	28708.98
Industrial Transportation	04/07/1990	0.42	5.48	6027.13	Nonlife Insurance	04/07/1990	0.15	3.84	1289.90
Support Services	22/04/1992	0.04	3.61	370.65	Life Insurance	01/05/2002	0.14	2.03	488.35
Auromobiles & Parts	18/07/1990	-0.05	2.85	637.31	Real Estate Investment & Services	27/12/2006	0.16	7.50	1332.07
Beverages	04/07/1990	0.27	3.99	8070.10	Real Estate Investment Trust				18510.12
Food Producers	04/07/1990	-0.07	5.01	24289.05	Financia Services	04/07/1990	0.07	3.44	7042.90
Household Goods & Home Construction	15/01/1992	0.15	4.44	4311.36	Software & Computer Services	22/01/1992	0.41	5.14	1398.54
Leisure Goods	04/07/1990	0.28	5.70	183.26	Technology Hardware & Equipment	31/07/1996	-0.36	7.95	694.86
Personal Goods	04/07/1990	0.29	3.64	7081.02					

Table 2. Continued

Europe									
	Start date	Return (%)	Std Dev (%)	Market cap (million USD)		Start date	Return (%)	Std Dev (%)	Market cap (million USD)
Oil & Gas Producers	01/07/1981	0.21	3.02	329569.46	Tobacco	01/07/1981	0.34	3.42	33131.83
Oil Equipment & Services	01/07/1981	0.14	3.51	20292.27	Healthcare & Equipment	01/07/1981	0.17	2.38	29692.92
Alternative Energy	11/05/1988	0.19	4.69	12618.24	Pharmaceuticals & Biotechnology	01/07/1981	0.20	2.51	259348.99
Chemicals	01/07/1981	0.15	2.75	114024.63	Food & Drug Retailers	01/07/1981	0.16	3.56	8516.90
Forestry & Paper	01/07/1981	0.11	2.98	16434.13	General Retailers	01/07/1981	0.15	2.78	75495.35
Industrial Metals & Mining	01/07/1981	0.14	3.79	36767.45	Media	01/07/1981	0.14	2.92	118403.33
Mining	01/07/1981	0.24	4.32	68652.86	Travel & Leisures	01/07/1981	0.08	2.65	68192.44
Construction & materials	01/07/1981	0.11	2.84	109627.55	Fixed Line Telecommunication	01/07/1981	0.14	3.13	152439.21
Aerospace & Defense	01/07/1981	0.12	3.06	32821.31	Mobile Telecommunication	01/07/1981	0.19	3.40	142219.21
General Industrials	01/07/1981	0.14	3.43	74636.73	Electricity	01/07/1981	0.15	2.41	117493.16
Electronic & Electric Equipment	01/07/1981	0.09	2.88	34137.81	Gas, Water & Multiutilities	01/07/1981	0.16	2.64	114572.25
Industrial Engineering	01/07/1981	0.13	2.92	86560.24	Banks	01/07/1981	0.11	3.07	518474.84
Industrial Transportation	01/07/1981	0.12	2.44	56286.79	Nonlife Insurance	01/07/1981	0.13	3.23	161275.06
Support Services	01/07/1981	0.12	2.57	59138.52	Life Insurance	01/07/1981	0.16	3.73	97346.68
Auromobiles & Parts	01/07/1981	0.09	3.34	88081.38	Real Estate Investment & Services	09/07/1986	-0.05	3.36	2933.27
Beverages	01/07/1981	0.21	2.58	69571.17	Real Estate Investment Trust	01/07/1981	0.11	2.82	33393.36
Food Producers	01/07/1981	0.17	2.23	120746.33	Financia Services	01/07/1981	0.13	2.51	81970.12
Household Goods & Home Construction	01/07/1981	0.13	2.34	36976.45	Software & Computer Services	01/07/1981	0.14	3.39	62221.52
Leisure Goods	01/07/1981	0.08	2.86	5816.34	Technology Hardware & Equipment	01/07/1981	0.15	4.21	86334.17
Personal Goods	01/07/1981	0.20	2.82	81587.64					

Table 2. Continued

North America									
	Start date	Return (%)	Std Dev (%)	Market cap (million USD)		Start date	Return (%)	Std Dev (%)	Market cap (million USD)
Oil & Gas Producers	01/07/1981	0.16	2.85	451049.20	Tobacco	01/07/1981	0.31	3.30	73364.15
Oil Equipment & Services	01/07/1981	0.10	3.63	81628.34	Healthcare & Equipment	01/07/1981	0.13	2.59	211447.45
Alternative Energy	21/12/1983	0.19	7.28	3526.63	Pharmaceuticals & Biotechnology	01/07/1981	0.18	2.56	488294.34
Chemicals	01/07/1981	0.15	2.89	133351.67	Food & Drug Retailers	01/07/1981	0.18	2.86	47208.86
Forestry & Paper	01/07/1981	0.10	3.56	24004.23	General Retailers	01/07/1981	0.19	3.03	343880.83
Industrial Metals & Mining	01/07/1981	0.13	4.04	66997.36	Media	01/07/1981	0.14	3.02	223157.76
Mining	01/07/1981	0.11	4.00	51898.35	Travel & Leisures	01/07/1981	0.16	2.85	118388.52
Construction & materials	01/07/1981	0.11	2.86	43868.57	Fixed Line Telecommunication	01/07/1981	0.16	2.60	199177.94
Aerospace & Defense	01/07/1981	0.14	2.66	111877.85	Mobile Telecommunication	01/07/1981	0.12	3.39	38560.67
General Industrials	01/07/1981	0.16	3.19	205378.80	Electricity	01/07/1981	0.15	2.09	166473.50
Electronic & Electric Equipment	01/07/1981	0.11	3.58	93670.52	Gas, Water & Multiutilities	01/07/1981	0.13	1.97	65030.33
Industrial Engineering	01/07/1981	0.13	2.98	98581.95	Banks	01/07/1981	0.14	3.19	511913.11
Industrial Transportation	01/07/1981	0.16	2.86	91375.54	Nonlife Insurance	01/07/1981	0.14	2.68	205746.34
Support Services	01/07/1981	0.09	2.53	127037.16	Life Insurance	01/07/1981	0.19	3.18	85829.07
Auromobiles & Parts	01/07/1981	0.16	3.54	60155.71	Real Estate Investment & Services	30/06/1993	0.16	6.13	5135.23
Beverages	01/07/1981	0.20	2.49	138345.41	Real Estate Investment Trust	01/07/1981	0.13	3.86	5728.29
Food Producers	01/07/1981	0.18	2.05	121718.82	Financia Services	01/07/1981	0.19	3.66	235869.27
Household Goods & Home Construction	01/07/1981	0.15	2.41	118111.48	Software & Computer Services	01/07/1981	0.16	3.32	403328.09
Leisure Goods	01/07/1981	0.14	3.19	22995.50	Technology Hardware & Equipment	01/07/1981	0.19	4.18	511251.92
Personal Goods	01/07/1981	0.19	2.53	82387.25					

Table 2. Continued

Japan									
	Start date	Return (%)	Std Dev (%)	Market cap (million USD)		Start date	Return (%)	Std Dev (%)	Market cap (million USD)
Oil & Gas Producers	01/07/1981	0.08	4.11	25781.47	Tobacco	09/11/1994	0.13	4.29	24650.84
Oil Equipment & Services	01/07/1981	-0.06	6.55	526.85	Healthcare & Equipment	01/07/1981	0.07	3.21	11241.76
Alternative Energy	18/11/1998	0.35	6.46	247.93	Pharmaceuticals & Biotechnology	01/07/1981	0.11	3.01	82176.27
Chemicals	01/07/1981	0.07	3.30	92874.14	Food & Drug Retailers	09/08/1989	0.14	4.10	4013.08
Forestry & Paper	01/07/1981	0.05	3.62	12005.11	General Retailers	01/07/1981	0.10	3.17	76994.97
Industrial Metals & Mining	01/07/1981	0.03	3.63	62536.82	Media	01/07/1981	0.08	3.35	25311.82
Mining	01/07/1981	0.02	4.55	1737.51	Travel & Leisures	01/07/1981	0.05	2.80	88594.14
Construction & materials	01/07/1981	0.02	3.19	89448.65	Fixed Line Telecommunication	01/07/1981	0.18	4.76	81128.08
Aerospace & Defense	01/07/1981	0.05	4.80	713.29	Mobile Telecommunication	15/09/1993	0.08	4.94	119029.91
General Industrials	01/07/1981	0.05	3.73	28235.55	Electricity	01/07/1981	0.11	3.58	81749.94
Electronic & Electric Equipment	01/07/1981	0.06	3.50	113606.32	Gas, Water & Multiutilities	01/07/1981	0.07	3.52	18548.15
Industrial Engineering	01/07/1981	0.07	3.37	114259.07	Banks	01/07/1981	0.07	4.05	240830.96
Industrial Transportation	01/07/1981	0.05	3.31	38499.80	Nonlife Insurance	01/07/1981	0.10	4.24	37109.93
Support Services	01/07/1981	0.11	3.68	63457.01	Life Insurance	10/04/2002	0.11	4.75	15746.73
Auromobiles & Parts	01/07/1981	0.10	3.28	195495.20	Real Estate Investment & Services	02/12/1981	0.15	5.33	2326.42
Beverages	01/07/1981	0.09	2.95	20786.75	Real Estate Investment Trust	19/09/2001	0.21	3.06	20124.67
Food Producers	01/07/1981	0.05	2.68	42538.57	Financia Services	01/07/1981	0.09	4.56	114296.71
Household Goods & Home Construction	01/07/1981	0.07	3.09	30915.59	Software & Computer Services	01/07/1981	0.10	4.33	39256.83
Leisure Goods	01/07/1981	0.04	3.62	98611.97	Technology Hardware & Equipment	01/07/1981	0.08	3.81	109310.57
Personal Goods	01/07/1981	0.05	2.61	38142.33					

Table 3. Industry names and the equivalent codes

Code	Full industry name	Code	Full industry name
OILGP	Oil & Gas Producers	TOBAC	Tobacco
OILES	Oil Equipment & Services	HCEQS	Healthcare & Equipment
ALTEN	Alternative Energy	PHARM	Pharmaceuticals & Biotechnology
CHMCL	Chemicals	FDRGR	Food & Drug Retailers
FSTPA	Forestry & Paper	GNRET	General Retailers
INDMT	Industrial Metals & Mining	MEDIA	Media
MNING	Mining	TRLES	Travel & Leisures
CNSTM	Construction & materials	TELFL	Fixed Line Telecommunication
AERSP	Aerospace & Defense	TELMB	Mobile Telecommunication
GNIND	General Industrials	ELECT	Electricity
ELTNC	Electronic & Electric Equipment	GWMUT	Gas, Water & Multiutilities
INDEN	Industrial Engineering	BANKS	Banks
INDTR	Industrial Transportation	NLINS	Nonlife Insurance
SUPSV	Support Services	LFINS	Life Insurance
AUTMB	Auromobiles & Parts	RLISV	Real Estate Investment & Services
BEVES	Beverages	REITS	Real Estate Investment Trust
FOODS	Food Producers	FNSVS	Financia Services
HHOLD	Household Goods & Home Construction	SFTCS	Software & Computer Services
LEISG	Leisure Goods	TECHD	Technology Hardware & Equipment
PERSG	Personal Goods		

Table 4. reports the computed $RMSE_{CORR}$ using formula (10) for six-factor and eight-factor model for five regions

	Asia-Pacific	Latin America	Europe	North America	Japan
Six-factor model	0.137	0.295	0.078	0.088	0.116
Eight-factor model	0.122	0.290	0.068	0.074	0.097

Table 5. presents the time-series mean of the difference between world beta and regional beta of the same risk factor. The results in this table are from betas estimated using the six-factor model. For each region, the column MKT reports the time-series average of $(\beta_\tau^{WMKT} - \beta_\tau^{RMKT})$, the column SMB reports the time-series average of $(\beta_\tau^{WSMB} - \beta_\tau^{RSMB})$, and the column HML reports the time-series average of $(\beta_\tau^{WHML} - \beta_\tau^{RHML})$

Asia-Pacific							
	MKT	SMB	HML		MKT	SMB	HML
OILGP	-0.454	-0.517	0.188	TOBAC	-0.212	-0.346	0.121
OILES	0.017	-0.662	0.232	HCEQS	0.154	-0.484	0.176
ALTEN	-0.508	-1.029	-0.246	PHARM	-0.604	-0.987	-0.165
CHMCL	-0.792	-1.044	-0.184	FDRGR	-0.329	-0.096	0.451
FSTPA	-0.461	-0.850	-0.012	GNRET	-0.108	-0.649	0.059
INDMT	0.131	-0.803	0.129	MEDIA	0.013	-0.597	-0.025
MNING	0.530	-0.321	0.423	TRLES	0.024	-0.510	0.017
CNSTM	-0.603	-0.885	-0.073	TELFL	0.282	-0.488	0.038
AERSP	0.159	-0.188	0.113	TELMB	-0.323	-0.137	0.180
GNIND	0.489	-0.482	-0.138	ELECT	0.468	-0.475	-0.252
ELTNC	-0.888	-1.010	-0.303	GWMUT	0.145	-0.419	-0.045
INDEN	-0.827	-1.168	-0.238	BANKS	0.045	-0.319	0.014
INDTR	-0.107	-0.467	-0.004	NLINS	-0.535	-0.548	-0.032
SUPSV	-0.798	-0.869	-0.129	LFINS	-0.349	-0.254	0.042
AUTMB	-0.926	-0.798	-0.273	RLISV	0.143	-0.412	0.126
BEVES	-0.029	-0.437	0.058	REITS	-0.128	-0.265	0.174
FOODS	-0.403	-0.615	-0.034	FNSVS	-0.616	-0.932	-0.240
HHOLD	-0.041	-0.903	-0.044	SFTCS	-0.616	-1.081	-0.198
LEISG	-0.947	-1.365	-0.271	TECHD	-0.541	-0.808	-0.276
PERSG	-0.592	-0.563	-0.100				

Latin America							
	MKT	SMB	HML		MKT	SMB	HML
OILGP	0.319	0.046	-0.028	TOBAC	0.028	-0.333	-0.043
OILES	-0.003	-0.022	0.036	HCEQS	-0.058	-0.260	-0.041
ALTEN	-0.215	-0.244	0.064	PHARM	0.117	-0.095	0.191
CHMCL	0.287	-0.311	-0.111	FDRGR	-0.112	-0.428	0.130
FSTPA	-0.014	-0.153	0.071	GNRET	0.047	-0.171	0.087
INDMT	0.315	-0.283	-0.085	MEDIA	0.243	-0.002	0.137
MNING	0.096	-0.205	0.080	TRLES	-0.254	-0.387	0.113
CNSTM	0.591	-0.043	0.026	TELFL	-0.125	-0.036	0.132
AERSP	-0.024	-0.512	0.144	TELMB	0.326	-0.095	0.010
GNIND	0.392	-0.097	0.090	ELECT	0.021	-0.377	-0.016
ELTNC	-0.102	-0.265	-0.058	GWMUT	-0.103	-0.572	-0.003
INDEN	-0.075	-0.447	0.013	BANKS	-0.075	-0.254	-0.034
INDTR	0.100	-0.360	0.136	NLINS	0.006	-0.372	0.087
SUPSV	-0.193	-0.037	0.092	LFINS	-0.017	-0.036	0.049
AUTMB	-0.097	-0.294	-0.043	RLISV	-0.060	-0.310	0.017
BEVES	0.061	-0.094	0.056	REITS	-	-	-
FOODS	0.369	-0.488	-0.018	FNSVS	-0.075	-0.293	0.079
HHOLD	-0.116	-0.673	0.077	SFTCS	-0.133	-0.377	0.125
LEISG	-0.128	-0.445	0.150	TECHD	-0.255	-0.570	-0.288
PERSG	0.079	-0.296	0.137				

Table 5. Continued

Europe							
	MKT	SMB	HML		MKT	SMB	HML
OILGP	0.063	0.047	0.239	TOBAC	0.138	0.243	0.241
OILES	0.015	-0.670	0.149	HCEQS	-0.036	-0.319	0.283
ALTEN	-0.121	-0.713	0.084	PHARM	0.126	0.253	0.341
CHMCL	0.037	-0.093	0.137	FDRGR	-0.109	0.118	0.322
FSTPA	0.107	-0.420	0.140	GNRET	-0.077	-0.098	0.210
INDMT	0.087	-0.471	0.141	MEDIA	0.032	-0.112	0.206
MNING	0.244	-0.283	0.299	TRLES	0.001	-0.276	0.177
CNSTM	-0.017	-0.208	0.070	TELFL	-0.102	0.172	0.021
AERSP	-0.039	-0.049	0.051	TELMB	-0.004	0.273	0.142
GNIND	0.246	0.084	0.034	ELECT	-0.158	-0.216	0.071
ELTNC	-0.051	-0.278	0.224	GWMUT	-0.058	-0.015	0.190
INDEN	0.046	-0.251	0.197	BANKS	0.099	-0.033	0.040
INDTR	-0.111	-0.367	0.124	NLINS	0.109	0.096	0.147
SUPSV	-0.064	-0.329	0.269	LFINS	0.086	0.044	0.158
AUTMB	0.135	-0.066	-0.032	RLISV	0.149	-0.719	0.188
BEVES	-0.035	-0.076	0.285	REITS	-0.113	-0.363	0.204
FOODS	-0.116	-0.078	0.332	FNSVS	0.064	-0.387	0.162
HHOLD	-0.091	-0.420	0.182	SFTCS	0.048	-0.402	0.198
LEISG	-0.085	-0.605	0.136	TECHD	0.285	0.074	0.214
PERSG	0.132	-0.023	0.209				

