Stock Market Comovements and Industrial Structure

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Abstract

We use monthly stock market indices for 58 countries to construct pairwise correlations of returns and explain these correlations with differences in the industrial structure across these countries. We find that countries with similar industries have stock markets that exhibit high correlation of returns. The results are robust to the inclusion of other regressors like differences in income per capita, stock market capitalizations, measures of institutions, as well as various fixed time, country and country-pair effects. We also find that differences in the structure of exports explain stock market correlations quite well. Our results are consistent with models in which the impact of each industry-specific shock is proportional to the share of this industry in the overall industrial output of the country. We also show that differences in production structures have higher explanatory power for segmented markets rather than for markets that are integrated.

JEL Classification: G15, G11, O14

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1 Introduction

Recent years have witnessed a huge increase in capital flows to emerging markets, with portfolio flows (fixed income and equity) becoming an ever important source of foreign capital (Bekaert and Harvey, 2000). Financial markets throughout the world have steadily become more open to foreign investors with $645 billion worth of equity flows across borders in 2004 (IFS). With the slow and steady erosion of barriers to portfolio flows, even in emerging markets, and with risk premia being determined globally, comovements in stock prices around the world are becoming increasingly pronounced. Figure 1 shows substantial variation in the average cross country correlations for 325 pairs of countries over the time period 1970-2006.[1] The average of all country-pair correlations of MSCI indices for 58 countries was in excess of 0.6 in 2006.

A number of authors have argued that the observed stock return comovement appears excessive relative to fundamentals. For example, Shiller (1989) argues that the comovement between U.K. and U.S. stock prices is too large to be fully explained by comovement in dividends. Lee, Shleifer, and Thaler (1991), Pindyck and Rotemberg (1993) and Froot and Dabora (1999) also provide evidence that comovements are excessive relative to fundamentals. King, Sentana and Wadhwani (1994) find only weak evidence of association between correlations in monthly national index returns for 16 markets and economic factors. Using higher frequency data, Karolyi and Stulz (1996) examine intraday returns across the USA and Japan for indexes, portfolios of stocks and ADRs. They too find that correlations are not significantly related to fundamentals such as macroeconomic news, interest rate and exchange rate shocks, dividend yields, and even trading volume.[2] [3]

[1]Computed using monthly returns over a 60 month rolling window. The country pair correlations range from -0.75 in the year 1989 for India and Japan to 0.98 in the year 2006 between Germany and Japan. To calculate the average correlations, we use only 26 countries for whom we have data for each year, over the period 1970-2006. This is to avoid composition effects.

[2]See Roll (1987) and Karolyi and Stulz (2003) for surveys.

[3]The study of correlations also attracted a lot of academic attention after a series of well-publicized crises in emerging markets. Crises seem to create excessive correlations between countries that some have termed "contagion." King and Wadhwani (1990) applied this concept to international stock returns: a shock in one market leads investors to withdraw funds from other markets because of irrational fears and thus leads to unusually high comovements of asset prices. Calvo and Reinhart (1996) showed that correlations of weekly returns on equities and Brady bonds for

In our paper, we examine the link between stock market comovements and the industrial structure across pairs of countries. In particular, we construct time-varying, country-pair-specific indices of differences in the production and trade and examine whether comovements between stock market returns are driven by similarities/differences in these indices. We expect that countries that are similar in their industrial structure will exhibit higher degree of comovements. The intuition behind this is simple. Consider a pair of countries that are similarly specialized in the production of a set of goods. In such a setting, global sector specific shocks will lead to a movement of returns in both countries in the same direction and we should observe a high correlation in national stock market returns. Even if country-pairs are specialized in different sectors, their stock returns may also move together if the covariance of the shocks in the sectors that they produce in is high. Country-pairs that specialize in very different sectors and where the covariance of sectoral shocks is low or close to zero will exhibit low comovements in stock returns.

We illustrate this intuition by deriving the link between industrial structure and stock markets. Our key argument is that countries with similar industries experience similar sectoral shocks, which in turn affect stock market returns. The explicit derivation of the correlation between stock market returns shows that in addition to the simple differences in production structure, one has to take into account volatility of shocks in different industries, as well as covariance of shocks across industries. To operationalize this insight we use the methodology developed by Koren and Tenreyro (2007) to calculate the variance-covariance matrix of global shocks at the sectoral level and construct a risk-adjusted (or volatility-weighted) differences in production structures. This variable is a summary measure that explicitly takes into account a) differences in production shares between pairs of countries; b) volatility of sectoral shocks and c) covariances between sectoral shocks. Across an array of specifications and for different country-pair sub samples, we find that pairs of countries with smaller risk-adjusted production structure differences tend to exhibit similar movements in stock market returns.

We start by showing that the *unconditional correlations* in stock returns depend negatively

Asian and Latin American emerging markets was higher after the Mexican crisis than before. Forbes and Rigobon (2001, 2002) however, argue that increases in volatility around crises leads to heteroskedasticity so that an increase in correlation could simply be a continuation of strong transmission mechanisms that exist in more stable periods.

on difference in the structure of production. Next, we estimate two asset pricing models and use the residuals from these models to calculate *conditional correlations.* The first is the Fama-French model (Fama and French 1996, 1998) and the second asset pricing model is an international and regional CAPM model (Bekaert and Harvey 1995, 1997). Embedding the correlations in these asset pricing models allows us to control for comovements due to the style of the stocks involved (Fama-French), and for comovements that may be ascribed to variations in world and regional integration for different countries (international and regional CAPM). We show that conditional correlations are higher for country-pairs with similar risk-adjusted production structures. We show that all of the results documented in the paper are robust to controlling for a wide range of differences between country-pairs that may plausibly affect return correlations - these span differences in levels of development, in financial sector development, differences in political institutions, trade links between these countries, and geographic proximity. Moreover, this relationship is stronger in segmented as opposed to integrated markets. Finally, as a robustness check, we show that pairs of countries with a similar *export* structure also exhibit higher stock market comovements.

The correlation of index returns and its changes over time, has important ramifications for investors looking to diversify their portfolios. More importantly, it requires a clear understanding of the sources of gains from diversification. While some maintain that the gains stem from the diversity of economic conditions underlying foreign capital markets due to differences in monetary and fiscal policies, movements in interest rates, budget deficits, and national growth rates, others propose that the benefits from international diversification come largely from the diversity of industrial structures across countries. Since countries specialize in different or similar industries, when an investor diversifies across countries, by definition they also diversify (or not) across industries. Moreover, the diversification benefits of, for example, holding country index funds in a portfolio is likely to change over time as the underlying industry structure in each of these countries also evolves over time. So a well-diversified portfolio in 1970 might not yield the same benefits in the year 2000. In particular, if the industrial structure between pairs of countries becomes similar over time then this in turn will affect the correlations in returns. We show that our results hold not just using pooled OLS but also in within-estimates over time. This implies that as the industrial structure within a pair of countries becomes more similar over time, the correlation of stock returns for this pair should also increase over time. In addition to rising stock market integration, the coevolution of industrial structures is a potential candidate for explaining why stock market comovements have increased over time.

The paper focuses exclusively on the production side of the economy and investigates how industry-specific shocks play a role in explaining comovements in stock prices. Needless to say, there are other important factors that also generate cross-country comovements – reduction in capital controls, improved access to foreign markets, increased stock market participation or sharp swings in liquidity are candidates that may affect investors' behavior and lead to changes in stock market dynamics across countries. While acknowledging their importance, we leave these considerations for future work.

The rest of the paper is organized as follows: section 2 embeds our rationale for the link between stock markets and industrial structure in the economics and finance literatures; section 3 develops our measure of risk-adjusted differences in production structure; section 4 provides a brief description of our data, the data sources and presents various summary statistics; section 5 presents regression results showing the relationship between differences in industry structure (both risk-adjusted and otherwise) and unconditional stock market correlations between pairs of countries; section 6 uses conditional correlations instead of unconditional ones; section 7 checks whether our results are robust to using the structure of exports instead of production, replicates the analyses for various sub-samples, and analyzes the effect of country-specific stock market liberalization; section 8 concludes.

2 Stages of Development, the Evolution of Production Structure, and Stock Comovements

Figures 2 and 3 show the evolution of stock market indices for various country-pairs. For USA and UK, we see that the stock indices track each other very closely. For USA and Singapore, the comovement in stock indices is less pronounced than is for USA and UK. But to a large degree this can be attributed to an initial time period between 1970 and 1985 where Singapore's growth miracle story was being played out and to the Asian crisis of 1997 which led to significant capital outflows from the region. Comparing USA and Japan, we observe a similar pattern. The stock indices diverge after the banking crisis in Japan in the 1990s which witnessed the bursting of an asset bubble in the end of the 1980s and a steady deterioration in the health of the banking sector accompanied by failing banks and sclerotic GDP growth. As the last graph in figure 2 for the post 1997 period shows, the USA and Japanese stock indices have closely tracked each other ever since. Figure 3 shows the stock indices for India and the USA and for India and Mexico. The stock indices for India and Mexico seem to track each other much more closely than the indices for India and US. While we present the evolution of stock indices for only a small subset of country-pairs, we do observe some intriguing patterns. Developed country pairs such as USA and UK exhibit high degrees of comovement as do the emerging market pair of India and Mexico. At the same time, countries that have made the transition from developing to developed such as Japan in the 1960s and Singapore in the 1990s have experienced rising comovements. This raises the question whether it is simply the degree of development that leads to high correlations between country-pairs or whether there is something more fundamental underlying economic development that could be a potential driver of such correlations.

There is broad agreement that economic development involves a fundamental transformation of the structure of the economy (Tsiang, 1964). An old literature in economics (Rostow, 1959; Clark, 1957; Kuznets, 1959) posits that countries move through various stages of development in a predictable fashion. Initially, the production and trade structure is overwhelmingly skewed towards agriculture and primary products, while in later stages of development, we observe a transition to capital-intensive manufacturing, followed by skill-intensive manufacturing and services. Recently, others such as Sachs (2004) suggest three broad stages in the evolution of the production structure - from agriculture to manufacturing to knowledge-based production. Therefore, as more and more emerging countries grow and catch up to the levels of development of advanced economies, we are likely to observe a convergence in industry structures across countries over time and a subsequent rise in stock market comovements over time. Not all countries can however, make the seamless transition from agriculture to manufacturing to services. Economies can get trapped at each of those steps of development and may become stuck producing only primary commodities without successfully industrializing, or specializing in low value-added unskilled intensive manufacturing sectors.[4] These countries are likely to exhibit lower stock comovements with developed countries and those that made a successful transition from developing to developed.

A more recent literature suggests that as countries develop they tend to diversify, at last initially, in a wider set of sectors (Imbs and Wacziarg, 2003). Theoretical justification for this is provided in a model by Acemoglu and Zilibotti (1997), where diversification occurs endogenously as a result of agents' decisions to invest in a range of imperfectly correlated risky sectors. Early in the development process diversification opportunities are limited, owing to the scarcity of capital and the indivisibility of investment projects. As countries grow and develop, the capital stock expands, as do diversification opportunities.[5] Koren and Tenreyro (2007) find that not only poorer countries are highly concentrated in few sectors, but also those sectors carry particularly high sector-specific risk. As these countries develop, they find both a diversification across sectors and a production shift towards lower-risk sectors.

The finance literature has examined in detail the relative importance of industry and country factors in accounting for correlation of equity markets. Lessard (1974) first considered the importance of differences in industrial composition for explaining the variation in global stock returns. While Roll (1992) confirms the importance of industry factors, others such as Heston and Rouwenhorst (1994, 1995), Griffin and Karolyi (1998) and Serra (2000) find that country factors are more important drivers of volatility and comovements. Even in a more integrated market such as the EU, country factors seem to dominate (Rouwenhorst, 1999). Bekaert et al (2005) confirm this result as well - that country factors are more important in fitting the covariance structure of country-industry portfolios than are industry dummies. More recently, Campa and Fernandes (2006) Baca, Garbe, and Weiss (2000), Cavaglia Brightman, and Aked (2000), Brooks and Del Negro (2004), and Flavin (2004) have shown that the industry effects have leveled or even surpassed the country effects in recent years.

