BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers

No 1003

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February 2022

JEL classification: F10, F36, F65, G10, G12, G15.

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This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Global Production Linkages and Stock Market Comovement*

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This version: February 14, 2022

Abstract

Although real integration conceptually plays an important role for the comovement of international equity markets, documenting this link empirically has proven challenging. We construct a new dataset of theory-guided, relevant measures of bilateral trade in final and intermediate goods and services. With these measures, we provide evidence of a strong link between changes in real integration – in particular global value chains – and equity market comovement. This also holds when controlling for financial openness and other factors that could confound the role of real openness. These results suggest that supply chain disruptions, for instance due to political tensions and the COVID-19 crisis, might also affect the interconnections between stock markets via rippling through the global production network.

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1 Introduction

A perennial issue in international finance is to understand how the forces of globalization shape the international comovement of asset returns, in particular that of stock markets (see, e.g. the surveys by Karolyi and Stulz (1996) or Lewis (2011)). In this literature – and despite ample evidence of the impact of trade tensions on valuations[1] or the supply chain ripple effects of policy shocks[2] – there has been surprisingly little empirical evidence that the overall comovement of asset returns can be traced to international trade in goods and services. By contrast, the literature seems to have converged to a view that asset price comovement largely owes to financial integration. This perspective, widely known for instance by the work of Rey (2013), takes credence from the process of capital account liberalization starting from the 1980s that resulted in reduced frictions to international portfolio flows and allowed for a greater ease of cross-country asset holdings.

This paper revisits the role of real integration as an economically significant driver of international asset return comovement. It overturns some of the previous dismal findings in this literature regarding the role of trade. Figure 1 gives a preview of our central result.

[Insert **Figure 1**]

The left-hand panel of Figure 1 summarizes the glaring lack of a link between trade openness defined as (exports+imports)/GDP and equity market comovement the literature has uncovered. This scatter plot follows the spirit of the approaches summarized for example in Bekaert, Harvey, Kiguel, and Wang (2016)'s survey of the literature, who demonstrate that, once a time trend is included, there is no relation between this and other measure of openness and measures of equity market comovement.[3]

By contrast, the right-hand panel of Figure 1 presents a scatter plot relating the same index of

[1] Desai and Hines (2008), for example, document stock price losses for US exporting firms after the European Union requested that the World Trade Organization declare US export subsidies illegal. Several studies document the impact of recent US-Chinese trade tensions (or the expectations thereof) for the stock prices of internationally-oriented firms (see, e.g., Wagner, Zeckhauser, and Ziegler (2018), Huang, Lin, Liu, and Tang (2019), and Ramelli and Wagner (2020) in the context of supply chain exposure to China).

[2] See di Giovanni and Hale (2020).

[3] Bekaert et al. (2016) use three measures of trade openness: an index of the country's compliance with IMF Article VIII rules on restrictions on international trade of goods and services; a trade restriction index building on Sachs, Warner, Åslund, and Fischer (1995); and the sum of exports and imports divided by GDP of the current calendar year. In a similar vein, Baele and Soriano (2010) conclude that the increase in equity market comovement the last decades have witnessed mainly arises from financial rather than economic integration.

stock market comovement to a theory-derived measure of bilateral international input-output linkages. This index is constructed from a dataset of bilateral trade linkages in final and intermediate goods and services, which are aggregated into indices of trade openness as they should matter for international profit comovement based on the predictions of neoclassical models of international trade (ultimately deriving from Krugman (1979)).

In comparison to more aggregate measures of trade interlinkages examined in prior work, our novel angle is hence to study real interconnectedness via bilateral measures of trade in final and intermediate goods and services, and to show how they need to be aggregated in the presence of reciprocal production linkages. The starting point of our analysis is to assemble a data set on global value chain (GVCs), which we combine with data on bilateral stock market correlations.

In Section 2, we present a simple model of international trade guiding us how to construct two empirical measures of intermediate goods and final goods trade intensity (**ITI** and **FTI**, respectively) that matter for stock market comovement. The main mechanism operates via sales in export markets as well as cost linkages, and is quite intuitive: if a firm is based in country A and exports to country B, an idiosyncratic demand shock in country B will also affect export sales of firms based in A. This in turn will also depress profits and stock prices in country A, and induce a co-movement in the two country's stock markets. A second link arises from the input-cost channel: if a firm in country A sources inputs from B, a negative productivity shock in B will slow production down also in A, thus again leading to co-moving stock market returns. And, in a network of global input-output trade, third-country effects exist as well.[4]

These model-implied indices of real integration allow us to resurrect international trade as an important and robust driver of equity market comovement, besides financial integration. In our empirical analysis, we merge several datasets of bilateral final and intermediate goods trade linkages that have hitherto not been used in the literature on asset market comovement. [5]

We obtain three main empirical results. *First*, as a preliminary analysis, we show there are substantial differences between **ITI** and **FTI** on the one hand and traditional openness measures,

[4]Our model abstracts from financial factors, and only focuses on trade linkages in affecting bilateral stock market co-movement.