North America							
	MKT	SMB	HML		MKT	SMB	HML
OILGP	0.071	-0.087	-0.245	TOBAC	-0.049	0.370	0.147
OILES	0.157	-0.363	-0.326	HCEQS	-0.059	-0.033	0.085
ALTEN	0.013	-0.906	-0.042	PHARM	0.099	0.441	0.090
CHMCL	0.169	-0.082	-0.065	FDRGR	-0.031	0.145	0.011
FSTPA	0.168	-0.225	-0.002	GNRET	-0.114	0.079	0.046
INDMT	0.303	-0.499	-0.191	MEDIA	0.024	-0.019	0.012
MNING	0.397	-0.646	-0.230	TRLES	-0.039	-0.182	0.025
CNSTM	0.057	-0.372	-0.090	TELFL	0.035	0.323	-0.088
AERSP	-0.077	-0.005	0.006	TELMB	0.155	0.002	-0.064
GNIND	-0.124	0.452	0.087	ELECT	-0.064	0.193	-0.135
ELTNC	0.013	-0.313	0.010	GWMUT	-0.029	0.086	-0.158
INDEN	0.115	-0.312	-0.057	BANKS	-0.132	0.040	-0.106
INDTR	0.018	-0.212	-0.027	NLINS	-0.059	0.262	-0.087
SUPSV	0.026	-0.208	0.030	LFINS	0.019	-0.061	-0.048
AUTMB	0.130	-0.014	0.000	RLISV	0.224	-0.188	0.004
BEVES	-0.013	0.504	-0.019	REITS	0.135	-0.250	-0.006
FOODS	-0.054	0.209	-0.018	FNSVS	-0.098	0.092	-0.123
HHOLD	-0.060	0.142	0.011	SFTCS	0.041	0.167	0.116
LEISG	-0.096	-0.341	-0.084	TECHD	-0.066	-0.165	0.138
PERSG	-0.070	0.024	0.061				

Table 5. Continued

Japan							
	MKT	SMB	HML		MKT	SMB	HML
OILGP	-0.027	-0.082	-0.021	TOBAC	-0.148	0.072	-0.155
OILES	-0.010	-0.498	0.049	HCEQS	-0.178	-0.111	-0.067
ALTEN	-0.055	-0.357	0.165	PHARM	-0.160	0.172	-0.026
CHMCL	-0.099	-0.105	-0.031	FDRGR	-0.353	-0.224	-0.038
FSTPA	-0.152	-0.089	-0.073	GNRET	-0.162	-0.067	-0.061
INDMT	-0.056	-0.013	0.048	MEDIA	-0.235	0.076	-0.102
MNING	-0.024	-0.433	0.216	TRLES	-0.204	-0.003	-0.086
CNSTM	-0.195	-0.155	0.033	TELFL	-0.129	0.219	-0.123
AERSP	-0.246	-0.384	0.276	TELMB	-0.014	0.283	0.044
GNIND	-0.105	0.139	-0.045	ELECT	-0.200	0.157	-0.176
ELTNC	-0.078	0.182	-0.058	GWMUT	-0.209	0.114	-0.250
INDEN	-0.110	-0.035	0.021	BANKS	-0.206	0.270	0.272
INDTR	-0.215	-0.020	0.020	NLINS	-0.169	0.325	0.045
SUPSV	-0.178	0.040	-0.039	LFINS	-0.024	0.139	0.046
AUTMB	0.008	0.353	-0.173	RLISV	-0.023	-0.591	0.503
BEVES	-0.114	-0.075	-0.127	REITS	0.010	0.026	0.066
FOODS	-0.232	-0.175	-0.043	FNSVS	-0.175	0.349	0.290
HHOLD	-0.181	-0.142	-0.010	SFTCS	-0.178	-0.226	0.292
LEISG	0.092	0.419	-0.050	TECHD	0.016	0.369	0.092
PERSG	-0.122	-0.152	-0.090		-0.148	0.072	-0.155

Table 6. presents the time-series mean of the difference between world beta and regional beta of the same risk factor. The results in this table are from betas estimated using the eight-factor model. For each region, the column MKT reports the time-series average of $(\beta_{\tau}^{WMKT} - \beta_{\tau}^{RMKT})$, the column SMB reports the time-series average of $(\beta_{\tau}^{WSMB} - \beta_{\tau}^{RSMB})$, and the column HML reports the time-series average of $(\beta_{\tau}^{WHML} - \beta_{\tau}^{RHML})$, the column WML reports the time-series average of $(\beta_{\tau}^{WWML} - \beta_{\tau}^{RWML})$.

Asia-Pacific									
	MKT	SMB	HML	WML		MKT	SMB	HML	WML
OILGP	-0.615	-0.453	0.172	-0.011	TOBAC	-0.236	-0.430	-0.096	-0.171
OILES	0.059	-0.781	0.196	0.101	HCEQS	-0.103	-0.569	0.199	-0.085
ALTEN	-0.794	-0.021	0.054	-0.049	PHARM	-0.451	-0.978	-0.054	-0.088
CHMCL	-0.745	-0.943	-0.018	0.028	FDRGR	-0.459	-0.136	-0.179	-0.047
FSTPA	-0.478	-0.946	-0.040	-0.077	GNRET	-0.145	-0.725	0.093	-0.058
INDMT	0.163	-0.632	0.196	-0.098	MEDIA	-0.039	-0.675	-0.032	-0.052
MNING	0.488	-0.344	0.385	-0.030	TRLES	-0.015	-0.522	-0.036	-0.007
CNSTM	-0.518	-0.887	-0.089	-0.084	TELFL	0.587	-0.546	0.102	0.036
AERSP	0.111	-0.495	0.348	0.038	TELMB	-0.740	-0.141	-0.056	-0.167
GNIND	0.386	-0.582	-0.207	-0.003	ELECT	0.461	-0.369	-0.168	0.004
ELTNC	-0.787	-0.840	-0.176	0.023	GWMUT	0.034	-0.439	-0.124	-0.042
INDEN	-0.810	-0.993	-0.191	0.014	BANKS	-0.028	-0.386	-0.005	-0.028
INDTR	-0.108	-0.493	-0.012	0.002	NLINS	-0.547	-0.487	0.048	-0.201
SUPSV	-0.752	-0.801	-0.041	0.019	LFINS	-0.449	-0.371	0.098	-0.115
AUTMB	-0.757	-0.781	-0.257	-0.073	RLISV	0.031	-0.584	0.090	-0.090
BEVES	-0.131	-0.616	0.005	0.058	REITS	-0.274	-0.322	0.207	-0.032
FOODS	-0.472	-0.622	-0.038	-0.046	FNSVS	-0.627	-0.817	-0.213	-0.118
HHOLD	-0.185	-0.954	-0.100	-0.032	SFTCS	-0.590	-1.193	-0.180	-0.041
LEISG	-0.796	-1.298	-0.241	0.040	TECHD	-0.489	-0.625	-0.077	-0.018
PERSG	-0.460	-0.614	-0.127	-0.078					

Latin America									
	MKT	SMB	HML	WML		MKT	SMB	HML	WML
OILGP	0.320	0.037	-0.070	0.137	TOBAC	0.064	-0.379	-0.049	0.025
OILES	-0.031	-0.033	0.072	-0.031	HCEQS	-0.038	-0.210	-0.027	-0.044
ALTEN	-0.008	-0.078	0.234	0.145	PHARM	-0.018	-0.118	0.120	0.017
CHMCL	0.214	-0.397	-0.051	0.013	FDRGR	-0.016	-0.451	0.099	0.059
FSTPA	-0.019	-0.191	0.090	0.036	GNRET	0.293	-0.130	0.046	0.006
INDMT	0.510	-0.208	-0.102	0.101	MEDIA	0.201	0.015	0.088	-0.004
MNING	0.158	-0.277	0.521	-0.262	TRLES	0.057	-0.126	0.085	0.027
CNSTM	0.297	-0.236	0.057	-0.008	TELFL	0.167	0.102	0.112	-0.010
AERSP	-0.050	-0.545	0.031	-0.197	TELMB	0.325	-0.025	0.095	-0.067
GNIND	0.272	-0.186	0.040	-0.037	ELECT	-0.136	-0.468	-0.037	-0.014
ELTNC	-0.050	-0.350	-0.052	-0.185	GWMUT	0.196	-0.856	0.524	-0.322
INDEN	-0.008	-0.487	-0.017	0.057	BANKS	-0.054	-0.277	-0.061	-0.099
INDTR	0.275	-0.287	0.133	-0.038	NLINS	-0.087	-0.413	0.066	-0.029
SUPSV	-0.154	-0.120	0.087	0.106	LFINS	-0.072	-0.061	-0.012	0.024
AUTMB	-0.078	-0.267	0.034	-0.027	RLISV	-0.048	-0.260	-0.013	-0.013
BEVES	0.110	-0.132	-0.030	0.047	REITS	-	-	-	-
FOODS	0.421	-0.278	-0.069	0.060	FNSVS	-0.064	-0.306	0.057	-0.021
HHOLD	-0.121	-0.654	0.135	0.082	SFTCS	-0.100	-0.420	0.025	0.016
LEISG	-0.248	-0.586	0.055	0.161	TECHD	-0.431	-0.378	-0.351	0.350
PERSG	0.231	-0.299	0.121	0.021					

Table 6. Continued

Europe									
	MKT	SMB	HML	WML		MKT	SMB	HML	WML
OILGP	0.052	0.076	0.235	-0.010	TOBAC	0.218	0.188	0.210	-0.129
OILES	-0.049	-0.633	0.155	0.026	HCEQS	-0.032	-0.322	0.240	-0.070
ALTEN	-0.049	-0.744	0.092	0.099	PHARM	0.142	0.232	0.330	-0.067
CHMCL	0.009	-0.102	0.136	0.064	FDRGR	-0.007	0.167	0.368	-0.033
FSTPA	0.095	-0.466	0.082	-0.063	GNRET	-0.125	-0.116	0.144	-0.040
INDMT	0.070	-0.383	0.115	0.079	MEDIA	0.009	-0.113	0.190	-0.057
MNING	0.298	-0.209	0.273	0.086	TRLES	0.008	-0.302	0.198	0.045
CNSTM	0.008	-0.215	0.083	0.027	TELFL	-0.104	0.174	0.013	-0.048
AERSP	-0.053	-0.062	0.031	-0.031	TELMB	0.062	0.239	0.158	-0.005
GNIND	0.210	0.088	0.058	0.003	ELECT	-0.158	-0.226	0.140	0.009
ELTNC	-0.074	-0.306	0.240	0.031	GWMUT	-0.050	-0.028	0.278	0.007
INDEN	0.055	-0.241	0.163	0.037	BANKS	0.078	-0.040	0.074	0.019
INDTR	-0.086	-0.361	0.109	0.017	NLINS	0.097	0.080	0.115	0.007
SUPSV	-0.052	-0.363	0.239	-0.009	LFINS	0.095	0.011	0.107	-0.074
AUTMB	0.124	-0.068	-0.170	-0.092	RLISV	0.071	-0.728	0.100	-0.101
BEVES	0.041	-0.139	0.288	-0.097	REITS	-0.149	-0.393	0.144	-0.076
FOODS	-0.064	-0.117	0.365	-0.066	FNSVS	0.050	-0.391	0.127	-0.020
HHOLD	-0.096	-0.419	0.152	0.044	SFTCS	0.009	-0.396	0.171	0.003
LEISG	-0.091	-0.581	0.086	0.023	TECHD	0.302	0.038	0.304	-0.013
PERSG	0.133	-0.021	0.196	-0.042					

North America									
	MKT	SMB	HML	WML		MKT	SMB	HML	WML
OILGP	0.033	-0.048	-0.332	-0.111	TOBAC	0.029	0.304	0.062	-0.050
OILES	0.125	-0.398	-0.383	-0.080	HCEQS	-0.064	-0.048	0.123	-0.012
ALTEN	0.004	-0.887	0.022	0.250	PHARM	0.072	0.419	0.057	-0.005
CHMCL	0.122	-0.110	-0.084	0.006	FDRGR	-0.047	0.041	0.019	0.071
FSTPA	0.145	-0.273	-0.049	0.013	GNRET	-0.075	0.061	0.027	0.055
INDMT	0.206	-0.409	-0.258	-0.150	MEDIA	0.042	-0.029	-0.019	-0.049
MNING	0.392	-0.593	-0.228	-0.044	TRLES	-0.031	-0.152	0.013	0.016
CNSTM	0.042	-0.382	-0.112	-0.009	TELFL	0.052	0.335	-0.070	-0.009
AERSP	-0.065	-0.026	0.014	0.051	TELMB	0.150	-0.089	0.030	0.115
GNIND	-0.115	0.365	0.068	-0.084	ELECT	-0.066	0.194	-0.105	-0.046
ELTNC	0.007	-0.249	0.108	0.100	GWMUT	-0.038	0.078	-0.153	-0.009
INDEN	0.102	-0.300	-0.029	0.014	BANKS	-0.048	0.016	-0.089	-0.061
INDTR	-0.019	-0.208	-0.010	0.010	NLINS	-0.029	0.283	-0.144	-0.084
SUPSV	0.027	-0.234	0.052	0.039	LFINS	0.027	-0.065	-0.096	-0.078
AUTMB	0.123	-0.027	0.008	-0.072	RLISV	0.284	-0.206	-0.130	0.009
BEVES	0.068	0.442	-0.042	-0.067	REITS	0.054	-0.273	-0.001	-0.039
FOODS	-0.033	0.136	-0.038	-0.066	FNSVS	-0.048	0.062	-0.121	-0.056
HHOLD	-0.013	0.067	0.026	0.022	SFTCS	0.021	0.168	0.110	0.034
LEISG	-0.094	-0.361	-0.082	-0.023	TECHD	-0.097	-0.079	0.176	-0.019
PERSG	-0.031	0.012	0.058	-0.059					

Table 6. Continued

Japan									
	MKT	SMB	HML	WML		MKT	SMB	HML	WML
OILGP	-0.110	-0.098	0.002	0.121	TOBAC	-0.107	0.089	-0.175	-0.184
OILES	0.032	-0.473	0.321	0.109	HCEQS	-0.150	-0.128	-0.086	0.131
ALTEN	-0.026	-0.224	-0.068	-0.087	PHARM	-0.142	0.185	-0.012	0.021
CHMCL	-0.115	-0.090	-0.066	0.035	FDRGR	-0.310	-0.228	-0.094	-0.057
FSTPA	-0.159	-0.108	0.072	0.112	GNRET	-0.125	-0.052	-0.032	-0.011
INDMT	-0.111	0.007	0.044	0.169	MEDIA	-0.247	0.079	-0.084	0.080
MNING	-0.059	-0.346	0.145	0.218	TRLES	-0.192	0.007	-0.038	-0.009
CNSTM	-0.181	-0.166	-0.050	0.067	TELFL	-0.019	0.256	-0.126	-0.204
AERSP	-0.247	-0.317	0.225	0.104	TELMB	0.035	0.302	0.036	0.011
GNIND	-0.132	0.106	-0.052	0.052	ELECT	-0.192	0.164	-0.087	0.140
ELTNC	-0.085	0.137	-0.122	0.045	GWMUT	-0.166	0.118	-0.251	0.036
INDEN	-0.140	-0.044	0.020	0.057	BANKS	-0.158	0.270	0.356	0.057
INDTR	-0.195	-0.022	-0.023	0.052	NLINS	-0.164	0.307	0.089	0.077
SUPSV	-0.193	0.072	-0.009	0.102	LFINS	-0.054	0.023	0.111	0.065
AUTMB	-0.032	0.304	-0.250	0.069	RLISV	-0.107	-0.671	0.654	-0.069
BEVES	-0.162	-0.085	-0.069	0.033	REITS	0.007	0.060	0.072	-0.043
FOODS	-0.227	-0.181	-0.030	0.026	FNSVS	-0.134	0.324	0.360	0.167
HHOLD	-0.184	-0.145	-0.053	0.123	SFTCS	-0.143	-0.221	0.299	0.020
LEISG	0.080	0.347	-0.073	0.120	TECHD	0.028	0.326	0.060	0.041
PERSG	-0.134	-0.169	-0.052	0.021					

Table 7. presents the estimated results of equation (11) which tests for trend and structural breaks during the five crises in global and regional betas. The betas here are estimated using six-factor model. Panel A presents the estimated results for world betas. Panel B presents the estimated results for regional betas. For each beta, we report the coefficient on the linear time trend and coefficients on five crisis dummies. (*) means significant at 10% level, (**) means coefficient is significant at 5% level and (***) means coefficient is significant at 1% level.

