Equity Market Comovement and Contagion:
A Sectoral Perspective

Kate Phylaktis*
Sir John Cass Business School
City of London
106 Bunhill Row
London EC1Y 8TZ

Lichuan Xia
Sir John Cass Business School
City of London
106 Bunhill Row
London EC1Y 8TZ

JEL classification: G11, G15, F3, F36, F15

Keywords: Contagion, International Diversification, Industry Returns, Financial Integration, Global Linkages

Abstract

The paper takes an asset pricing perspective to investigate the equity market comovement and contagion at the sector level during the period 1990-2004 across the regions of Europe, Asia and Latin America. It examines whether unexpected shocks from a particular market, or group of markets, are propagated to the sectors in other countries. The results confirm the sector heterogeneity of contagion, which implies that there are sectors which can still provide a channel for achieving the benefits of international diversification during crises despite the prevailing contagion at the market level.

*Corresponding author: Fax: 020 70408881; Email: K.Phylaktis@city.ac.uk

Acknowledgement: We would like to thank the Emerging Markets Group, Cass Business School, in London for financial support.

1. Introduction

Researchers have shown a long time interest in the study of financial market comovement. Various studies have found that market comovement is currently higher.[1] This increased comovement can be attributed to the increasing market integration in relation to the close economic and financial links. However, market integration may not fully explain this comovement, and contagion may, in part, contribute to the process. In the last decade or so, financial markets were hit by a series of crises: the 1992 ERM attacks, the 1994 Mexican peso collapse, the 1997 East Asian crisis, the 1998 Russian collapse, the 1998 LTCM crisis, the 1999 Brazilian devaluation and the 2000 technological crisis. A striking feature during those crises is that markets tend to move more closely together than in the tranquil times. Such strong comovement is frequently referred to as contagion. Evaluating if contagion occurs and understanding its origin is important for policy makers and fund managers aiming to diversify risks. If contagion prevails in times of crises, the benefits of international diversification will be hampered when they are mostly needed.

Many papers have studied the contagion effect on the equity markets (e.g. King and Wadhwani, 1990; Forbes and Rigobon, 2001, 2002; and Bekaert, Harvey and Ng, 2003). All of them focus on the empirical evidence at the market level and examine whether contagion exists across markets. The question they try to answer is whether idiosyncratic shocks from one particular market or group of markets are transmitted to the other markets during financial crises. In this paper, we take a different perspective and explore the equity market contagion at the disaggregated sector level, an issue which has not yet been examined in the literature. The question we endeavour to answer is whether unexpected shocks from a particular market, or group of markets, are propagated to the sectors in other countries.

Studying the contagion effect at sector level is important for several reasons. First, studying the contagion at the market level may mask the heterogeneous performances of various sectors. Sector contagion can be asymmetric, in the sense that some sectors are more severely affected by external shocks than other sectors within a market. Forbes (2001) shows that trade linkage is an

[1] See, e.g. Freimann (1998) and Goetzmann, Li and Rouwenhorst (2005)

important determinant of a country's vulnerability to crises that originate from elsewhere in the world. If this is so, sectors with extensive international trade (e.g. traded goods sectors) would tend to be more prone to external shocks than sectors with less international trade (e.g. non-traded goods sectors). Some sectors (e.g. Banking) may even constitute a major channel in transmitting the shocks across markets during crises (see e.g. Tai, 2004; and Kaminsky and Reinhart, 1999). From the point view of portfolio management, the sector heterogeneity of contagion implies that there are sectors which can still provide a channel for achieving the benefits of international diversification during crises despite the prevailing contagion at the market level. Second, there is evidence showing that in recent years the global industry factors are becoming more important than the country specific factors in driving the variation of international equity returns (e.g. Baca et al., 2000; Cavaglia et al., 2000; and Phylaktis and Xia, 2004).[2] Industries have overcome the cross-border restrictions and become increasingly correlated worldwide, which increases the likelihood of industries' role in propagating global shocks and providing a channel for transmitting the contagion effect. Third, the industrial composition varies across global markets. Large, mature markets (e.g. US and UK) are comprised of more diversified industries whereas small, less mature markets (e.g. Switzerland) are usually concentrated on a few industries. It is thus interesting to know whether markets with similar industrial structures will co-move more closely with each other and be more prone to contagion during crises compared to markets with different industrial structures.

The importance of industry/sector analysis is also highlighted in other studies. Campbell et al. (2001) decompose the firms' returns into market, industry and firm specific components to study the volatility at the market, industry and firm levels. They have found that all the three volatility measures increase substantially in economic downturns and tend to lead recessions. The volatility measures, particularly the industry-level volatility, help to forecast economic activity and reduce the significance of other commonly used forecasting variables, such as market returns and lagged GDP growth rates. Griffin and Stulz (2001) examine the importance of exchange rate movement and industry competition for equity returns and find that common shocks to industries across countries are

[2] A detailed literature review can be found in Phylaktis and Xia (2004, 2006).

more important than competition shocks due to changes in exchange rates. Moskowitz and Grinblatt (1999) and Rouwenhorst (1998) show that industry momentum strategies are profitable and suggest the existence of time-varying industry risk premium.

The literature on contagion has shown no consensus on the exact definition of contagion. In this paper, we define contagion as excess correlation – that is, correlation over and above what one would expect from economic fundamentals.[3] Our paper takes an asset pricing perspective and contagion is defined by the correlation of the model residuals. Our asset pricing model follows the methodology of Bekaert, Harvey and Ng (2003) and examines two sources of risk: one from the US equity market (proxy for the world market) and the other from the regional market. This structure nests a world asset pricing model (CAPM) with the US equity return as the benchmark and a regional CAPM with a regional portfolio as the benchmark. We test the asset pricing specifications by adding local factors. Essentially the test of integration or segmentation constitutes a critical step in our analysis. If a sector is globally integrated for most of the sample period but suddenly experiences a strong integration at the regional level during a regional crisis, our test will reject the null hypothesis of no contagion. Conversely, if the sector is initially integrated at the regional level, an increase of regional integration during the regional crisis may not indicate a contagion; rather it is simply a consequence of increased interdependence.

Therefore, our main contribution to the literature is the examination of contagion effect at the sector level. As it has been argued above sector level contagion is an important issue, which has not yet been examined. We focus on the sectors of small equity markets across three regions: Europe, Asia and Latin America. At the same time, our model tests whether the sectors are more integrated at the global or regional level, thus nesting the empirical work on equity market integration at the industry level, a subject covered in papers such as Carrieri et al. (2004), Berben and Jansen (2005) and Kaltenhauser (2002, 2003). However, the novelty of our analysis in this area is our focus on the sector returns in 29 smaller markets in Europe, Asia and Latin America, whereas the previous papers

[3] The detailed definitions of contagion are shown on the World Bank's website: http://www1.worldbank.org/economicpolicy/managing%20volatility/contagion

mainly concentrate on sectors either in the euro zone, or in a few major markets such as the US, UK, Japan, or G-7 countries. This constitutes our paper's second major contribution to the literature.

The remaining of our paper is organized as follows: after reviewing the relevant literature in Section 2, we describe our estimation and modelling framework in Section 3. While Section 4 presents the data and the empirical results, the final section summarizes and concludes this paper.

2. Related Literature

As mentioned above, our paper draws from two strands of literature: equity market contagion and equity market integration.

2.1 Equity market contagion

The primary focus of our paper is to examine the contagion effect at sector level in equity markets and test whether contagion exists in sectors during the periods of financial crises such as the Mexican crisis in 1994 and the Asian crisis in 1997. The previous literature focuses on the cross-market evidence. The early studies make use of correlation analysis. The central idea is to assess whether the correlation coefficient between two equity markets changes across tranquil and volatile periods. If the correlation increases significantly, it suggests that the transmission between the two markets amplifies after the shock and thus contagion occurs. Papers following this methodology examine the contagion immediately after the US equity market crash of 1987. The seminal reference is King and Wadhwani (1990), which uses hourly equity market data for the period September 1987 to November 1987 and finds that cross-market correlations between the US, UK and Japan increased significantly after the US crash.

Bertero and Mayer (1990) extend this analysis to a sample of 23 industrialized and developing countries and find also that the correlation coefficients increased appreciably following the equity market crash in the US. Lee and Kim (1993) find further evidence of contagion when applying the same approach to twelve major markets: the average weekly cross-market correlations went from 0.23 before the 1987 crash up to 0.39 afterwards. Calvo and Reinhart (1996) focus on emerging markets and find that the correlations in equity prices and Brady bonds between Asian and Latin American emerging markets increased significantly during the 1994 Mexican peso crisis. Baig and Goldfajn (1999) present the most thorough analysis using this framework and test for contagion in equity indices, currency prices, interest rates and sovereign spreads in emerging markets during the 1997-1998 Asian crisis. They document a surge of cross-market correlations during the crisis for many of the countries.

However, later studies have recognized that focusing on correlations can be misleading. For example, Forbes and Rigobon (2001, 2002) show that looking at unadjusted correlation coefficients is not appropriate, as the calculated correlation coefficient is an increasing function of the variance of the underlying asset return, so that when coefficients between a tranquil period and a crisis period are compared, the coefficient in the crisis period is biased upwards as volatility rises substantially. After correcting for this bias, they find no contagion during the 1997 Asian crisis, the 1994 Mexican peso collapse, and the 1987 US equity market crash. Instead, a high level of market co-movement is found during these crises periods, which reflects a continuation of strong cross-market linkages present globally. Their conclusion is “there is no contagion, only interdependence”. On the other hand, a contrary argument is developed in Corsetti et al. (2002), who suggest that the results of Forbes and Rigobon (2001, 2002) are highly dependent on their specification of idiosyncratic shocks. When these shocks are accounted for, contagion was present during the Asian crisis.

Bekaert, Harvey and Ng (2003) avoid the above correlation analysis and develop a two-factor (global and regional) asset pricing model to examine the equity market contagion in the regions of Europe, South-East Asia and Latin America during both the Mexican and Asian crises of the 1990s. By defining contagion as correlation among the model residuals after controlling for the local and foreign shocks, the authors show that there is no evidence of additional contagion caused by the Mexican crisis. However, economically meaningful increases in the residual correlation are found, especially in Asia, during the Asian crisis, a result confirmed by Dungey, Fry and Martin (2003) and others who have studied the contagion in Asian equity markets.

2.2 Industry level integration

Equity market integration has been extensively studied, while integration at the industry level has been of recent interest (see e.g. Carrieri et al., 2004; Barben and Jansen, 2005; and Kaltenhauser, 2002, 2003). Our paper is closely related to this literature and examines whether sectors are integrated at the global or regional level. However, our focus is on the evidence in smaller countries in Europe, Asia and Latin America, whereas the above papers concentrate on either the euro zone or the large, developed countries such as the US, UK and Japan or the G-7 countries.

Carrieri et al. (2004) apply a conditional asset pricing framework to a sample of 458 weekly returns from 18 industries across the G-7 countries during the periods of 1991-1999, and find that global industry risk is priced for some industries and that the time variation in the prices of global industry risks has recently increased. Their evidence further shows that market level integration does not preclude industry level segmentation. Even if a market is integrated with world markets, some of its industries may still be segmented. Similarly, some of industries may be integrated even though a market is segmented from the rest of the world.

Berben and Jansen (2005) develop a novel bivariate GARCH model with smoothly time-varying correlation to test for an increase in co-movements between equity returns at the market and industry level. They find that in the period 1980-2000 conditional correlations among Germany, UK and the US equity markets have doubled and this correlation behaviour is broadly reflected at the industry level as well.

Kaltenhauser (2002) estimates the time-varying spillover effects from European and US return innovations to 10 industry sectors within the euro area, the US and UK for the period 1988-2002. Over time sectors have become more heterogeneous, and the response to aggregate shocks has increasingly varied across sectors. This provides evidence that sector-specific effects have gained in importance. They also indicate that information technology and non-cyclical services, which are most affected by the aggregate European and US shocks, are the most integrated sectors worldwide. On the other hand, basic industries, non-cyclical consumer goods, resources, and utilities are less affected by aggregate shocks.

In another paper, Kaltenhauser (2003) distinguishes between three types of linkages (cross-country linkages, cross-sector linkages within a given country, and the linkages among equivalent sectors across countries) and explores the spillover effects between equity returns of ten sectors in the euro area, the US and Japan during the periods of 1986-2002. The results indicate that the price innovations in European equities, stemming from both aggregate and sector returns, have doubled or tripled their impacts on other equity markets. At the same time, the response to aggregate shocks in the countries examined has increasingly varied across sectors. Overall, the equity markets in the euro area and the US have become more integrated with each other during the late 1990s, and this higher integration is especially pronounced for sectors compared to the aggregate markets.