All these studies rely on the Heston and Rouwenhorst (1994) methodology of regressing country stock returns on industry and country dummies, and then examining the relative importance

[4]Various reasons have been advanced for this failure from the role of geography to culture to institutions to inappropriate industrial policies.

[5]Empirical evidence consistently shows that poor countries exhibit considerably higher variability of output than more developed economies (See Lucas, 1988; Koren and Tenryro, 2007).

of these industry and country effects. This is a convenient methodology to capture the relative importance of the two factors under certain assumptions about the correlation structure of shocks. Technically, if we decompose stock returns into industry, country and idiosyncratic shocks, nothing prevents these shocks from being correlated with one another.[6] Rather than using the dummy variable methodology, we will quantify the differences in structure of production across countries and examine the role it plays, if any, in stock market comovements. Our approach will not be able to answer whether industry or country effects are prevalent, but it will help us understand how the industrial evolution across countries shapes cross-country stock market correlations. Second, development also seems to be related closely to diversification across sectors and the inherent riskiness of these sectors. So while countries differ in the industries that they produce in, it is important to also account for the idiosyncratic volatility of sectors and the comovements of the industrial sectors themselves. Therefore, we adopt a different modeling framework which shows that returns of countries are more likely to move together if 1) they produce in the same sectors; 2) that this effects is magnified when they produce in similar sectors that have higher idiosyncratic volatility, that is sectors exposed to large and frequent shocks and 3) when they produce in different sectors but the covariance of sectoral shocks is high.

3 A Risk Adjusted Measure of the Differences in Structure of Production

In this section, we show how stock return correlations depend on the structure of production and on a matrix of global sector specific shocks, that captures the inherent volatility and comovement properties of sectors. We draw on Koren and Tenreyro (2007) and di Giovanni and Levchenko (2008) to construct such a sector-level covariance matrix that is common across countries and years. We combine this with covariance matrix of sectoral shocks with differences in production shares for each available country-pair and time period to construct a summary measure that we

[6] In the Heston and Rouwenhorst (1994) setup returns are regressed on country and industry dummies in cross-sectional monthly regressions. The shocks (or industry and country-specific returns) are obviously not the dummies but the coefficients on these dummies. There is no mechanical link that requires the time-varying industry and country coefficients to be orthogonal to each other.

term the risk-adjusted difference in production structure.

When constructing this measure, we explicitly recognize that financial market liberalization and integration with the world market may make stock returns more correlated with world market factors in a multi-factor framework (Bekaert and Harvey, 2000). For instance, developed countries with similar industrial structures may simply be more integrated with world markets so that their comovements reflects this rather than any aspects of industrial structure. Therefore, we embed our estimation strategy in 1) a Fama-French model, and 2) an international and regional CAPM model. Assume that the excess stock return in country i at time τ (in months) $R_{i\tau}$ is written using either of these two models as

$$R_{i\tau} = \Phi^h_{i\tau} \left(\mathbf{M} \boldsymbol{\beta} \right) + e_{i\tau}$$

where Φ^h refers to one of the Fama-French model or the international and regional CAPM model.[7] Now assume that the residuals $e_{i\tau}$ can be written as a weighted average of sector-specific shocks $\epsilon_{k\tau}$ which is the global shock to sector k at time τ.

$$e_{i\tau} = \lambda \left[\sum_{k=1}^{K} pshare^i_{k\tau} \epsilon_{k\tau} \right]$$

Each of the K sectors receives a weight $pshare^i_{k\tau}$ which is the production share of sector k in country i at time τ. We use λ as a scaling factor that links on average the industry-specific shock to the random component in the country's stock market return. Similarly, for country j in time τ we can write

$$e_{j\tau} = \lambda \left[\sum_{k=1}^{K} pshare^j_{k\tau} \epsilon_{k\tau} \right]$$

Subtracting we get

$$e_{i\tau} - e_{j\tau} = \lambda \left[\sum_{k=1}^{K} \left(pshare^i_{k\tau} - pshare^j_{k\tau} \right) \epsilon_{k\tau} \right]$$

We can calculate then the variance of this difference year-by-year (indexed by t) as:

$$\sigma^2_{i,t} + \sigma^2_{j,t} - 2cov_t \left(e_i, e_j \right) = \lambda^2 \mathbf{a}'_{ij,t} \Omega \mathbf{a}_{ij,t}$$

This expression shows the link between annual volatility of unexpected stock market returns in any pair of countries and the covariance between these returns as a function of the scaling parameter λ,

[7] See section 6 for more details on the two factor models.

the (K x 1) vector of differences in production shares $\left(pshare^i_{k,t} - pshare^j_{k,t}\right)$ denoted by $\mathbf{a}_{ij,t}$ and the variance-covariance matrix of global shocks to the K sectors denoted by Ω. Since our value-added data is annual, we will not be able to calculate annual values for the variance-covariance matrix of shocks. We will use the full sample to obtain a time-invariant estimate for Ω. The conditional correlation of stock returns in each year t is given by

$$\rho_{ij,t} = \frac{\sigma_{i,t}}{\sigma_{j,t}} + \frac{\sigma_{j,t}}{\sigma_{i,t}} - \lambda^2 \frac{\mathbf{a}'_{ij,t}\Omega\mathbf{a}_{ij,t}}{\sigma_{i,t}\sigma_{j,t}} \tag{1}$$

The last term $\frac{\mathbf{a}'_{ij,t}\Omega\mathbf{a}_{ij,t}}{\sigma_{i,t}\sigma_{j,t}}$ is our measure of risk-adjusted differences in the structure of production. It combines volatility of different sectors (diagonal elements of Ω), covariances across sectors (off-diagonal elements) and industrial similarity ($\mathbf{a}_{ij,t}$). Country-pairs with high values of $\frac{\mathbf{a}'_{ij,t}\Omega\mathbf{a}_{ij,t}}{\sigma_{i,t}\sigma_{j,t}}$ are countries that have either very different production structure, or they have small differences but in very volatile industries, or they specialize in industries with uncorrelated or negatively correlated shocks. Countries with high values of this measure will exhibit lower comovements in stock market returns.

4 Data and Variables

4.1 Stock Returns

Our dependent variable is the correlation between returns on country stock indices. Our sample of national equity markets includes data for both developed markets, as compiled by Morgan Stanley Capital International (MSCI), and emerging markets from S&P's Emerging Market Database (EMDB). We use monthly data from MSCI for stock market indices, over the period 1970-2006. We complement this data with monthly stock indices from EMDB that covers 35 emerging country markets with data beginning in 1975. Appendix table A1 provides a complete list of the countries included in our sample. Next, we calculate monthly returns and subtract the 1-year risk free T-bill rate for the US to obtain excess returns. We used this monthly excess return to calculate pairwise unconditional correlations over the 12 months of each year.[8] Figure 4 shows the distribution of the

[8]As a robustness check, we expanded the 12 month window to a 60 month rolling window. The results are qualitatively similar for the correlations calculated with the 60 month overlapping window.

annual unconditional correlations (along with the mean) for two years - 1985 and 1995. In 1985, this ranges from a low of -0.82 between New Zealand and Philippines to a high of 0.98 between Malaysia and Singapore. In 1995, the highest correlation is between Netherlands and Belgium and lowest between Nigeria and France. Comparing the distributions for the two time periods, we observe a doubling of the mean unconditional correlations. Second, both distributions are negatively skewed - while the skewness measure in 1985 is -0.03, in 1995 there is a ten-fold jump in the skewness measure (in absolute terms) to -0.33.

4.2 Production and Trade Structure Differences

We first construct a variable measuring only differences in the industrial structure. This measure is not influenced by the volatility of industry-specific shocks or by the correlation of these shocks across industries. To construct this measure, we use industry-level panel data on both production and trade. The data on industry structure is from the UNIDO database which provides annual data on production, value-added, employment, and number of firms for 28 manufacturing sectors (3 digit ISIC codes are reported) for 183 countries over the time period 1979-2001.[9] Data on production is the most comprehensive, both across countries and over time so we use the production data to measure industrial production structure. The data on production is in current US dollars. For each country-year, we calculate the proportion of production in each of the 28 3-digit manufacturing sectors. Our measure of difference in industry structure is the sum of the squared differences in production shares between country-pairs i and j at time t, where the summation is carried out over the 28 manufacturing sectors.

$$\textit{Difference in Industry Structure}_t^{i,j} = \mathbf{a}'_{ij,t}\mathbf{a}_{ij,t} = \sum_{k=1}^{28}\left(pshare_{kt}^i - pshare_{kt}^j\right)^2$$

k is the index for the 28 manufacturing sectors, and

$$pshare_{kt}^i = \frac{prod_{kt}^i}{\sum_{k=1}^{28} prod_{kt}^i}$$

is the production share in the k^{th} manufacturing sector and $prod_{kt}^i$ is the production in sector k in country i at time t. Countries with the same structure of production will have a value of 0 for

[9]See Appendix table A2 for the list of the 28 manufacturing sectors included in our calculations.

this index. Differences in industrial structures will be reflected in higher values of the index and for countries that specialize only in one industry (which is different from the industry of the other country in the pair), the index will attain its maximum value of 2.

We also examine if our results are robust to differences in trade structure. The advantage of examining differences in trade structure is that while the UNIDO data covers only the manufacturing sector, the trade data encompasses all merchandise trade. Trade data over the same time span come from the World Trade Database (Feenstra et al. 2005), which contains information on more than 150 countries. This database contains bilateral trade flows between pairs of countries, accounting for 98 percent of world trade. Trade flows are reported using the 4-digit SITC Revision 2 classification. We aggregate bilateral flows across countries to obtain total exports in each country and industry. At the 4-digit level, there are a number of instances, where the authors could not classify trade as falling into one of the 4-digit SITC categories, which leads to trade in a 3-digit being sometimes higher than the sum of the trade in the corresponding 4-digit sub-categories. To minimize this problem, and for comparability to our measures of industrial structure, we use trade in 3-digit SITC categories. There are 241 3-digit categories. Our measure of difference in export structure between country-pairs i and j at time t is the sum of the squared differences in export shares between country-pairs i and j at time t, where the summation is carried out over the 241 3-digit sectors.

$$\textit{Difference in Export Structure}_t^{i,j} = \sum_{k=1}^{241} \left(xshare_{kt}^i - xshare_{kt}^j \right)^2$$

k is the index for the 241 sectors that encompass merchandise trade,

$$xshare_{kt}^i = \frac{export_{kt}^i}{\sum_{k=1}^{241} export_{kt}^i}$$

is the export share in the k^{th} SITC sector and $export_{kt}^i$ is the exports by country i in sector k at time t.

Figure 5 shows the empirical cumulative distribution functions for production and trade structure. Comparing the two, we find that for 80% of the sample, the variable "difference is production structure" takes the value less than 0.1, while for the variable "difference in export structure" only

60% of the sample shows a value of less than 0.1. Figure 6 provides a snapshot of the evolution of differences in production structure by plotting its distribution for the two years, 1985 and 1995.[10] By construction, both distributions are right-skewed with an increase in skewness from 1.4 in 1985 to 1.5 in 1995. More interestingly, we see an increase in the mass of the distribution close to 0, for the year 1995 as compared to 1985, which suggests that at least for some proportion of our sample, there has been a convergence in industry structure. In addition, some proportion of the sample in 1995 takes values in excess of 0.2 which is not true in 1985, suggesting that there have been some divergence in the structure of production as well. We examined the set of country-pairs whose production differences exceed 0.2 in 1995 and found Singapore in each of these country-pairs.[11] As is well known, Singapore has been one of the few growth miracles in last 30 years or so, and has been remarkably successful in transforming its economy into a high-skill manufacturing and service based economy. A partial snapshot of the transformation of the industry structure in Singapore is provided in figure 7, which plots production share of each of the 28 manufacturing sectors for the years 1985 and 1995. The biggest differences are discernible in petroleum refineries (a sharp decline from 0.28 in 1985 to 0.09 in 1995) and manufacturing of machinery, except electrical (a substantial jump in production share from 0.05 to 0.33). The graphs so far suggest that there has is substantial differences in the industrial structure between country-pairs and within country-pairs over time.