[5]These data – a novel combination of the various vintages of the World Input-Output database from the latest ADB MRIO Input-Output Table and OECD Input-Output Database and IDE-JETRO Asian Input-Output tables used in Johnson and Noguera (2017) – cover up to 30 sectors, 41 countries (both developed and emerging ones) during the period 1980 to 2017.

such as (exports+imports)/GDP, on the other hand. In particular, **ITI** is very distinct from the traditional measures in large economies such as the US or Germany. *Second*, we find that bilateral stock market co-movement to be related to trade integration measured by granular input-output linkages and value added of trade (whereas the traditional openness measures also fail to explain stock market correlations in our sample). A one standard deviation in bilateral intermediate goods trade intensity is associated with a 24% of a standard deviation increase in bilateral stock market correlations, a sizable effect. *Third*, real integration remains a robust determinant of equity market correlation even when controlling for time trends, country characteristics, socioeconomic ties, and a rich set of measures of financial integration.[6] To account for possible comovement in risk premia in affecting our main dependent variable that captures comovement, we also run a robustness exercise based on an alternative measure that is purged of the effects of time-varying expected returns. Our main conclusions also carry over to this setting.

Our approach thus allows us to resolve the failure of traditional measures of real integration in explaining international asset comovement. Tracing stock market comovement to cross-country linkages in final and intermediate goods trade is intuitive in light of the developments in trade over the past few decades. In today's trading system, the same good crosses borders multiple times differently depending on sectors as inputs in different countries. The aggregate volume of trade between countries, as often relied upon in past research, is therefore a highly inaccurate measure of true economic linkages. In contrast, our proposed measures take account of input-output linkages and value chain structure in trade flows. This in turn results in a more accurate representation of how much an economy depends on production inputs from its trading partner.

Overall, our findings suggest that international trade is indeed an economic force that matters for equity market comovement. This finding has important implications from an asset allocation perspective in that it highlights the need for international investors to pay close attention to ongoing developments in international trade. All the while, policy-makers monitoring financial market developments in their respective economies, need to take into account both financial flows as well as real integration. The question of the impact of global trade on asset prices has gained particular relevance in light of recent geopolitical events (not least, Brexit or the US-China trade war), as well as the ongoing disruption of supply chains due to the COVID-19 pandemic. These events

[6] Specifically, even in the a specification that absorbs all country-pair fixed effects and time trends, the impact of real integration effect remains economically and statistically strong.

underscore the importance of examining how real integration via GVCs shapes international stock market comovement.

Related literature. Our paper contributes to three main strands of literature. First, it contributes to the literature on asset market comovement and international asset pricing.[7] Classical papers in this literature, e.g. Karolyi and Stulz (1996), Ang and Bekaert (1999), and Longin and Solnik (2001) typically focused on the measurement of comovement and questions around international diversification. Several papers also sought to connect international asset return comovement with the process of globalisation. For instance, Bekaert, Hodrick, and Zhang (2009) study stock return comovements but did not find evidence for an upward trend in return correlations, except for European stock markets. Pukthuanthong and Roll (2009) propose a novel measure based on the regression R^2 of a global factor model and interpret their evidence as suggesting a rise in market integration over time.

Some work in international asset pricing has also tried to go a step further, linking comovement in returns with observable proxies for real and financial integration.[8] In early work, drawing on aggregate measures, Karolyi (2003) only finds very weak evidence of trade integration as a driver of asset comovements. Lane and Milesi-Ferretti (2002) study the impact of cross-country portfolio holdings via IMF CPIS data. Our paper relates closely to Bekaert et al. (2016) who provide a very thorough analysis of the drivers of international comovement in asset returns, including proxies of financial and real integration. While measures of financial integration perform quite well as explanatory variables, they show that trade flow fails to explain asset comovements once taking account of time trends. We advance this literature by showing that, properly measured,

[7] See Lewis (2011) for a literature review.

[8] Some papers have approached this question indirectly from the standpoint of the Campbell and Shiller (1988a) VAR framework. In particular, Ammer and Mei (1996) study the integration of stock markets between the United Sates and the United Kingdom and find that common news about future risk premiums accounts for the bulk of stock return comovements between the two countries, while the dividend growth components of the two returns are also highly correlated. Baele and Soriano (2010), also drawing on a Campbell-Shiller framework, document a rise in European stock market comovement, which they trace to greater comovement in discount rates, rather than cash flows. In a previous version of this paper we observerved that a global factor model has increasing explanatory power (R-squared), there is no conclusive evidence for a global factor model catch-up in terms of pricing errors (alpha) or a convergence in country-specific factor premia. They argue that progressing real integration in the presence of remaining barriers to fully integrated pricing can explain this pattern. Caselli, Koren, Lisicky, and Tenreyro (2019) also argue that international trade is a more relevant source of comovement than financial integration for most countries.