3. Framework of Analysis

3.1 The models

We examine the sector returns using the two-factor asset pricing model developed in Bekaert, Harvey and Ng (2003), where the two factors are defined as the US market (proxy for the global source of risk) and a particular regional market (proxy for the regional source of risk). We also allow for local factors to be priced. Our model has the following specification:

$$r_{i,j,t} = \delta_{i,j} X_{i,j,t-1} + \beta^{us}_{i,j,t-1}\mu_{us,t-1} + \beta^{reg}_{i,j,t-1}\mu_{reg,t-1} + \beta^{us}_{i,j,t-1}e_{us,t} + \beta^{reg}_{i,j,t-1}e_{reg,t} + e_{i,j,t}, \qquad (1)$$

$$e_{i,j,t} \mid \Omega_{t-1} \sim N(0, \sigma^2_{i,j,t}), \qquad (2)$$

$$\sigma^2_{i,j,t} = a_{i,j} + b_{i,j}\sigma^2_{i,j,t-1} + c_{i,j}e^2_{i,j,t-1} + d_{i,j}\eta^2_{i,j,t-1}, \qquad (3)$$

where $r_{i,j,t}$ is the weekly excess return of sector i in country *j*. $\mu_{us,t-1}$ and $\mu_{reg,t-1}$ are the conditional expected excess returns on the US and a regional market, respectively, based on information available at time *t-1*; and $e_{us,t}$ and $e_{reg,t}$ are the respective residuals of the US and regional market excess returns. All the excess returns are calculated in excess of the weekly US one-month Treasury-bill rate and expressed in US dollars. $e_{i,j,t}$ is the idiosyncratic shock of sector i in country *j*, and Ω_{t-1} includes all the information available at time *t-1*. The variance of the idiosyncratic return shock of sector i follows a GARCH process as specified in (3) with asymmetric effects in conditional variance. $\eta_{i,j,t}$ is the negative return shock of sector i in country j, i.e. $\eta_{i,j,t} = \min\{0, e_{i,j,t})$. The vector $X_{i,j,t-1}$ contains a set of local economic fundamentals which help estimate the expected return of sector i. In our analysis, the fundamentals are proxied by a constant, the dividend yield of sector i and the market dividend yield of country j which sector i belongs to.

The parameter $\beta^{us}_{i,j,t-1}$ measures the sensitivities of sector i to the US news factors, which derives from two components: the conditional expected returns ($\mu_{us,t-1}$) and the residuals ($e_{us,t}$). An analogy applies to the parameter $\beta^{reg}_{i,j,t-1}$, which measures the sensitivities of sector i to the regional news factors. Those conditional betas $\beta^{us}_{i,j,t-1}$ and $\beta^{reg}_{i,j,t-1}$ are the cornerstone of our tests of integration and contagion. We begin with an examination of model (1)-(3) assuming the betas to be constant in order to obtain the benchmark case, and then allow those betas to change over time in order to capture their time-varying nature. The time-varying parameters of $\beta^{us}_{i,j,t-1}$ and $\beta^{reg}_{i,j,t-1}$ are obtained through a one-year window rolling estimation. Specifically, we take a 12-month regression window, starting from the beginning of our data sample and moving this 12-month window forward by one month at a time. We use this method to study the time-varying integration of our sectors.[4]

The US and regional market models are the special cases of (1)-(3). For the US market, $r_{i,j,t} = r_{us,t}$, $\beta^{us}_{us,t-1} = \beta^{reg}_{us,t-1} = 0$, and $X_{i,j,t-1} = X_{us,t-1}$ where the latter comprises a set of world information variables, including a constant, the world market dividend yield, the spread between the 90-day Eurodollar rate and the 3-month Treasury-bill yield, the difference between the US 10-year Treasury bond yield and the 3-month bill yield, the change in the 90-day Treasury bill yield, and the US money supply (M3). These variables are often used in the literature to capture the movement of international equity market returns. For the regional market model, $r_{i,j,t} = r_{reg,t}$, $\beta^{reg}_{reg,t-1} = 0$ and $X_{i,j,t-1} = X_{reg,t-1}$, which includes a constant and the regional market dividend yield.

[4] See, e.g. Fratzscher (2002) and Kaltenhauser (2002, 2003) for a similar approach to time-varying integration.

Apart from examining the beta parameters, we also calculate the variance ratios for each sector i. As shown in (1), the return of sector i is composed of expected (i.e., the expected excess return) and unexpected parts: the expected excess return of sector i, $\mu_{i,j,t}$, is a linear function of some local information variables as well as the expected excess return on the US and regional markets,

$$\mu_{i,j,t} = E[r_{i,j,t} \mid \Omega_{t-1}] = \delta_{i,j} X_{i,j,t-1} + \beta^{us}_{i,j,t-1}\mu_{us,t-1} + \beta^{reg}_{i,j,t-1}\mu_{reg,t-1} \tag{4}$$

Similarly, the unexpected part of the sector return ($\varepsilon_{i,j,t}$) is driven not only by its own idiosyncratic shocks, but also by the shocks from the US and regional markets,

$$\varepsilon_{i,j,t} = \beta^{us}_{i,j,t-1} e_{us,t} + \beta^{reg}_{i,j,t-1} e_{reg,t} + e_{i,j,t} \tag{5}$$

To complete the model, we assume that the idiosyncratic shocks from the US, region and the sector i are orthogonal with each other, and therefore the conditional variance of sector i is in the following form:

$$h_{i,j,t} = E[\varepsilon^2_{i,j,t} \mid \Omega_{t-1}] = (\beta^{us}_{i,j,t-1})^2 \sigma^2_{us,t} + (\beta^{reg}_{i,j,t-1})^2 \sigma^2_{reg,t} + \sigma^2_{i,j,t} \tag{6}$$

Equation (6) allows us to derive two variance ratios to explore how much of the local sector return variance is explained by the respective US and regional factors ($VR^{us}_{i,j,t}$ and $VR^{reg}_{i,j,t}$):

$$VR^{us}_{i,j,t} = \frac{(\beta^{us}_{i,j,t-1})^2 \sigma^2_{us,t}}{h_{i,j,t}} \tag{7}$$

$$VR^{reg}_{i,j,t} = \frac{(\beta^{reg}_{i,j,t-1})^2 \sigma^2_{reg,t}}{h_{i,j,t}} \ . \tag{8}$$

3.2 Tests of integration and contagion at sector level

In examination of the two-factor model of (1)-(3), we assume first that the conditional betas are time-invariant to obtain a benchmark case, and then relax this assumption and allow the betas to change over time. The model (1)-(3) with time-invariant betas can test several integration hypotheses. On the one hand, if the model holds, that is, if the two foreign risk factors are sufficient in explaining the expected returns of sectors within a particular country, the local instruments should have no explanatory power on those sector returns, and thus $\delta_{i,j} = 0$. We interpret this test as a test of integration, where the integration can be either global or regional. On the other hand, the model nests the one-factor CAPM model as a special case. If $\beta^{reg}_{i,j,t-1} = 0$ together with $\delta_{i,j} = 0$, the model reduces to the traditional CAPM with the US being the benchmark market and sector i priced with the US market. In this case, the model implies that sector i is fully integrated with the world market. Similarly, if $\beta^{us}_{i,j,t-1} = 0$ together with $\delta_{i,j} = 0$, the model becomes one-factor model with the region being the benchmark market. We interpret this as a full integration of sector i at the regional level.

The model (1)-(3) with time-variant betas is examined via the rolling estimation method with one-year regression window. We use this method to study the time-varying integration at sector level. After the time-variant betas have been accounted for, we employ the model residuals to examine the sector level contagion effect. Contagion is measured by the correlation of the model's idiosyncratic shocks. Any significant correlations amongst those shocks would indicate that sector residuals are correlated beyond what is captured in our model, suggesting evidence of contagion.

For each sector i, three correlations are considered: with the global shocks from the US market, with the regional shocks from a geographic region, and with intra-sector shocks from the equivalent sectors in other countries within a region. Our model is in the following form:

$$\hat{e}_{i,j,t} = \nu_{i,j} + \phi_{i,j,t}\hat{e}_{g,t} + \xi_{i,j,t} \tag{9}$$

$$\phi_{i,j,t} = m + nD_{i,t} \tag{10}$$

where $\hat{e}_{i,j,t}$, $\hat{e}_{g,t}$ are the estimated idiosyncratic return shocks of sector i and a country-group respectively after the time-varying betas have been accounted for. Three country-groups are employed: the return shocks from the US, $\hat{e}_{g,t} = \hat{e}_{us,t}$, the return shocks from a geographic region, $\hat{e}_{g,t} = \hat{e}_{reg,t}$, and the intra-sector shocks (i.e. the sum of equivalent sector shocks within a particular region excluding that sector in country j to be considered), $\hat{e}_{g,t} = \sum_{\substack{k\neq j\\ k\subset G}} \hat{e}_{i,k,t}$, where G denotes a particular region country k belongs to.

The regression of model (9) across time yields the time-varying coefficient, $\phi_{i,j,t}$, for each sector i. The time-varying coefficients $\phi_{i,j,t}$ of equivalent sectors are pooled into cross-sectional time-series data and examined separately in model (10) for each of the three regions: Europe, Asia and Latin America[5]. $D_{i,t}$ is a dummy variable that represents two sample periods: the Mexican crisis period from November 1994 to December 1995 and the Asian crisis period from April 1997 to October 1998. In estimation of the above regression, we establish a baseline level of contagion by examining the shock correlations over the full sample period, i.e. whether the coefficients of *m* and *n* are zero (overall contagion for the whole sample period), and test for additional contagion during crisis periods by examining the significant increase of shock correlations during a particular crisis period, i.e. whether *n* is significantly different from zero (contribution of a particular crisis period to contagion).

3.3 Model estimation and specification test

Sector returns, together with the US and regional market returns, can be treated as a joint multivariate likelihood function. We estimate this joint function in three stages. In the first stage, the model for the US market is estimated, and then based on the US estimates, we examine the regional market model. In the final stage, a univariate model in (1)-(3) is estimated sector by sector, conditioning on the US and the regional market estimates.[6]

By using the generalized method of moments, we conduct a series of specification tests on the estimated standardized idiosyncratic shocks, $\hat{z}_{i,j,t} = \hat{e}_{i,j,t} / \hat{\sigma}_{i,j,t}$ for sector i (including the US and regional markets). Under the null hypothesis that the model is correctly specified,

$$E[\hat{z}_{i,j,t}] = 0\,, \tag{11a}$$

$$E[\hat{z}_{i,j,t}\hat{z}_{i,j,t-s}] = 0\,, \text{ for } s = 1,\ldots,\tau\,, \tag{11b}$$

$$E[\hat{z}^2_{i,j,t} - 1] = 0\,, \tag{11c}$$

$$E[(\hat{z}^2_{i,j,t} - 1)(\hat{z}^2_{i,j,t-s} - 1)] = 0\,, \text{ for } s = 1,\ldots,\tau\,, \tag{11d}$$

---

[5] The estimation of model (10) for each region corrects for the serial correlation and group-wise heteroskedasticity.

[6] This methodology has also been employed in, for example, Bekaert and Harvey (1997).

$$E[\hat{z}^3_{i,j,t}] = 0\,, \tag{11e}$$

$$E[\hat{z}^4_{i,j,t} - 3] = 0 \tag{11f}$$

Equation (11b) and (11d) are a sequence of the correct specification for the conditional mean and variance, and we test these two conditions by Ljung-Box Q-statistics. The unconditional moments in the other four constraints are jointly tested by a χ^2 statistics with four degrees of freedom.

4. Empirical Results

4.1 Data

The empirical analysis is conducted on the sector returns for a set of 29 countries that are grouped into three geographical regions – Europe, Asia and Latin America. All the sector indices as well as the US and regional market indices are compiled by and extracted from Datastream International. We follow the broad distinction of ten economic sectors according to the Financial Times Actuaries, which Datastream uses: Basic Industries, Cyclical Consumer Goods, Cyclical Services, Financials, General Industries, Information Technology, Non-cyclical Consumer Goods, Non-cyclical Services, Resources, and Utilities (see appendix for a more detailed description of sector classifications and a list of our sample countries).