4.3 Construction of the Sector Variance-Covariance Matrix Ω

For our preferred measure of industrial structure differences – the risk-adjusted measure, we need the variance-covariance matrix of sector-specific shocks. Using annual data on industry-level value added per worker growth from the UNIDO database over 1979-2001, we construct a cross-sectoral variance-covariance matrix using the following procedure (see Koren and Tenreyro, 2007, for details). Let y_{ikt} be the growth rate of value added per worker in country i, sector k, in year t. We control for long-run differences in value added growth across countries in each sector, by demeaning

[10]To facilitate comparison, we plot the variable only for country-pairs for which data is available for both 1985 and 1995.

[11]The countries paired up with Singapore are Jordan, Colombia, Chile and Pakistan.

y_{ikt} using the mean growth rate for each country and sector over the entire time period.

$$\widetilde{y}_{ikt} = y_{ikt} - \frac{1}{T}\sum_{Y=1}^{T} y_{ikt}$$

Next for each year and sector we calculate the cross-country average of growth in value-added per worker.

$$Y_{kt} = \frac{\sum_{i=1}^{C} \widetilde{y}_{ikt}}{C}$$

where C is the set of countries. Y_{kt} is a time series of the average growth for each sector, and can be thought of as a global sector-specific shock. Using these time series, we calculate the sample variance for each sector, and the sample covariance for each combination of sectors along the time dimension. This results in a 28 x 28 variance-covariance matrix of sectoral shocks, which is Ω. By virtue of its construction, we think of it as a matrix of variances and covariances of sectors, which is clearly time- and country-invariant. For the diagonal terms in Ω, which is simply the variance of sectoral shocks, the two most volatile sectors are petroleum refineries and miscellaneous petroleum and products (variance slightly higher than 0.01) and the least volatile is manufacturing of transport equipment (variance equal to 0.003).

Combining Ω with the vector of difference in production shares $\mathbf{a}_{ij,t}$ and the annual standard deviation of stock returns for country i and j, we obtain the risk-adjusted difference in production $\frac{\mathbf{a}'_{ij,t}\Omega\mathbf{a}_{ij,t}}{\sigma_{i,t}\sigma_{j,t}}$ This variable takes into account not simply the squared differences in the production sector but also sector-specific volatility and covariance structure of sectoral shocks. This variable ranges from a low of 0.0004 between France and Spain in 1987 to a high of 1.18 between Oman and South Africa in 2000.[12]

4.4 Specification and controls

The main regression is:

$$\rho_{ij\tau} = \alpha + \beta X_{ij\tau} + \gamma' Z_{ijt} + e_{ij\tau} + \tau_t \tag{2}$$

[12]The correlation between the risk-adjusted measure of the difference in the structure of production and simple squared differences in production structure is equal to 0.46.

The dependent variable ρ is the conditional or unconditional annual pairwise correlation of monthly stock index excess returns for 58 countries from 1975 to 2000. The main coefficient of interest is β, which captures the effect of industrial structure similarity on cross-country correlations. For $X_{ij\tau}$ we use three different measures – pure difference in production structure; differences in export structure; and risk-adjusted difference in production structure. τ_t refers to time dummies.

To ensure that the estimated β is not unduly influenced by omitted variables, we include a vector of controls (Z_{ijt}). First, drawing on the literature of bilateral equity flows we include a series of gravity-type variables.[13] Martin and Rey (2004) derive a gravity model of bilateral flows of assets, which demonstrates the importance of size of economies and transaction costs for these cross-border flows. Their model is consistent with recent empirical evidence on bilateral cross-border equity flows in Portes and Rey (2005). They show that such flows depend positively on a measure of country size (measured by market capitalization) and negatively on transaction costs and informational frictions (proxied by distance). Therefore, we control for country size and stock market development using the product of stock market capitalization, and include the geographic distance between capital cities of country-pairs.[14] Second, we include a variable that takes the value 1 if the two countries are from the same region.[15] Next, we measure country pair integration using data on bilateral trade flows from IMF's Direction of Trade Statistics database. We operationalize this variable as the average of bilateral export shares between pairs of countries. Another variable used to measure integration is a dummy variable that takes the value one if the two countries are part of a free trade area or a customs union since this facilitates the flow of goods and services between the two countries. To capture differences in degree of development, we add a control which equals the absolute difference in per capita GDP in constant international dollars from the World Development Indicators. We also control for differences in political institutions by including a dummy variable that takes the value one if both countries are classified as democracies, and zero otherwise. Following Giavazzi and Tabellini (2004) and Persson (2005) we classify a country as a democracy if it receives a positive Polity score. Data are from Polity IV Project that classifies

[13] See also Baldwin and Taglioni, 2006 for a survey of the gravity literature on bilateral trade flows.

[14] We experimented with distance between financial centers and got similar results.

[15] We use the World Bank's 8-fold regional classification. North America, Latin America, Western Europe, East Europe and Central Asia, East Asia and Pacific, South Asia, Middle East and North Africa, and Sub Saharan Africa.

countries on a scale of -10 to 10 with higher numbers indicating more democratic regimes (Marshall, Jaggers and Gurr, 2000). [16] Finally, we control for aggregate shocks such as a world business cycle, movements in the world rate of interest, or global capital market shocks using time dummies, and control for region-specific shocks by using time-varying regional dummies.

Table 1 lists the summary statistics and the data source for each of the variables.

5 Unconditional Correlations and the Structure of Production

First we look at the relationship between differences in the production structure without accounting for the variance-covariance structure of sectoral shocks. Here we are explicitly assuming that Ω is an identity matrix. These estimates are shown in Columns 1-3 of Table 2. All columns include time fixed effects. Column 2 adds time dummies to column 1, column 3 adds country-specific effects, and column 4 presents within-estimates, with country-pair specific fixed effects, time dummies, and time-varying regional effects. In column 1, we see a negative and significant coefficient on our industry structure variable - it implies that correlation between country pairs is higher if they have a similar industry structure. Column 2 shows that this effect persists even when we add time-invariant country-specific effects (two dummies are added for each country pair) to capture unobserved time-invariant country characteristics. The differences in industrial structure remain a significant driver of stock return correlations. Column 4 includes country-pair fixed effects so that the estimates are within-effects. The negative coefficient on differences in industry structure imply that country-pairs that have become similar in terms of industrial structure over time exhibit a higher degree of comovement in stock market returns. Since the regional dummy and the distance measure are time-invariant, they are automatically dropped for the within-estimates shown in column 4. However, column 4 also includes time-varying regional dummies, so we can be fairly confident that our measure of industrial structure is not simply a proxy for common region-specific shocks that arise out of geographic specialization of production.

In terms of the magnitude of effects, we find that for the estimates in column 1 (3), a one

[16]Note that we used the POLITY2 measure, which transforms the Polity "standardized authority codes" (i.e., -66, -77, and -88) to scaled POLITY scores so the POLITY scores may be used consistently in time-series analyses without losing crucial information by treating the "standardized authority scores" as missing values.

standard deviation reduction in the difference in industry structure increase correlations by 0.01 (0.012). A second way to understand the magnitude of effects is to consider two country pairs, one of which has similar production structure and another pair that has very different production structures. In 1999, the variable $Difference\ in\ Industry\ Structure$ takes the value 0.14 for the pair (USA, Pakistan) and the value 0.002 for (USA, UK). Our estimates in column 3 imply that if Pakistan's production structure became identical to that of the UK, its correlation with the USA would rise by 0.03. With an average correlation of 0.1 for (USA, Pakistan) this amounts to a 30% increase in the magnitude of correlations.

Columns 4-6 in Table 2 use the risk-adjusted measure of differences in production structure, $\frac{\mathbf{a}'_{ij,t}\Omega\mathbf{a}_{ij,t}}{\sigma_{i,t}\sigma_{j,t}}$, that in addition to the squared differences in the production sectors, also takes into account sector-specific volatility and covariance structure of sectoral shocks.[17] We find a strong negative influence of this measure on stock market correlations - country-pairs with larger values on this measure exhibit lower return comovements, both in the pooled OLS specifications (with or without country-specific dummies) and in the within-effects over time. Accounting for the variance-covariance of sectoral shocks results in a tripling in the magnitude of the effect - the estimates in column 4 imply that a one standard deviation decline in the risk-adjusted measure if difference in industry structure raises unconditional correlations by 0.03. The magnitude of the effect for the within-estimates in column 6 are the same as that in column 3, which is not surprising given that the variance-covariance matrix of sector-level shocks are time-invariant.

For our control variables, we find that countries with similar levels of stock market development, at similar levels of development in terms of per capita GDP, and that have democratic political institutions exhibit higher comovements in stock returns. The difference in per capita GDP is not significant in the within-estimates in column 6 of Table 2. This implies that what matters for rising correlations over time is not whether country-pairs become similar in terms of per capita incomes but that they become similar in terms of their risk-adjusted structure of production. We also find county-pairs that are geographically proximate to each other, those that exhibit a higher degree of bilateral trade, and who are members of a common free trade area have larger stock return correlations. Free trade areas imply higher stock market comovements for both the pooled OLS and

[17] Columns 4-6 include a variable $(\blacksquare_i^2 + \blacksquare_j^2)/\blacksquare_i\blacksquare_j$ where $\blacksquare_i$ is the standard deviation of the returns in country i.

within-estimates while bilateral trade seems to play a role only in the pooled OLS specifications. Finally, stock markets of countries from the same region tend to move together. Our explanatory variables account for 22-36% of the variation in correlations across country-pairs and all models are jointly significant at the 1 % level.

6 Conditional Correlations and the Structure of Production

So far we have focused on unconditional correlations and shown that these are significantly influenced by the structure of production and trade. However, as Longin and Solnik (1995) argue, even if the conditional correlations are constant, unconditional correlations tend to be very unstable over time and that this could be driven solely by time variation in market expected returns and variances.[18] First, expected returns may depend on worldwide and region-specific variables. Moreover the level of integration of national equity markets differs across countries and may change over time. Some countries are more integrated with the rest of the world and their returns are likely to be highly correlated. Similarly, countries within the same region may be more integrated and may have similar production structures (due to similar endowments). Growing international and/or regional integration over time could also lead to a progressive increase in market correlation. Second, the variance of returns may be heteroskedastic. In fact, the conditional variance of national equity markets has been modelled with good success using a univariate GARCH approach for several national markets. For all these reasons, it is important to consider conditional correlations, because unconditional correlations might be driven by changes in the volatility of either the world or regional factor, or by changes in the factor loadings through time-variation in regional and world integration. And if these changes in volatility coincide with changes in industrial structure, then our estimates will be biased and inconsistent.