Panel A. World betas

		Asia-Pacific		Latin America		Europe		North America		Japan	
		Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
MKT	c	-0.013	*0.704*	-0.027	*0.764*	-0.005	*0.834*	-0.003	*0.913*	-0.002	*0.943*
	TR	0.000	*0.968*	0.000	*0.970*	0.000	*0.992*	0.000	*0.997*	0.000	*0.997*
	Mex	0.049	*0.593*	0.473**	*0.028*	0.001	*0.993*	-0.026	*0.762*	-0.008	*0.927*
	Asian	0.145	*0.115*	0.007	*0.971*	0.020	*0.752*	-0.055	*0.523*	-0.004	*0.961*
	Argen debt	0.075	*0.403*	0.110	*0.594*	0.037	*0.560*	-0.013	*0.882*	-0.050	*0.539*
	GFC	0.031	*0.600*	-0.010	*0.934*	0.021	*0.622*	0.087	*0.119*	0.041	*0.436*
	EU debt	0.003	*0.970*	0.009	*0.960*	0.034	*0.595*	-0.017	*0.841*	0.022	*0.782*
SMB	c	0.009	*0.714*	0.009	*0.902*	-0.012	*0.479*	-0.017	*0.463*	0.003	*0.923*
	TR	0.000	*0.936*	0.000	*0.928*	0.000	*0.981*	0.000	*0.945*	0.000	*0.966*
	Mex	-0.025	*0.706*	-0.256	*0.143*	0.007	*0.877*	-0.007	*0.916*	-0.039	*0.643*
	Asian	0.046	*0.488*	0.068	*0.683*	-0.019	*0.692*	-0.017	*0.785*	-0.019	*0.817*
	Argen debt	-0.138**	*0.033*	0.006	*0.973*	-0.070	*0.135*	-0.017	*0.790*	0.032	*0.688*
	GFC	-0.031	*0.469*	0.022	*0.828*	0.137***	*0.000*	0.237***	*0.000*	-0.001	*0.985*
	EU debt	-0.017	*0.794*	0.012	*0.940*	0.096**	*0.039*	-0.003	*0.960*	-0.089	*0.267*
HML	c	-0.016	*0.700*	-0.034	*0.683*	-0.002	*0.957*	0.000	*0.995*	-0.006	*0.877*
	TR	0.000	*0.984*	0.000	*0.974*	0.000	*0.961*	0.000	*0.948*	0.000	*0.991*
	Mex	0.124	*0.276*	-0.029	*0.882*	0.001	*0.991*	-0.012	*0.897*	-0.064	*0.543*
	Asian	0.343***	*0.002*	-0.094	*0.621*	-0.039	*0.622*	0.121	*0.193*	0.040	*0.705*
	Argen debt	0.075	*0.499*	0.444**	*0.023*	0.069	*0.378*	0.133	*0.151*	0.222**	*0.029*
	GFC	0.020	*0.780*	0.120	*0.299*	-0.003	*0.947*	-0.081	*0.181*	0.037	*0.573*
	EU debt	-0.132	*0.237*	0.100	*0.566*	-0.012	*0.874*	-0.089	*0.335*	-0.136	*0.182*

Table 7. Continued

Panel B. Regional betas

		Asia-Pacific		Latin America		Europe		North America		Japan	
		Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
MKT	c	0.007	*0.925*	-0.065	*0.619*	-0.003	*0.885*	-0.008	*0.761*	-0.005	*0.807*
	TR	0.000	*0.942*	0.000	*0.948*	0.000	*0.994*	0.000	*0.919*	0.000	*0.992*
	Mex	-0.043	*0.840*	0.258	*0.405*	0.016	*0.754*	-0.005	*0.943*	0.070	*0.190*
	Asian	0.375*	*0.074*	-0.019	*0.947*	0.027	*0.586*	-0.018	*0.803*	-0.001	*0.983*
	Argen debt	0.123	*0.550*	0.389	*0.201*	-0.040	*0.421*	0.000	*0.995*	-0.013	*0.801*
	GFC	-0.105	*0.437*	0.128	*0.477*	0.006	*0.852*	0.098**	*0.038*	0.033	*0.323*
	EU debt	-0.257	*0.213*	0.229	*0.400*	0.058	*0.239*	0.090	*0.215*	0.005	*0.921*
SMB	c	-0.010	*0.818*	-0.033	*0.591*	-0.006	*0.814*	0.014	*0.580*	0.007	*0.780*
	TR	0.000	*0.924*	0.000	*0.990*	0.000	*0.949*	0.000	*0.978*	0.000	*0.971*
	Mex	0.027	*0.825*	-0.254*	*0.084*	-0.137**	*0.043*	0.005	*0.939*	-0.012	*0.854*
	Asian	0.014	*0.906*	-0.016	*0.911*	0.125*	*0.066*	-0.041	*0.560*	-0.004	*0.954*
	Argen debt	0.146	*0.222*	0.131	*0.355*	0.109	*0.107*	-0.047	*0.497*	-0.060	*0.349*
	GFC	0.007	*0.933*	0.204**	*0.018*	0.026	*0.554*	-0.136***	*0.003*	-0.045	*0.283*
	EU debt	-0.006	*0.958*	0.171	*0.188*	-0.026	*0.706*	-0.023	*0.736*	0.016	*0.800*
HML	c	-0.011	*0.815*	-0.004	*0.931*	0.008	*0.817*	0.009	*0.755*	-0.004	*0.919*
	TR	0.000	*0.952*	0.000	*0.957*	0.000	*0.963*	0.000	*0.932*	0.000	*0.974*
	Mex	-0.066	*0.626*	0.175	*0.135*	-0.022	*0.810*	-0.007	*0.928*	0.036	*0.763*
	Asian	-0.028	*0.833*	-0.266**	*0.017*	-0.070	*0.443*	0.095	*0.250*	-0.011	*0.925*
	Argen debt	0.177	*0.179*	0.180	*0.115*	0.086	*0.345*	0.112	*0.176*	0.046	*0.685*
	GFC	0.115	*0.179*	-0.044	*0.523*	-0.043	*0.471*	-0.187***	*0.001*	0.052	*0.486*
	EU debt	-0.113	*0.392*	0.095	*0.361*	-0.162*	*0.077*	-0.083	*0.316*	-0.108	*0.341*

Table 8. presents the estimated results of equation (11) which tests for trend and structural breaks during the five crises in global and regional betas. The betas here are estimated using eight-factor model. Panel A presents the estimated results for world betas. Panel B presents the estimated results for regional betas. For each beta, we report the coefficient on the linear time trend and coefficients on five crisis dummies. (*) means significant at 10% level, (**) means coefficient is significant at 5% level and (***) means coefficient is significant at 1% level.

Panel A. World betas

		Asia-Pacific		Latin America		Europe		North America		Japan	
		Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
MKT	c	-0.018	*0.718*	-0.025	*0.780*	0.000	*0.992*	0.001	*0.979*	-0.001	*0.985*
	TR	0.000	*0.985*	0.000	*0.939*	0.000	*0.998*	0.000	*0.998*	0.000	*1.000*
	Mex	0.031	*0.821*	0.530**	*0.015*	0.026	*0.709*	-0.028	*0.754*	-0.001	*0.989*
	Asian	0.206	*0.133*	0.127	*0.537*	0.070	*0.309*	-0.060	*0.506*	0.009	*0.928*
	Argen debt	0.096	*0.477*	-0.008	*0.967*	-0.024	*0.724*	0.028	*0.753*	-0.066	*0.490*
	GFC	0.061	*0.484*	-0.078	*0.539*	-0.047	*0.297*	0.035	*0.551*	0.025	*0.692*
	EU debt	0.030	*0.824*	0.050	*0.791*	0.036	*0.603*	-0.055	*0.539*	0.016	*0.862*
SMB	c	0.018	*0.740*	0.018	*0.809*	-0.007	*0.702*	-0.009	*0.718*	0.004	*0.891*
	TR	0.000	*0.970*	0.000	*0.904*	0.000	*0.978*	0.000	*0.966*	0.000	*0.963*
	Mex	-0.024	*0.867*	-0.275	*0.112*	-0.018	*0.725*	-0.009	*0.888*	-0.075	*0.364*
	Asian	0.044	*0.760*	0.010	*0.952*	-0.014	*0.795*	-0.029	*0.663*	-0.032	*0.696*
	Argen debt	-0.188	*0.184*	-0.038	*0.822*	0.004	*0.936*	-0.059	*0.377*	-0.085	*0.287*
	GFC	-0.087	*0.345*	0.003	*0.975*	0.040	*0.237*	0.157***	*0.000*	0.011	*0.832*
	EU debt	-0.076	*0.590*	0.036	*0.814*	0.136***	*0.009*	-0.003	*0.962*	0.007	*0.934*
HML	c	-0.025	*0.664*	-0.048	*0.678*	0.013	*0.671*	-0.004	*0.921*	-0.010	*0.811*
	TR	0.000	*0.992*	0.000	*0.957*	0.000	*0.980*	0.000	*0.962*	0.000	*0.995*
	Mex	0.093	*0.549*	-0.093	*0.736*	-0.036	*0.658*	0.014	*0.888*	-0.092	*0.412*
	Asian	0.382**	*0.014*	-0.023	*0.929*	-0.063	*0.444*	0.138	*0.171*	0.001	*0.993*
	Argen debt	0.113	*0.457*	0.503*	*0.062*	-0.008	*0.919*	0.101	*0.318*	0.303***	*0.005*
	GFC	0.066	*0.504*	0.215	*0.179*	-0.107**	*0.047*	-0.058	*0.376*	0.094	*0.180*
	EU debt	-0.027	*0.858*	0.096	*0.689*	-0.034	*0.677*	-0.042	*0.676*	-0.174	*0.106*
WML	c	-0.011	*0.715*	-0.003	*0.976*	-0.001	*0.957*	-0.006	*0.815*	-0.006	*0.836*
	TR	0.000	*0.967*	0.000	*0.982*	0.000	*0.986*	0.000	*0.999*	0.000	*0.987*
	Mex	0.091	*0.255*	-0.305	*0.137*	0.043	*0.440*	0.069	*0.294*	0.061	*0.419*
	Asian	-0.002	*0.982*	0.156	*0.424*	-0.048	*0.379*	-0.012	*0.855*	0.018	*0.808*
	Argen debt	0.089	*0.253*	-0.020	*0.923*	0.106*	*0.055*	0.059	*0.373*	-0.078	*0.285*
	GFC	0.008	*0.872*	0.045	*0.705*	0.010	*0.786*	0.017	*0.700*	0.109**	*0.022*
	EU debt	0.087	*0.266*	0.074	*0.681*	-0.082	*0.136*	0.013	*0.841*	-0.096	*0.187*

Table 8. Continued

Panel B. Regional betas

		Asia-Pacific		Latin America		Europe		North America		Japan	
		Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
MKT	c	0.025	*0.792*	-0.117	*0.359*	0.004	*0.829*	-0.002	*0.935*	-0.002	*0.911*
	TR	0.000	*0.937*	0.000	*0.895*	0.000	*0.998*	0.000	*0.937*	0.000	*0.999*
	Mex	-0.151	*0.565*	0.438	*0.150*	-0.009	*0.855*	-0.029	*0.714*	0.087	*0.131*
	Asian	0.381	*0.144*	0.210	*0.468*	0.043	*0.404*	-0.015	*0.852*	-0.007	*0.897*
	Argen debt	-0.037	*0.886*	0.566*	*0.057*	-0.046	*0.369*	-0.064	*0.418*	-0.044	*0.423*
	GFC	-0.175	*0.294*	0.202	*0.254*	-0.055*	*0.095*	0.072	*0.158*	0.022	*0.542*
	EU debt	-0.301	*0.240*	0.386	*0.148*	0.027	*0.594*	0.056	*0.475*	-0.017	*0.753*
SMB	c	-0.007	*0.892*	-0.050	*0.442*	-0.007	*0.793*	0.015	*0.567*	0.006	*0.807*
	TR	0.000	*0.931*	0.000	*0.961*	0.000	*0.955*	0.000	*0.986*	0.000	*0.989*
	Mex	0.010	*0.947*	-0.200	*0.197*	-0.120	*0.094*	-0.023	*0.751*	0.016	*0.824*
	Asian	0.004	*0.980*	-0.051	*0.728*	0.083	*0.248*	-0.043	*0.551*	0.041	*0.569*
	Argen debt	0.149	*0.293*	0.350**	*0.021*	0.130*	*0.070*	-0.044	*0.537*	-0.078	*0.264*
	GFC	-0.017	*0.855*	0.275***	*0.002*	0.039	*0.400*	-0.124***	*0.008*	-0.061	*0.184*
	EU debt	-0.022	*0.878*	0.163	*0.231*	-0.020	*0.785*	-0.048	*0.508*	0.003	*0.960*
HML	c	-0.012	*0.836*	0.009	*0.885*	0.017	*0.626*	0.007	*0.838*	-0.004	*0.923*
	TR	0.000	*0.970*	0.000	*0.969*	0.000	*0.961*	0.000	*0.937*	0.000	*0.968*
	Mex	-0.022	*0.891*	0.056	*0.704*	-0.010	*0.916*	-0.032	*0.738*	0.094	*0.397*
	Asian	-0.073	*0.642*	-0.341**	*0.016*	-0.147	*0.113*	0.100	*0.297*	-0.057	*0.606*
	Argen debt	0.185	*0.228*	0.136	*0.353*	0.078	*0.402*	0.075	*0.430*	0.067	*0.528*
	GFC	0.102	*0.310*	-0.078	*0.372*	-0.103*	*0.087*	-0.156**	*0.012*	0.022	*0.752*
	EU debt	-0.054	*0.727*	0.139	*0.287*	-0.208	*0.025*	-0.040	*0.674*	-0.085	*0.428*
WML	c	0.003	*0.895*	-0.024	*0.723*	-0.003	*0.924*	-0.004	*0.887*	-0.014	*0.660*
	TR	0.000	*0.953*	0.000	*0.994*	0.000	*0.997*	0.000	*0.995*	0.000	*0.961*
	Mex	0.074	*0.285*	0.254	*0.113*	0.060	*0.402*	0.000	*0.997*	-0.012	*0.895*
	Asian	-0.011	*0.877*	-0.098	*0.528*	-0.107	*0.136*	-0.029	*0.733*	0.117	*0.192*
	Argen debt	0.038	*0.573*	-0.117	*0.448*	-0.027	*0.711*	0.126	*0.142*	0.043	*0.618*
	GFC	-0.057	*0.200*	0.108	*0.250*	0.047	*0.310*	-0.023	*0.675*	0.103*	*0.070*
	EU debt	-0.018	*0.793*	0.134	*0.345*	0.028	*0.693*	0.091	*0.287*	0.048	*0.581*

Table 9. reports the estimated coefficients α, γ_i, and θ_i of equation (13). Panel A reports results for residuals that are estimated using six-factor model. Panel B reports results for residuals that are estimated using eight-factor model. (***) indicates the coefficient is significantly positive at 1% level

Panel A. Results from six-factor model			
	c	gamma_0	gamma_1
ASIA	0.000***	0.032***	0.002
	0.000	*0.000*	*0.151*
LA	-0.001	-0.003	0.001
	1.000	*0.999*	*0.295*
EU	0.000***	0.016***	-0.012
	1.000	*0.000*	*1.000*
NA	0.000	-0.030	-0.023
	0.707	*1.000*	*1.000*
Panel B. Results from eight-factor model			
	c	gamma_0	gamma_1
ASIA	0.000***	0.034***	0.004
	0.001	*0.000*	*0.109*
LA	0.000	-0.002	0.001
	1.000	*0.989*	*0.349*
EU	0.000	0.015***	-0.011
	1.000	*0.000*	*1.000*
NA	0.000	-0.025	-0.027
	1.000	*1.000*	*1.000*

Table 10. presents the intra-contagion test estimated coefficients c, λ_0, and λ_1 for residuals of six-factor and eight-factor model. Panel regression is employed for each region. (*) means significant at 10% level, (**) means coefficient is significant at 5% level and (***) means coefficient is significant at 1% level.