international trade powerfully helps explain international equity co-movement.[9]

Second, our paper contributes to a growing literature that employs the richness of economic networks to study asset pricing phenomena. A few papers have exploited trade networks. For instance, Chang, Huancheng, Lou, and Polk (2021) study the predictability in CDS premia based on trade networks. Richmond (2019) documents that trade centrality plays a key role as a driver of risk premia in currency markets. Ready, Roussanov, and Ward (2017) link carry trade returns to commodity-trading patterns across countries. In addition, some recent papers argue that network structures themselves play an important role in the moments of asset prices. For instance, Herskovic, Kelly, Lustig, and Van Nieuwerburgh (2018) use customer-supplier network to analyze how shocks propagate through the network, thereby leading to an amplification that increases the volatility of returns. Gofman, Segal, and Wu (2018) focus on the vertical position in production networks and study implications for the predictability stock returns. Iwadate (2021) uses the network of portfolio weights across ETFs to study the contagion in the ETF market.

Last, but not least, our paper extends the growing literature on global value chains, which has hitherto largely focused on the real economy, by showing its power to explain phenomena in financial markets. Johnson and Noguera (2012) and Johnson and Noguera (2017) highlight the importance of GVCs and document that trade flows are most accurately captured through value added terms (see also Timmer, Los, Stehrer, and de Vries (2016)). Several papers try to establish a link with international business cycles and output synchronization. Auer, Borio, and Filardo (2017) study the impact on domestic CPI inflation, while Auer, Levchenko, and Sauré (2019) document that input-output linkages account for half of the synchronization in producer prices across countries. di Giovanni, Levchenko, and Mejean (2018) document the evidence of transmission of business cycle shocks through direct trade and multinational ownership linkages at the firm level.[10] Some more recent work addresses the disruption of supply chains due to COVID-19; see, for example, Bonadio, Huo, Levchenko, and Pandalai-Nayar (2020), who use the Huo, Levchenko, and Pandalai-Nayar (2020) framework, and Eppinger, Felbermayr, Krebs, and Kukharskyy (2020).

[9] Some earlier studies suggest a link between trade and comovement, e.g. Chen and Zhang (1997) and Forbes and Chinn (2004). The robustness of those results is questionable, however. For instance, the earlier literature typically did not incorporate fixed effects nor socio-economic and financial variables studied in the international trade/finance literature, as pointed out also by Bekaert et al. (2016). As such, we regard our study to be the first one to document this relationship in robust fashion.

[10] Kalemli-Ozcan, Papaioannou, and Peydró (2009) show how banking sector integration affects GDP synchronization.

Some authors have recently begun to link elements of trade activities to developments in financial markets. Gopinath and Stein (2018) argue that when a larger share of a country's imports are invoiced in U.S. dollar, its citizens have a greater demand for dollar-denominated safe claims. Bruno, Kim, and Shin (2018) argue that dollar strength is a determinant of global trade activity, as a stronger dollar tightens of dollar credit conditions. Our paper extends this emerging literature on the relationship between GVCs and financial markets by providing the first evidence of the linkage between granular trade flows and equity comovement. In a related study, di Giovanni and Hale (2020) study how US monetary policy shocks exhibit ripple effects throughout the world by way of global value chains. Our focus, by contrast, is not on the spillovers of monetary policy shocks but on the determinants of stock market comovement via trade channels (also between countries other than the US).

2 Measuring real integration and its effect on profit comovement

In this section, we use a stylized theoretical model to examine how real linkages give rise to international comovement in profits and share prices. We show that the impact of bilateral trade linkages can be subsumed into two indices, one measuring final goods trade intensity (FTI) and another one measuring intermediate goods trade intensity (ITI).[11] We then construct these two indices of real integration using relevant International Trade Input-Output Tables in the subsequent section.

We want to model how firm profits, and consequently stock market valuations, comove in the presence of trade in final consumption goods, as well as reciprocal input-output linkages. As we will show, such linkages give rise to cross-border spillovers of national demand and supply shocks. We start from the perspective of an individual firm that sells its final good both domestically and on foreign export markets, and that sources its production inputs both domestically and internationally. We then aggregate firm-specific profit comovement to the national level, to examine how overall profits co-move depending on aggregate bilateral trade flows.

The notation we adopt is the following. $f \epsilon F$ indexes final goods producers. Each firm has one location of production, $c \epsilon C$. The set of firms that is located in country c is F_C. A firm f

[11] In the empirical section, we take into consideration international trade in both goods and services. For sake of brevity, we refer only to "goods" in this theoretical section.

located in c sells to many export markets. For expositional clarity, when summing over exports to various markets, we index export markets by $e\epsilon C$. A firm f located in c uses imports from potentially many source countries. For expositional clarity, when summing over imported inputs from various sources, we index source countries by $s\epsilon C$.