Our Wednesday-to-Wednesday sample covers the period from 3 January 1990 to 30 June 2004 for most countries and a somewhat shorter time period for a few countries where some of the time series started later. All weekly returns are calculated in excess of the weekly US one-month Treasury-bill rate and expressed in US dollars. The other data, including dividend yields, 90-day Eurodollar rate, 3-month Treasury-bill yield, US 10-year Treasury bond yield and the US money supply (M3) are also downloaded from Datastream.

4.2 US and regional models

Table 1 details the US and regional market estimation. For the US market (first row in the table), asymmetric GARCH model is selected as the hypothesis of no asymmetry in the conditional variances is strongly rejected. All three specification tests fail to reject the US model specification.

The Wald test on the information variables indicates that the explanatory power of those variables is significant.

The rest of Table 1 presents the regional market estimation. Like the US market, both Asia and Latin America exhibit asymmetric volatility. However, we find little evidence of asymmetry in the region of Europe. The three specification tests fail to provide evidence against our model specification for all three regions. The local instruments have significant explanatory power in Asia, but not in Latin America or Europe.

The conditional betas with respect to the US market are significant for all three regions, with Europe being the highest (0.593), followed by Latin America (0.576) and Asia (0.431). In terms of variance ratios, more than 30% of the conditional return variance in Europe can be attributed to the US shocks, whereas the ratios are 15.68% and 12.25% for Latin America and Asia respectively.

4.3 Sector level integration

In this sub-section, we estimate GARCH model (1)-(3) for sectors with constant coefficients, i.e. with coefficients that are assumed to be time-invariant. Our framework tests the sector level integration and nests at least two distinct models: an asset pricing model with a single US factor and an asset pricing model with a single regional factor. Detailed sector-by-sector tests are available upon request. Here we summarize the main results.

In total, the numbers of sector returns to be tested are 130 in Europe, 76 in Asia and 61 in Latin America. We first test whether the lagged local information enters the mean equation (test of $\delta_{i,j} = 0$). If the asset pricing model is properly specified, those local instruments should not enter the model. This test can be thought of as a test of whether the conditional alpha (or pricing error) is zero and, under the null hypothesis of the regional or world CAPM, as a test of market integration. In Europe, 34 out of total 130 sector returns represented in 14 countries reject the hypothesis that local information is unrelated to the pricing errors. In Asia, 24 out of a total of 76 sector returns presented in 8 countries show the significant explanatory power of the local information, whereas in Latin

America the local information is important for explaining the pricing errors in 21 sector returns out of a total of 61 presented in 7 countries.

Tests of whether betas are significantly different from zero indicate that the beta with respect to the US ($\beta^{us}_{i,j,t-1}$) is significant in 110 sector returns in Europe, 68 in Asia and 41 in Latin America. The number of sector returns with significant beta with respect to the regional factor ($\beta^{reg}_{i,j,t-1}$) are 121, 73 and 53 respectively for Europe, Asia and Latin America.

We also test restrictions on two sets of parameters. If $\beta^{reg}_{i,j,t-1} = 0$ and $\delta_{i,j} = 0$, the model reduces to the traditional world CAPM with the US being the benchmark. This model is rejected at the 5% level for 116 sector returns in Europe, 75 in Asia and 48 in Latin America. If $\beta^{us}_{i,j,t-1} = 0$ and $\delta_{i,j} = 0$, the model becomes one-factor model with the region being the benchmark. This model is rejected at the 5% level for 126 sector returns in Europe, 75 in Asia and 55 in Latin America.

Generally, our Wald tests reveal that most sectors in the three regions are priced at both regional and global level, with local information having little explanatory power in the return process. However, one single factor CAPM (special case of our two factor model) is usually rejected, indicating that it is not a good description of the data by itself. Nevertheless, the covariance with one factor benchmark is a significant determinant of expected returns for most sectors.

The conditional betas and variance ratios are our primary focus on the sector level integration analysis. Table 2 reports the average betas and variance ratios with respect to the US and regional markets across the sectors in Europe, Asia and Latin America[7]. In Europe, out of the 10 sectors examined, Information Technology has the highest average betas (0.7105 on the US vs. 0.6368 on the region), whereas Utilities has the lowest betas (0.1255 vs. 0.3635). This is consistent with our prior expectation as Information Technology sector is considered more international in nature, while Utilities sector is more subject to local country-specific factors. Generally, sectors have a greater beta on the regional market relative to on the US market, suggesting that the European sectors are more

[7] There are only 9 sectors in Latin America and the Information Technology is unclassified in the dataset.

responsive to the shocks from their own regional market than to shocks from the US market and thus more integrated at the regional level. The only exception is Information Technology sector, which responds more strongly to the US market innovations as shown by a higher beta with respect to the US than with respect to the region. Not surprisingly, the variance ratios follow the same pattern, and the fraction of the return shock variance explained by the region is larger than that by the US (except for Information Technology).

In Asia, like in Europe, the sector with the highest betas is Information Technology (0.694 on the US vs. 0.5659 on the region) and the sector with lowest betas is Utilities (0.2055 vs. 0.2352). However, for most sectors, the betas with respect to the US market are larger than the betas with respect to the regional market, suggesting the dominance of the US market in the region. The pattern of the US market dominance is about the same in terms of the variance ratios.

In Latin America, Non-cyclical Services sector tops the rest with the highest betas (0.5834 on the US vs. 0.6885 on the region) and the smallest betas go to the sector of Cyclical Consumer Goods (0.1397 vs. 0.2667). Nevertheless, the sectors in the region display a pattern closer to what we see for the region of Europe, with the betas on the regional market higher than those on the US market. Clearly, the regional integration, relative to the global one, is stronger in Latin America. A similar result can be made from the comparison of the variance ratios.

Summarizing the above, we find that the performance of sectors does vary across regions: while sectors are dominated by the regional market and thus more strongly integrated at the regional level in Europe and Latin America, they are more influenced by the US market and thus more integrated at the global level in Asia. One point to notice is the distinct deviation of Information Technology sector, which is more responsive to the global shocks and this global nature is ubiquitous across different regions.

Our finding of regional dominance in Europe is consistent with the market integration analysis in Fratzscher (2002), where it is shown that the European regional market has gained considerably in importance in world financial markets and has taken over from the US as the dominant market in Europe. Similarly, Hardouvelis et al. (2005) have also found that expected returns became increasingly determined by EU-wide market risk and less by local risk implying stock market integration across the Eurozone countries. This regional dominance can to a large part be attributed to the drive toward EMU and in particular, the elimination of exchange rate volatility and uncertainty in the process of monetary unification after the introduction of the euro.

The dominance by the regional market in Latin America is also reported in other papers. For example, Heaney et al. (2002) find that the equity markets in Latin America are becoming regionally integrated at a faster rate than globally, reflecting the growing co-operation between Latin American countries since liberalization in the early 1990s. On the other hand, the stronger connection to the US market found in Asia is documented in papers such as, Masih and Masih (1997), Siklos and Ng (2001), and Bekaert, Harvey and Ng (2003) in their investigation of market interdependence in Asian countries.

4.4 Time-varying integration

To capture the time-varying nature of sector level integration, we relax the assumption of constant betas and allow them to change over time. Our GARCH model (1)-(3) are re-examined via a one-year window rolling estimation to obtain those time-variant betas. Figure 1 details the inter-temporal movement of sector average betas in Europe, Asia and Latin America. Indeed those betas vary substantially, with several peaks and troughs along the time horizon, but distinct features across regions can be observed. For sectors in Europe, the regional betas dominated the US ones for most of the sample period (except for the Information Technology, which mainly had a higher beta with respect to the US than the one with respect to the region). However, we see some periodic shifts from the regional beta dominance to the US beta dominance and the occurrence of those shifts coincide with the crisis periods such as the Mexican crisis in 1994-1995, the Asian crisis in 1997-1998 and Technology bubbles in 2000-2001, a phenomenon which may suggest possible contagion effects sustained at sector level.

The sector betas in Asia present a different scenario. Compared to other regions, the beta dominance in Asia was more unstable and fluctuated from time to time. The US betas went to the lowest and even negative in 1992-1994, implying that sector movement in Asia during this time period was in opposite direction with the US market and solely positively correlated with the regional market. However, immediately after this period, the US betas rose abruptly and began to dominate the regional betas in 1994-1996, indicating the increasingly strong impact of US market in the Asian countries. Another period of high US betas was in 1997-1999, which happened to be the Asian crisis period. But the regional betas during this period were even higher and dominated the US betas. Phylaktis and Ravazzolo (2002) find a similar result when examining real and financial links for the Asian countries during the period 1980-1998. In their study they analysed the covariances of excess returns on national stock markets and used the comovement of innovations in future expected stock returns as an indicator of financial integration and the comovement of dividend news between two countries as an indicator of economic integration.

In Latin America, the movement of betas was least volatile out of the three regions. All the sectors display a stronger regional level integration for most of the sample period. There were periodic switches of beta dominance over time and those switches were also related to the financial crisis periods.

In general, sector betas in the three regions had a great deal of variation and the beta dominance was unstable over time. We find that the changes of beta dominance from one to the other usually occurred during crisis periods, a possible indication of contagion effects sustained at the sector level.

4.5 Sector level Contagion

As explained before, our framework decomposes the correlations of sector returns into two components: the part the asset pricing model explains and the part the model does not explain. The explained part provides potential insights about sector level integration through the movements in the conditional betas. The unexplained part allows us to examine the correlations of model residuals, which we define as the contagion effects at the sector level.

We examine model (9)-(10) to detect the overall contagion for the whole sample as well as the additional contagion during particular crisis periods, where two crises are considered: the Mexican crisis during 1994-1995 and the Asian crisis during 1997-1998 (see Table 3). Panel A in Table 3 reports the estimation for the Mexican crisis. Looking first at the overall contagion through the joint test of $m = n = 0$, we reject the null of no contagion against all the country-group benchmarks at the 5% level for the majority of sectors in the three regions. However, the channels and magnitude of contagion vary across regions. On the one hand, in Europe and Asia the overall contagion comes from all three channels, each of which is significant: the global shocks, regional shocks and the shocks of regional equivalent sectors. In Latin America it is mainly transmitted via the global and regional shocks channels but the link with the regional equivalent sector shocks is not as widely spread as that in Europe or Asia. On the other hand, comparing the m coefficients against the three benchmarks within each region, we find that sectors in Europe and Latin America had the greatest correlation with the regional residuals whereas in Asia the correlation with the sum of equivalent sector residuals was the greatest. In other words, the highest magnitude of contagion is driven by regional shocks for sectors in Europe and Latin America, but by the equivalent sector shocks for sectors in Asia.

The n coefficient measures the additional correlation during the Mexican crisis. 5 sectors in Europe and Asia and 4 in Latin America displayed a positive significant coefficient with respect to the US residuals. Clearly the Mexican crisis did cause contagion and nearly half of the sectors in the three regions were affected. This contagion was mainly driven by the global shocks (shocks from the US market).

Panel B of Table 3 presents the results for the Asian crisis. 5 (4) sectors in Asia had a positive significant n coefficient with respect to the US (regional), whereas the number of significant n coefficients in Europe and Latin America was negligible. This finding indicates that the Asian crisis worsened contagion for most sectors in Asia but had no effect elsewhere. However, the finding also points out that even though contagion was prevalent at the market level, there are still some sectors which were immune from the contagion effect during the crisis. The overall contagion test confirms the result in Panel A of the cross-regional differences in terms of the channels and magnitude of contagion.

Overall, our analysis reveals that sector residuals are correlated beyond what is captured in our model, suggesting evidence of contagion. On the one hand, an overall contagion at sector level over our entire sample period is found but it varies across regions. In terms of possible channels, contagion across the three regions is transmitted via global and regional shocks. But in Europe and

Asia, an additional channel is identified, which is the shocks from equivalent sectors within the region. This confirms our prior expectation that contagion occurs at the sector level and sectors provide channels in propagating unexpected shocks. In terms of the magnitude of contagion, in Europe and Latin America the most severe contagion comes from the regional shocks whereas in Asia it is mainly driven by the shocks from equivalent sectors within the region. On the other hand, in studying whether contagion worsened during particular crisis periods, our paper shows that nearly half sectors in the three regions were affected during the Mexican crisis and the contagion was mainly transmitted via the global shocks. However, during the Asian crisis, no additional contagion is found in Europe or Latin America, but we do find that the crisis worsened the contagion for most sectors in Asia transmitted via the global and regional shocks channels.