Panel A. Intra-region contagion test results for residuals obtained from six-factor model

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
ASIA	0.000	0.001	-0.076	0.000	0.000	0.008*	0.000	0.001	0.001	0.000	0.000	0.005*	0.000	0.001	-0.016
	0.993	*0.156*	*0.034*	*0.997*	*0.856*	*0.000*	*0.970*	*0.203*	*0.677*	*0.933*	*0.620*	*0.016*	*0.914*	*0.098*	*0.011*
LA	0.000	0.001	0.021*	0.000	0.002***	-0.013	0.000	0.001	0.001	0.000	0.002	-0.003	0.000	0.000	0.010*
	0.848	*0.524*	*0.003*	*0.918*	*0.043*	*0.000*	*0.967*	*0.321*	*0.852*	*0.980*	*0.164*	*0.302*	*0.881*	*0.704*	*0.013*
EU	0.000	-0.003	-0.022	0.000	-0.004	0.008*	0.000	-0.003	-0.013	0.000	-0.003	-0.001	0.000	-0.003	-0.009
	0.970	*0.000*	*0.307*	*0.991*	*0.000*	*0.003*	*0.973*	*0.000*	*0.001*	*0.941*	*0.000*	*0.497*	*0.923*	*0.000*	*0.075*
NA	0.000	-0.001	-0.014	0.000	-0.001	-0.004	0.000	-0.001	-0.009	0.000	-0.001	0.002	0.000	-0.001	0.000
	0.996	*0.158*	*0.466*	*0.981*	*0.254*	*0.234*	*0.933*	*0.334*	*0.017*	*0.999*	*0.077*	*0.227*	*0.998*	*0.157*	*0.944*
JAP	0.000	0.000	-0.035	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	-0.012
	0.995	*0.667*	*0.257*	*0.976*	*0.764*	*0.661*	*0.993*	*0.695*	*0.976*	*0.992*	*0.830*	*0.639*	*0.955*	*0.434*	*0.010*

Panel B. Intra-region contagion test results for residuals obtained from eight-factor model

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
ASIA	0.000	0.004***	-0.057	0.000	0.004***	0.003	0.000	0.004***	0.002	0.000	0.004***	0.002	0.000	0.005***	-0.017
	0.883	*0.000*	*0.062*	*0.877*	*0.000*	*0.174*	*0.884*	*0.000*	*0.536*	*0.883*	*0.000*	*0.362*	*0.833*	*0.000*	*0.004*
LA	0.000	0.001	0.024*	0.000	0.002***	-0.007	0.000	0.002	0.000	0.000	0.002***	-0.002	0.000	0.001	0.008*
	0.793	*0.218*	*0.001*	*0.889*	*0.025*	*0.055*	*0.932*	*0.085*	*0.963*	*0.957*	*0.046*	*0.325*	*0.851*	*0.252*	*0.034*
EU	0.000	-0.003	0.003	0.000	-0.004	0.009*	0.000	-0.003	-0.007	0.000	-0.003	-0.003	0.000	-0.003	-0.010
	0.896	*0.000*	*0.857*	*0.961*	*0.000*	*0.001*	*0.923*	*0.000*	*0.044*	*0.861*	*0.000*	*0.142*	*0.886*	*0.000*	*0.041*
NA	0.000	-0.001	0.000	0.000	-0.001	-0.002	0.000	-0.001	-0.006	0.000	-0.001	0.000	0.000	-0.001	0.002
	0.964	*0.060*	*0.980*	*0.961*	*0.085*	*0.619*	*0.923*	*0.133*	*0.071*	*0.966*	*0.069*	*0.912*	*0.969*	*0.055*	*0.687*
JAP	0.000	-0.001	-0.008	0.000	-0.001	-0.001	0.000	-0.001	0.003	0.000	-0.001	0.005*	0.000	0.000	-0.009
	0.977	*0.374*	*0.724*	*0.976*	*0.415*	*0.743*	*0.973*	*0.300*	*0.436*	*0.996*	*0.085*	*0.017*	*0.976*	*0.560*	*0.054*

Table 11. presents the intra-contagion test estimated coefficients c, λ_0, and λ_1 for residuals of the six-factor. A panel regression is employed for each sector. (*) means significant at 10% level, (**) means coefficient is significant at 5% level and (***) means coefficient is significant at 1% level.

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
OILGP	0.000	0.113***	-0.048	0.000	0.114***	-0.015	0.000	0.113***	0.000	0.000	0.107***	0.036**	0.000	0.112***	0.023
	0.676	*0.000*	*0.740*	*0.683*	*0.000*	*0.509*	*0.675*	*0.000*	*0.986*	*0.669*	*0.000*	*0.014*	*0.680*	*0.000*	*0.447*
OILES	0.000	0.014**	0.108	0.000	0.016**	-0.013	0.000	0.012*	0.062*	0.000	0.004	0.062***	0.000	0.016**	-0.040
	0.888	*0.046*	*0.112*	*0.850*	*0.026*	*0.604*	*0.898*	*0.090*	*0.056*	*0.768*	*0.639*	*0.001*	*0.860*	*0.022*	*0.360*
ALTEN	0.000	0.029***	0.250	0.000	0.028***	0.022	0.000	0.028***	0.011	0.000	0.027**	0.005	0.000	0.029***	0.000
	0.810	*0.004*	*0.626*	*0.818*	*0.004*	*0.830*	*0.816*	*0.006*	*0.802*	*0.820*	*0.017*	*0.838*	*0.818*	*0.005*	*0.996*
CHMCL	0.000	0.032***	-0.103	0.000	0.034***	-0.034	0.000	0.030***	0.037	0.000	0.030***	0.013	0.000	0.033***	-0.024
	0.983	*0.000*	*0.484*	*0.995*	*0.000*	*0.186*	*0.976*	*0.000*	*0.160*	*0.974*	*0.000*	*0.445*	*0.994*	*0.000*	*0.497*
FSTPA	0.000	0.036***	-0.070	0.000	0.037***	-0.013	0.000	0.033***	0.064*	0.000	0.040***	-0.017	0.000	0.035***	0.020
	0.921	*0.000*	*0.553*	*0.951*	*0.000*	*0.604*	*0.947*	*0.000*	*0.055*	*0.940*	*0.000*	*0.303*	*0.913*	*0.000*	*0.497*
INDMT	0.000	0.106***	-0.143	0.000	0.108***	-0.074***	0.000	0.105***	0.009	0.000	0.086***	0.069***	0.000	0.104***	0.044
	0.825	*0.000*	*0.251*	*0.939*	*0.000*	*0.009*	*0.861*	*0.000*	*0.724*	*0.809*	*0.000*	*0.000*	*0.789*	*0.000*	*0.100*
MNING	0.000	0.049***	-0.080	0.000	0.049***	-0.003	0.000	0.048***	0.011	0.000	0.067***	-0.050	0.000	0.050***	-0.022
	0.952	*0.000*	*0.667*	*0.944*	*0.000*	*0.935*	*0.944*	*0.000*	*0.783*	*0.879*	*0.000*	*0.001*	*0.989*	*0.000*	*0.508*
CNSTM	0.000	0.018***	-0.006	0.000	0.022***	-0.058**	0.000	0.017**	0.024	0.000	0.005	0.069***	0.000	0.019***	-0.050
	0.841	*0.006*	*0.901*	*0.805*	*0.001*	*0.027*	*0.841*	*0.014*	*0.403*	*0.873*	*0.485*	*0.000*	*0.832*	*0.004*	*0.245*
AERSP	0.000	0.010	0.025	0.000	0.010	0.004	0.000	0.007	0.059*	0.000	0.008	0.022	0.000	0.011	-0.030
	0.965	*0.156*	*0.643*	*0.976*	*0.202*	*0.818*	*0.918*	*0.307*	*0.056*	*0.925*	*0.283*	*0.309*	*0.979*	*0.112*	*0.472*
GNIND	0.000	0.005	0.037	0.000	0.006	-0.009	0.000	0.000	0.064***	0.000	0.010	-0.026	0.000	0.004	0.040
	0.844	*0.446*	*0.695*	*0.851*	*0.385*	*0.698*	*0.903*	*0.946*	*0.006*	*0.815*	*0.182*	*0.138*	*0.828*	*0.596*	*0.229*
ELTNC	0.000	0.005	-0.116	0.000	0.002	0.034	0.000	0.001	0.075*	0.000	0.003	0.002	0.000	0.000	0.053*
	0.917	*0.505*	*0.095*	*0.926*	*0.786*	*0.335*	*0.892*	*0.862*	*0.078*	*0.946*	*0.667*	*0.939*	*0.990*	*0.967*	*0.080*
INDEN	0.000	0.042***	-0.084	0.000	0.049***	-0.072***	0.000	0.040***	0.038	0.000	0.022***	0.071***	0.000	0.040***	0.037
	0.875	*0.000*	*0.224*	*0.954*	*0.000*	*0.001*	*0.889*	*0.000*	*0.292*	*0.967*	*0.003*	*0.000*	*0.944*	*0.000*	*0.234*
INDTR	0.000	-0.005	0.080	0.000	-0.002	-0.018	0.000	-0.006	0.036	0.000	-0.008	0.045*	0.000	-0.004	0.044
	0.997	*0.500*	*0.295*	*0.974*	*0.736*	*0.455*	*0.966*	*0.403*	*0.232*	*0.967*	*0.257*	*0.054*	*0.962*	*0.509*	*0.461*

Table 11. Continued

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
SUPSV	0.000	0.011	0.131	0.000	0.002	0.082***	0.000	0.012*	-0.088	0.000	0.009	0.020	0.000	0.012*	-0.035
	0.974	*0.122*	*0.205*	*0.988*	*0.733*	*0.000*	*0.974*	*0.070*	*0.112*	*0.962*	*0.227*	*0.335*	*0.954*	*0.086*	*0.477*
AUTMB	0.000	0.053***	0.005	0.000	0.054***	-0.009	0.000	0.052***	0.027	0.000	0.038***	0.051***	0.000	0.053***	0.011
	0.914	*0.000*	*0.959*	*0.908*	*0.000*	*0.722*	*0.923*	*0.000*	*0.300*	*0.891*	*0.000*	*0.000*	*0.912*	*0.000*	*0.666*
BEVES	0.000	0.021***	-0.066	0.000	0.030***	-0.086***	0.000	0.018***	0.059**	0.000	0.008	0.070***	0.000	0.021***	0.005
	0.928	*0.001*	*0.640*	*0.858*	*0.000*	*0.000*	*0.850*	*0.009*	*0.023*	*0.981*	*0.252*	*0.000*	*0.919*	*0.001*	*0.895*
FOODS	0.000	0.019***	0.053	0.000	0.020***	-0.023	0.000	0.019***	-0.005	0.000	0.016**	0.042*	0.000	0.019***	0.012
	0.983	*0.004*	*0.680*	*0.987*	*0.003*	*0.521*	*0.993*	*0.004*	*0.910*	*0.987*	*0.019*	*0.094*	*0.998*	*0.004*	*0.813*
HHOLD	0.000	-0.002	0.026	0.000	-0.005	0.037	0.000	-0.004	0.040	0.000	0.003	-0.032	0.000	0.000	-0.051
	0.935	*0.770*	*0.748*	*0.909*	*0.477*	*0.122*	*0.889*	*0.553*	*0.162*	*0.908*	*0.731*	*0.108*	*0.878*	*0.983*	*0.188*
LEISG	0.000	0.027***	0.035	0.000	0.026***	0.033	0.000	0.026***	0.025	0.000	0.027***	0.003	0.000	0.027***	0.012
	0.806	*0.000*	*0.727*	*0.844*	*0.000*	*0.250*	*0.795*	*0.000*	*0.373*	*0.810*	*0.000*	*0.890*	*0.800*	*0.000*	*0.619*
PERSG	0.000	0.011	0.024	0.000	0.014**	-0.026	0.000	0.011*	-0.005	0.000	0.008	0.023	0.000	0.011	0.002
	0.971	*0.100*	*0.858*	*0.995*	*0.041*	*0.174*	*0.972*	*0.098*	*0.860*	*0.983*	*0.221*	*0.277*	*0.967*	*0.105*	*0.949*
TOBAC	0.000	0.016**	-0.019	0.000	0.020***	-0.036*	0.000	0.012*	0.076***	0.000	0.014**	0.009	0.000	0.016**	-0.021
	0.945	*0.019*	*0.872*	*0.964*	*0.005*	*0.083*	*0.977*	*0.094*	*0.010*	*0.939*	*0.046*	*0.633*	*0.923*	*0.017*	*0.621*
HCEQS	0.000	0.012*	-0.070	0.000	0.013*	-0.009	0.000	0.009	0.047*	0.000	0.025***	-0.075	0.000	0.005	0.092***
	0.999	*0.078*	*0.724*	*0.996*	*0.077*	*0.777*	*0.957*	*0.210*	*0.097*	*0.971*	*0.001*	*0.000*	*0.923*	*0.491*	*0.000*
PHARM	0.000	0.009	-0.014	0.000	0.014*	-0.021	0.000	0.011	-0.014	0.000	0.006	0.036	0.000	0.010	-0.032
	0.978	*0.176*	*0.955*	*0.975*	*0.074*	*0.210*	*0.990*	*0.140*	*0.544*	*0.991*	*0.446*	*0.110*	*0.983*	*0.144*	*0.441*
FDRGR	0.000	-0.002	-0.111	0.000	-0.003	0.007	0.000	-0.005	0.052*	0.000	0.000	-0.020	0.000	-0.002	0.012
	0.942	*0.840*	*0.333*	*0.959*	*0.735*	*0.781*	*0.977*	*0.497*	*0.089*	*0.946*	*0.961*	*0.379*	*0.959*	*0.766*	*0.815*
GNRET	0.000	0.026***	0.031	0.000	0.029***	-0.045*	0.000	0.023***	0.036	0.000	0.025***	0.008	0.000	0.026***	-0.015
	0.933	*0.000*	*0.670*	*0.936*	*0.000*	*0.076*	*0.953*	*0.000*	*0.153*	*0.958*	*0.000*	*0.679*	*0.940*	*0.000*	*0.706*
MEDIA	0.000	0.033***	0.041	0.000	0.037***	-0.036	0.000	0.031***	0.026	0.000	0.032***	0.011	0.000	0.035***	-0.115
	0.988	*0.000*	*0.577*	*0.978*	*0.000*	*0.101*	*0.977*	*0.000*	*0.315*	*0.969*	*0.000*	*0.624*	*0.983*	*0.000*	*0.013*

Table 11. Continued

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
TRLES	0.000	0.035***	0.163	0.000	0.036***	-0.009	0.000	0.035***	0.008	0.000	0.024***	0.056***	0.000	0.036***	-0.023
	0.976	*0.000*	*0.266*	*0.988*	*0.000*	*0.691*	*0.985*	*0.000*	*0.789*	*0.990*	*0.001*	*0.001*	*0.976*	*0.000*	*0.464*
TELFL	0.000	0.025***	-0.465	0.000	0.026***	-0.021	0.000	0.022***	0.037	0.000	0.020***	0.026	0.000	0.024***	0.003
	0.825	*0.000*	*0.007*	*0.830*	*0.000*	*0.334*	*0.891*	*0.001*	*0.224*	*0.895*	*0.004*	*0.163*	*0.876*	*0.000*	*0.951*
TELMB	0.000	0.025***	0.054	0.000	0.023***	0.018	0.000	0.027***	-0.029	0.000	0.030***	-0.037	0.000	0.025***	0.020
	0.960	*0.000*	*0.519*	*0.974*	*0.001*	*0.379*	*0.962*	*0.000*	*0.352*	*0.990*	*0.000*	*0.090*	*0.951*	*0.000*	*0.663*
ELECT	0.000	0.022***	-0.037	0.000	0.016**	0.045**	0.000	0.019***	0.030	0.000	0.013*	0.072***	0.000	0.023***	-0.070
	0.830	*0.001*	*0.328*	*0.875*	*0.025*	*0.038*	*0.808*	*0.007*	*0.259*	*0.892*	*0.071*	*0.001*	*0.827*	*0.001*	*0.066*
GWMUT	0.000	0.009	-0.030	0.000	0.010	-0.004	0.000	0.005	0.038	0.000	0.003	0.050**	0.000	0.009	0.014
	0.980	*0.191*	*0.904*	*0.978*	*0.205*	*0.811*	*0.975*	*0.461*	*0.104*	*0.984*	*0.653*	*0.022*	*0.993*	*0.213*	*0.758*
BANKS	0.000	0.049***	0.033	0.000	0.049***	-0.004	0.000	0.050***	-0.025	0.000	0.034***	0.065***	0.000	0.048***	0.022
	0.952	*0.000*	*0.680*	*0.929*	*0.000*	*0.855*	*0.936*	*0.000*	*0.444*	*0.742*	*0.000*	*0.000*	*0.934*	*0.000*	*0.536*
NLINS	0.000	0.002	-0.048	0.000	0.002	-0.001	0.000	0.003	-0.019	0.000	0.000	0.012	0.000	0.001	0.033
	0.968	*0.760*	*0.680*	*0.970*	*0.777*	*0.954*	*0.945*	*0.653*	*0.481*	*0.952*	*0.955*	*0.473*	*0.952*	*0.913*	*0.373*
LFINS	0.000	0.033***	-0.022	0.000	0.032***	0.026	0.000	0.028***	0.062**	0.000	0.046***	-0.049	0.000	0.030***	0.041
	0.823	*0.000*	*0.933*	*0.813*	*0.000*	*0.621*	*0.868*	*0.001*	*0.048*	*0.877*	*0.000*	*0.009*	*0.825*	*0.000*	*0.237*
RLISV	0.000	-0.002	-0.036	0.000	-0.006	0.080**	0.000	-0.003	0.036	0.000	0.002	-0.022	0.000	0.000	-0.061
	0.951	*0.810*	*0.857*	*0.931*	*0.488*	*0.041*	*0.946*	*0.739*	*0.542*	*0.981*	*0.836*	*0.308*	*0.958*	*0.993*	*0.192*
REITS	0.000	0.012	-0.057	0.000	0.012	-0.013	0.000	0.018*	-0.124***	0.000	0.003	0.036	0.000	0.008	0.087*
	0.979	*0.250*	*0.871*	*0.985*	*0.238*	*0.779*	*0.977*	*0.083*	*0.006*	*0.969*	*0.806*	*0.127*	*0.985*	*0.449*	*0.077*
FNSVS	0.000	0.003	-0.052	0.000	0.009	-0.032*	0.000	0.002	0.027	0.000	-0.006	0.047***	0.000	0.003	-0.009
	0.983	*0.660*	*0.624*	*0.964*	*0.222*	*0.054*	*0.983*	*0.763*	*0.521*	*0.893*	*0.420*	*0.006*	*0.973*	*0.659*	*0.827*
SFTCS	0.000	0.024***	-0.003	0.000	0.025***	-0.026	0.000	0.016**	0.130***	0.000	0.024***	-0.003	0.000	0.023***	0.009
	0.934	*0.002*	*0.988*	*0.951*	*0.001*	*0.521*	*0.960*	*0.036*	*0.000*	*0.935*	*0.004*	*0.883*	*0.937*	*0.003*	*0.768*
TECHD	0.000	0.048***	-0.175	0.000	0.048***	0.002	0.000	0.050***	-0.013	0.000	0.043***	0.036**	0.000	0.048***	0.023
	0.947	*0.000*	*0.491*	*0.944*	*0.000*	*0.928*	*0.956*	*0.000*	*0.555*	*0.940*	*0.000*	*0.047*	*0.969*	*0.000*	*0.609*

Table 12. presents the intra-contagion test estimated coefficients c , λ_0 , and λ_1 for residuals of the eight-factor. A panel regression is employed for each sector. (*) means significant at 10% level, (**) means coefficient is significant at 5% level and (***) means coefficient is significant at 1% level.