The structure of the economy is as follows. In each country, a competitive input production sector transforms local labor into intermediate goods. Intermediate goods are used by monopolistic final producers. The output of these final goods producers is consumed by households. Both final and intermediate goods are internationally tradeable.

Consumer demand, pricing, and profits. Suppose that in each export market $e\epsilon C$, demand for each firm's consumption variety f is isoelastic in its price, and sales are further affected by country-specific demand shocks $d_{e,t}$. At each point in time t, the representative household in e obtains utility

$$u_{e,t} = d_{e,t} \sum_{f \epsilon F} \left(q_{f,e,t}\right)^{\frac{\sigma-1}{\sigma}} + O_{e,t}, \tag{1}$$

where $O_{e,t}$ is the quantity of the outside O good that is available at a price normalized to 1. $d_{e,t}$ is a time-varying demand shifter for differentiated goods. σ is the elasticity of substitution. The household's maximization of (1) implies that demand for variety f on market e is $q_{f,e,t} = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} \left(p_{f,e,t}/d_{e,t}\right)^{-\sigma}$.[12] If we denote the constant marginal cost of production of firm f by $mc_{f,t}$ and the iceberg trade cost to ship from f's home market c to e by $\tau_{c,e}$, the firm charges a price of $p_{f,e,t} = \frac{\sigma}{\sigma-1}\tau_{c,e} mc_{f,t}$. f's profits on market e are thus

$$\pi_{f,e,t} = (p_{f,e,t} - \tau_{c,e} mc_{f,t}) d_{e,t} = \frac{(d_{e,t})^{\sigma}}{\left(\tau_{c,e} mc_{f,t}\right)^{(\sigma-1)}} (\sigma-1)^{-1} \tag{2}$$

Equation (2) also holds for domestic firms, i.e. the firms that are producing in market e. For the latter set of firms, $\tau_{e,e} = 1$, whereas $\tau_{c,e} > 1$ for all other firms.

Production technologies & costs. In each country c, final goods producers f combine intermediate inputs to produce. Final good producers can use both domestic and imported input varieties. The production function features a constant elasticity of demand ρ over each input good. Denoting firm f's total production by $q_{f,t}$ and the amount of inputs that firm f uses from supplying country

[12]Throughout the analysis, we assume that income in c is larger than $\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} (d_{c,t})^{\sigma} \sum_{f \epsilon F} p_{f,c,t}^{1-\sigma}$, such that consumption of the O good is nonnegative.

s by $q_{f,s,t}$, we have

$$q_{f,t} = \varphi_{f,t} \left(\sum_{s \epsilon C} \left(q_{f,s,t} \right)^{(\rho-1)/\rho} \right)^{\rho/(\rho-1)}. \quad (3)$$

Here, $\varphi_{f,t}$ is a firm-specific productivity shifter. Minimizing total costs $\sum_{s\epsilon C} p_{f,s,t} q_{f,s,t}$ for a given level of production implies that the marginal cost of production $mc_{f,t}$ is equal to

$$mc_{f,t} = \varphi_{f,t}^{-1} \left(\sum_{s \epsilon C} \left(p^I_{f,s,t} \right)^{-(\rho-1)} \right)^{-1/(\rho-1)} \quad (4)$$

Production of input goods is perfectly competitive. Each input good takes one unit of local labor to produce and can thus be produced at the wage of the supplying country $w_{s,t}$. It can be shipped from s to the market where f is located at iceberg trade costs $\tau^I_{s,c}$. It thus holds that $p^I_{f,s,t} = w_{s,t}\tau^I_{s,c}$.[13]

The outside good and market equilibrium. The production of the outside good is done in a competitive sector according to $y^O_{c,t} = \varphi^O_{c,t} L^O_{c,t}$. The outside good can be freely traded, which, together with the normalization of its price to 1 pins down the wage in each country: $w_{c,t} = \varphi^O_{c,t}$. Denoting labor supply in c by $L_{c,t}$, market clearing requires that the amount of inputs used by firm f adjusted for the iceberg trade cost from c to f, $\tau^I_{c,f}$, plus the amount of labor that is used for the production of the outside good do not exceed the supply of labor: $\sum_{f\epsilon F} \tau^I_{c,f} q_{f,c,t} + L^O_{c,t} = L_{c,t}$.[14]

Aggregation, shocks, and observables. Above, we have laid out a firm-specific theory. However, we empirically observe trade linkages only at an aggregate level, that is, between countries. We therefore aggregate across firms and then show how shocks are propagated. Importantly, as we show in the appendix, the extent to which shocks at home and abroad affect the profitability of the domestic industry can be expressed in terms of sectoral aggregates that we observe in international input-output data sets. In what follows below, a $\widehat{}$ symbol denotes a percentage change in a variable.