5. Conclusions

The last decade or so witnessed a series of financial crises and one common observation during those crises is that financial markets tend to co-move more closely than during the tranquil times. Such strong comovement across markets is often referred to as contagion. At the same time, there is evidence showing the increasing importance of industry factors in driving the global equity returns. Industries or sectors overcome the cross-border restrictions and become more closely correlated and such increasing correlation across industries/sectors in different countries may lend themselves to the possible impact from the external shocks and contagion effects may sustain at the industry/sector level. The purpose of this paper is to examine the sector level contagion across the regions of Europe, Asia and Latin America, an issue not yet studied in the literature. A by-product of our analysis is the investigation of industry/sector level integration on equity markets, which has been studied at the limited coverage of the Euro zone, the US, UK and G-7 countries.

The literature has shown no agreement on the exact definition of contagion and in this paper we define contagion as excess correlation – i.e. correlation over and above what one expects from economic fundamentals. As no consensus is agreed upon what the fundamentals are, our paper follows the two-factor international asset pricing model framework of Bekaert, Harvey and Ng (2003) to study the sector level integration and contagion. Essentially, our framework decomposes the correlations of sector returns into two components: the part the asset pricing model explains and the part the model does not explain. The time-varying nature of integration is captured through the estimation of the asset-pricing model over a 12-month rolling window. The explained part controls for the economic fundamentals and provides insights on sector level integration through the movements in the conditional betas. The unexplained part allows us to examine the correlation of model residuals. Any significant correlation found in the residuals is beyond what our model can account for and therefore suggests evidence of contagion. Such an approach to contagion, however, depends on model specification and care has been taken to correctly specify it.

Our analysis focuses on the 10 broad sectors in 29 smaller markets in Europe, Asia and Latin America during the period of Jan 1990 – June 2004. The main results are summarized as follows: first, the sector level integration displays a distinct pattern across regions: sectors in Europe and Latin America have higher betas with respect to the regional market than with respect to the US market, suggesting the stronger integration at the regional level. Conversely, sectors in Asia are more responsive to the US market than to the regional market and thus more integrated at the global level. Our findings of regional differences are also confirmed in other papers studying the international equity market comovements. The heterogeneous performance of sectors across regions indicates that those sectors are less globally correlated than we have expected and still subject to the regional effects. However, one exception is Information Technology, which is more globally integrated regardless of its geographic location.

Second, the pattern of sector integration changes over time, especially during the crisis periods. Across the three regions, we find many sectors showing a sudden change from regional beta dominance to the US beta dominance or vise versa during crisis times. This beta shift points to the fact that contagion is possibly sustained at the sector level.

Third, we find that the sector residuals are economically and statistically significantly correlated with the US market residuals and regional market residuals as well as with the sum of equivalent sector residuals and such correlations are beyond what our asset pricing model accounts for, indicating evidence of contagion. An overall contagion over our entire sample period is found for the majority of sectors in Europe, Asia and Latin America. However the transmitting channels and the magnitude of contagion vary across regions. On the one hand, while contagion in Europe and Asia is transmitted via the global and regional shocks as well as the equivalent sector shocks, it is mainly connected to the global and regional shocks in Latin America and the equivalent sector shocks plays little role in contagion propagation. On the other hand, the most severe impact of contagion derives from the channel of regional shocks in Europe and Latin America, whereas in Asia it comes from the channel of equivalent sector shocks.

Finally, in examining whether the Mexican and Asian crises provide additional contagion effects, we find that nearly half sectors in the three regions were affected via the global shocks during the Mexican crisis. During the Asian crisis no additional contagion is found in Europe or Latin America, but a worsened contagion transmitted via the global and regional shocks is found for most sectors in Asia.

Our findings have important implications for portfolio managers aiming to diversify risks. On the one hand, industries/sectors are found to have crossed the national boundaries and become integrated with the rest of the world. This means that domestic risk factors now matter less and non-domestic factors matter more so that diversification across countries may be losing the merit and diversification across industries is preferable. However, the divergence of integration across regions points to the fact that industries/sectors are not as globally correlated as we expect and regional effects still play a role. Therefore selecting portfolios across regions rather than within regions would be more efficient. On the other hand, international investors and portfolio managers are concerned with diversification in volatile times, especially during the crisis periods when it is most needed. Our evidence shows that some sectors are plagued with contagion during crises, so investors and portfolio managers should avoid choosing individual securities from those contagious sectors. However, our evidence also shows that there are sectors which are immune from the external shocks or contagion during the financial crises. Those sectors can provide a tool to diversify risks during the crisis periods and the benefits of diversification can still be achieved.

References:

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

Baig, T., Goldfajn, I., 1999. Financial market contagion in the Asian crisis, *IMF Staff Papers* 46(2) 167-195.

Bekaert, G., Harvey, C.R., 1997. Emerging equity market volatility, *Journal of Financial Economics*, 43, 29-77.

Bekaert, G., Harvey, C.R., Ng, A., 2003. Market integration and contagion, NBER *Working Paper*, 9510; *Journal of Business*, forthcoming.

Berben, R.P., Jansen, W.J., 2005. Co-movement in international equity markets: a sectoral view, *Journal of International Money & Finance*, 24 (5), 832-857.

Bertero, E., Mayer, C., 1990. Structure and performance: global interdependence of stock markets around the crash of October 1987, *European Economic Review*, 34, 1155-1180.

Calvo, S., Reinhart, C., 1996. Capital flows to Latin America: is there evidence of contagion effects? in Calvo, G., Goldstein, M. and Hochreiter, E. (eds), *Private capital flows to emerging markets, institute for international economics*, Washington.

Campbell, J.Y., Lettau, M., Malkiel, B. G., Xu, Y., 2001. Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk, *Journal of Finance*, 56, 1-43.

Carrieri, F., Errunza, V., Sarkissian, S., 2004. Industry risk and market integration, *Management Science*, 50(2), 207-221.

Cavaglia, S., Brightman, C., Aked, M., 2000., The increasing importance of industry factors, *Financial Analysts Journal*, September/October, 41-54.

Corsetti, G., Pericoli, M., Sbracia, M., 2002. Some contagion, some interdependence: more pitfalls in tests of financial contagion, *Mimeo.*

Dungey, M., Fry, R., Martin, V.L., 2003. Equity transmission mechanisms from Asia and Australia: interdependence or contagion? *Australian Journal of Management*, 28, 157-182.

Forbes, K., 2001. Are trade linkages important determinants of country vulnerability to crises? *NBER Working Paper*, No. 8194, http://www.nber.org/papers/w8194

Forbes, K., Rigobon, R., 2001. Measuring contagion: conceptual and empirical issues, in S. Claessens and K. Forbes (Eds), *International Financial Contagion*, New York: Kluwer Academic Publishers.

Forbes, K., Rigobon, R., 2002. No contagion, only interdependence: measuring stock market co-movements, *Journal of Finance*, 57, 2223-62.

Fratzscher, M., 2002. Financial market integration in Europe: on the effects of EMU on stock markets, *International Journal of Finance and Economics*, 7(3), 165-194.

Freimann, E., 1998. Economic Integration and Country Allocation in Europe, *Financial Analysts Journal*, 54, No 5, 32-41.

Goetzmann, W., Li, L., Rouwenhorst, G., 2005. Long-Term Global Market Correlations, *Journal of Business*, 78(1), 1-38.

Griffin, J.M., Stulz, R.M., 2001. International competition and exchange rate shocks: a cross-country industry analysis of stock returns, *The Review of Financial Studies*, 14 (1), 215-241.

Hardouvelis, G.A., Malliaropoulos, D., Priestley, R., 2005. "EMU and European stock market integration", *Journal of Business*, forthcoming.

Heaney, R.A., Hooper, V., Jagietis, M., 2002. Regional integration of stock markets in Latin America, *Journal of Economic Integration,* 17, 4, 745-760.

Kaltenhauser, B., 2002. Return and volatility spillovers to industry returns: does EMU play a role? *Working paper*, CFS (Centre for Financial Studies).

Kaltenhauser, B., 2003. Country and sector-specific spillover effects in the euro area, the United States and Japan, *Working Paper*, ECB (European Central Bank), No. 286

Kaminsky, G.L., Reinhart, C.M., 2000. On crises, contagion and confusion, *Journal of International Economics*, 51, 145-168.

Kaminsky, G.L., Reinhart, C.M., 1999. The two crises: the causes of banking and balance-of-payments problems, *American Economic Review*, 89, 473-500.

King, M., Wadhwani, S., 1990. Transmission of volatility between stock markets, *The Review of Financial Studies*, 3(1), 5-33.

Lee, S.B., Kim, K.J., 1993. Does the October 1987 crash strengthen the co-movements among national stock markets? *Review of Financial Economics*, 3(1), 89-102.

Masih, A., Masih, R., 1997. A comparative analysis of the propagation of stock market fluctuations in alternative models of dynamic causal linkages, *Applied Financial Economics*, 7, 1, 59-74.

Moskowitz, T., Grinblatt, M., 1999. Do industries explain momentum? *Journal of Finance*, 54, 1249-1290.

Phylaktis, K., Ravazzolo, F., 2002. Measuring financial and economic integration with equity prices in emerging markets, *Journal of International Money & Finance*, 21(6), 879-903

Phylaktis, K., Xia, L., 2004. The changing role of industry and country effects in the global equity markets, *Emerging Markets Group WP.*

Phylaktis, K., Xia, L., 2006. Sources of firms' industry and country effects in emerging markets, *Journal of International Money and Finance*, forthcoming.

Rouwenhorst, K.G., 1998. International momentum strategies, *Journal of Finance*, 53, 267-284.

Siklos, P. L., Ng, P., 2001. Integration among Asia-Pacific and international stock markets: common stochastic trends and regime shifts, *Pacific Economic Review*, 89-110.

Tai, C., 2004. Can bank be a source of contagion during the 1997 Asian crisis? *Journal of Banking & Finance*, 28, 399-421.

Table 1 US and Regional Market Return Model

The following GARCH model is examined:

$$r_{i,t} = \delta_i X_{i,t-1} + \beta^{us}_{i,t-1}\mu_{us,t-1} + \beta^{us}_{i,t-1}e_{us,t} + e_{i,t}$$
$$e_{i,t} \mid \Omega_{t-1} \sim N(0, \sigma^2_{i,t})$$
$$\sigma^2_{i,t} = a_i + b_i\sigma^2_{i,t-1} + c_i e^2_{i,t-1} + d_i\eta^2_{i,t-1}$$
$$\eta^2_{i,t-1} = \min\{0, e_{i,t}\}$$

where $r_{i,t}$ is the excess return and $X_{i,t-1}$ represents local information variables available at time t-1. $\mu_{us,t-1}$ and $e_{us,t}$ are the conditional expected excess return and residual of the US market. For the US market (i = us), $\beta^{us}_{i,t-1}$ is zero, and $X_{i,t-1}$ represents a set of US or world information variables, which includes a constant, the world market dividend yield, the spread between the 90-day Eurodollar rate and the 3-month T-bill yield, the difference between the US 10-year Treasury bond yield and the 3-month Treasury bill yield, the change in the 90-day Treasury bill yield, and the US money supply (M3). All the information variables are lagged by one period. For the regional market (i = *reg*), $X_{i,t-1}$ represents a set of regional variables, which includes a constant and the regional market dividend yield.

To test for model specification, Q(20) and $Q^2(20)$ are the 20^{th} order Ljung Box statistics for the autocovariances of the scaled residuals (10b) and the autocovariances of the squared scaled residuals (10d); the moments are based on joint test of four moments (10a,c, e, f). The Wald test is the test of the significance of the local information in the mean, i.e. $\delta_i = 0$. The *p* value is shown in brackets and * represents significance at 5% level or less.