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
OILGP	0.000	0.097***	-0.012	0.000	0.096***	0.012	0.000	0.099***	-0.026	0.000	0.093***	0.032	0.000	0.096***	0.024
	0.730	*0.000*	*0.921*	*0.724*	*0.000*	*0.568*	*0.730*	*0.000*	*0.279*	*0.767*	*0.000*	*0.042*	*0.728*	*0.000*	*0.449*
OILES	0.000	0.014**	0.095	0.000	0.016**	-0.007	0.000	0.008	0.107***	0.000	0.006	0.049***	0.000	0.016**	-0.047
	0.919	*0.044*	*0.193*	*0.886*	*0.032*	*0.775*	*0.981*	*0.269*	*0.000*	*0.810*	*0.418*	*0.007*	*0.893*	*0.022*	*0.287*
ALTEN	0.000	0.023**	0.599	0.000	0.023**	0.038	0.000	0.021**	0.041	0.000	0.025**	-0.007	0.000	0.022**	0.029
	0.787	*0.019*	*0.245*	*0.821*	*0.020*	*0.725*	*0.811*	*0.042*	*0.309*	*0.818*	*0.026*	*0.758*	*0.782*	*0.035*	*0.474*
CHMCL	0.000	0.024***	-0.164	0.000	0.026***	-0.039	0.000	0.020***	0.051*	0.000	0.021***	0.017	0.000	0.025***	-0.054
	0.957	*0.000*	*0.388*	*0.970*	*0.000*	*0.166*	*0.998*	*0.002*	*0.052*	*0.931*	*0.003*	*0.349*	*0.981*	*0.000*	*0.163*
FSTPA	0.000	0.032***	-0.134	0.000	0.031***	0.008	0.000	0.029***	0.065**	0.000	0.037***	-0.029	0.000	0.030***	0.030
	0.942	*0.000*	*0.264*	*0.941*	*0.000*	*0.748*	*0.963*	*0.000*	*0.044*	*0.997*	*0.000*	*0.104*	*0.931*	*0.000*	*0.278*
INDMT	0.000	0.095***	-0.157	0.000	0.097***	-0.042	0.000	0.095***	0.003	0.000	0.080***	0.057***	0.000	0.093***	0.051*
	0.563	*0.000*	*0.206*	*0.628*	*0.000*	*0.126*	*0.589*	*0.000*	*0.891*	*0.509*	*0.000*	*0.000*	*0.525*	*0.000*	*0.052*
MNING	0.000	0.050***	-0.009	0.000	0.051***	-0.005	0.000	0.050***	-0.002	0.000	0.054***	-0.009	0.000	0.052***	-0.027
	0.888	*0.000*	*0.956*	*0.891*	*0.000*	*0.868*	*0.887*	*0.000*	*0.963*	*0.879*	*0.000*	*0.552*	*0.944*	*0.000*	*0.397*
CNSTM	0.000	0.017***	-0.016	0.000	0.021***	-0.049*	0.000	0.014**	0.051*	0.000	0.010	0.043**	0.000	0.019***	-0.051
	0.917	*0.008*	*0.764*	*0.911*	*0.002*	*0.056*	*0.911*	*0.039*	*0.057*	*0.990*	*0.177*	*0.012*	*0.914*	*0.005*	*0.208*
AERSP	0.000	0.012*	0.025	0.000	0.012*	-0.003	0.000	0.008	0.066**	0.000	0.010	0.020	0.000	0.013*	-0.028
	0.906	*0.092*	*0.673*	*0.901*	*0.093*	*0.880*	*0.866*	*0.247*	*0.025*	*0.858*	*0.179*	*0.356*	*0.918*	*0.066*	*0.480*
GNIND	0.000	0.011*	0.039	0.000	0.010	0.012	0.000	0.009	0.033	0.000	0.014*	-0.015	0.000	0.011	0.010
	0.850	*0.097*	*0.661*	*0.850*	*0.143*	*0.594*	*0.885*	*0.209*	*0.180*	*0.826*	*0.057*	*0.386*	*0.848*	*0.109*	*0.773*
ELTNC	0.000	0.011	-0.087	0.000	0.007	0.052	0.000	0.009	0.018	0.000	0.007	0.017	0.000	0.006	0.046
	0.967	*0.152*	*0.139*	*0.984*	*0.370*	*0.129*	*0.980*	*0.245*	*0.674*	*0.984*	*0.401*	*0.415*	*0.971*	*0.442*	*0.101*
INDEN	0.000	0.046***	-0.137	0.000	0.052***	-0.070***	0.000	0.043***	0.049	0.000	0.026***	0.075***	0.000	0.043***	0.039
	0.950	*0.000*	*0.041*	*0.939*	*0.000*	*0.001*	*0.971*	*0.000*	*0.149*	*0.843*	*0.000*	*0.000*	*0.947*	*0.000*	*0.191*
INDTR	0.000	-0.001	0.078	0.000	0.002	-0.036	0.000	-0.002	0.034	0.000	-0.003	0.031	0.000	-0.001	0.045
	0.975	*0.845*	*0.268*	*0.998*	*0.732*	*0.137*	*0.994*	*0.744*	*0.268*	*0.977*	*0.638*	*0.193*	*0.988*	*0.856*	*0.434*

Table 12. Continued

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis		
	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1	c	v0	v1
SUPSV	0.000	0.012*	0.108	0.000	0.005	0.067***	0.000	0.013*	-0.082	0.000	0.009	0.030	0.000	0.013*	-0.027
	0.947	*0.089*	*0.276*	*0.946*	*0.491*	*0.003*	*0.953*	*0.050*	*0.121*	*0.943*	*0.220*	*0.164*	*0.926*	*0.066*	*0.571*
AUTMB	0.000	0.044***	0.027	0.000	0.042***	0.020	0.000	0.041***	0.035	0.000	0.042***	0.009	0.000	0.042***	0.025
	0.955	*0.000*	*0.772*	*0.935*	*0.000*	*0.401*	*0.947*	*0.000*	*0.161*	*0.945*	*0.000*	*0.545*	*0.963*	*0.000*	*0.332*
BEVES	0.000	0.017***	-0.093	0.000	0.025***	-0.076***	0.000	0.013**	0.069**	0.000	0.004	0.070***	0.000	0.017**	0.004
	0.999	*0.008*	*0.485*	*0.954*	*0.000*	*0.000*	*0.918*	*0.050*	*0.014*	*0.897*	*0.557*	*0.000*	*0.985*	*0.011*	*0.925*
FOODS	0.000	0.026***	0.057	0.000	0.028***	-0.043	0.000	0.026***	0.012	0.000	0.024***	0.027	0.000	0.026***	0.016
	0.984	*0.000*	*0.595*	*0.985*	*0.000*	*0.179*	*0.996*	*0.000*	*0.777*	*0.986*	*0.000*	*0.228*	*0.993*	*0.000*	*0.718*
HHOLD	0.000	0.001	0.008	0.000	-0.004	0.058**	0.000	-0.003	0.068**	0.000	0.004	-0.028	0.000	0.002	-0.030
	0.924	*0.935*	*0.920*	*0.883*	*0.525*	*0.015*	*0.836*	*0.671*	*0.024*	*0.888*	*0.557*	*0.163*	*0.891*	*0.808*	*0.415*
LEISG	0.000	0.029***	0.033	0.000	0.028***	0.021	0.000	0.028***	0.031	0.000	0.030***	-0.005	0.000	0.029***	0.009
	0.856	*0.000*	*0.750*	*0.879*	*0.000*	*0.452*	*0.842*	*0.000*	*0.288*	*0.846*	*0.000*	*0.777*	*0.850*	*0.000*	*0.727*
PERSG	0.000	0.005	0.035	0.000	0.009	-0.025	0.000	0.005	-0.001	0.000	0.004	0.014	0.000	0.004	0.025
	0.967	*0.433*	*0.780*	*0.939*	*0.215*	*0.189*	*0.973*	*0.433*	*0.980*	*0.970*	*0.573*	*0.527*	*0.980*	*0.507*	*0.499*
TOBAC	0.000	0.013*	-0.007	0.000	0.014*	-0.007	0.000	0.009	0.071**	0.000	0.014*	-0.009	0.000	0.012*	0.011
	0.996	*0.058*	*0.948*	*0.998*	*0.058*	*0.731*	*0.972*	*0.206*	*0.017*	*0.997*	*0.054*	*0.647*	*0.994*	*0.069*	*0.791*
HCEQS	0.000	0.005	-0.160	0.000	0.005	-0.003	0.000	0.003	0.038	0.000	0.020**	-0.082***	0.000	-0.004	0.109***
	0.959	*0.471*	*0.479*	*0.967*	*0.483*	*0.927*	*0.996*	*0.728*	*0.200*	*0.939*	*0.013*	*0.000*	*0.901*	*0.614*	*0.000*
PHARM	0.000	0.004	-0.252	0.000	0.005	-0.004	0.000	0.004	-0.007	0.000	0.002	0.020	0.000	0.005	-0.047
	0.991	*0.607*	*0.425*	*0.991*	*0.571*	*0.791*	*0.999*	*0.566*	*0.760*	*0.998*	*0.827*	*0.396*	*0.997*	*0.489*	*0.252*
FDRGR	0.000	-0.008	-0.016	0.000	-0.010	0.021	0.000	-0.010	0.034	0.000	-0.006	-0.016	0.000	-0.009	0.016
	0.952	*0.273*	*0.896*	*0.933*	*0.194*	*0.420*	*0.960*	*0.190*	*0.312*	*0.936*	*0.421*	*0.496*	*0.950*	*0.255*	*0.764*
GNRET	0.000	0.018***	0.080	0.000	0.021***	-0.036	0.000	0.017**	0.040	0.000	0.024***	-0.043**	0.000	0.019***	0.002
	0.893	*0.006*	*0.227*	*0.917*	*0.001*	*0.152*	*0.952*	*0.014*	*0.141*	*0.899*	*0.001*	*0.033*	*0.932*	*0.004*	*0.949*
MEDIA	0.000	0.021***	0.077	0.000	0.024***	-0.023	0.000	0.020***	0.024	0.000	0.018***	0.034	0.000	0.024***	-0.118***
	0.982	*0.002*	*0.274*	*0.987*	*0.001*	*0.275*	*0.961*	*0.004*	*0.378*	*0.958*	*0.009*	*0.128*	*0.991*	*0.000*	*0.008*