Proposition 2.1 (Shocks and observables) *$\widehat{\pi}_{c,t}$, the change in total profits of c's industry is equal to*

$$\widehat{\pi}_{c,t} = -(\sigma - 1) \sum_{s\epsilon C} \gamma_{c,s,t} \widehat{w}_{s,t} + \sigma \sum_{e\epsilon C} s_{e,c,t} \widehat{d}_e + \widehat{\varepsilon}_{c,t}$$

[13] Iceberg shipping costs are $\tau^I_{c,c} = 1$, whereas $\tau^I_{s,c} > 1$ whenever $s \neq c$.

[14] If each national stock market is fully owned by local households and profits are fully disbursed, income in each market is equal to $w_{c,t} L_{c,t} + \sum_{f\epsilon F_c} \sum_{e\epsilon C} \pi_{f,e,t}$, where F_c is the set of firms that is owned by households in c and e indexes export markets.

where $s_{e,c,t}$ is the share of sales that firms producing in c make in market e ($\sum_{e\epsilon C} s_{e,c,t} = 1$), $\gamma_{c,s,t}$ is the aggregate cost share of inputs from s in the production of final goods in c ($\sum_{s\epsilon C} \gamma_{c,s,t} = 1$), and $\widehat{\varepsilon}_{c,t}$ is equal to $(\sigma - 1)\,\widehat{\varphi}_{c,t}$.

Proof. *See appendix* ■

Interpretation and derivation of bilateral real integration indices. Proposition 2.1 provides a general result mapping profit comovement in a multi-country world. To see the intuition for this result, we next illustrate profit comovement in a two-country case, corresponding to an analysis of a given country vis-a-vis the rest of the world.[15] Indexing the two countries by 1 and 2, Proposition 2.1 implies that the evolution of profits in country 1 is equal to[16]

$$\widehat{\pi}_1 = \sigma \quad \underbrace{(s_{1,1}\widehat{d}_1}_{\substack{\text{home share}\\ \text{scaled by home}\\ \text{demand shock}}} \quad + \quad \underbrace{s_{1,2}\widehat{d}_2)}_{\substack{\text{foreign sales}\\ \text{scaled by foreign}\\ \text{demand shock}}} \quad -(1-\sigma) \quad \underbrace{(\gamma_{1,1}\widehat{w}_1}_{\substack{\text{intermediate goods}\\ \text{home share scaled by}\\ \text{home supply shock}}} \quad + \quad \underbrace{\gamma_{1,2}\widehat{w}_2}_{\substack{\text{intermediate goods}\\ \text{foreign sales scaled by}\\ \text{foreign scaled by supply shock}}} \quad) + \widehat{\varepsilon}_1 \tag{5}$$

where $\widehat{d}$ and $\widehat{w}$ are the demand and supply shocks respectively for each country. A symmetric equation holds for country 2.[17]

Final good linkages create comovement because firms that sell final goods on the same markets are commonly affected by fluctuations in demand in this market. Assume that within a country, demand and supply shocks are independent and that the standard deviation of shocks within countries are identical.[18] Then, comovement can be captured by an index we call **FTI**, given by:[19]

$$\textit{Final Trade Intensity}_{i,j} = \mathbf{FTI}_{i,j} = \underbrace{s_{j,i}}_{\substack{import\\ j\to i}} \underbrace{s_{i,i}}_{\substack{home\\ share\ i}} + \underbrace{s_{i,j}}_{\substack{export\\ i\to j}} \underbrace{s_{j,j}}_{\substack{home\\ share\ j}} \tag{6}$$

In turn, intermediate good linkages generate comovement as they propagate cost shocks. The strength of these effects can be aggregated into **ITI** as:

[15] We present a measure of value added trade that also accounts for third-country effects in the next section

[16] All variables are indexed by $x_{exporter,importer}$.

[17] ie $\widehat{\pi}_2 = \sigma \left(s_{2,1}\widehat{d}_1 + s_{2,2}\widehat{d}_2\right) - (1-\sigma)\left(\gamma_{2,1}\widehat{w}_1 + \gamma_{2,2}\widehat{w}_2\right) + \widehat{\varepsilon}_2$

[18] That is, $var\left(\widehat{d}_1\right) = var\left(\widehat{d}_2\right) = \Omega_d^2$, while $var\left(\widehat{w}_1\right) = var\left(\widehat{w}_1\right) = \Omega_w^2$; and $cov\left(\widehat{d}_1, \widehat{d}_2\right) = cov\left(\widehat{w}_1, \widehat{w}_2\right) = 0$

[19] Note that $s_{1,1}$ are home shares in 1, ie $s_{1,1} = 1 - s_{2,1}$ and $s_{2,2} = 1 - s_{1,2}$.