Note: Latin Am. – *Latin America.*

Market	Model	Specification test			Wald test	$\hat{\beta}^{us}_{i,t-1}$	$\hat{V}\hat{R}^{us}_{i,t-1}$ (%)
		Q(20)	**Q^2(20)**	**Moments**	$\delta_i = 0$		
US	Asymmetric	20.250 [0.442]	16.067 [0.712]	6.412 [0.170]	**34.757*** [0.000]	-	-
Europe	Symmetric	18.598 [0.233]	16.037 [0.714]	0.797 [0.939]	0.896 [0.826]	**0.593***	31.79
Asia	Asymmetric	21.268 [0.381]	17.748 [0.604]	0.326 [0.988]	**15.646*** [0.001]	**0.431***	12.25
Latin Am.	Asymmetric	33.789 [0.289]	12.647 [0.892]	0.186 [0.996]	3.844 [0.146]	**0.576***	15.68

Table 2 GARCH Summary for Sector Level Integration

The following asymmetric GARCH model is examined:

$$r_{i,j,t} = \delta_{i,j} X_{i,j,t-1} + \beta^{us}_{i,j,t-1}\mu_{us,t-1} + \beta^{reg}_{i,j,t-1}\mu_{reg,t-1} + \beta^{us}_{i,j,t-1}e_{us,t} + \beta^{reg}_{i,j,t-1}e_{reg,t} + e_{i,j,t}$$
$$e_{i,j,t} \mid \Omega_{t-1} \sim N(0, \sigma^2_{i,j,t})$$
$$\sigma^2_{i,j,t} = a_{i,j} + b_{i,j}\sigma^2_{i,j,t-1} + c_{i,j}e^2_{i,j,t-1} + d_{i,j}\eta^2_{i,j,t-1}$$
$$\eta_{i,j,t} = \min\{0, e_{i,j,t})$$

where $r_{i,j,t}$ is the excess return, $\mu_{us,t-1}$ and $e_{us,t}$ ($\mu_{reg,t-1}$ and $e_{reg,t}$) are the conditional expected excess return and residual on the US (regional) market. $e_{i,j,t}$ is the idiosyncratic shock of any sector i in country j, and $X_{i,j,t-1}$ represents local information variables available at time t-1.

The table reports the sample average across all countries within the region of beta parameters ($\hat{\beta}^{us}_{i,j}$ and $\hat{\beta}^{reg}_{i,j}$) and variance ratios accounted for by the US and the corresponding region ($V\hat{R}^{us}_{i,j}$ and $V\hat{R}^{reg}_{i,j}$) for sector i. Standard deviations are given in parentheses.

Note: *Std dev. – standard deviation, Latin Am. – Latin America, BASIC – basic industries, CYCGD – cyclical consumer goods, CYSER – cyclical services, GENIN – general industries, ITECH – information technology, NCYCG – non-cyclical consumer goods, NCYSR – non-cyclical services, RESOR – resources, TOTLF – financials, and UTILS – utilities.*

Sector	$\hat{\beta}^{us}_{i,j}$		$\hat{\beta}^{reg}_{i,j}$		$V\hat{R}^{us}_{i,j}$ (%)		$V\hat{R}^{reg}_{i,j}$ (%)	
	Mean	*(Std dev.)*	*Mean*	*(Std dev.)*	*Mean*	*(Std dev.)*	*Mean*	*(Std dev.)*
Europe								
BASIC	0.3299	(0.148)	0.4858	(0.075)	5.9794	(4.745)	9.0025	(5.059)
CYCGD	0.3569	(0.199)	0.4479	(0.212)	3.6816	(4.397)	3.5554	(2.192)
CYSER	0.3922	(0.177)	0.5107	(0.127)	6.9211	(5.738)	9.1897	(5.629)
GENIN	0.4019	(0.295)	0.5286	(0.114)	8.0265	(8.238)	8.4258	(4.975)
ITECH	0.7105	(0.364)	0.6368	(0.207)	7.2742	(7.147)	4.4303	(2.766)
NCYCG	0.2694	(0.117)	0.4392	(0.072)	3.9709	(3.779)	6.8267	(3.594)
NCYSR	0.3967	(0.229)	0.4886	(0.260)	5.5331	(4.667)	6.5537	(4.280)
RESOR	0.1841	(0.198)	0.4119	(0.158)	2.5906	(3.544)	4.1710	(3.536)
TOTLF	0.4395	(0.222)	0.5543	(0.096)	8.6642	(7.371)	10.8427	(5.628)
UTILS	0.1255	(0.192)	0.3635	(0.114)	1.5847	(2.173)	4.9105	(4.124)
Asia								
BASIC	0.3359	(0.123)	0.3196	(0.099)	2.1120	(1.277)	2.4681	(1.759)
CYCGD	0.3912	(0.138)	0.2731	(0.215)	2.6236	(2.444)	2.2119	(1.840)

CYSER	0.3722 (0.139)	0.3374 (0.069)	4.4800 (4.460)	3.6968 (2.158)
GENIN	0.4735 (0.203)	0.3413 (0.081)	5.5982 (5.212)	3.6256 (3.198)
ITECH	0.6940 (0.289)	0.5659 (0.338)	5.2074 (3.119)	4.5234 (2.604)
NCYCG	0.2786 (0.087)	0.2622 (0.065)	2.0027 (1.796)	2.2676 (1.751)
NCYSR	0.3888 (0.196)	0.3251 (0.058)	3.2120 (3.061)	2.7145 (1.197)
RESOR	0.2966 (0.148)	0.3289 (0.078)	1.3433 (1.077)	1.6345 (0.765)
TOTLF	0.4426 (0.142)	0.3345 (0.063)	4.7466 (4.539)	3.1358 (2.046)
UTILS	0.2055 (0.081)	0.2352 (0.098)	0.7535 (0.394)	1.4007 (0.918)
Latin Am.				
BASIC	0.3409 (0.199)	0.4528 (0.260)	3.9528 (3.939)	12.1821 (13.353)
CYCGD	0.1397 (0.126)	0.2667 (0.238)	0.5203 (0.613)	2.6004 (2.919)
CYSER	0.2185 (0.284)	0.3972 (0.346)	2.9667 (4.160)	7.8290 (8.813)
GENIN	0.2657 (0.335)	0.4344 (0.297)	3.0495 (3.683)	8.2466 (9.224)
ITECH	-	-	-	-
NCYCG	0.3086 (0.182)	0.4365 (0.236)	3.1929 (2.883)	10.5641 (10.009)
NCYSR	0.5834 (0.350)	0.6885 (0.384)	6.9520 (7.799)	15.3412 (16.930)
RESOR	0.2552 (0.312)	0.4008 (0.360)	2.8214 (2.746)	9.2245 (13.216)
TOTLF	0.3185 (0.233)	0.4676 (0.290)	3.2746 (2.890)	10.8926 (10.141)
UTILS	0.2980 (0.221)	0.4095 (0.416)	2.4305 (2.620)	9.5409 (14.915)

Table 3 Cross-sectional Analysis of Sector Residuals

The following models are estimated:

$$\hat{e}_{i,j,t} = \nu_{i,j} + \phi_{i,j,t}\hat{e}_{g,t} + \xi_{i,j,t}$$
$$\phi_{i,j,t} = m + nD_{i,t}$$

where $\hat{e}_{i,j,t}$, $\hat{e}_{g,t}$ are the estimated idiosyncratic return shocks of sector i and a country-group respectively in examination of model (1)-(3) with time-variant betas. Three country-groups are considered: the return shocks from the US, $\hat{e}_{g,t} = \hat{e}_{us,t}$, the return shocks from a geographic region, $\hat{e}_{g,t} = \hat{e}_{reg,t}$, and the return shocks from the sum of residuals of sector i in a region excluding the country to be considered, $\hat{e}_{g,t} = \sum_{\substack{k\neq j \\ k\subset G}} \hat{e}_{k,t}$, where G denotes a particular region country k belongs to. The former equation involves the time series regression and $\phi_{i,j,t}$ is the time-varying coefficient of each sector i. The time-varying coefficients $\phi_{i,j,t}$ of equivalent sectors in each region (Europe, Asia and Latin America) are pooled together and the latter equation involves the panel data regression. The estimation corrects for individual serial correlations by adding cross-sectional AR(1) term in equation and group-wise heteroskedasticity by employing seemingly unrelated regression (SUR) method. $D_{i,t}$ is a dummy variable that represents two sample periods: the Mexican crisis period from November 1994 to December 1995, the Asian crisis period from April 1997 to October 1998. The parameter estimates of m and n are reported, with standard errors in parenthesis, while p-values are given in brackets. * represents significance at 5% level or less.

Wald t – Wald test, Latin Am. – Latin America, BASIC – basic industries, CYCGD – cyclical consumer goods, CYSER – cyclical services, GENIN – general industries, ITECH – information technology, NCYCG – non-cyclical consumer goods, NCYSR – non-cyclical services, RESOR – resources, TOTLF – financials, and UTILS – utilities.

Sector	**US residuals** $e_{us,t}$			**Regional residuals** $e_{reg,t}$			**Sum of residuals** $\sum_{\substack{k\neq j \\ k\subset G}} e_{kt}$		
	m	n	Wald t m=n=0	m	n	Wald t m=n=0	m	n	Wald t m=n=0
Panel A: Mexican crisis dummy									
EUROPE									
BASIC	**0.11***	0.018	**127.68***	**0.203***	-0.01	**148.17***	**0.033***	-0.003	**114.54***
	(0.01)	(0.028)	[0.000]	(0.017)	(0.038)	[0.000]	(0.003)	(0.004)	[0.000]
CYCGD	**0.111***	**0.174***	**100.01***	**0.179***	-0.039	**89.07***	**0.025***	0.008	**56.49***
	(0.013)	(0.045)	[0.000]	(0.019)	(0.048)	[0.000]	(0.003)	(0.005)	[0.000]
CYSER	**0.129***	0.058	**134.99***	**0.224***	0.076	**168.14***	**0.029***	-0.000	**161.26***
	(0.012)	(0.031)	[0.000]	(0.018)	(0.042)	[0.000]	(0.002)	(0.003)	[0.000]
GENIN	**0.099***	0.048	**103.53***	**0.188***	-0.009	**111.68***	**0.034***	0.001	**198.39***
	(0.011)	(0.029)	[0.000]	(0.018)	(0.04)	[0.000]	(0.002)	(0.003)	[0.000]
ITECH	**0.181***	**0.242***	**120.67***	**0.295***	0.049	**130.78***	**0.035***	0.004	**36.1***
	(0.021)	(0.056)	[0.000]	(0.027)	(0.064)	[0.000]	(0.006)	(0.005)	[0.000]
NCYCG	**0.086***	**0.054***	**91.04***	**0.2***	**0.086***	**139.33***	**0.037***	0.004	**166.06***
	(0.01)	(0.026)	[0.000]	(0.018)	(0.038)	[0.000]	(0.003)	(0.003)	[0.000]
NCYSR	**0.098***	0.06	**66.52***	**0.389***	-0.024	**163.88***	**0.051***	-0.002	**94.93***
	(0.013)	(0.034)	[0.000]	(0.031)	(0.058)	[0.000]	(0.005)	(0.005)	[0.000]
RESOR	**0.099***	**0.145***	**82.38***	**0.132***	**0.146***	**54.34***	**0.03***	0.005	**29.13***
	(0.014)	(0.038)	[0.000]	(0.02)	(0.054)	[0.000]	(0.006)	(0.006)	[0.000]
TOTLF	**0.071***	0.052	**47.07***	**0.208***	0.066	**120.58***	**0.047***	0.001	**189.75***
	(0.012)	(0.029)	[0.000]	(0.02)	(0.044)	[0.000]	(0.003)	(0.003)	[0.000]