Therefore, as a next step we take an asset pricing perspective and estimate two asset pricing models. The first is the Fama-French three factor model and the second is a two-factor model with time-varying factor loadings where one is a common world factor and the other is a regional

[18]This goes back to Kaplanis (1988) who finds that the correlation matrix over four equal 46 months sub-periods is more stable than the counterpart covariance matrix. The instability in the covariance matrix is attributed to the non-stationarity of a few variances which cause a structural change in the level of the covariances.

factor. We use the parsimonious factor model proposed by Fama and French (1998) to capture style exposures in an international context. The world Fama-French model, has three factors, a world market factor, a size factor (WSMB) and a value factor (WHML). The model in Fama and French (1998) only has the world market factor (μ_τ^W) and the value factor ($WHML_\tau$), the data for which is available from Kenneth French.[19] In addition, we also include factors that are specific to the US which is the world's largest stock market. For the US, we include the excess return in the US (μ_τ^{US}), a US size factor ($USSMB_\tau$) and a US value factor ($USHML_\tau$). We estimate the following excess return equation using monthly data

$$\begin{aligned} R_{i\tau} &= \beta_i^W \mu_\tau^W + \beta_i^{US} \mu_\tau^{US} + \beta_i^{WHML} WHML_\tau + \beta_i^{USSMB} USSMB_\tau + \beta_i^{USHML} USHML_\tau + e_{i\tau} \\ & e_{i\tau} \sim N(0, \sigma_{i\tau}^2) \\ \sigma_{i\tau}^2 &= a_i + b_i \sigma_{i\tau-1}^2 + c_i e_{i\tau-1}^2 + d_i \left[\max\left(0, e_{i\tau-1}\right)\right]^2 \end{aligned} \tag{3}$$

The variance of the idiosyncratic return shock in market i, $e_{i\tau}$ follows a GARCH process in eq. (3) with asymmetric effects in conditional variance, as in Glosten, Jagannathan, and Runkle (1993). Previous research such as Longin and Solnik (1995), Erb, Harvey, and Viskanta (1994) and De Santis and Gerard (1997) find different correlations in up and down markets and that volatility reacts in an asymmetric fashion to positive and negative news.

For the second factor model, we follow the setup of Bekaert and Harvey (1997) and Bekaert, Harvey and Ng (2005). This model in addition to the asymmetric GARCH specification, also incorporates time-varying factor loadings, where the factor loadings are influenced by trade patterns. Chen and Zhang (1997) and Bekaert, Harvey and Ng (2005) find that the crossmarket correlations of stock returns are related to external trade among countries. For each country, we estimate the following excess return equation

$$\begin{aligned} R_{i\tau} &= \beta_{i\tau}^W \mu_\tau^W + \beta_{i\tau}^{REG} \mu_\tau^{REG} + e_{i\tau} \\ & e_{i\tau} \sim N(0, \sigma_{i\tau}^2) \\ \sigma_{i\tau}^2 &= a_i + b_i \sigma_{i\tau-1}^2 + c_i e_{i\tau-1}^2 + d_i \left[\max\left(0, e_{i\tau-1}\right)\right]^2 \end{aligned} \tag{4}$$

[19] Like Fama and French (1998) we are relying on MSCI data. They show that such a database of large stocks does not allow meaningful tests for a size effect. Therefore, they restrict themselves to the world value factor.

where μ_τ^W is the monthly excess return on a world portfolio, μ_τ^{REG} is the excess return on a regional portfolio and $e_{i\tau}$ is the idiosyncratic shock of any market i.[20] The sensitivity of each market i to the world and regional portfolios is measured by the time-varying parameters $\beta_{i\tau}^W$ and $\beta_{i\tau}^{REG}$. These time-varying parameters are modeled as depending in a linear fashion on trade patterns with $\beta_{i\tau}^W$ a function of country i's trade (exports plus imports) with the world as a whole, and $\beta_{i\tau}^{REG}$ a function of country i's trade (exports plus imports) with all the other countries in its region.[21] For each country, we use monthly data to estimate (3) and (4), extract the residual $\widehat{e}_{i\tau}$ in each specification and calculate the conditional correlations over each year. We use the conditional correlations as our dependent variable.

Columns 1-3 in Table 3 shows how the Fama-French conditional correlations are affected by differences in industry structure. As with the unconditional correlations, we find that bigger the differences in industry structure, lower are the stock market comovements between pairs of countries. This result holds in a pooled OLS with time dummies, when we add country-fixed effects, as well as in a within-estimation with country-pair fixed effects and time-varying regional dummies. Comparing the magnitude of the coefficients in Table 3 to that in Table 2 (that uses unconditional correlations), we see that the magnitude increases substantially across specifications, with the increase especially pronounced for the within-estimates in column 3. Here, a one standard deviation decline in the difference in the structure of industry increases pairwise correlation by 0.03 which is thrice as high as than the magnitude of the effect for unconditional correlations in column 3 of Table 2. The explanatory power of our variables range from 23% for the pooled OLS without any fixed effects to 39% for the within-estimates that includes country-pair and time-varying regional fixed effects.

[20]For the world index, we use the MSCI World Market Index. For the regional indices we use the Asia, Middle East and Africa and Latin America indices from EMDB. For European countries we use the MSCI Europe Index, for Australia and New Zealand we use the MSCI Pacific Index, for Japan we use the Pacific Index excluding Japan, for Canada we use the US index. Finally, for the US given its overwhelming size in world markets we do not include any regional index. Note that the this regional classification is based on the MSCI data and is coarser that the World Bank's classification used to construct the dummy variable "same region."

[21]Since data on trade is available only on an annual basis the time-variation in the $\beta's$ is effectively on an annual basis.

Columns 4-6 use the risk-adjusted measure of differences in production structure. Now the pooled OLS estimates in Column 4 imply that a one standard deviation reduction in the risk-adjusted measure of structure of production, raises conditional correlations by about 0.05. When we add time and country-fixed effects, in columns 2 and 3, the coefficient declines but remains strongly significant. To get an idea of the magnitude of effects, consider the country pair (USA, Singapore). The risk-adjusted measure of difference in production structure takes the value 0.63 in the year 1977 and 0.01 in the year 1999, underlying which is an unprecedented transformation in the industrial structure of Singapore. The within-estimate of the coefficient on the risk-adjusted measure of difference in production structure equals -0.745 in Table 3. This implies an increase in the correlation between the stock returns in Singapore and USA by 0.46. This is a substantial increase in correlation, which will necessitate a significant reshuffling of portfolio allocations across these two markets. Although in the mid-1970s investing in Singapore might have given US investors significant diversification benefits, today this cross-country diversification will yield much smaller gains in reducing the overall portfolio variance. Importantly, the reason for this change in cross-country diversification benefits is the change in the industrial structure in Singapore.

Table 4 examines the conditional correlations based on the international and regional CAPM model with time varying betas. Once again across specifications, we find that countries who specialize and produce in different manufacturing sectors tend to exhibit lower conditional correlations. The relationship holds for both the pooled OLS specification and in the within-effects over time. It holds for both for the simple differences in production structure and for the risk-adjusted measure. Once again there is a marked increase in the magnitude of the coefficients on production structure differences as compared to those in Table 2, with a similar doubling (for the pooled OLS) and trebling (for the within-effects) as we obtained for the Fama-French results.

7 Extensions and Robustness

7.1 Exports

In order to explore how the industrial structure affects stock market comovements, we also look at the structure of exports. The data on exports covers all merchandise trade while the data on industry structure spans only the manufacturing sector. The summary statistics in Table 1 reflect this difference by documenting larger differences in export structure as compared to industry structure.

Table 5 reports how the conditional correlations are affected by differences in the structure of exports. As with the structure of production, we find that across all specifications, a bigger difference in export structure implies a smaller correlation between country-pairs.[22] The most demanding specifications are the one with time, country-pair and time-varying regional fixed effects as shown in columns 2 and 4. These are also the specifications where we obtain a higher coefficient on differences in export structure (as compared to columns 1 and 3), both in terms of magnitude and in terms of statistical significance.

Comparing production differences to export differences, we find that the pooled OLS estimates imply a magnitude of effect for export differences that is nearly 1.5 times as high as that for production differences. This seems reasonable for a couple of reasons. First, as mentioned earlier, data on exports are much more comprehensive and covers all merchandise trade and as such may be a better proxy for the overall industrial and production structure of the country. Second, research on firm-level exports has shown that a very small percentage of firms account for an overwhelming proportion of exports (e.g., of the 5.5 million firms operating in the United States in 2000, just 4 percent were exporters. Among these exporting firms, the top 10 percent accounted for 96 percent of total U.S. exports. See Bernard et al, 2008.) These firms tend to be the large multinationals that receive large weights in the construction of country stock indices. Therefore, common worldwide shocks weighted by exports structure differences are likely to be tied closely to comovements in stock returns.

[22] We also find that there is an increase in the absolute magnitude of the coefficient on export differences when we restrict our sample to non-oil exporting countries. This implies that the comovements of the stock markets in oil-producing economies with the rest of the world cannot be predicted well by the export structure because of the skewed nature of exports.

7.2 Sub-samples

One possible criticism of our results is that a particular subset of country-pairs is primarily responsible for the negative relationship between differences in production structure and stock market correlation - that this relationship holds only for country-pairs where one is a developed country and the other a developing country. To examine this possibility, Table 6 presents regression results, taking various permutations in the choice of country-pairs in the sample. Column 1 restricts the sample to country-pairs where both countries are developing countries; Column 2 uses the sample of pairs, where one is developed and the other developing; Column 3 restricts the sample to developed country-pairs. We use the World Bank classification for developed vs. developing countries. Across these various sub-samples, we find evidence for a negative relation between risk-adjusted differences in the structure of production and conditional stock market correlations (based on the Fama-French model). In terms of both statistical significance and magnitude of effect, the relationship is strongest for country-pairs where one is developed and one is developing. However, the relationship holds for the other two sub-samples as well, with almost equally strong results for the sub-sample where both countries are developed. This attests to the robustness of this relationship.

7.3 Segmentation vs. integration

The literature on international stock market comovements analyzes also the effect of financial liberalization for correlations and more generally it studies trends in financial integration (e.g. Bekaert and Harvey, 2000; Bekaert, Hodrick, and Zhang, 2005). If financial markets are integrated, then the degree of correlation will be affected more by investors' preferences and other demand-driven idiosyncratic factors. Analogously, variations in segmented markets will be driven more by local investors and by the industry-specific shocks. We test this hypotheses in Table 7. We use data on stock market liberalization dates from Bekaert, Harvey and Lundblad (2005). Using this data we created two dummy variables – one for cases when one market is integrated (liberalized) while the other is segmented and a dummy variable that takes a value of 1 when both markets are segmented. The default option captured by the constant term is when both markets are liberalized. Our interest is to see how the role of industrial structure changes with financial liberalization. To estimate this effect we include our measure of risk-adjusted production structure and the interaction of this variable with the two dummy variables capturing the state of financial liberalization. Column 1 of Table 7 shows that industrial differences still remain an important explanatory variable for cross-country stock comovements, but the effect differs depending on the level of integration. While the coefficient on industrial structure for two liberalized economies is -0.724, for countries where at least one of the markets is segmented the coefficients increases in absolute value by about 1.5 to 1.7. In other words, industrial structure differences matter much more for countries that do not have liberalized financial markets.

In the last two columns we investigate the effect of financial liberalization by using a difference-in-difference estimator. Column 2 includes a dummy variable that takes the value of 1 once a country-pair has transited to integrated stock markets. Column 3 includes both this dummy variable and its interaction with risk-adjusted industrial structure.[23] In both cases liberalization raises cross-markets correlations by about five percentage points. Industrial structure still explains conditional correlations, but the coefficient on the interaction term in column 3 shows that its role changes very little in the post-liberalization period.[24]

8 Conclusion

In this paper we have focused on the role of industry-specific shocks in explaining cross-country comovements in stock market indices. We have documented that differences in industrial structure as well as differences in export structure across pairs of countries are significant and robust predictors of stock market correlations. This finding can be rationalized in models where the stochastic component of stock market returns is affected directly by industry-specific shocks, which then influence the overall stock market return through the share that this industry takes in the overall economic activity in the country. Thus, we show that fundamentals as captured by idiosyncratic

[23]Columns 2 and 3 include time fixed effects and country-pair fixed effects. The dummy variable captures the event when a pair of countries made the transition to a situation where both can be classified as having integrated stock markets. It takes the value 1 in all years after both countries had made a switch to liberalized stock markets. It takes the value 0 if either country has a segmented market or if both countries had liberalized stock markets on or before 1975.