$$Intermediate\ Trade\ Intensity_{i,j} = \mathbf{ITI}_{i,j} = \underbrace{\gamma_{j,i}}_{\substack{import \\ j \to i}} \underbrace{\gamma_{i,i}}_{\substack{home \\ share\ i}} + \underbrace{\gamma_{i,j}}_{\substack{export \\ i \to j}} \underbrace{\gamma_{j,j}}_{\substack{home \\ share\ j}} \tag{7}$$

Overall, intuitively, in this very simple model which abstracts from financial forces (and in particular the role of risk premia), trade linkages affect bilateral stock market co-movement through a profit channel that operates via sales in export markets and via cost linkages. First, if a firm is based in country A and exports to B, a negative demand shock in country B that in a closed economy would only lead to a decline of B's profits and hence stock prices will also affect export sales of firms based in A, thus depressing its stock price and ultimately leading to co-movement. A second link operates via the input-cost channel: if a firm in country A sources inputs from B, a negative productivity shock in B will slow production down also in A, thus again leading to co-moving stock market returns. Third, in a network of global input-output trade, also higher-order effects matter, as for example a shock in country 1 affects prices in country 2, which in turn affects prices in country 1. Overall, the correlation of profits in two countries is given by:

$$\text{Corr}\left(\widehat{\pi}_1, \widehat{\pi}_2\right) = \underbrace{\frac{\sigma^2\Omega_d^2}{\sigma_{\pi_1}\sigma_{\pi_2}}}_{\text{Demand shock } \beta} FTI_{1,2} + \underbrace{\frac{(1-\sigma)^2\Omega_w^2}{\sigma_{\pi_1}\sigma_{\pi_2}}}_{\text{Supply shock } \beta} ITI_{1,2} \tag{8}$$

Here, Ω_d and Ω_w denote variances for demand and supply shocks respectively. Intuitively, co-movement of profits between two countries derives from a demand shock-driven component and a supply shock-driven component. Empirically, since we do not know the elasticity of substitution Ω_d nor the variance of demand and supply shocks Ω_d and Ω_w, we estimate those in a regression of the form

$$cov(\widehat{\pi}_1, \widehat{\pi}_2) = \widehat{\beta}_d FTI_{1,2} + \widehat{\beta}_w ITI_{1,2} \tag{9}$$

3 Measuring integration and equity comovement: data sources

An overview of the definitions of all variables of interest is contained in Table IA.1 in the Appendix. We present summary statistics in Table 1, which we discuss in the subsequent subsections. Correlations are in Table IA.2 in the Appendix.

[Insert **Table 1**]

3.1 Measuring stock market comovement

Our dependent variable is equity index comovement of country i and j in year t. We follow Pukthuanthong and Roll, 2009) in employing equity indices from Thomson Datastream. Taking into account the data availability of international trade (see below), our sample consists of 40 countries from 1980 to 2017.

To measure comovement, we compute realized correlations based on a methodology that has been used both in and outside the comovement literature. To this end, we estimate annual realized correlations drawing on sums of cross-products of daily stock returns as follows

$$\hat{\rho}_{i,j,t} = \frac{\frac{1}{N(t)} \sum_{k=1}^{N(t)} (r_{i,k} - \overline{r_i})(r_{j,k} - \overline{r_j})}{\sqrt{\frac{1}{N(t)} \sum_{k=1}^{N(t)} (r_{i,k} - \overline{r_i})^2} \sqrt{\frac{1}{N(t)} \sum_{k=1}^{N(t)} (r_{j,k} - \overline{r_j})^2}}. \tag{10}$$

The methodological underpinning for this approach is provided by Barndorff-Nielsen and Shephard (2004) who study the asymptotic properties of realized variances and covariation based on the statistical theory of Quadratic Variation. Further, beyond the financial econometrics and stock comovement literature, realized correlations are widely used in other applications (see, e.g., Pollet and Wilson, 2010 or Cieslak and Schrimpf, 2019). We prefer this realized correlation measure over possible alternatives such as rolling correlations.

Table 1 presents summary statistics. The average equity market correlation is 0.32, but there is wide variation, with the interquartile range going from 0.12 to 0.49.

[Insert **Figure 4**]

Figure 4 illustrates how the measure of comovement fluctuates over time, and in particular examines whether there are any discernible time trends. It provides a disaggregated look for advanced economies, emerging markets as well as frontier countries. As the graph shows, equity market comovement has generally picked up since the 1980s. Recently however, comovement has receded somewhat.

Correlation coefficients are not normally distributed, as they can take only values between

-1 and 1. In most of our regression analysis, we, therefore, normalize our realized correlation measures and define:

$$\mathbf{RCORR}_{i,j,t} \equiv Inverse\ Normal(0.5 + 0.5 * \hat{\rho}_{i,j,t}). \tag{11}$$

With this transformation, our comovement measures become normally distributed with infinite support. Our results are robust to not employing this transformation.