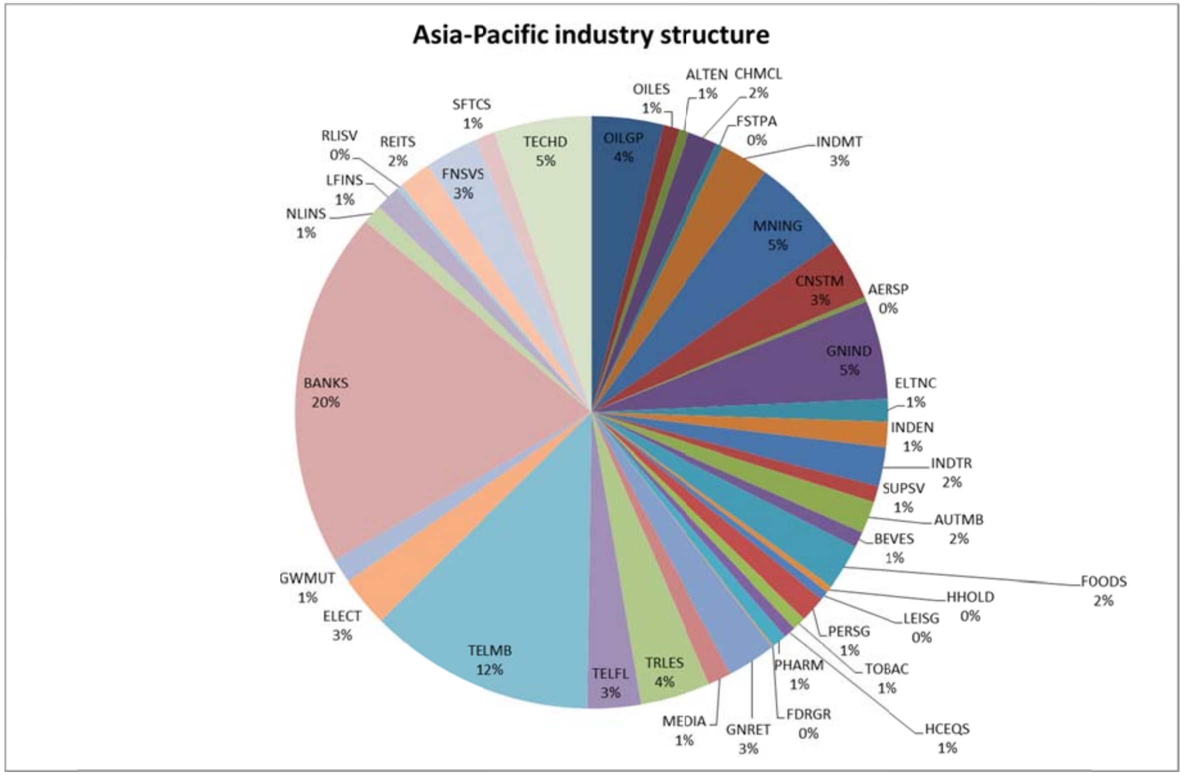
Table 12. Continued

	Mexican crisis			Asian crisis			Argentine Debt crisis			GFC			European Debt crisis	
	c	v0	v1	c	v0	c	v0	v1	c	v0	c	v0	v1	c	v0
TRLES	0.000	0.030***	0.075	0.000	0.029***	0.006	0.000	0.029***	0.009	0.000	0.020***	0.054***	0.000	0.031***	-0.028
	1.000	*0.000*	*0.658*	*0.999*	*0.000*	*0.802*	*0.997*	*0.000*	*0.766*	*0.903*	*0.004*	*0.002*	*0.999*	*0.000*	*0.355*
TELFL	0.000	0.020***	-0.393	0.000	0.017**	0.016	0.000	0.016**	0.064**	0.000	0.019***	-0.001	0.000	0.019***	-0.010
	0.908	*0.002*	*0.010*	*0.964*	*0.012*	*0.446*	*0.956*	*0.016*	*0.036*	*0.930*	*0.006*	*0.946*	*0.932*	*0.003*	*0.859*
TELMB	0.000	0.016**	0.046	0.000	0.014*	0.018	0.000	0.019***	-0.042	0.000	0.020***	-0.029	0.000	0.016**	0.032
	0.951	*0.021*	*0.514*	*0.966*	*0.055*	*0.391*	*0.947*	*0.009*	*0.196*	*0.998*	*0.008*	*0.200*	*0.933*	*0.025*	*0.467*
ELECT	0.000	0.023***	-0.004	0.000	0.017**	0.053***	0.000	0.020***	0.042*	0.000	0.018***	0.053**	0.000	0.025***	-0.053
	0.853	*0.001*	*0.935*	*0.898*	*0.018*	*0.010*	*0.812*	*0.004*	*0.097*	*0.931*	*0.009*	*0.023*	*0.840*	*0.000*	*0.167*
GWMUT	0.000	0.005	0.091	0.000	-0.004	0.045***	0.000	0.002	0.035	0.000	0.002	0.036	0.000	0.005	0.014
	0.982	*0.432*	*0.644*	*0.988*	*0.629*	*0.009*	*0.959*	*0.817*	*0.115*	*0.973*	*0.815*	*0.106*	*0.990*	*0.458*	*0.744*
BANKS	0.000	0.040***	0.037	0.000	0.039***	0.010	0.000	0.040***	-0.012	0.000	0.027***	0.056***	0.000	0.039***	0.012
	0.968	*0.000*	*0.613*	*0.981*	*0.000*	*0.644*	*0.985*	*0.000*	*0.707*	*0.848*	*0.000*	*0.000*	*0.992*	*0.000*	*0.761*
NLINS	0.000	-0.001	-0.020	0.000	-0.002	0.012	0.000	0.001	-0.021	0.000	-0.006	0.025	0.000	-0.001	0.010
	0.976	*0.932*	*0.851*	*0.961*	*0.807*	*0.616*	*0.953*	*0.919*	*0.440*	*0.948*	*0.449*	*0.137*	*0.970*	*0.889*	*0.802*
LFINS	0.000	0.035***	0.036	0.000	0.034***	0.010	0.000	0.031***	0.046	0.000	0.042***	-0.026	0.000	0.033***	0.030
	0.859	*0.000*	*0.896*	*0.855*	*0.000*	*0.845*	*0.895*	*0.000*	*0.147*	*0.887*	*0.000*	*0.154*	*0.856*	*0.000*	*0.418*
RLISV	0.000	-0.012	-0.098	0.000	-0.017	0.096**	0.000	-0.013	0.045	0.000	-0.014	0.010	0.000	-0.010	-0.067
	0.989	*0.145*	*0.619*	*0.992*	*0.049*	*0.016*	*0.990*	*0.115*	*0.436*	*0.997*	*0.124*	*0.636*	*0.999*	*0.221*	*0.176*
REITS	0.000	0.018*	-0.085	0.000	0.020**	-0.067	0.000	0.023**	-0.112	0.000	0.004	0.055**	0.000	0.014	0.075
	0.989	*0.078*	*0.801*	*0.984*	*0.046*	*0.175*	*0.964*	*0.024*	*0.015*	*0.997*	*0.738*	*0.018*	*0.983*	*0.159*	*0.130*
FNSVS	0.000	0.000	-0.033	0.000	0.007	-0.031	0.000	-0.001	0.053	0.000	-0.008	0.043**	0.000	0.000	0.004
	0.996	*0.956*	*0.742*	*0.994*	*0.375*	*0.058*	*0.996*	*0.858*	*0.201*	*0.953*	*0.308*	*0.013*	*0.997*	*0.987*	*0.920*
SFTCS	0.000	0.019***	-0.003	0.000	0.019**	0.012	0.000	0.013*	0.131***	0.000	0.020***	-0.004	0.000	0.019**	0.013
	0.934	*0.010*	*0.988*	*0.928*	*0.014*	*0.764*	*0.965*	*0.086*	*0.000*	*0.935*	*0.017*	*0.833*	*0.944*	*0.019*	*0.670*
TECHD	0.000	0.032***	-0.105	0.000	0.031***	0.012	0.000	0.032***	0.000	0.000	0.028***	0.027	0.000	0.031***	0.020
	0.960	*0.000*	*0.639*	*0.961*	*0.000*	*0.631*	*0.954*	*0.000*	*1.000*	*0.975*	*0.000*	*0.159*	*0.976*	*0.000*	*0.655*

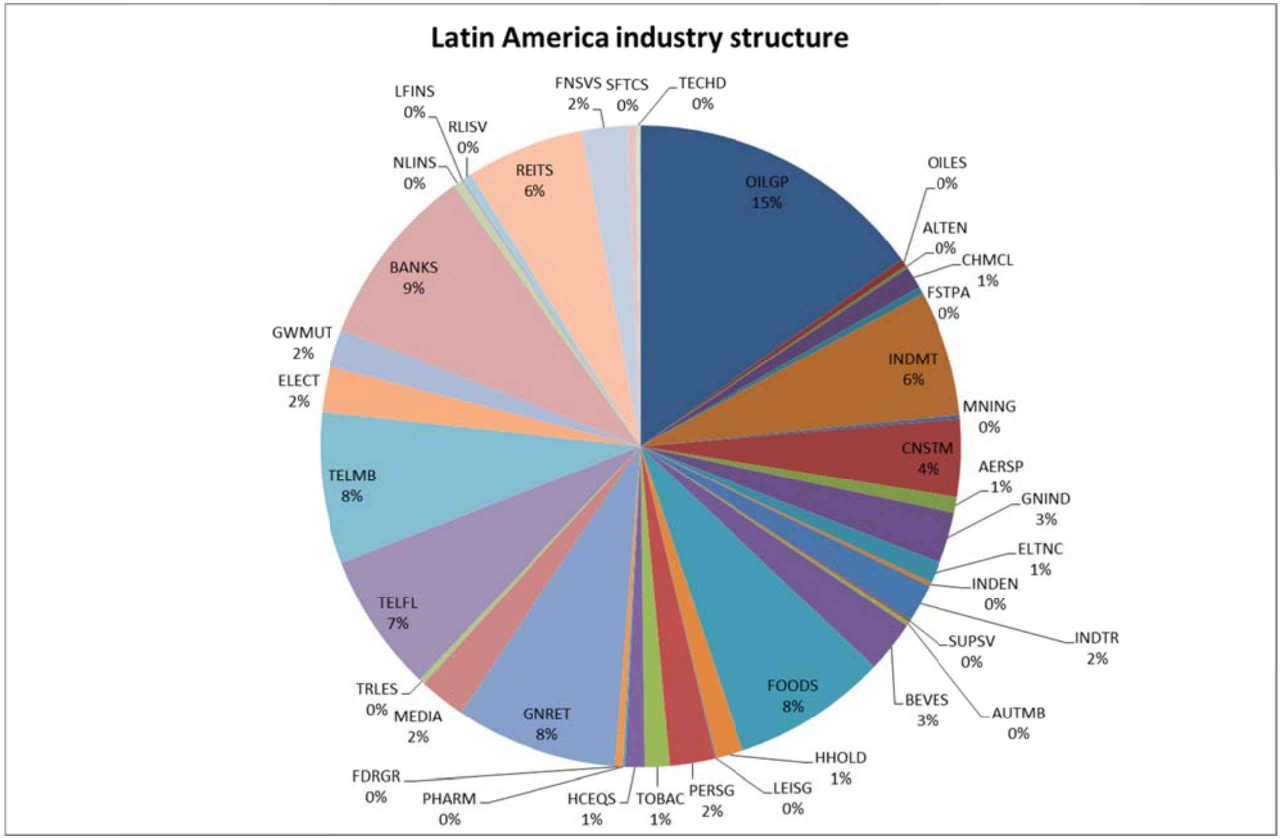
Figures

Figure 1. Industry composition in each region, based on average market capitalisation of each sector.