UTILS	**0.079***	**0.107***	**75.54***	**0.178***	0.074	**96.25***	**0.036***	0.001	**78.94***
	(0.011)	(0.032)	[0.000]	(0.019)	(0.043)	[0.000]	(0.004)	(0.004)	[0.000]
ASIA									
BASIC	**0.051***	0.097	**9.112***	**0.08***	0.02	**25.99***	**0.075***	0.012	**90.35***
	(0.024)	(0.06)	[0.011]	(0.017)	(0.045)	[0.000]	(0.008)	(0.007)	[0.000]
CYCGD	**0.048***	**0.139***	**12.103***	**0.073***	0.006	**12.16***	**0.075***	**0.031***	**96.82***
	(0.023)	(0.061)	[0.002]	(0.022)	(0.057)	[0.002]	(0.008)	(0.01)	[0.000]
CYSER	**0.032***	0.08	**9.476***	**0.063***	0.05	**29.49***	**0.063***	0.008	**94.79***
	(0.016)	(0.045)	[0.009]	(0.013)	(0.036)	[0.000]	(0.007)	(0.007)	[0.000]
GENIN	0.026	**0.105***	**9.55***	**0.085***	-0.095	**21.84***	**0.086***	0.009	**166.47***
	(0.017)	(0.046)	[0.008]	(0.019)	(0.046)	[0.000]	(0.007)	(0.008)	[0.000]
ITECH	-0.003	**0.394***	**25.63***	**0.062***	-0.043	**6.189***	**0.085***	**0.048***	**42.86***
	(0.019)	(0.079)	[0.000]	(0.025)	(0.079)	[0.045]	(0.014)	(0.02)	[0.000]
NCYCG	0.016	**0.152***	**21.1***	0.022	0.05	**6.923***	**0.05***	**0.044***	**95.96***
	(0.012)	(0.038)	[0.000]	(0.013)	(0.033)	[0.031]	(0.006)	(0.009)	[0.000]
NCYSR	0.012	**0.133***	**12.43***	**0.038***	-0.008	**9.321***	**0.064***	0.003	**41.25***
	(0.015)	(0.043)	[0.002]	(0.013)	(0.038)	[0.009]	(0.01)	(0.01)	[0.000]
RESOR	**0.059***	0.009	5.505	0.037	0.037	4.184	**0.042***	-0.002	**34.11***
	(0.026)	(0.068)	[0.064]	(0.022)	(0.052)	[0.123]	(0.007)	(0.011)	[0.000]
TOTLF	0.019	0.018	1.699	**0.054***	-0.008	**10.27***	**0.063***	0.007	**96.29***
	(0.017)	(0.046)	[0.427]	(0.017)	(0.046)	[0.006]	(0.006)	(0.006)	[0.000]
UTILS	**0.027***	0.135	3.617	0.034	-0.124	3.809	**0.04***	0.043	**8.63***
	(0.03)	(0.09)	[0.164]	(0.028)	(0.071)	[0.149]	(0.019)	(0.024)	[0.013]
LATIN AM.									
BASIC	0.026	**0.212***	**35.05***	**0.127***	0.006	**14.51***	**0.012***	**0.024***	**11.35***
	(0.016)	(0.041)	[0.000]	(0.017)	(0.034)	[0.000]	(0.006)	(0.009)	[0.000]
CYCGD	0.027	-0.097	1.649	0.008	-0.011	0.017	0.002	0.001	0.132
	(0.023)	(0.057)	[0.199]	(0.014)	(0.025)	[0.897]	(0.008)	(0.007)	[0.716]
CYSER	**0.045***	**0.109***	**18.95***	**0.163***	-0.003	**8.94***	-0.021	0.017	0.019
	(0.011)	(0.037)	[0.000]	(0.024)	(0.054)	[0.003]	(0.014)	(0.027)	[0.891]
GENIN	**0.092***	0.108	**11.22***	0.088*	0.046	**10.31***	0.003	0.009	1.057
	(0.023)	(0.061)	[0.0001]	(0.016)	(0.043)	[0.001]	(0.007)	(0.011)	[0.304]
ITECH	-	-	-	-	-	-	-	-	-
NCYCG	**0.042***	0.021	**4.08***	**0.129***	-0.000	**16.48***	0.024	0.023	**5.647***
	(0.011)	(0.032)	[0.043]	(0.012)	(0.033)	[0.000]	(0.013)	(0.016)	[0.017]
NCYSR	**0.069***	0.002	1.411	**0.074***	-0.015	0.834	0.015	-0.022	0.085
	(0.022)	(0.061)	[0.235]	(0.029)	(0.063)	[0.361]	(0.014)	(0.024)	[0.771]
RESOR	0.015	0.07	3.09	**0.091***	0.007	**6.634***	0.012	-0.003	0.36
	(0.018)	(0.049)	[0.079]	(0.017)	(0.038)	[0.01]	(0.009)	(0.014)	[0.548]
TOTLF	**0.03***	**0.079***	**7.842***	**0.047***	0.031	**6.482***	**0.021***	0.005	**8.087***
	(0.015)	(0.04)	[0.005]	(0.012)	(0.031)	[0.011]	(0.004)	(0.009)	[0.004]
UTILS	**0.039***	**0.128***	**11.69***	**0.051***	-0.000	1.479	0.018	0.065	**4.457***
	(0.016)	(0.049)	[0.000]	(0.014)	(0.041)	[0.224]	(0.014)	(0.039)	[0.035]
Panel B: Asia crisis dummy									
EUROPE									
BASIC	**0.112***	-0.009	**17.98***	**0.199***	0.031	**150.93***	**0.033***	-0.000	**112.54***
	(0.01)	(0.025)	[0.000]	(0.017)	(0.036)	[0.000]	(0.003)	(0.003)	[0.000]
CYCGD	**0.112***	0.047	**30.86***	**0.167***	0.067	**95.96***	**0.025***	0.004	**54.35***
	(0.014)	(0.03)	[0.000]	(0.019)	(0.041)	[0.000]	(0.004)	(0.004)	[0.000]
CYSER	**0.129***	0.039	**36.9***	**0.227***	0.009	**160.03***	**0.03***	0.000	**160.88***
	(0.012)	(0.029)	[0.000]	(0.019)	(0.039)	[0.000]	(0.002)	(0.003)	[0.000]
GENIN	**0.107***	-0.042	**6.478***	**0.185***	0.048	**111.05***	**0.034***	0.002	**203.02***
	(0.011)	(0.026)	[0.011]	(0.019)	(0.039)	[0.000]	(0.002)	(0.003)	[0.000]
ITECH	**0.211***	-0.013	**14.68***	**0.296***	0.064	**129.63***	**0.035***	0.003	**36.96***
	(0.021)	(0.053)	[0.000]	(0.027)	(0.06)	[0.000]	(0.006)	(0.005)	[0.000]
NCYCG	**0.094***	-0.024	**8.886***	**0.205***	**0.086***	**149.44***	**0.037***	-0.002	**166.94***
	(0.01)	(0.024)	[0.003]	(0.018)	(0.036)	[0.000]	(0.003)	(0.003)	[0.000]
NCYSR	**0.102***	0.029	**15.08***	**0.387***	-0.01	**162.12***	**0.051***	0.004	**99.73***
	(0.014)	(0.035)	[0.000]	(0.031)	(0.054)	[0.000]	(0.005)	(0.005)	[0.000]
RESOR	**0.111***	-0.019	**7.381***	**0.133***	-0.032	**42.59***	**0.031***	0.001	**29.14***
	(0.015)	(0.034)	[0.007]	(0.02)	(0.048)	[0.000]	(0.006)	(0.006)	[0.000]
TOTLF	**0.075***	0.001	**8.336***	**0.206***	0.05	**119.16***	**0.047***	0.000	**188.58***
	(0.012)	(0.027)	[0.004]	(0.02)	(0.041)	[0.000]	(0.003)	(0.003)	[0.000]
UTILS	**0.086***	-0.033	3.589	**0.184***	0.016	**89.43***	**0.037***	-0.007	**85.07***
	(0.011)	(0.029)	[0.058]	(0.02)	(0.04)	[0.000]	(0.004)	(0.004)	[0.000]

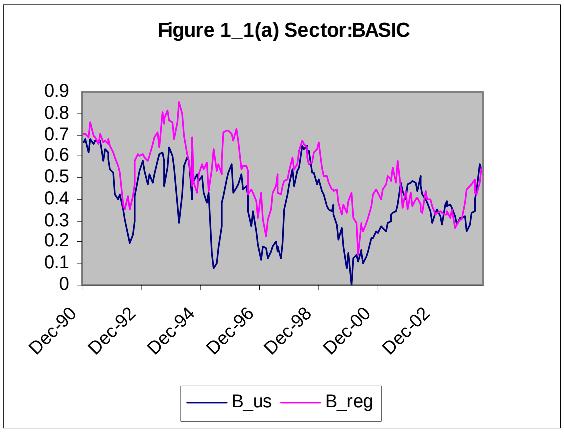
ASIA									
BASIC	0.032	**0.209***	**24.21***	**0.072***	0.064	**27.52***	**0.076***	-0.003	**84.32***
	(0.022)	(0.052)	[0.000]	(0.017)	(0.041)	[0.000]	(0.008)	(0.007)	[0.000]
CYCGD	0.035	**0.154***	**14.89***	**0.063***	0.094	**15.88***	**0.071***	-0.003	**49.52***
	(0.022)	(0.054)	[0.000]	(0.022)	(0.052)	[0.000]	(0.01)	(0.01)	[0.000]
CYSER	0.025	**0.08***	**8.997***	**0.059***	**0.07***	**30.02***	**0.066***	-0.01	**86.84***
	(0.016)	(0.04)	[0.011]	(0.014)	(0.034)	[0.000]	(0.007)	(0.007)	[0.000]
GENIN	0.025	0.044	4.321	**0.073***	0.068	**23.89***	**0.086***	0.006	**158.18***
	(0.017)	(0.043)	[0.115]	(0.018)	(0.043)	[0.000]	(0.007)	(0.008)	[0.000]
ITECH	0.009	0.068	2.715	**0.051***	0.08	**8.133***	**0.09***	-0.001	**41.85***
	(0.021)	(0.051)	[0.257]	(0.025)	(0.059)	[0.017]	(0.014)	(0.011)	[0.000]
NCYCG	**0.035***	-0.1	**11.48***	0.023	0.037	**6.125***	**0.051***	0.005	**48.22***
	(0.013)	(0.036)	[0.003]	(0.013)	(0.031)	[0.047]	(0.008)	(0.009)	[0.000]
NCYSR	0.025	-0.019	2.684	**0.029***	**0.098***	**18.87***	**0.065***	0.001	**40.9***
	(0.015)	(0.041)	[0.261]	(0.012)	(0.034)	[0.000]	(0.01)	(0.01)	[0.000]
RESOR	0.042	**0.159***	**13.94***	0.019	**0.163***	**16.53***	**0.04***	0.013	**38.33***
	(0.025)	(0.059)	[0.000]	(0.02)	(0.046)	[0.000]	(0.007)	(0.01)	[0.000]
TOTLF	0.013	**0.087***	**6.206***	**0.047***	0.052	**11.97***	**0.065***	-0.014	**94.01***
	(0.017)	(0.043)	[0.044]	(0.017)	(0.042)	[0.003]	(0.007)	(0.006)	[0.000]
UTILS	0.039	-0.041	1.745	-0.004	**0.214***	**16.1***	**0.045***	0.006	**5.98***
	(0.03)	(0.064)	[0.418]	(0.026)	(0.055)	[0.000]	(0.019)	(0.022)	[0.05]
LATIN AM.									
BASIC	0.03	0.046	5.804	**0.126***	0.011	**60.51***	**0.014***	0.009	5.867
	(0.018)	(0.042)	[0.055]	(0.017)	(0.033)	[0.000]	(0.007)	(0.01)	[0.053]
CYCGD	0.007	0.044	1.083	-0.007	**0.051***	4.137	0.006	-0.008	1.106
	(0.024)	(0.054)	[0.582]	(0.014)	(0.026)	[0.126]	(0.008)	(0.008)	[0.575]
CYSER	**0.053***	0.01	**19.597***	**0.174***	-0.041	**54.49***	-0.024	0.043	4.926
	(0.013)	(0.036)	[0.000]	(0.024)	(0.052)	[0.000]	(0.014)	(0.026)	[0.085]
GENIN	**0.097***	0.057	**22.49***	**0.094***	-0.024	**33.51***	0.002	0.005	0.334
	(0.024)	(0.056)	[0.000]	(0.016)	(0.039)	[0.000]	(0.008)	(0.011)	[0.846]
ITECH	-	-	-	-	-	-	-	-	-
NCYCG	**0.041***	0.023	**18.37***	**0.124***	0.028	**130.61***	0.022	0.018	4.867
	(0.011)	(0.028)	[0.000]	(0.012)	(0.03)	[0.000]	(0.013)	(0.016)	[0.088]
NCYSR	**0.066***	0.028	**11.06***	0.058	0.061	**6.673***	0.01	0.02	1.743
	(0.022)	(0.055)	[0.004]	(0.028)	(0.057)	[0.036]	(0.014)	(0.021)	[0.418]
RESOR	0.013	0.034	1.601	**0.092***	0.002	**29.66***	0.011	0.006	1.838
	(0.018)	(0.044)	[0.449]	(0.018)	(0.035)	[0.000]	(0.009)	(0.014)	[0.399]
TOTLF	**0.035***	0.01	5.789	**0.045***	0.039	**19.19***	**0.023***	-0.014	**27.67***
	(0.016)	(0.037)	[0.055]	(0.013)	(0.029)	[0.000]	(0.004)	(0.009)	[0.000]
UTILS	**0.034***	**0.074***	**11.52***	**0.051***	-0.005	**12.79***	0.019	0.014	4.023
	(0.017)	(0.037)	[0.003]	(0.015)	(0.034)	[0.002]	(0.014)	(0.013)	[0.134]