[24]We get very similar if we use the conditional correlations based on the international and regional CAPM model.

sectoral shocks do explain comovements in stock market indices.

There are two issues that arise from the results in this paper. First, the explanatory power of industrial structure is always statistically significant but it is not overwhelming on average – for average changes in industrial structure we explain about five percentage points of pairwise correlations. There are examples, however, where industrial structure seems to matter more. For Singapore and the US, the actual change in production structure raises correlations by forty-six percentage points. When we look at the average economic significance, one of the reasons for the low explanatory power is that we do not investigate industry-specific portfolios. One can use the methodology of the paper to investigate to what extent cross-country correlations of industry-based portfolios are explained by industry specific shocks. Second, we do recognize that to have a more complete explanation of the observed correlations, one has to go beyond the production side and analyze also the role capital controls, liquidity fluctuations, regulation, etc. and in particular their relationship to the role of the industrial structure. Some of these topics have been already discussed in the literature (e.g. Bekaert, Hodrick, and Zhang, 2005), others we leave for future research.

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Figure 1: Average Correlations for 26 pairs of Countries (1970-2006)

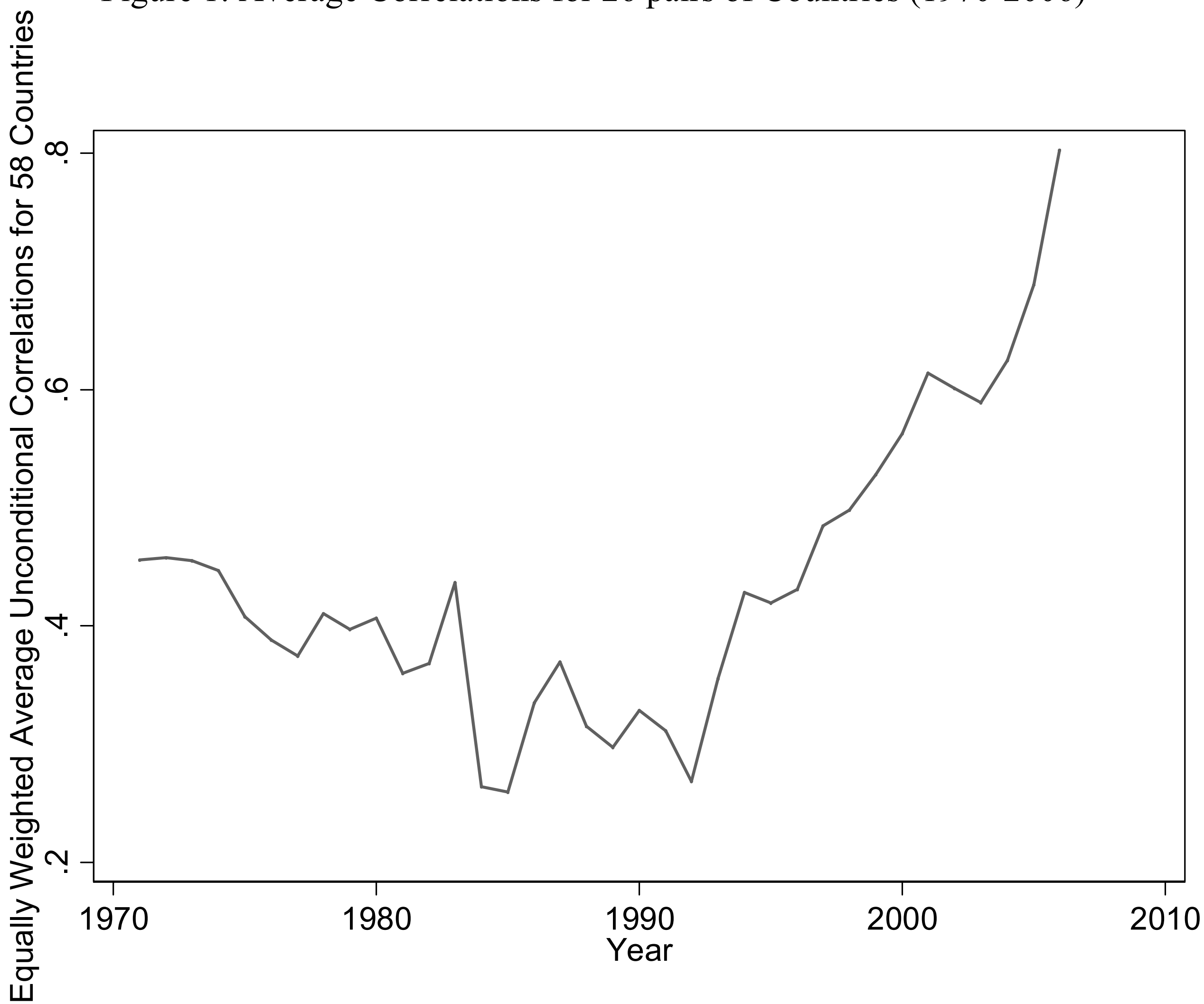


Figure 2: Stock Indices for Various Country-Pairs

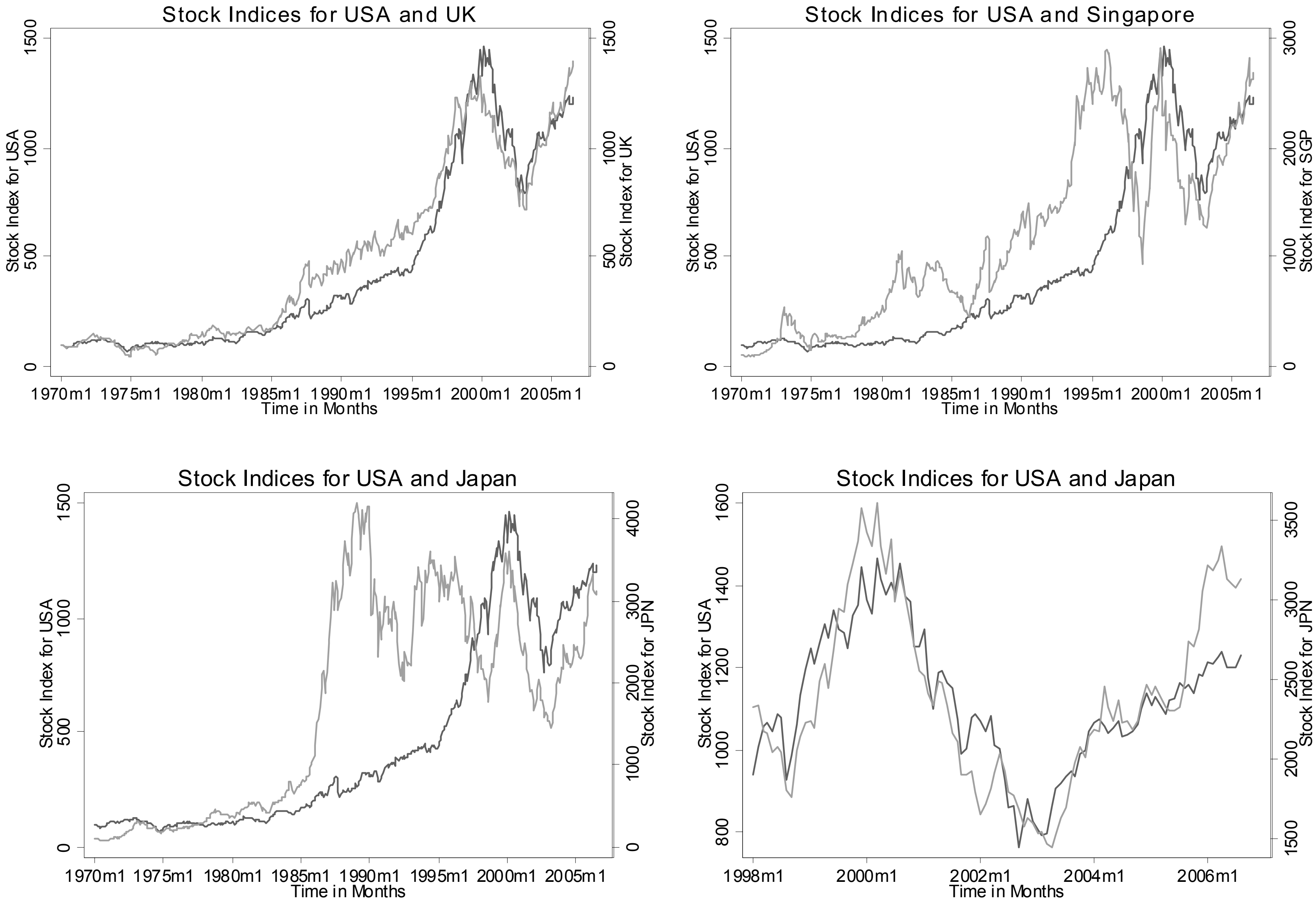
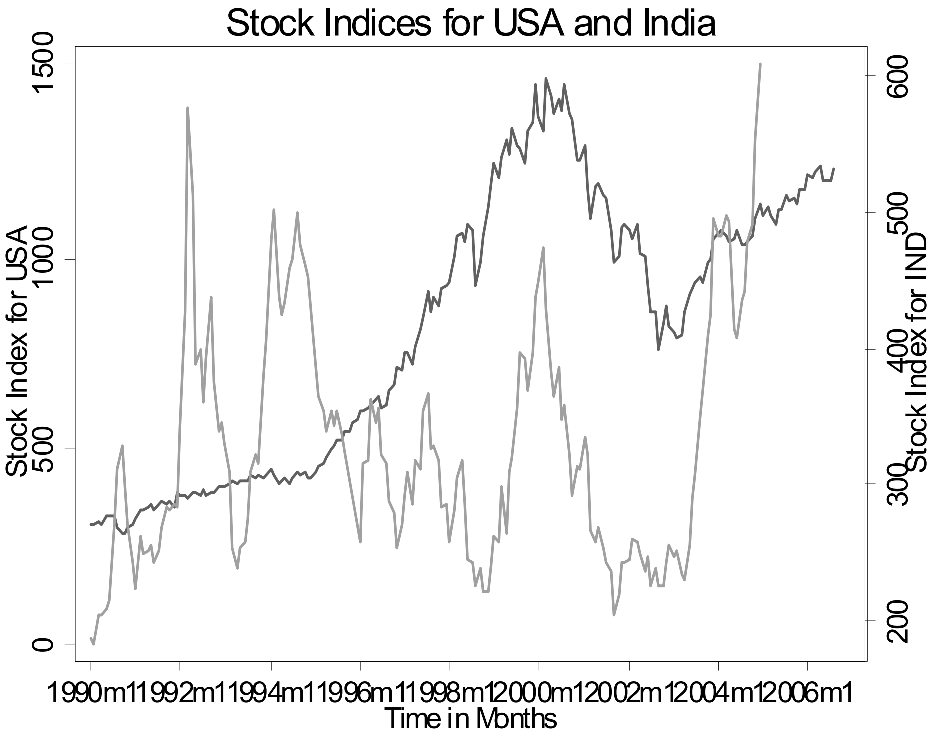