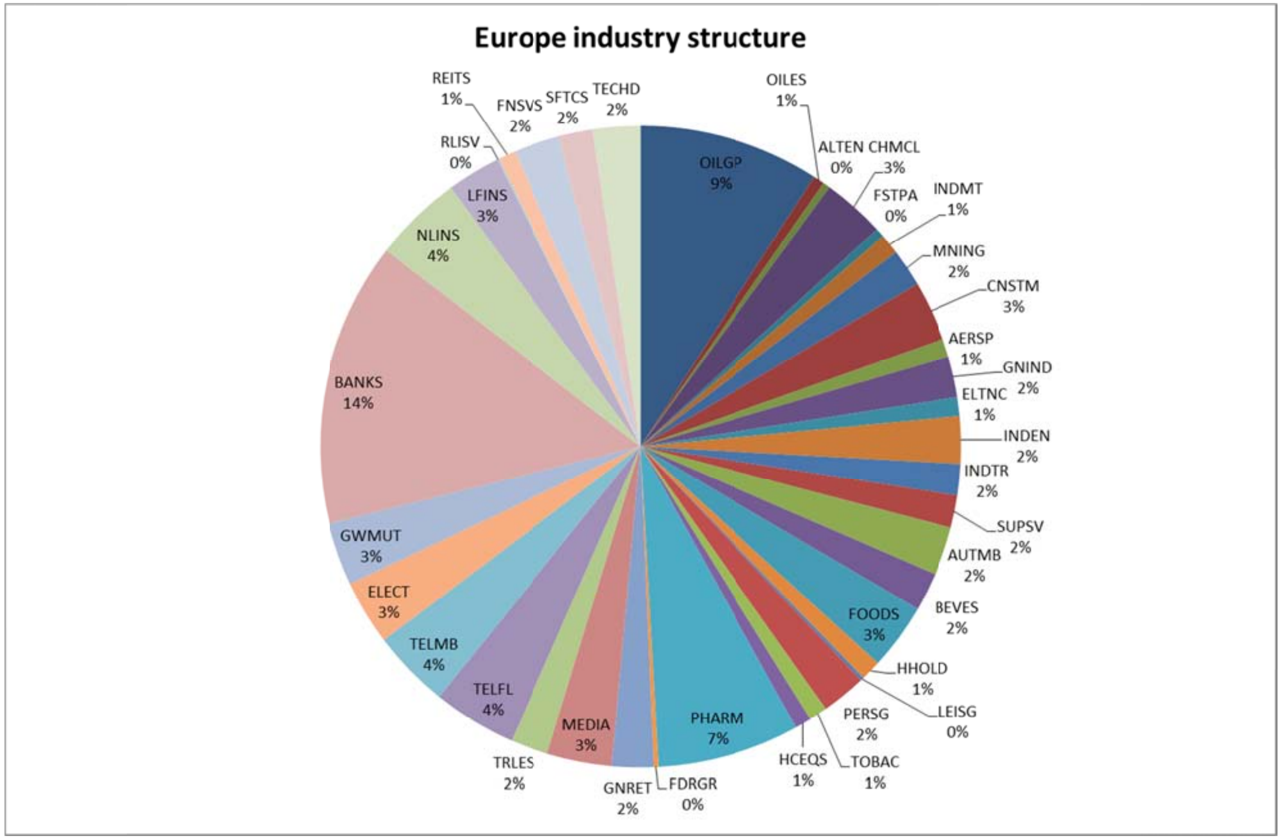
Panel A. Asia-Pacific



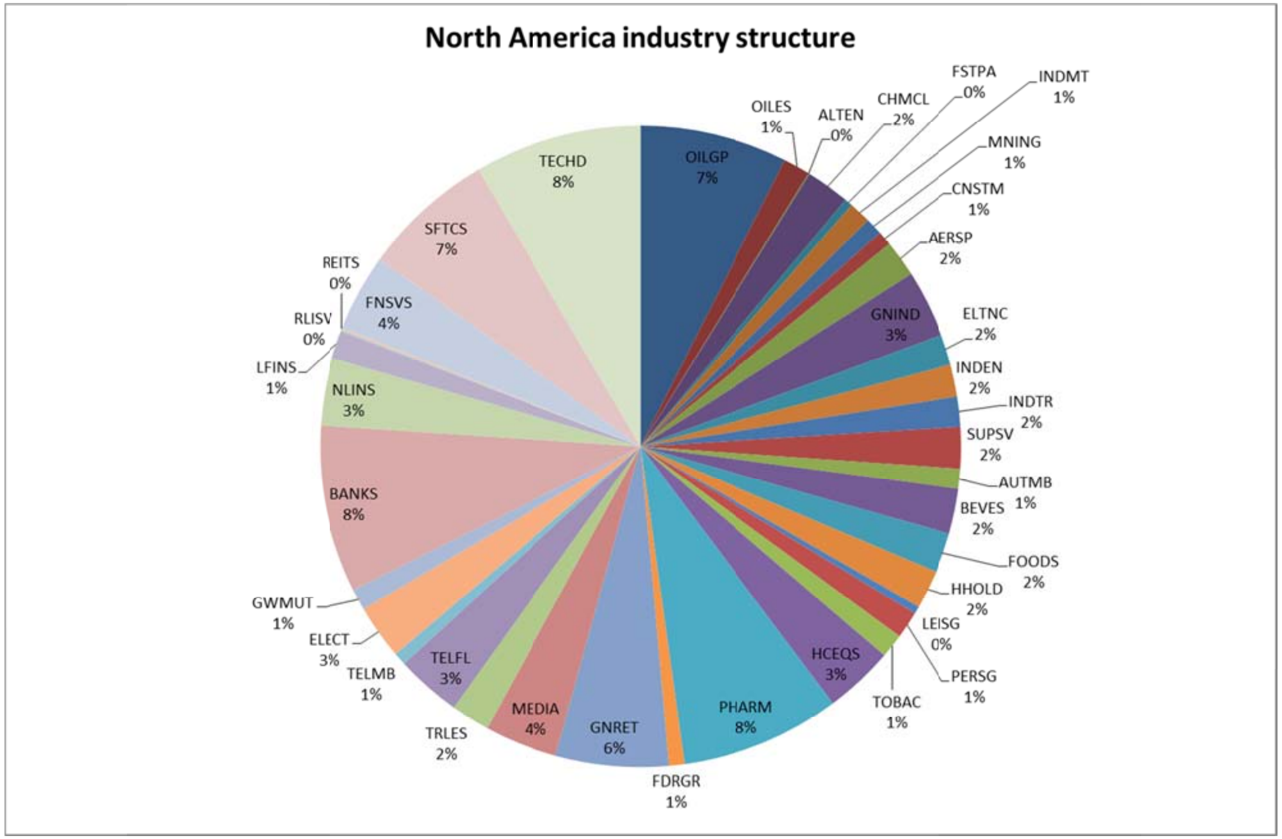
Panel B. Latin America



Panel C. Europe



Panel D. North America



Panel E. Japan

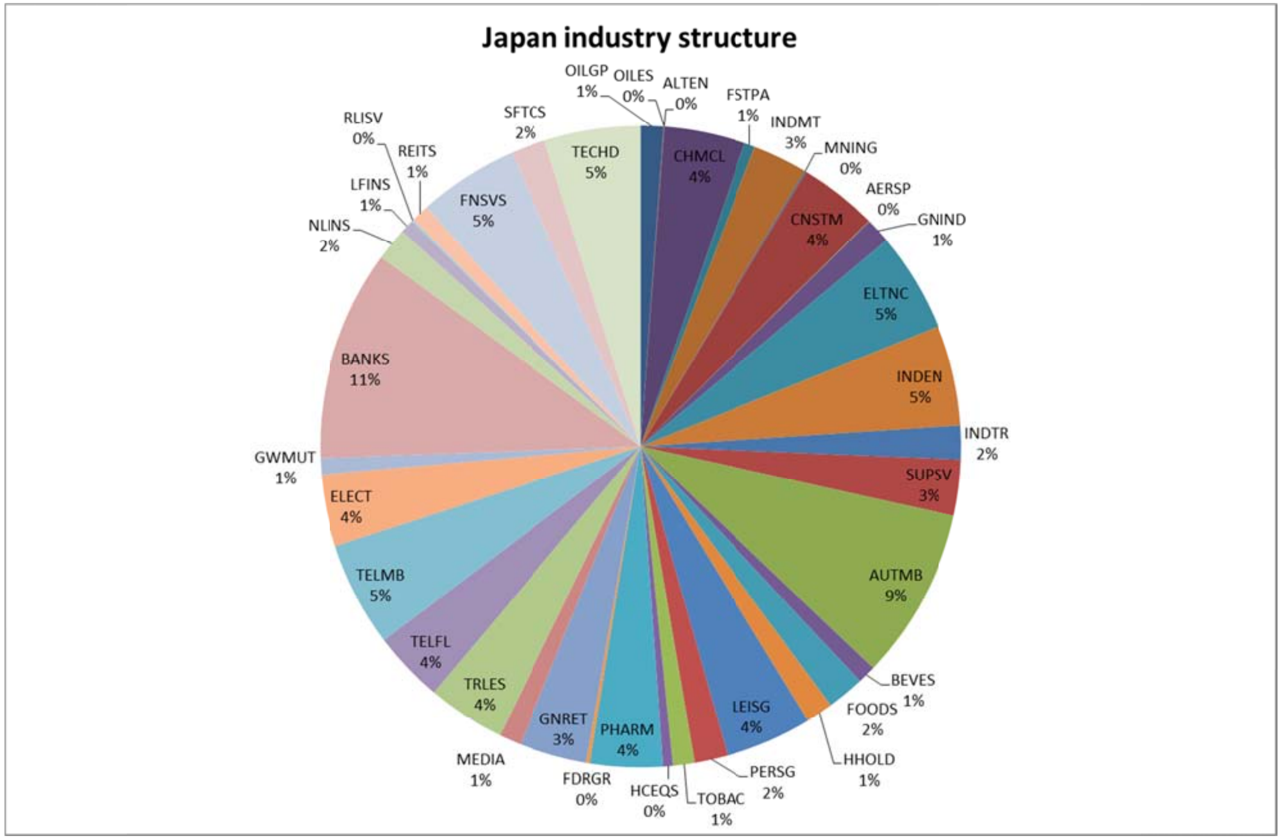
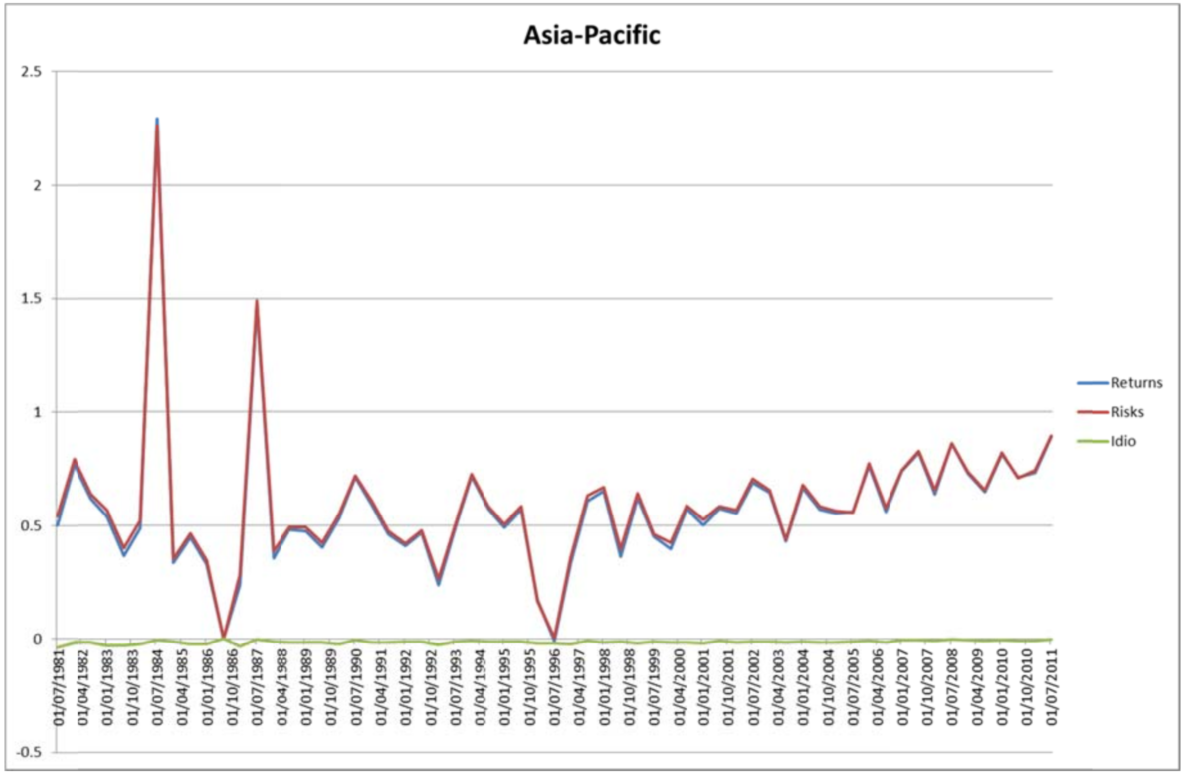
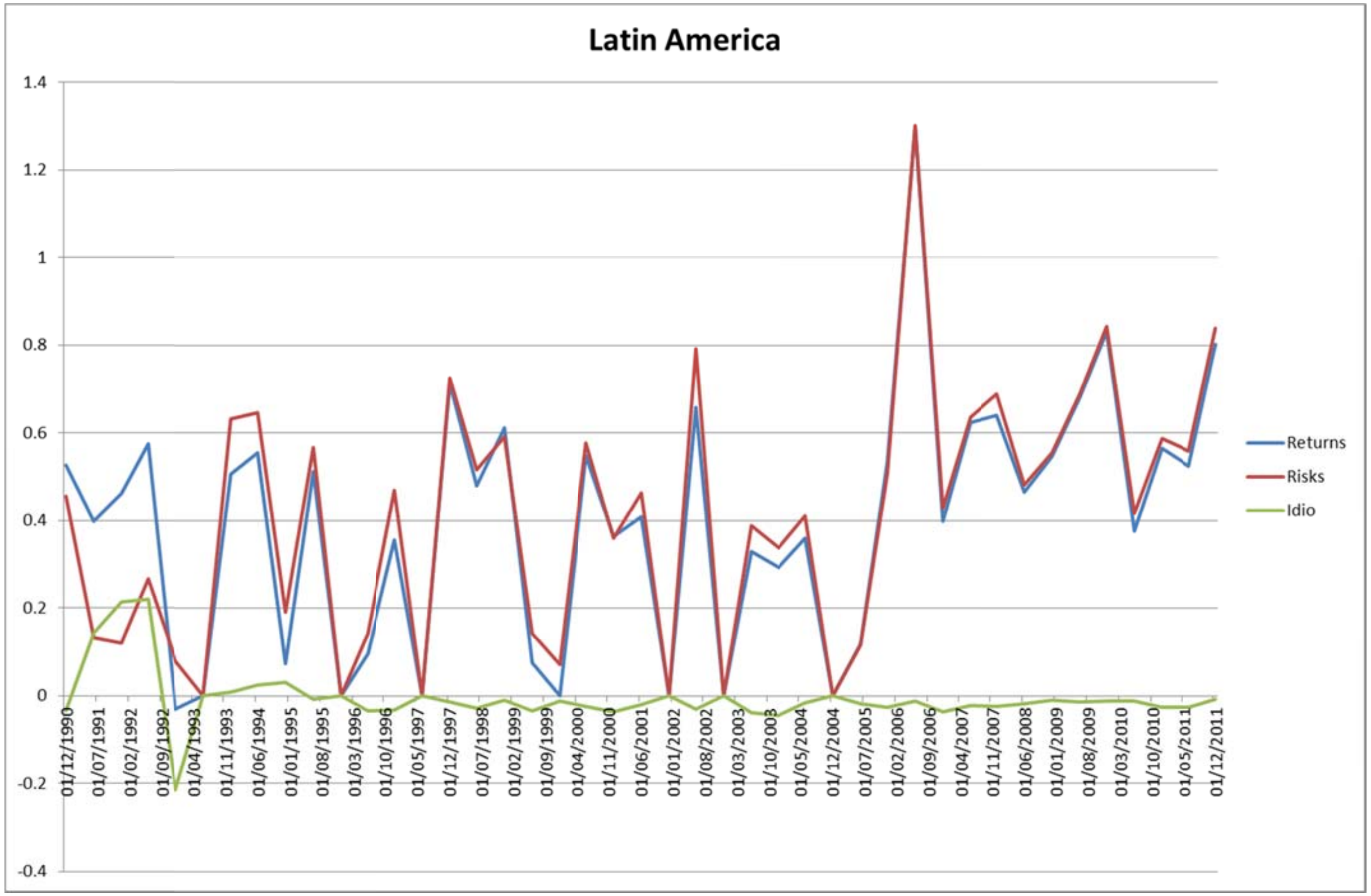


Figure 2. Plots of time-varying empirical covariance γ_{sample}^{CORR} (blue line), time-varying covariance captured by risk factors γ_{risk}^{CORR} (red line) and time-varying covariance of the idiosyncratic shocks γ_{idio}^{CORR} (green line) estimated using six-factor model.