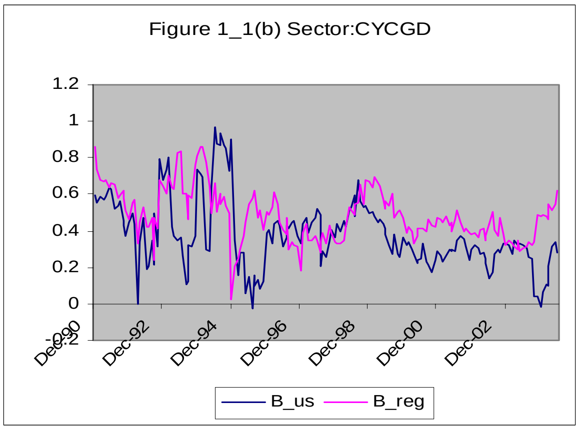
Figure 1 Summary of Time-Varying Sector Level Integration: GARCH 12-Month Rolling Estimates

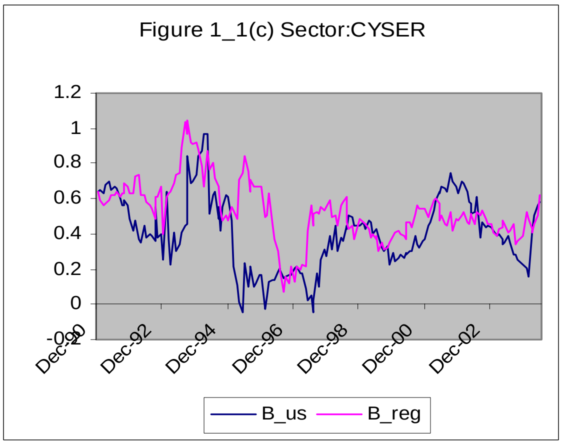
The model description is identical to that in Table 2. The result is the 12-month regression window rolling estimation moved month by month. The coefficients of $\hat{\beta}_i^{us}$ and $\hat{\beta}_i^{reg}$ are the averages across all the countries within a region examined.

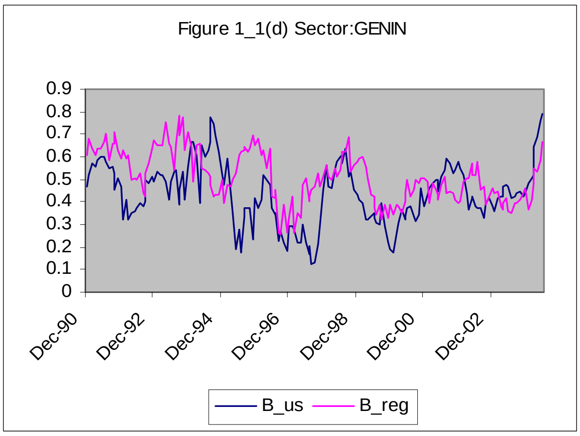
B_us – $\hat{\beta}_i^{us}$, *B_reg* – $\hat{\beta}_i^{reg}$, *BASIC – basic industries, CYCGD – cyclical consumer goods, CYSER – cyclical services, GENIN – general industries, ITECH – information technology, NCYCG – non-cyclical consumer goods, NCYSR – non-cyclical services, RESOR – resources, TOTLF – financials, and UTILS – utilities*

A. Europe

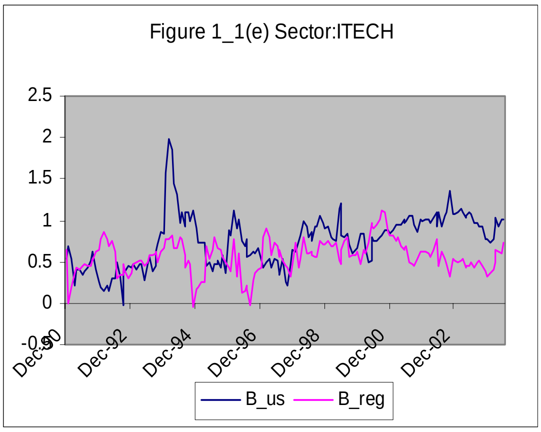


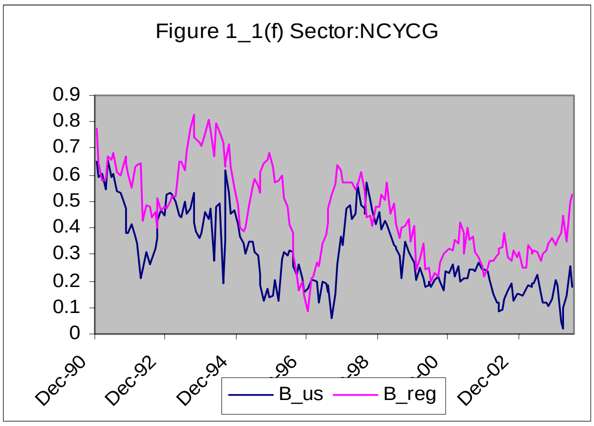


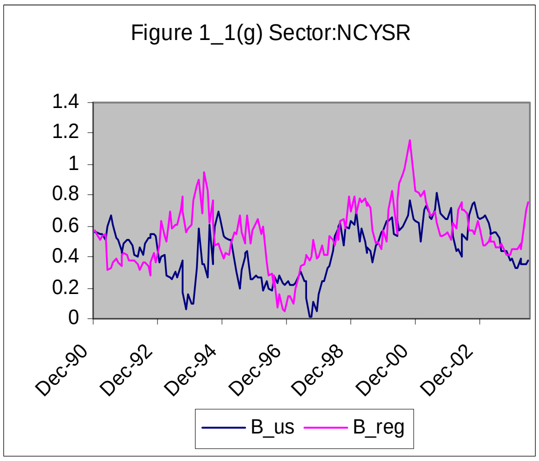


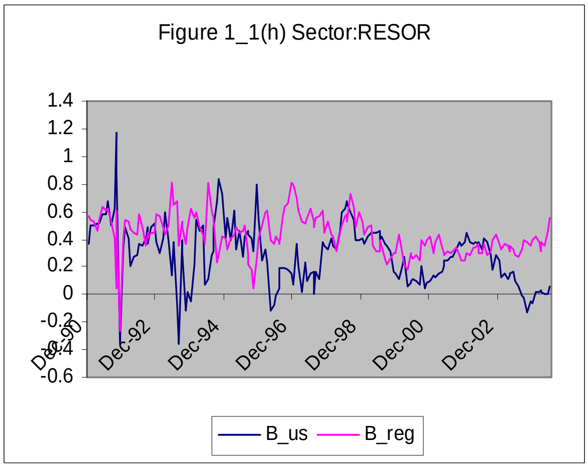


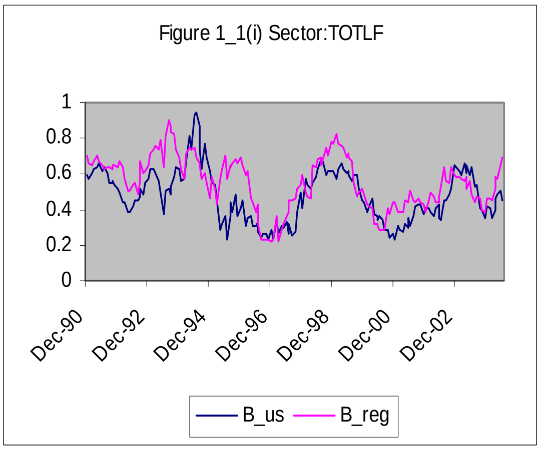
(Figure 1, continued)

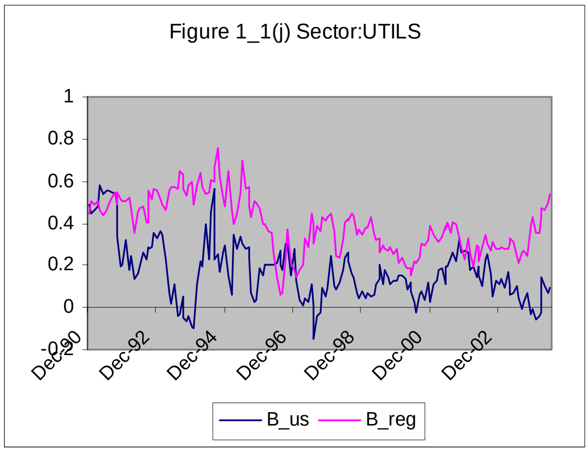






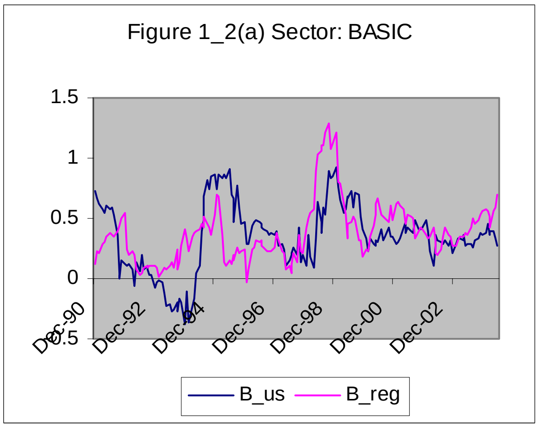


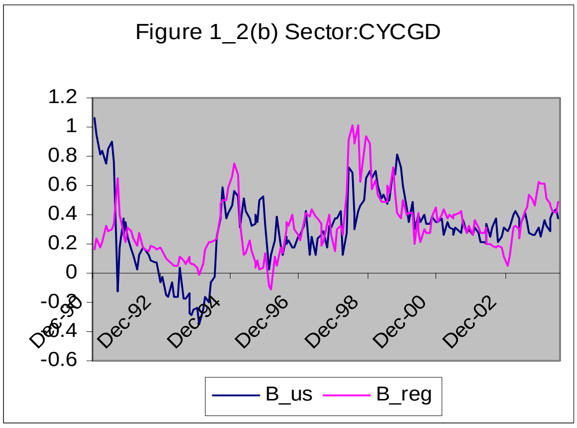


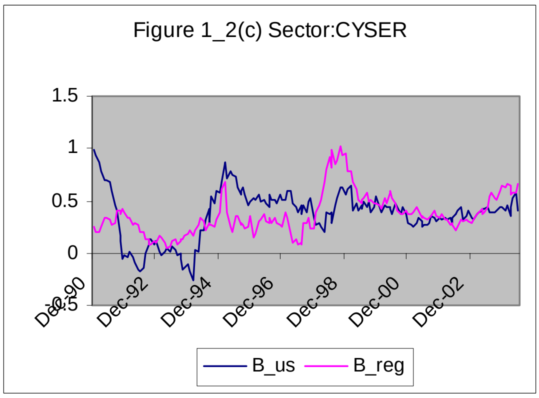


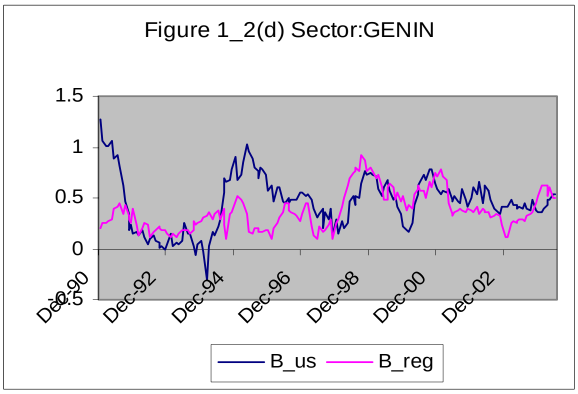
(Figure 1, continued)