3.2 Constructing granular trade interlinkage measures - ITI and FTI

We next construct the above-introduced measures of trade integration, **ITI** and **FTI**. For this part of the analysis, we combine two different data sets on global trade in final and input goods and services. For one, we rely on the data from Johnson and Noguera (2017) (henceforth, JN), which maps final and input-output trade for the period 1980-2009 in 42 advanced and emerging market economies.[20] Second, we use the Asian Development Bank's Multi-Region Input-Output Database (MRIO), which covers 41 countries and the years from 2008 to 2017.[21]

We chain these two datasets, which results in an unbalanced panel of bilateral real integration from 1980 to 2017 for 40 countries. We include the union of the countries covered in JN and MRIO. Of the resulting 47 countries, 40 have a time series of daily stock markets returns reaching back to 1980.[22]

There are breaks between the JN and MRIO data. The reason is that the two sources are constructed using different methodologies – stemming from the use of different input-output tables. We therefore chain the data sets as follows. The data from JN is used from 1980 to 2007 and the one from MRIO from 2008 onward. All pre-2008 data is chained backwards, ie. starting from the level in 2008 in MRIO and then using changes within the JN data for every value before 2007. For example, the 2007 value is based on the 2008 MRIO data adjusted for the 2007-2008 change in JN.

[20] JN also covers the period 1970-1980, but we do not use this part of the analysis due to the lack of reliable stock market indices for a large number of markets.

[21] See Mariasingham (2015) for a description of the methodology underlying the MRIO. Note that MRIO relies on the World Input Output Database (WIOD) developed in Timmer, Dietzenbacher, Los, Stehrer, and De Vries (2015), which maps global input-output linkages from 1995 to 2011.

[22] The full list of countries in each dataset is in IA.3. Of the 42 countries included in JN, ARG, CHL, IDN, ISR, NZL, ZAF are not included in MRIO. Of the 41 countries included in MRIO, BGR, CYP, HRV, LTU, and MLT are not included in JN.

All chaining is done at the bilateral level (and for intermediate goods and bilateral final goods separately, as well as for imports and exports separately). For those countries included only in one of the two data sets, we use the full available data. [23]

The sample we cover has seen a dramatic rise in input-output trade, particular during the late 90s and the early 2000s. Figure 2 illustrates bilateral trade flows of intermediate goods in 1990 and 2006, respectively. Their comparison shows a change in the network structure of trade. Between 1990 and 2006, China has emerged as a major hub and former frontier countries such as Estonia, Slovenia, and Slovak Republic become embedded in GVCs following the fall of the iron curtain.

Intuition for the granular trade measures and comparison to traditional openness measures. In the following, we provide further intuition on the newly proposed measures of trade interlinkages by using several examples and contrasting them with the traditional measures. As Table 1 indicates, the average level of **ITI** across the countries in our sample is 0.006. While this is a fairly small number, the standard deviation is quite large, at 0.012. As an example of the drivers of **ITI**, take bilateral trade between Belgium (country *i*) and Russia (country *j*). On average for the years in our panel, for this country pair, the sample mean of $\gamma_{j,i}$ is 0.007, while the sample mean of $\gamma_{i,j}$ is 0.001. $\gamma_{i,i}$ and $\gamma_{j,j}$ are, respectively, 0.53 and 0.94 on average. With a relatively low home share in Belgium, the first component of ITI will have little weight because Russia as a trade partner is less prone to be affected by a local supply shock in Belgium.

As another example, take trade between France (*i*) and the US (*j*). Here, the sample mean of $\gamma_{j,i}$ is 0.011, while the sample mean of $\gamma_{i,j}$ is 0.001. Home share variables, $\gamma_{i,i}$ and $\gamma_{j,j}$, are, respectively, 0.88 and 0.95. With high home shares, trade flows between two countries will carry more weight because both countries are prone to supply shocks in each local market to pursue economic activity using intermediate goods. With a low home share in Belgium, a similar intermediate goods import would not necessarily lead to high trade intensity. Overall, in these two examples, $ITI_{FRA,USA} = 0.011$, while $ITI_{BEL,RUS} = 0.005$. In other words, the resulting intermediate goods trade intensity between France and the US is twice as high as that between between Belgium and Russia.

Figure 3 compares **ITI** with the traditional measure of openness, the ratio of exports and im-

[23] We note that since we employ a strategy to chain backwards using absolute changes, it is possible that this could give rise to negative trade flows. This indeed happens in 604 observations. Whenever it does, we replace the respective data point by the value from the preceding year.

ports to GDP. While there is a positive correlation of trade openness and each of the proposed granular measures, the figure highlights that there are some substantial differences. While the bottom-up trade index is in some cases comparable to the simple openness measure (see, for example, Slovakia, Estonia on the open side and Argentina or Spain on the closed side), it is very different in the case of others, most importantly for the US and Germany. How does this stark difference in some cases arise? Intuitively, although, for example, the rest of the world is not very important to the US in terms of trade, the US is in many aspects very important to the rest of the world. It essentially serves as an important node in the GVC network, which would not be captured in the traditional openness measure.