Figure 3: Stock Indices for Various Country-Pairs



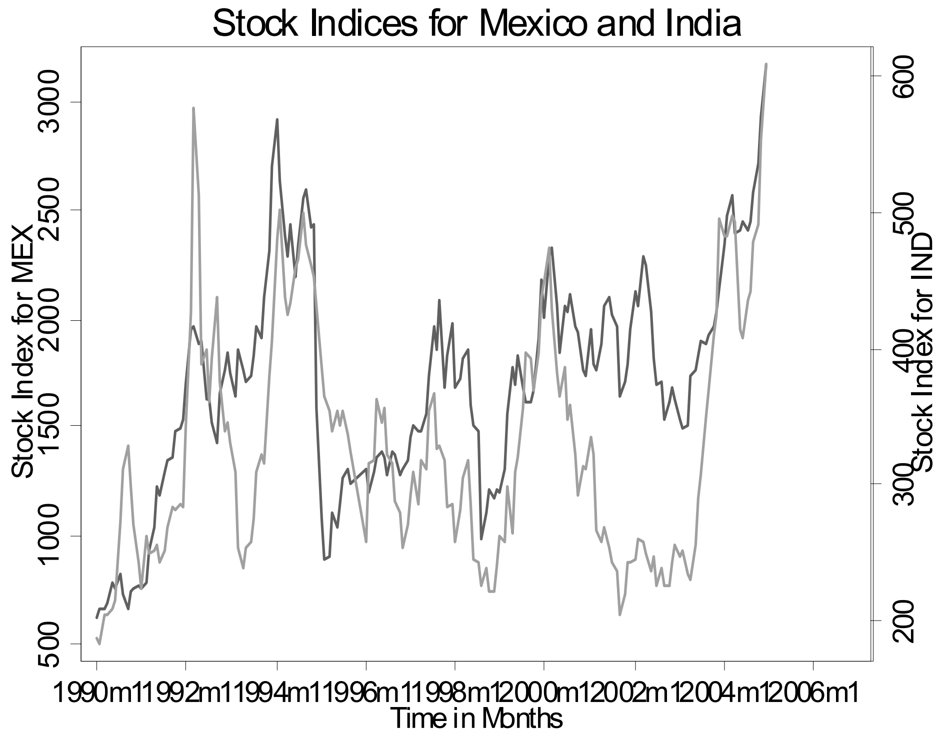


Figure 4: Distribution of Stock Correlations (1985 and 1995)

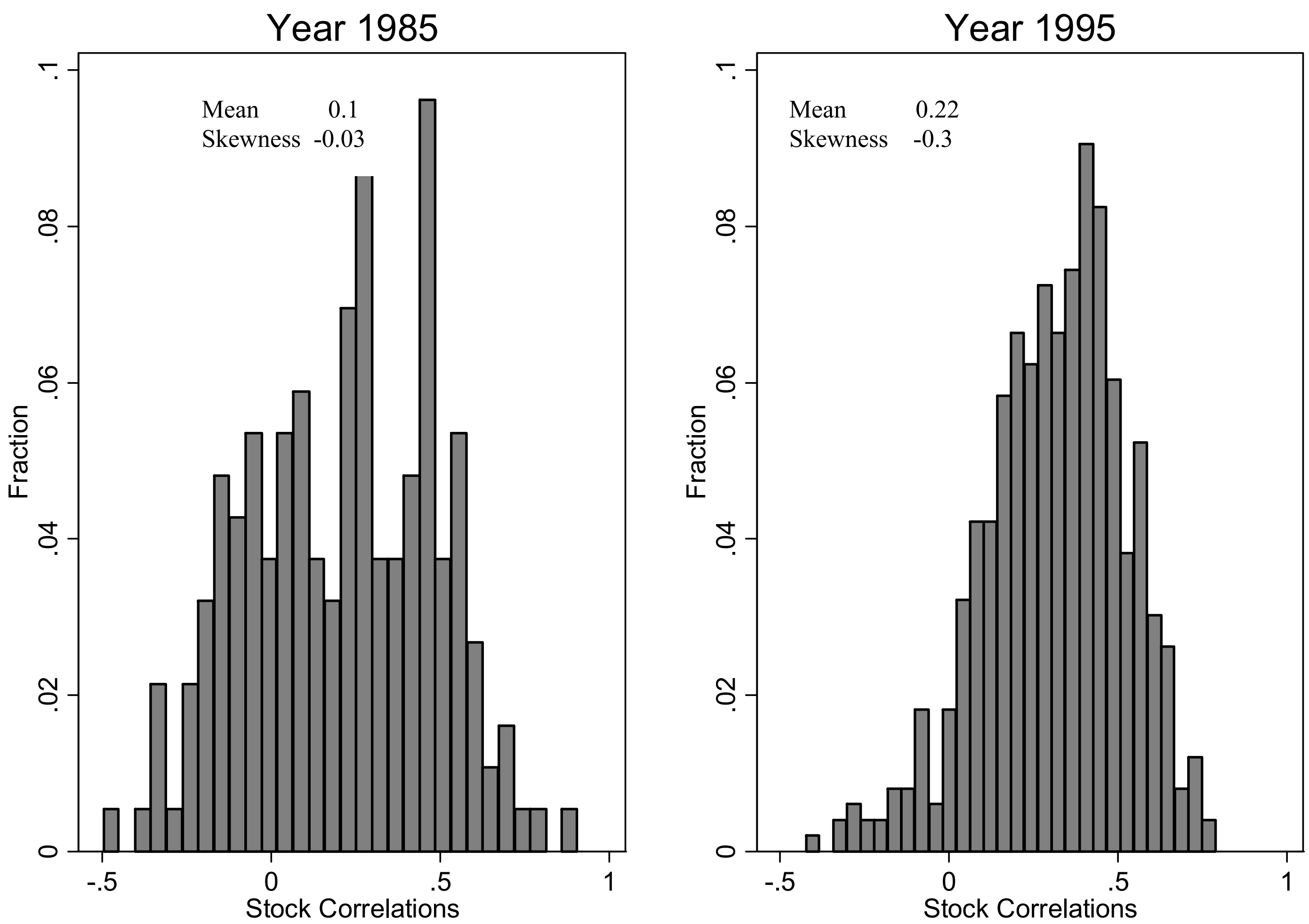


Figure 5: Empirical Distribution Function for Differences in Production and Export Structure