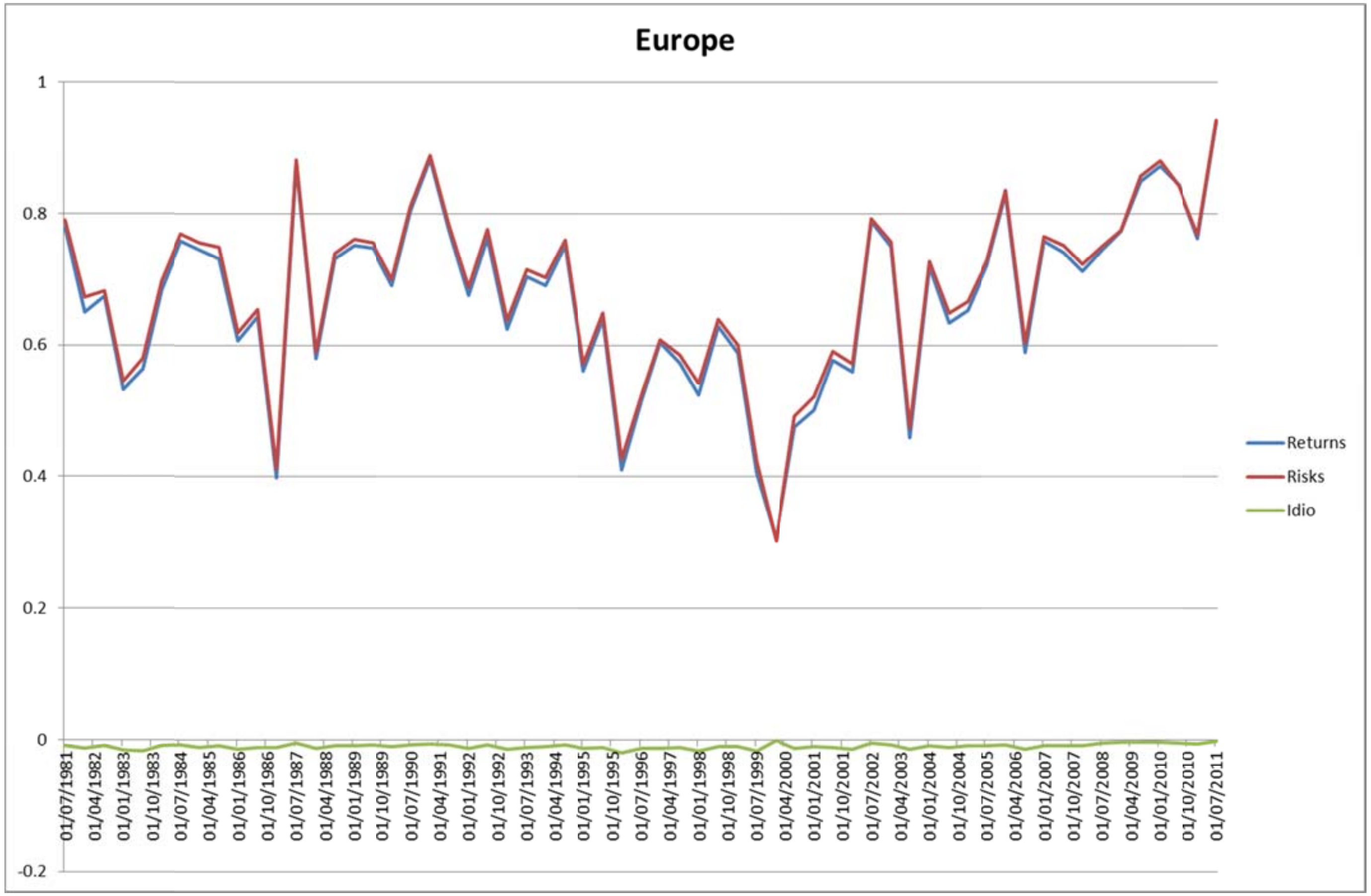
Panel A. Asia-Pacific



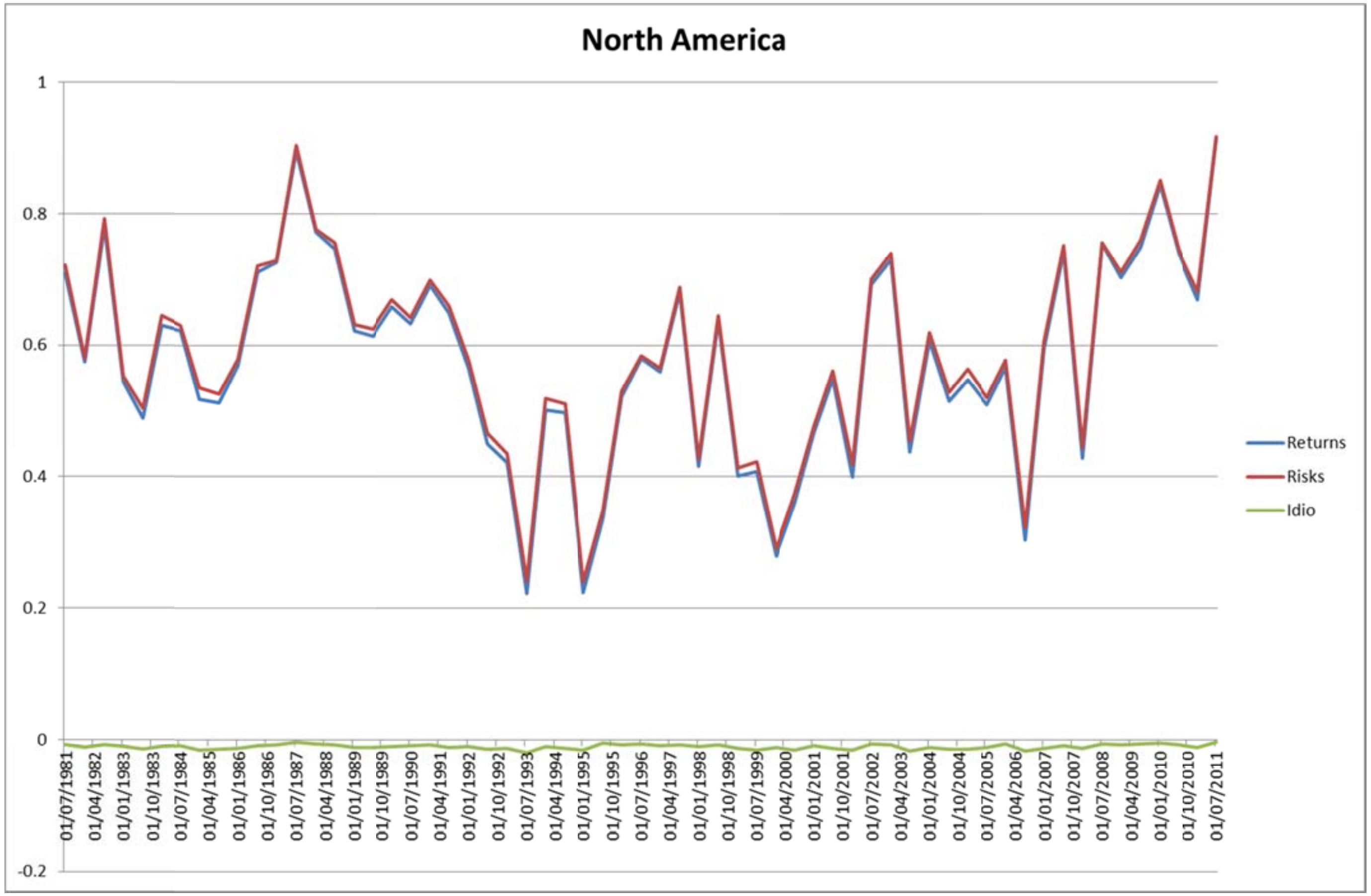
Panel B. Latin America



Panel C. Europe



Panel D. North America



Panel E. Japan

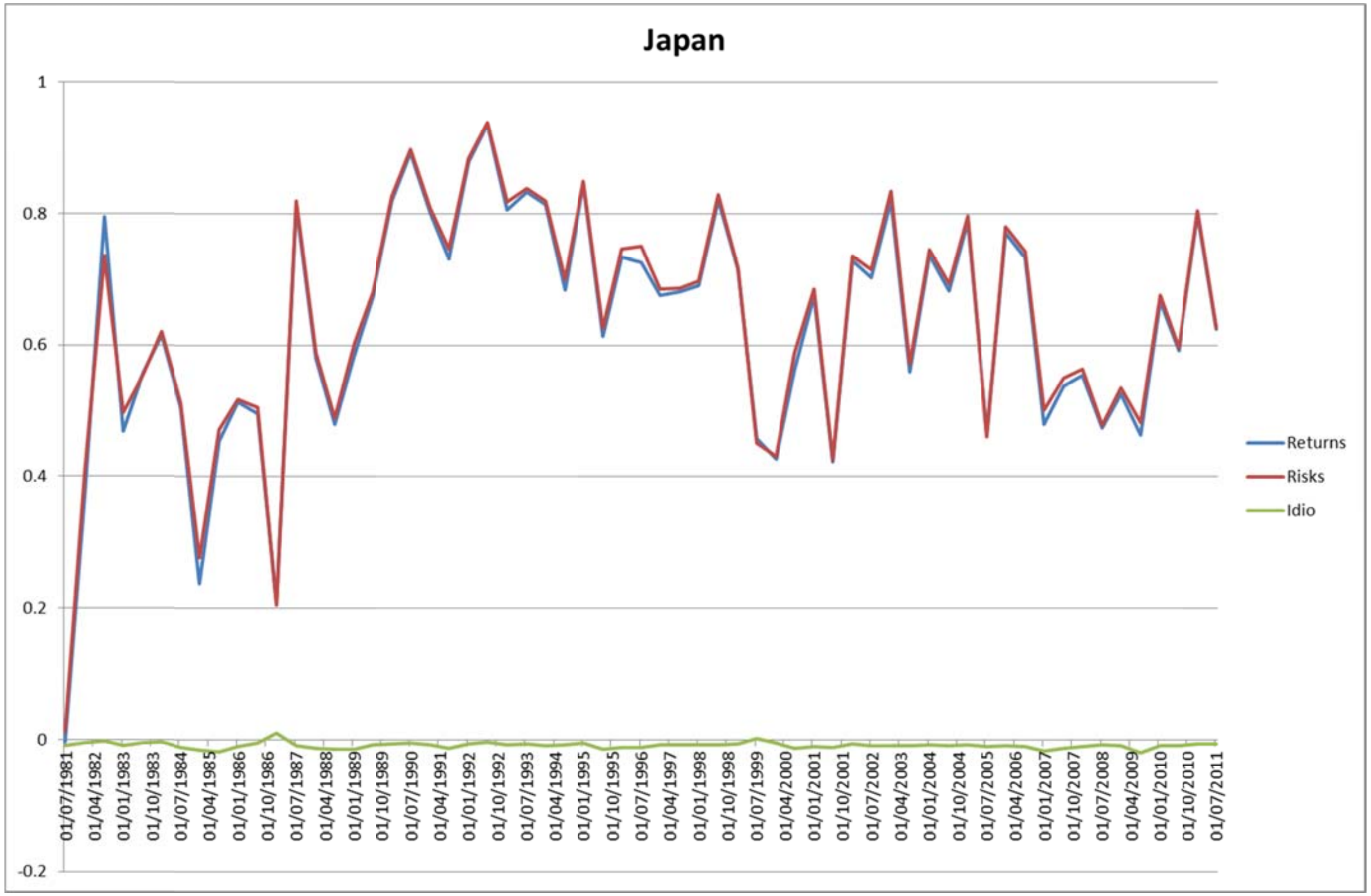
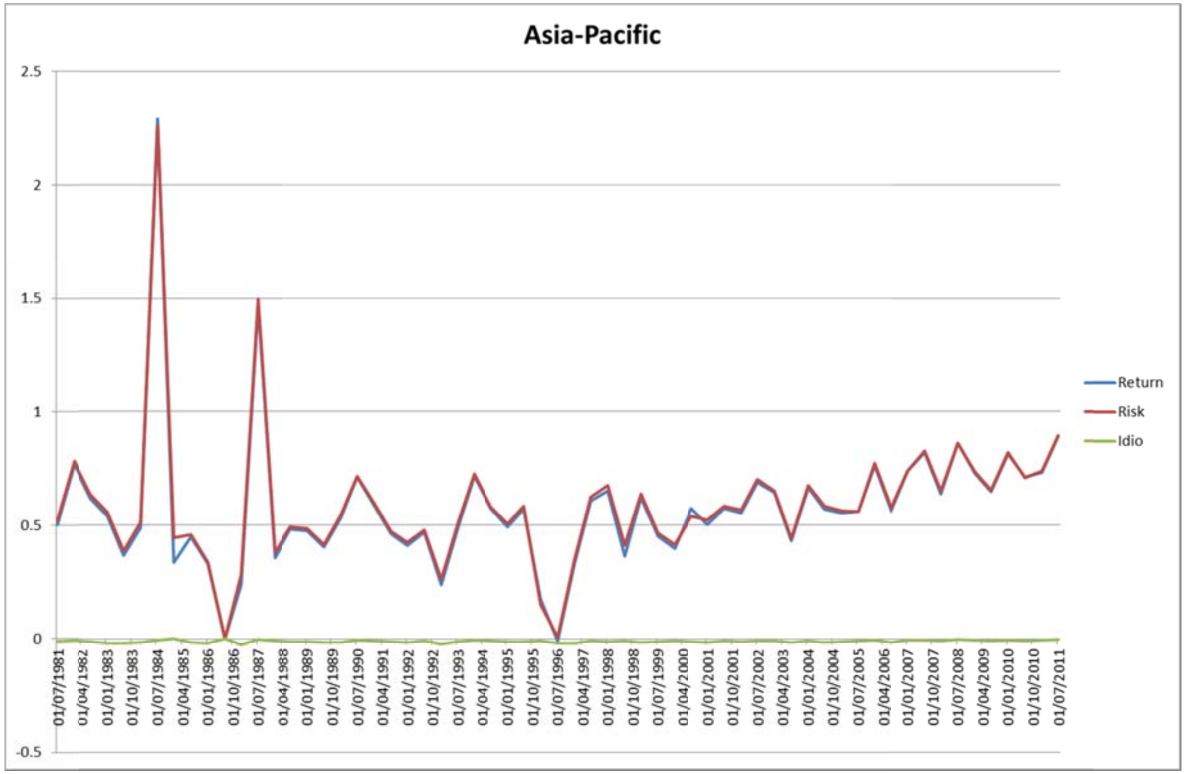
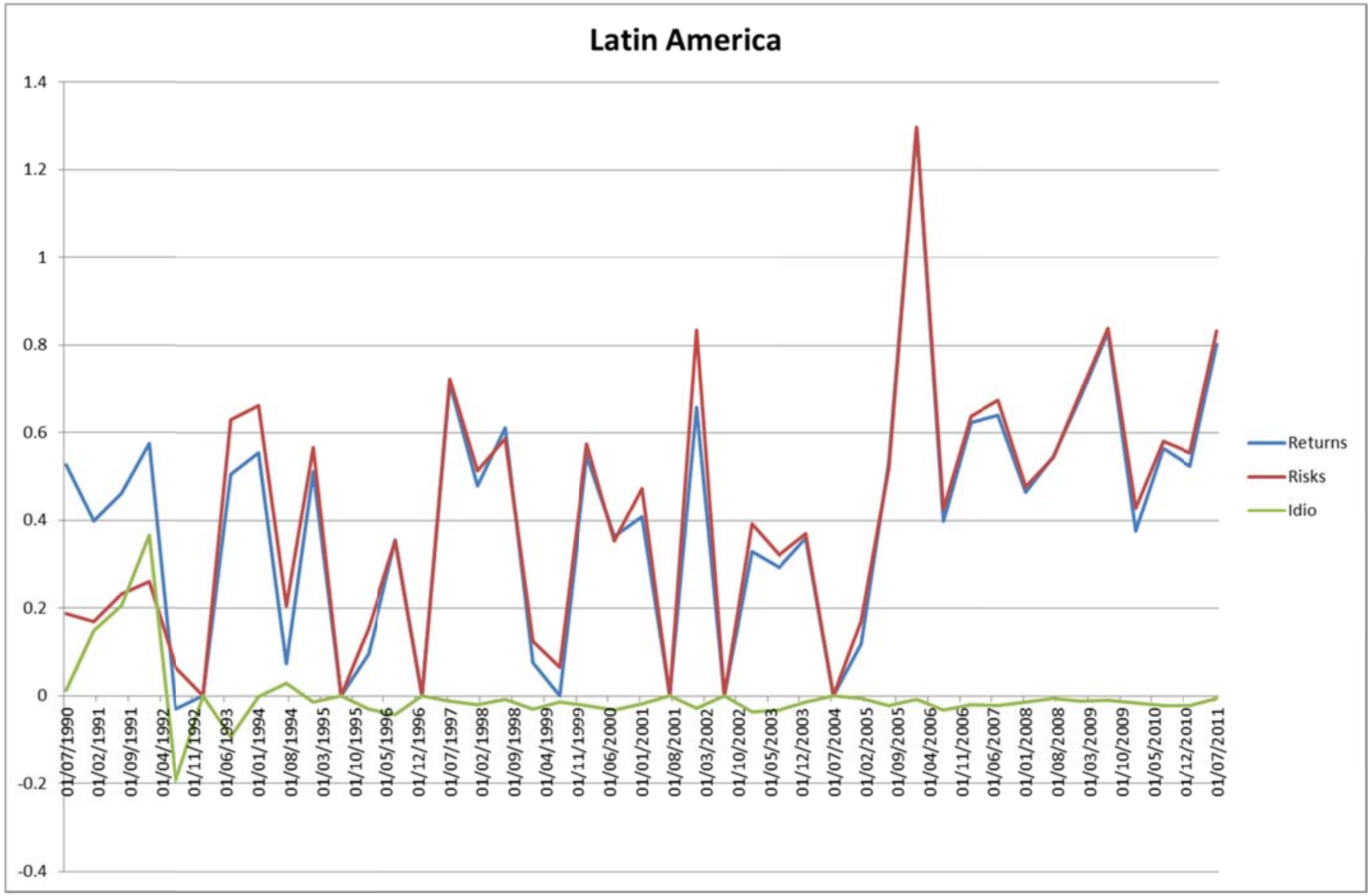


Figure 3. Plots of time-varying empirical covariance γ_{sample}^{CORR} (blue line), time-varying covariance captured by risk factors γ_{risk}^{CORR} (red line) and time-varying covariance of the idiosyncratic shocks γ_{idio}^{CORR} (green line) estimated using eight-factor model.

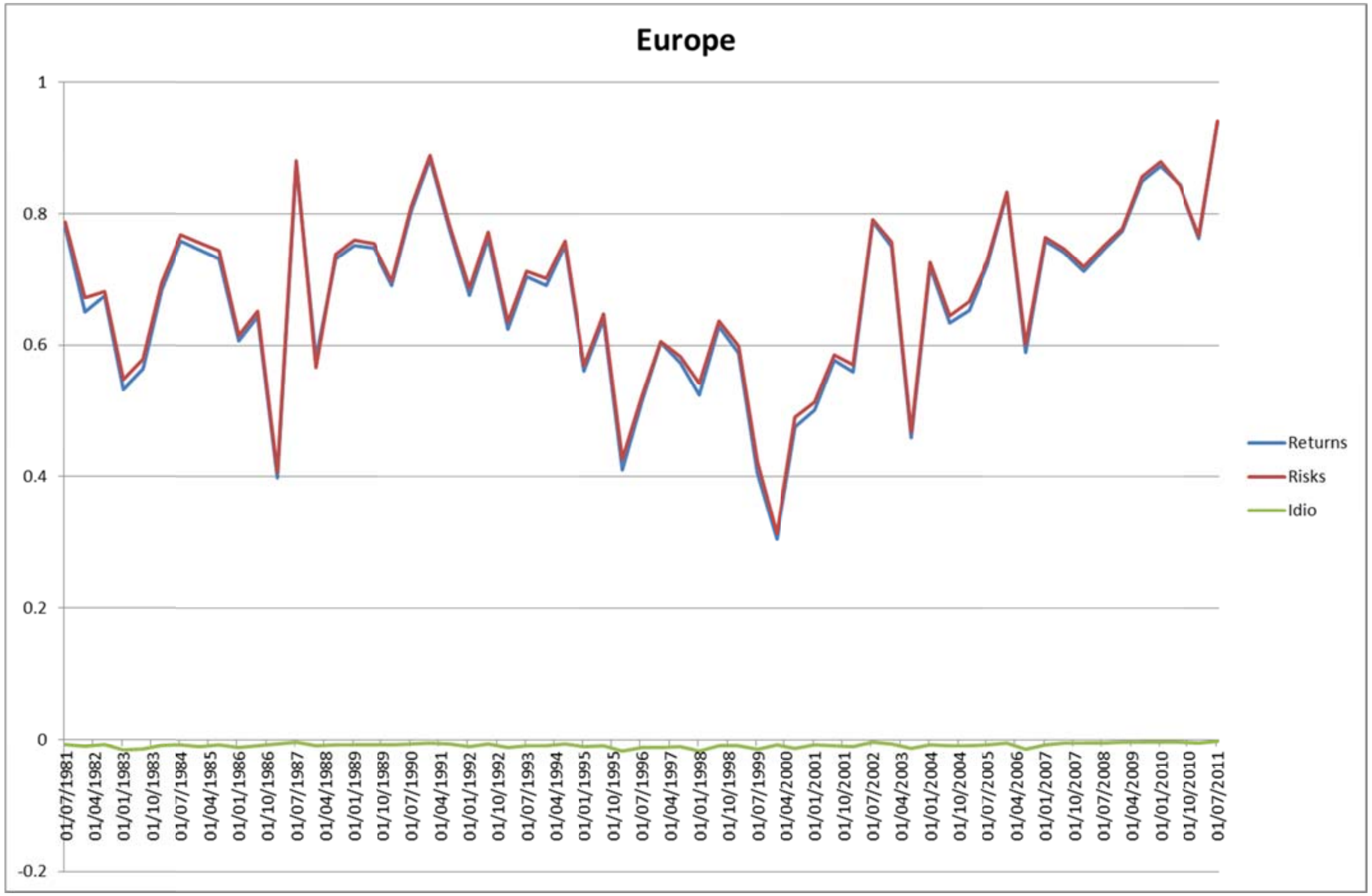
Panel A. Asia-Pacific



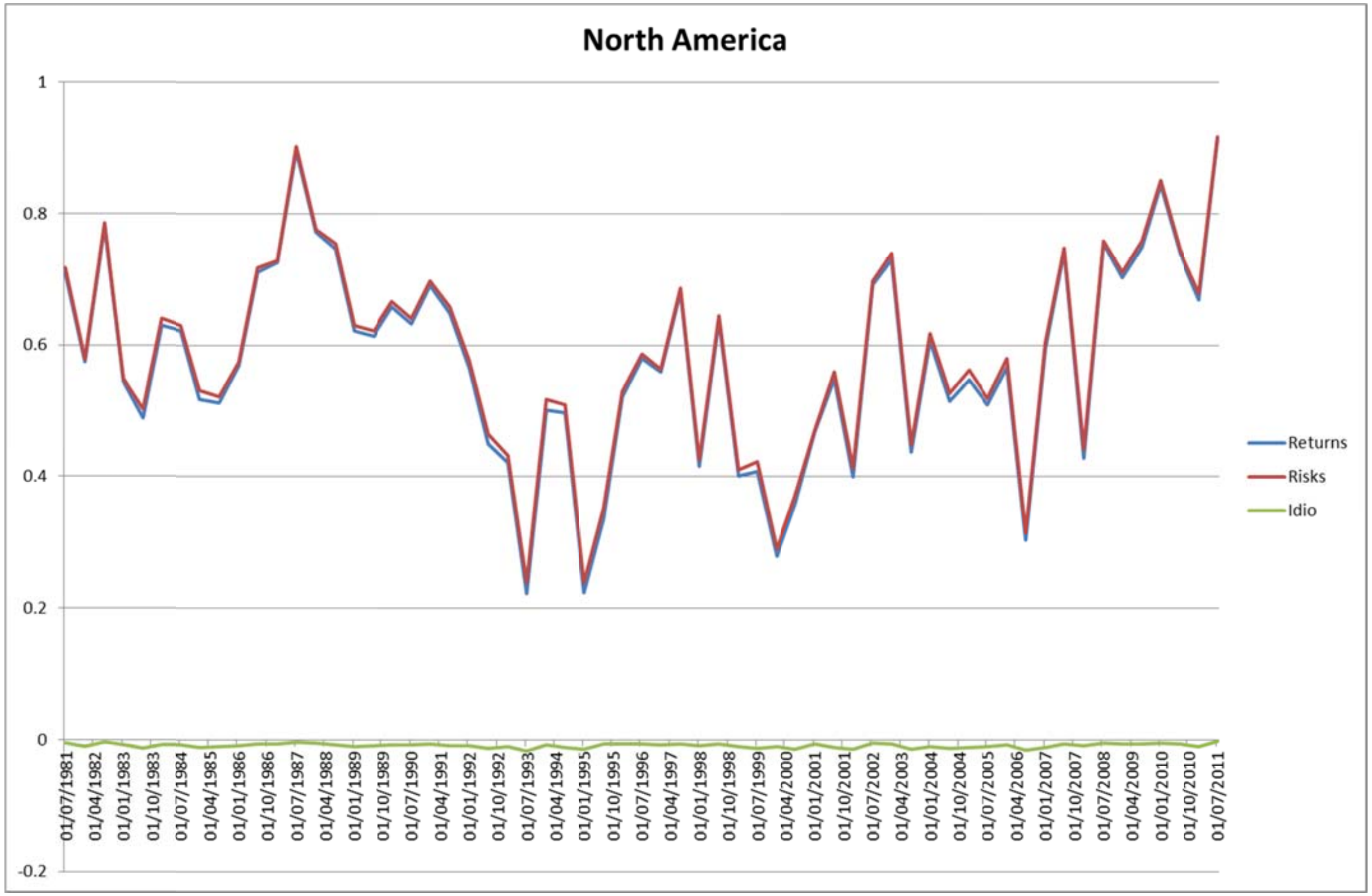
Panel B. Latin America



Panel C. Europe



Panel D. North America



Panel E. Japan