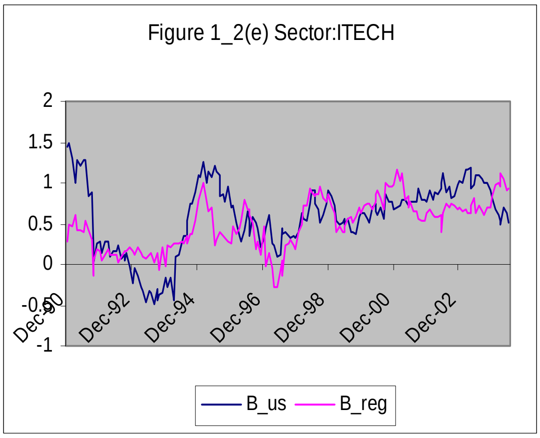
B. Asia

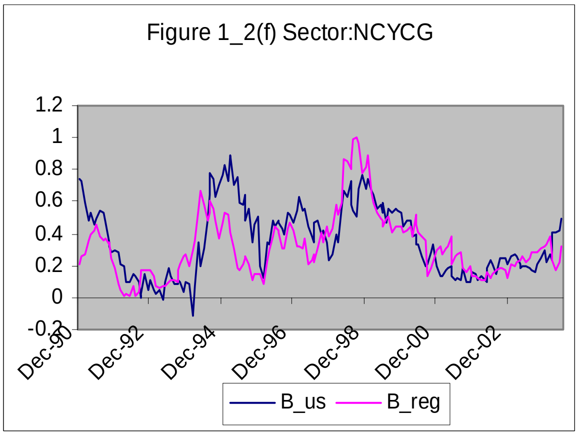












(Figure 1, continued)

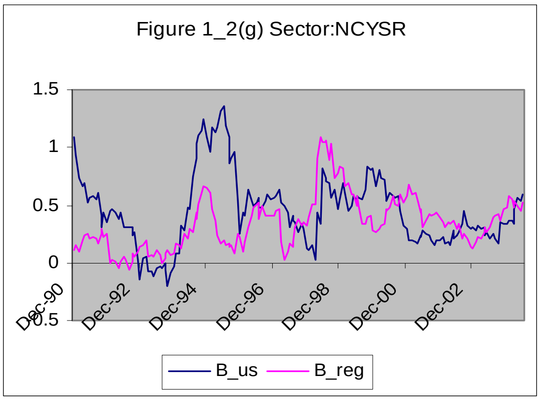


Figure 1_2(g) Sector:NCYSR

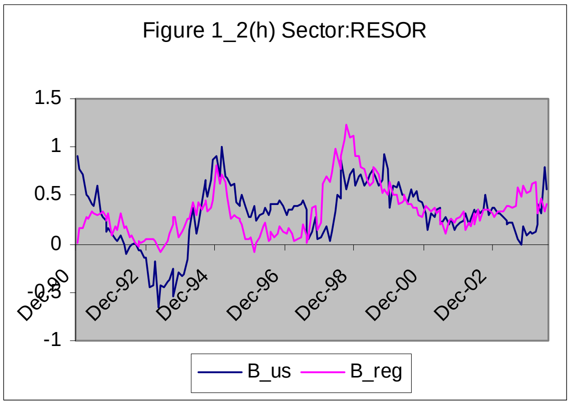


Figure 1_2(h) Sector:RESOR

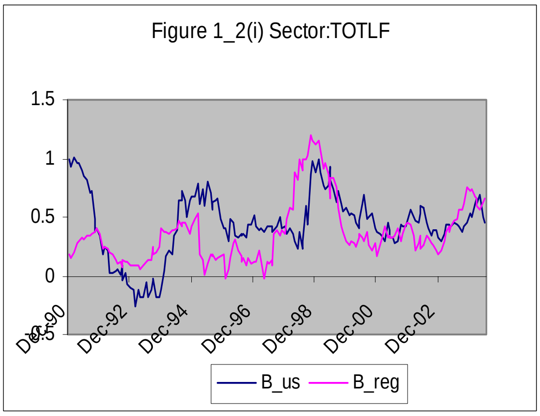


Figure 1_2(i) Sector:TOTLF

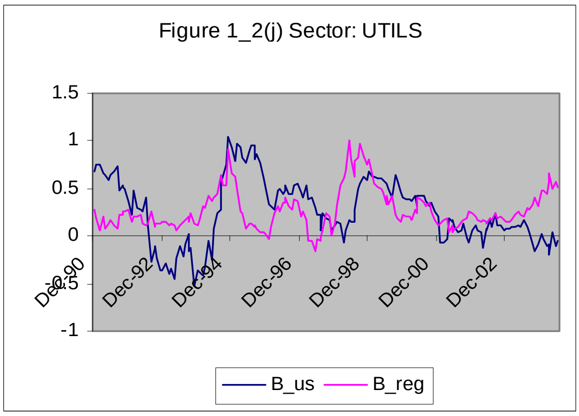


Figure 1_2(j) Sector: UTILS

C. Latin America

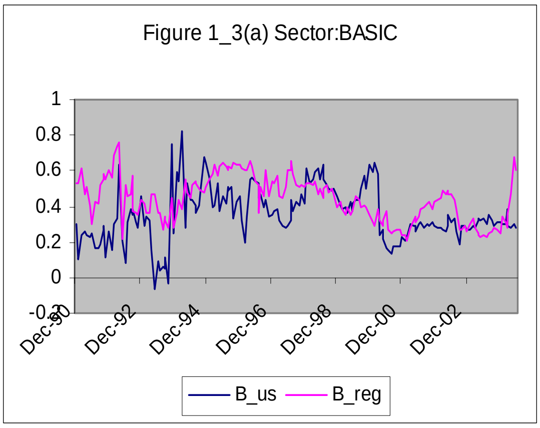


Figure 1_3(a) Sector:BASIC

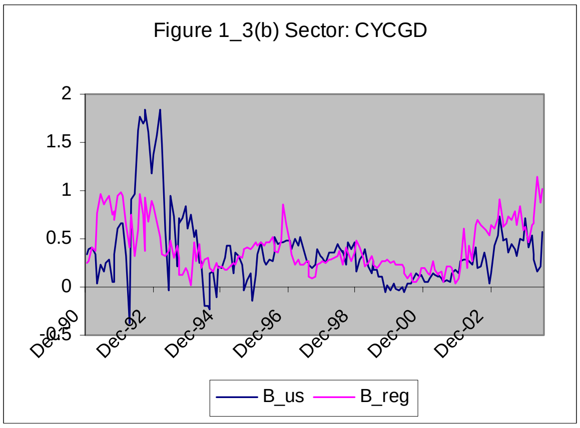
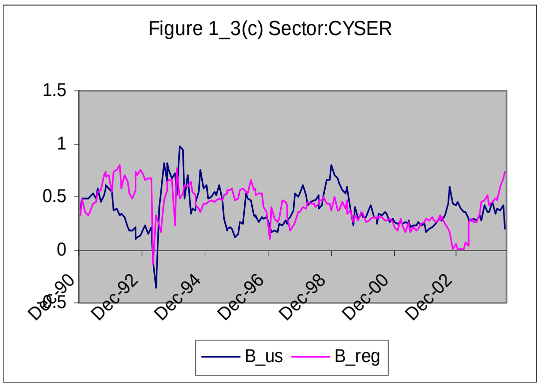
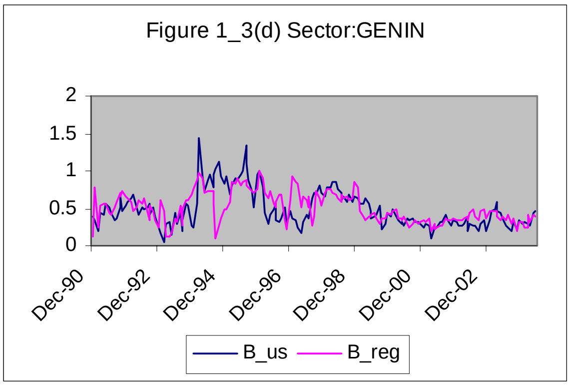
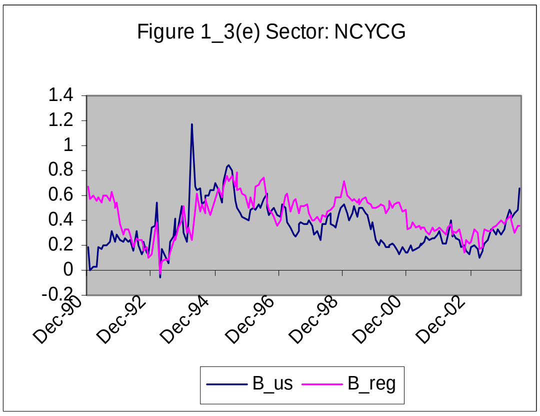


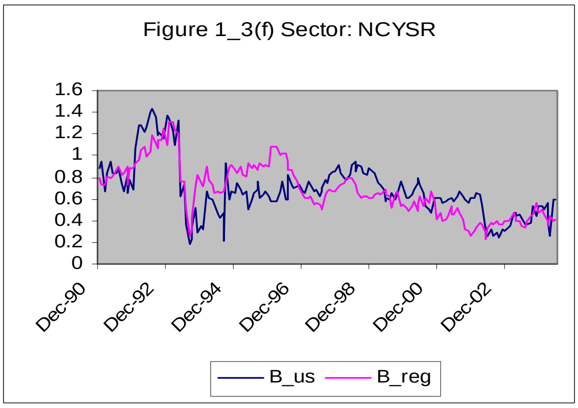
Figure 1_3(b) Sector: CYCGD

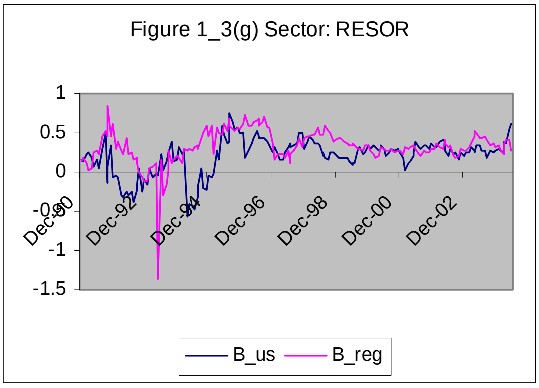
(Figure 1, continued)

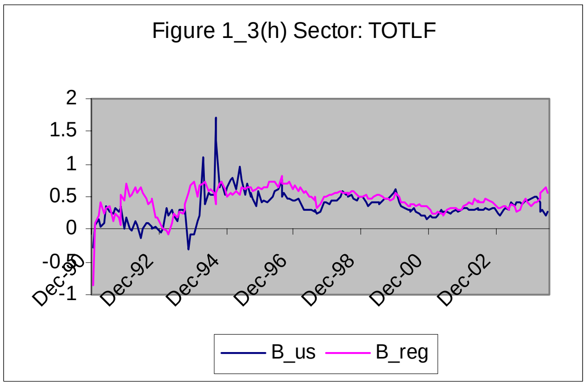


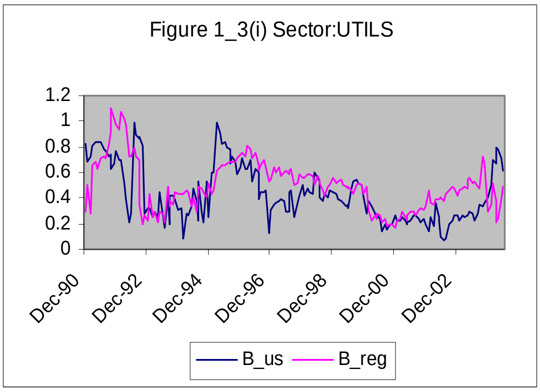












Appendix 1. FTSE Actuaries (Sector and Industry Classification)

Sector	**Industries Included**
Basic Industries	Chemicals Construction & Building Materials Forestry & Paper Steel & Other Metals Chemicals, Construction & Building Materials, Forestry & Paper Steel & Other Metals
Cyclical Consumer Goods	Automobiles & Parts Household Goods & Textiles
Cyclical Services	General Retailers Leisure Entertainment & Hotels Media & Photography Support Services Transport
General Industries	Aerospace & Defence Electronic & Electrical Equipment Engineering & Machinery
Information Technology	Information Technology Hardware Software & Computer Services
Non-cyclical Consumer Goods	Beverages Food Producers & Processors Health Personal Care & Household Products Pharmaceuticals & Biotechnology Tobacco
Non-cyclical Services	Food & Drug Retailers Telecommunication Services
Resources	Mining Oil & Gas
Financials	Banks Insurance Life Assurance Investment Companies Real Estate Speciality & Other Finance
Utilities	Electricity Gas Distribution Water

Appendix 2. Sample Countries included in the Analysis

Region	**Countries Included**
Europe	Belgium, Denmark, Spain, Finland, Greece, Ireland, Luxemburg, Netherlands, Norway, Austria, Portugal, Sweden, Switzerland, Turkey
Asia	Hong Kong, Malaysia, Korea, Indonesia, Singapore, Thailand, Taiwan, Philippines
Latin America	Argentine, Brazil, Columbia, Chile, Mexico, Peru, Venezuela