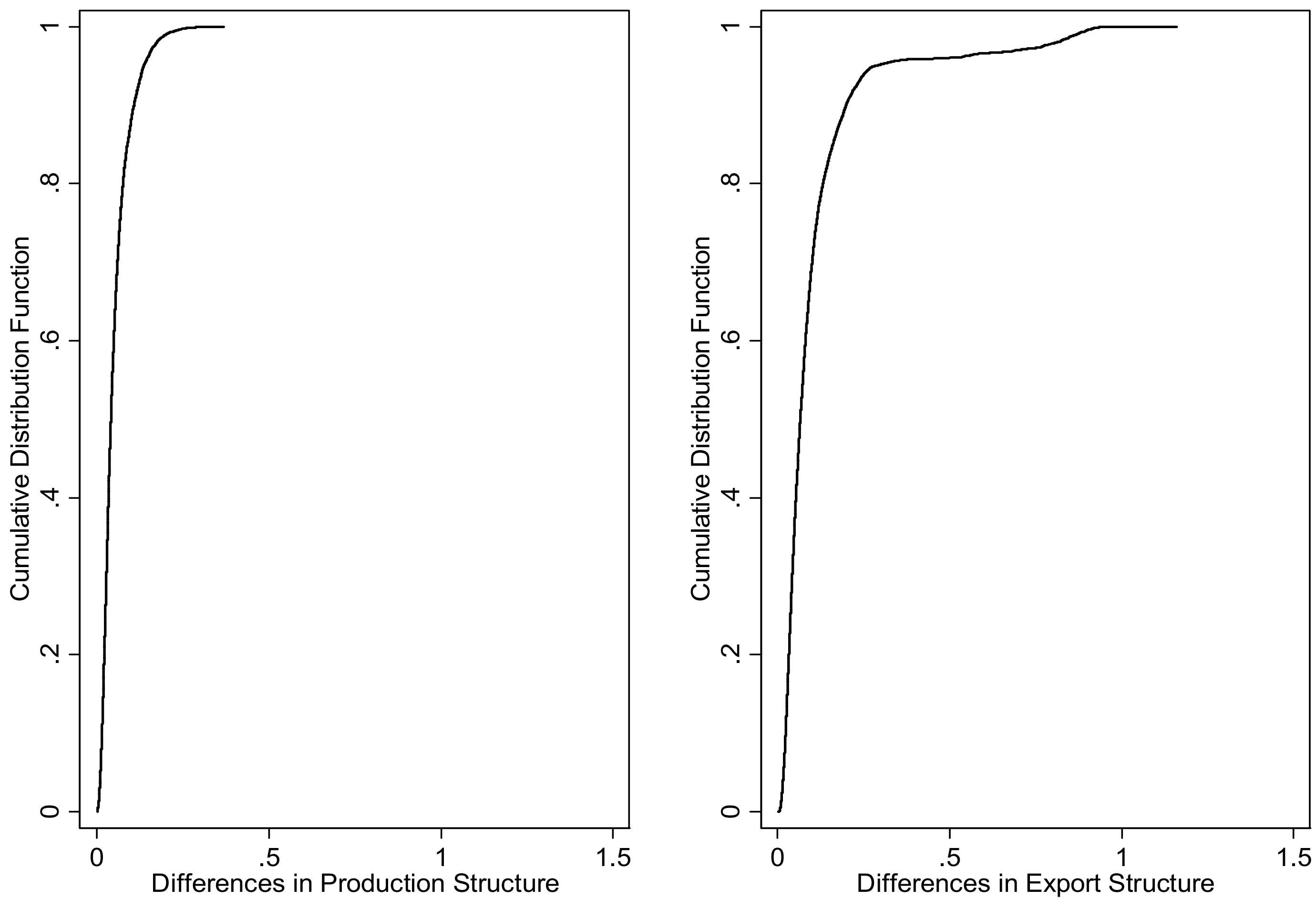


Figure 6: Distribution of Difference in Production Structure in 1985 and 1995

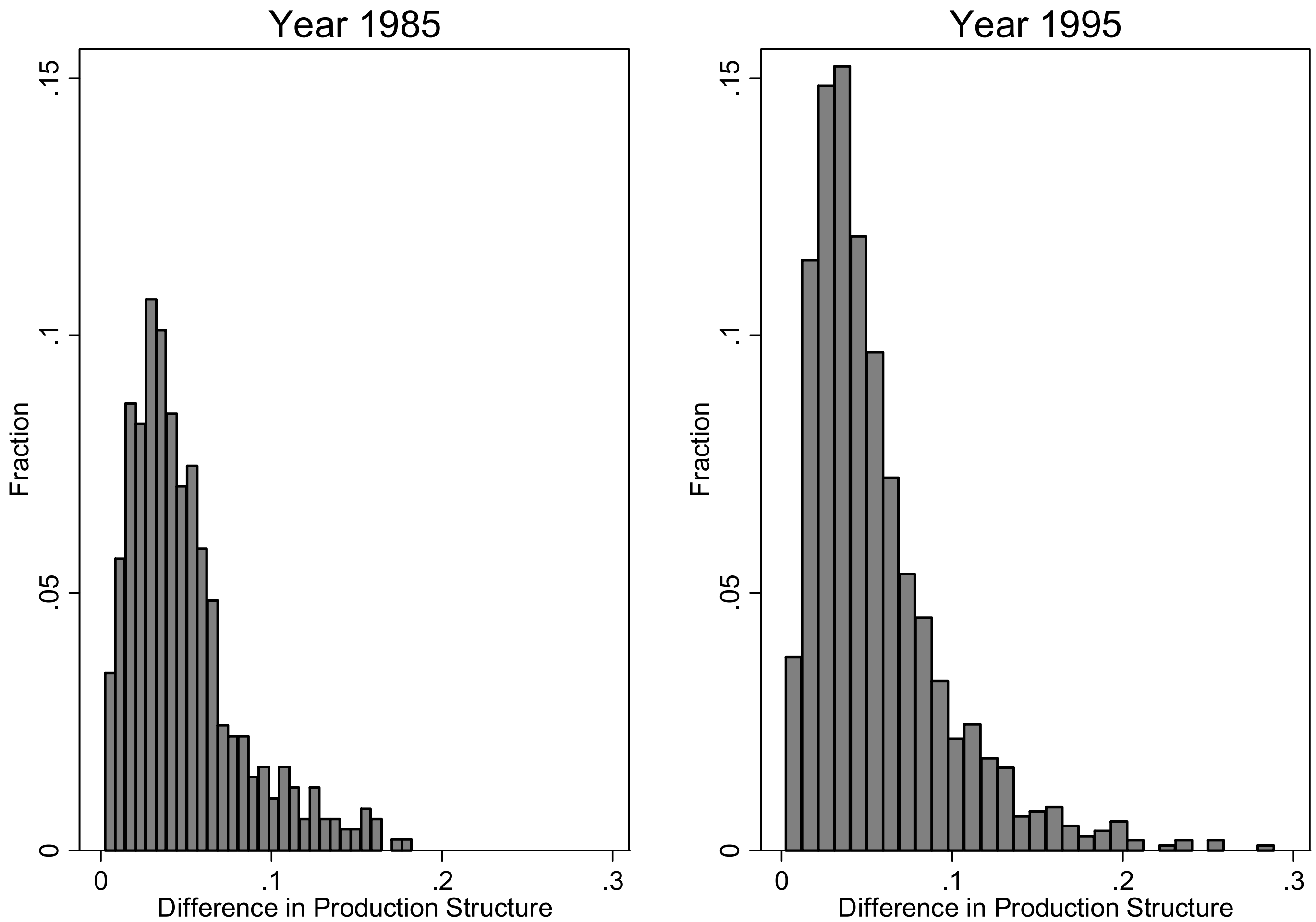


Figure 7: Production Structure in Singapore in 1985 and 1995

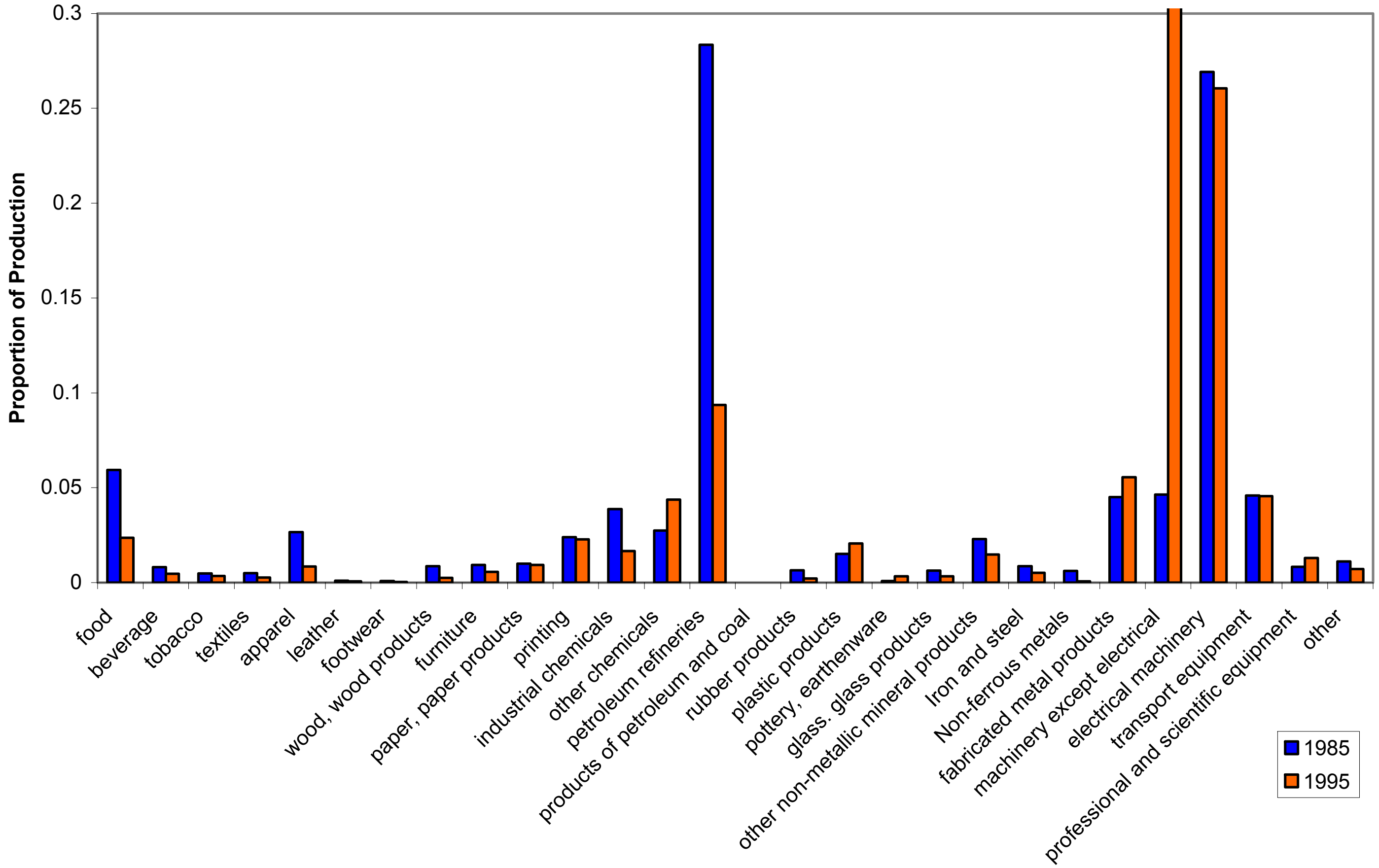


Table 1: Variables, Summary Statistics and Data Sources

Variable	*N*	*Mean*	*Std. Dev.*	*Data Source*
Unconditional correlations	27446	0.277	0.347	MSCI and EMDB databases
Conditional correlations (Fama-French)	22443	0.312	0.338	MSCI and EMDB databases; Fama-French website
Conditional correlations (International+Regional CAPM)	19423	0.297	0.328	MSCI and EMDB databases
Difference in production structure	31875	0.054	0.043	UNIDO database
Difference in export structure	48447	0.191	0.21	World Trade Database, NBER
Risk-adjusted difference in production structure	12843	0.022	0.038	UNIDO database
Product of stock market capitalization (logged)	36649	-2.771	2.149	Database of Financial Sector Development World Bank
Difference in per capita GDP	49292	1.031	0.807	World Development Indicators, World Bank
Dummy =1 if both countries are democratic	58339	0.457	0.498	Polity IV Project
Distance (logged)	95874	8.616	0.922	www.cepii.org
Average of bilateral trade as a proportion of total trade	70638	0.017	0.053	Direction of Trade Statistics, IMF
Dummy =1 if countries from the same region	95874	0.157	0.364	www.cepii.org
Dummy =1 if countries are members of FTA or Customs Union	75100	0.061	0.239	www.cepii.org

Table 2: Unconditional Stock Market Correlations and Structure of Production

	(1)	(2)	(3)	(4)	(5)	(6)
	Unconditional correlation	Unconditional correlation	Unconditional correlation	Unconditional correlation	Unconditional correlation	Unconditional correlation
difference in production structure	-0.149**	-0.308***	-0.233*			
	(0.071)	(0.111)	(0.141)			
risk-adjusted difference in production structure				-0.318***	-0.159**	-0.175**
				(0.062)	(0.074)	(0.072)
product of stock market capitalization	0.032***	0.024***	0.024***	0.032***	0.021***	0.021***
	(0.002)	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)
difference in per capita GDP	-0.041***	-0.051***	0.041**	-0.040***	-0.049***	0.028
	(0.004)	(0.004)	(0.019)	(0.003)	(0.004)	(0.019)
both democracies	0.077***	0.065***	0.065***	0.070***	0.061***	0.063***
	(0.006)	(0.010)	(0.011)	(0.006)	(0.010)	(0.011)
average of bilateral export shares	0.322***	0.226***	0.112	0.325***	0.227***	0.062
	(0.051)	(0.065)	(0.156)	(0.051)	(0.065)	(0.156)
free trade area	0.124***	0.057***	0.071***	0.122***	0.057***	0.072***
	(0.010)	(0.011)	(0.019)	(0.010)	(0.011)	(0.018)
distance	-0.006	-0.023***		-0.009**	-0.024***	
	(0.004)	(0.006)		(0.004)	(0.006)	
same region	0.069***	0.041***		0.059***	0.036***	
	(0.009)	(0.011)		(0.009)	(0.011)	
Observations	15066	15066	15066	15066	15066	15066
R-squared	0.22	0.29	0.35	0.23	0.29	0.36
Joint significance test	162.41***	57.64***	48.15***	159.15***	57.81***	48.56***
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	No	No	Yes	No
Pair fixed effects	No	No	Yes	No	No	Yes
Time-varying regional fixed effects	No	No	Yes	No	No	Yes

Standard errors in parentheses are adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%

The dependent variable is the unconditional correlation of monthly stock market excess returns over each year. For each year, the correlation for country-pairs is calculated over a 12-month horizon. Columns 4-6 include a variable $(\sigma_i^{\,2} + \sigma_j^{\,2})/\,\sigma_i\,\sigma_j$ where σ_i is the standard deviation of the returns. All columns include a constant (not shown).

Table 3: Conditional Stock Market Correlations (Fama-French) and Structure of Production

	(1)	(2)	(3)	(4)	(5)	(6)
	Conditional correlations	Conditional correlations	Conditional correlations	Conditional correlations	Conditional correlations	Conditional correlations
difference in production structure	-0.367***	-0.457***	-0.661***			
	(0.079)	(0.135)	(0.197)			
risk-adjusted difference in production structure				-0.900***	-0.588***	-0.745***
				(0.111)	(0.134)	(0.140)
product of stock market capitalization	0.040***	0.032***	0.029***	0.042***	0.028***	0.025***
	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)	(0.005)
difference in per capita GDP	-0.047***	-0.051***	0.007	-0.048***	-0.047***	0.000
	(0.004)	(0.005)	(0.034)	(0.004)	(0.005)	(0.033)
both democracies	0.024***	0.080***	0.074***	0.023***	0.087***	0.085***
	(0.009)	(0.016)	(0.016)	(0.008)	(0.015)	(0.016)
average of bilateral export shares	0.327***	0.265***	0.224	0.336***	0.265***	0.157
	(0.052)	(0.065)	(0.165)	(0.051)	(0.065)	(0.171)
free trade area	0.117***	0.055***	0.060***	0.113***	0.055***	0.059***
	(0.010)	(0.012)	(0.018)	(0.010)	(0.012)	(0.019)
distance	0.003	-0.017***		-0.000	-0.018***	
	(0.005)	(0.006)		(0.005)	(0.006)	
same region	0.077***	0.047***		0.063***	0.039***	
	(0.009)	(0.012)		(0.009)	(0.012)	
Observations	11456	11456	11568	11456	11456	11456
R-squared	0.23	0.31	0.39	0.24	0.32	0.39
Joint significance test	139.47***	49.15***	50.30***	140.92***	49.85***	45.09***
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	No	No	Yes	No
Pair fixed effects	No	No	Yes	No	No	Yes
Time-varying regional fixed effects	No	No	Yes	No	No	Yes

Standard errors in parentheses are adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%. Columns 4-6 include a variable $(\sigma_i^2 + \sigma_j^2)/\sigma_i \sigma_j$ where σ_i is the standard deviation of the Fama-French residuals. All columns include a constant (not shown). We estimate the following 3-factor Fama-French model country-by-country and calculate the correlation of residuals for country-pairs over a 12-month horizon.

$$
\begin{aligned}
R_{it} &= \beta_i^W \mu_t^W + \beta_i^{US} \mu_t^{US} + \beta_i^{WHML} WHML_t + \beta_i^{USHML} USHML_t + \beta_i^{US} USSMB_t + e_{it} \\
& e_{it} \sim N(0, \sigma_{it}^2) \\
\sigma_{it}^2 &= a_i + b_i \sigma_{it-1}^2 + c_i e_{it-1}^2 + d_i [\max\{0, e_{it-1}\}]^2
\end{aligned}
$$

Table 4: Conditional Stock Market Correlations (International + Regional CAPM) and Structure of Production

	(1)	(2)	(3)	(4)	(5)	(6)
	Conditional correlations	Conditional correlations	Conditional correlations	Conditional correlations	Conditional correlations	Conditional correlations
difference in production structure	-0.344***	-0.411***	-0.621***			
	(0.076)	(0.135)	(0.198)			
risk-adjusted difference in production structure				-0.778***	-0.368**	-0.495***
				(0.150)	(0.184)	(0.159)
product of stock market capitalization	0.042***	0.032***	0.030***	0.043***	0.028***	0.025***
	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)	(0.005)
difference in per capita GDP	-0.046***	-0.052***	-0.003	-0.047***	-0.048***	-0.016
	(0.004)	(0.005)	(0.034)	(0.004)	(0.005)	(0.034)
both democracies	0.022***	0.082***	0.074***	0.023***	0.091***	0.087***
	(0.008)	(0.015)	(0.016)	(0.008)	(0.015)	(0.016)
average of bilateral export shares	0.345***	0.275***	0.243	0.357***	0.276***	0.189
	(0.059)	(0.065)	(0.163)	(0.051)	(0.064)	(0.164)
free trade area	0.115***	0.060***	0.063***	0.110***	0.059***	0.063***
	(0.011)	(0.012)	(0.018)	(0.010)	(0.012)	(0.018)
distance	-0.001	-0.018***		-0.004	-0.019***	
	(0.005)	(0.006)		(0.005)	(0.006)	
same region	0.072***	0.043***		0.059***	0.035***	
	(0.009)	(0.011)		(0.009)	(0.012)	
Observations	11451	11451	11451	11451	11451	11451
R-squared	0.23	0.31	0.39	0.24	0.32	0.39
Joint significance test	105.90***	49.21***	48.62***	137.89***	50.09***	49.94***
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	No	No	Yes	No
Pair fixed effects	No	No	Yes	No	No	Yes
Time-varying regional fixed effects	No	No	Yes	No	No	Yes

Standard errors in parentheses are adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%. Columns 4-6 include a variable $(\sigma_i^2 + \sigma_j^2)/\sigma_i \sigma_j$ where σ_i is the standard deviation of the CAPM residuals. All columns include a constant (not shown). We estimate the following 2-factor GARCH equation country-by-country and calculate the correlation of residuals for country-pairs over a 12-month horizon.

$$R_{it} = \beta_{it}^{W}\mu_t^{W} + \beta_{it}^{REG}\mu_t^{REG} + e_{it}$$
$$e_{it} \sim N(0, \sigma_{it}^2)$$
$$\sigma_{it}^2 = a_i + b_i\sigma_{it-1}^2 + c_i e_{it-1}^2 + d_i[\max\{0, e_{it-1}\}]^2$$

Table 5: Conditional Stock Market Correlations and Structure of Exports

	(1)	(2)	(3)	(4)
	Fama-French	Fama-French	International & Regional CAPM	International & Regional CAPM
difference in export structure	-0.124***	-0.335***	-0.120***	-0.394***
	(0.037)	(0.127)	(0.037)	(0.131)
product of stock mkt. capitalization	0.038***	0.027***	0.041***	0.032***
	(0.002)	(0.005)	(0.002)	(0.005)
difference in per capita GDP	-0.051***	0.023	-0.050***	0.016
	(0.005)	(0.037)	(0.005)	(0.037)
both democracies	0.038***	0.078***	0.029***	0.081***
	(0.008)	(0.019)	(0.009)	(0.019)
average of bilateral export shares	0.359***	0.312*	0.359***	0.311*
	(0.054)	(0.170)	(0.054)	(0.169)
free trade area	0.131***	0.064***	0.126***	0.066***
	(0.012)	(0.021)	(0.012)	(0.021)
distance	0.017***		0.010*	
	(0.005)		(0.005)	
same region	0.084***		0.075***	
	(0.010)		(0.010)	
R-squared	0.22	0.40	0.22	0.40
Joint significance test	115.54***	43.64***	113.41***	42.65***
Time fixed effects	Yes	Yes	Yes	Yes
Pair fixed effects	No	Yes	No	Yes
Time-varying regional fixed effects	No	Yes	No	Yes

Standard errors in parentheses are adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%
Columns 1-2 use Fama-French 3 factor model to extract residuals and calculate correlations. They include a variable $(\sigma_i^{2} + \sigma_j^{2})/ \sigma_i \sigma_j$ where σ_i is the standard deviation of the Fama-French residuals. Columns 3-4 use the time-varying international plus regional CAPM model to extract residuals and calculate correlations. They include a variable $(\sigma_i^{2} + \sigma_j^{2})/ \sigma_i \sigma_j$ where σ_i is the standard deviation of the CAPM residuals. For each year, the correlation for country-pairs is calculated over a 12-month horizon. All columns include a constant (not shown).

Table 6: Conditional Stock Market Correlations and Risk-Adjusted Structure of Production (country sub-samples)

	(1)	(2)	(3)
	Both developing countries	One developed, one developing	Both developed countries
risk-adjusted production structure difference	-0.885*	-1.550***	-1.117***
	(0.539)	(0.146)	(0.181)
product of stock mkt. capitalization	0.026***	0.041***	0.047***
	(0.005)	(0.003)	(0.003)
difference in per capita GDP	0.012	-0.026***	-0.190***
	(0.015)	(0.007)	(0.023)
both democracies	0.044***	0.005	-0.049**
	(0.016)	(0.011)	(0.020)
average of bilateral export shares	0.737*	0.120	0.281***
	(0.433)	(0.090)	(0.065)
free trade area	0.168***	0.193***	0.035**
	(0.039)	(0.022)	(0.014)
distance	0.038***	0.021***	-0.040***
	(0.013)	(0.008)	(0.007)
same region	0.162***	0.033	0.013
	(0.029)	(0.020)	(0.014)
Observations	1962	4926	4563
R-squared	0.11	0.08	0.14
Joint significance test	25.65***	48.07***	97.22***

Standard errors in parentheses are adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%

All columns include a variable $(\sigma_i^{\,2} + \sigma_j^{\,2})/\,\sigma_i\,\sigma_j$ where σ_i is the standard deviation of the Fama-French residuals. All columns include a constant (not shown). We estimate the following 3-factor Fama-French model country-by-country and calculate the correlation of residuals for country-pairs over a 12-month horizon.

$$R_{it} = \beta_i^W \mu_t^W + \beta_i^{US} \mu_t^{US} + \beta_i^{WHML} WHML_t + \beta_i^{USHML} USHML_t + \beta_i^{US} USSMB_t + e_{it}$$

$$e_{it} \sim N(0, \sigma_{it}^2)$$

$$\sigma_{it}^2 = a_i + b_i \sigma_{it-1}^2 + c_i e_{it-1}^2 + d_i [\max\{0, e_{it-1}\}]^2$$

Table 7: Conditional Stock Market Correlations and Structure of Production (Segmentation vs. Integration)

	(1)	(2)	(3)
	Fama-French	Fama-French	Fama-French
Risk-adjusted difference in production structure	-0.724***	-0.734***	-0.691***
	(0.103)	(0.142)	(0.183)
one integrated and one segmented market	0.021**		
	(0.009)		
one integrated & one segmented market*Risk-adjusted production structure difference	-1.684***		
	(0.291)		
both segmented markets	0.028		
	(0.026)		
both segmented markets* risk-adjusted production structure difference	-1.554**		
	(0.733)		
stock market liberalization dummy		0.050***	0.052***
		(0.012)	(0.013)
stock market liberalization dummy*risk-adjusted production structure difference			-0.088
			(0.229)
product of stock mkt. capitalization	0.042***	0.026***	0.026***
	(0.003)	(0.005)	(0.005)
difference in per capita GDP	-0.046***	-0.032	-0.034
	(0.004)	(0.034)	(0.034)
both democracies	0.023***	0.087***	0.087***
	(0.008)	(0.016)	(0.016)
average of bilateral export shares	0.330***	0.095	0.097
	(0.051)	(0.164)	(0.164)
free trade area	0.115***	0.055***	0.055***
	(0.010)	(0.018)	(0.018)
distance	-0.000		
	(0.005)		
same region	0.061***		
	(0.010)		
Observations	11456	11456	11456
R-squared	0.25	0.39	0.39
Joint significance test	126.89***	81.87***	79.42***
Time fixed effects	Yes	Yes	Yes
Country-pair fixed effects	No	Yes	Yes
Test: coeff [prod. structure difference] + coeff [one integrated one segmented markets*production structure difference] = 0	74.9***		
Test: coeff [prod. structure difference] + coeff [one segmented markets*production structure difference] = 0	9.84***		

Standard errors in parentheses are adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%

We use Fama-French 3 factor model to extract residuals and calculate conditional correlations. The both integrated dummy =1 if both markets are integrated; The one integrated dummy =1 if exactly one of the country-pairs is integrated while the other is segmented. The both segmented dummy =1 if both markets are segmented. The stock market liberalization dummy takes the value 1 in all years after both countries had made a switch to liberalized stock markets. It takes the value 0 if either country has a segmented market or if both countries had liberalized stock markets on or before 1975. Stock market liberalization dates are from Bekaert et al (2005). Columns 4-6 include a variable $(\sigma_i^{\,2} + \sigma_j^{\,2})/ \sigma_i \sigma_j$ where σ_i is the standard deviation of the Fama-French residuals. All columns include a constant (not shown).

Appendix

Table A1: List of Countries

Argentina
Australia
Austria
Bahrain
Belgium
Brazil
Canada
Chile
China
Colombia
Czech Republic
Denmark
Egypt
Finland
France
Germany
Greece
Hong Kong
Hungary
Indonesia
India
Ireland
Iceland
Israel
Italy
Japan
Jordan
Korea
Luxembourg
Malaysia
Mexico
Morocco
Nigeria
Netherlands
Norway
New Zealand
Oman
Pakistan
Peru
Philippines
Poland
Portugal
Russian Federation
Saudi Arabia
Singapore
Slovak Republic
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Thailand
Turkey
Taiwan
United States
United Kingdom
Venezuela
Zimbabwe

Table A2: ISIC Manufacturing sectors

Food manufacturing
Beverage industries
Tobacco manufactures
Textiles
Wearing apparel, except footwear
Leather and products of leather, leather substitutes and fur, except footwear and wearing apparel
Footwear, except vulcanized or moulded rubber or plastic footwear
Wood and wood and cork products, except furniture
Furniture and fixtures, except primarily of metal
Paper and paper products
Printing, publishing and allied industries
Industrial chemicals
Other chemical products
Petroleum refineries
Miscellaneous products of petroleum and coal
Rubber products
Plastic products not elsewhere classified
Pottery, china and earthenware
Glass and glass products
Other non-metallic mineral products
Iron and steel basic industries
Non-ferrous metal basic industries
Fabricated metal products, except machinery and equipment
Machinery except electrical
Electrical machinery apparatus, appliances and supplies
Transport equipment
Professional and scientific and measuring and controlling equipment not elsewhere classified
Other Manufacturing Industries