[Insert **Figure 3**]

3.3 Further controls: financial integration, historical ties, and third-country effects

In our regressions we control for factors that can affect stock return comovement other than real integration. A first candidate for this is international financial holdings which are commonly used to proxy for financial integration. The data used to construct variables of bilateral financial integration comes from CPIS (Coordinated Portfolio Investment Survey) of the IMF. It consists of 37 countries and spans 2001 through 2017. We define equity holdings, debt holdings, and total asset holdings by using total holdings of the institutions across all the sectors in both exporter and importer countries respectively.

We include other relevant variables commonly used in the literature as follows.[24] For bilateral institutional and socioeconomic backgrounds, we control for contiguity, shared languages, geographic distance, and common colonial histories. We obtain these data from the CEPII - GeoDist database. We also control for a measure of the macroeconomic output cycle, constructed following Bekaert et al. (2016). Output cycle ("Cycle" from here on) is defined as $Cycle_{i,t} = \frac{gdp_t}{gdp_{t-1}} - \frac{1}{5}\sum_{k=0}^{4}\frac{gdp_{t-k}}{gdp_{t-k-1}}$, ie. the deviation of GDP growth from the recent past trend growth. To compute the Cycle measure, we draw on Worldbank GDP data for the countries in our sample.

In the literature, such as Bekaert, Hodrick, and Zhang (2009), it is understood that the correlation between country return and the global factor increases as the volatility of the factor increases,

[24] See, e.g., Bekaert et al. (2016).

$\rho_{i,f} = \beta_i \frac{\sigma_f}{\sigma_i}$, and hence there is a need to control for the volatility of the global equity market. Because we study bilateral correlations, we instead use the volatilities of stock returns for each country pair (that is, the volatility of the importer and of the exporter) to control for effects from each of the underlying volatilities keeping covariance between two countries constant, and to control for possible volatility spillovers. Realized variance is constructed based on on daily stock return data as $RV_{i,t} = \sum_{d=1}^{N_{days}(t)} [log(R_{t,d-1,d})]^2 \frac{22}{N_{days}(t)}$. Figure A-1 plots volatility over time.

Above, we have laid out how profits comove in a two country setting. However, in a multi-country setting, also third-country effects matter. One key channel is that trade flows also through indirect networks between countries. For example, two countries might be linked economically not because they trade with each other directly, as trade might flow via a third country.

Specifically, we follow Johnson and Noguera (2012) and define value added as

$$VA_{ij} \equiv \underbrace{\overbrace{f_{ij} + A_{ij} f_{jj}}^{\text{absorption}} + A_{ii} f_{ij} - \overbrace{[\iota [A_{ii} + A_{Ii}] \operatorname{diag}(f_{ij})]'}^{\text{total intermediate use}}}_{\text{net absorption}} + \underbrace{\sum_{k \neq i,j} A_{ik} f_{kj}}_{\text{indirect exports}} \tag{12}$$

$$\textbf{Value Added}_{i,j} = \frac{VA_{i,j}}{GDP_i} \tag{13}$$

where f_{ij} denotes final goods absorbed in country j from sectors in country i, A_{ij} is ij element of the global I-O matrix A. $A_{Ii} = \sum_{k \neq i} A_{ki}$ is the overall imported input use matrix for country i. We use the this variable as alternative interlinkage measure in some of the empirical tests below.

4 Results

4.1 Baseline results

The initial "smell test" shown in Figure 1 gives a preview of our central result. More formally, in this section, we estimate variations of the following panel regression models, on the bilateral level:

$$RCORR_{i,j,t} = \alpha_{i,j} + \alpha_t + \beta^{ITI} \cdot ITI_{i,j,t} + \beta^{FTI} \cdot FTI_{i,j,t} + \sum^{k} CONTROLS^{k}_{i,t} + \varepsilon_{i,j,t} \tag{14}$$

Table 2 presents the baseline results. Column (1) shows that bilateral equity-market correlations are strongly positively associated with intermediate good trade intensity, **ITI**. A one standard deviation increase in **ITI** (0.012) is associated with 4.558*0.012/0.244 = 22% of a standard deviation increase in the raw correlation, a sizable effect.

[Insert **Table 2**]

Column (2) instead uses the transformed correlation, with similar results, both qualitatively and quantitatively. A one standard deviation increase in **ITI** is associated with a 7.712*0.012/0.383 = 24% of a standard deviation increase in RCORR. Similarly, column (3) shows that final good trade intensity also correlates strongly with equity comovement. Regressions further below include other control variables, which allow us to compare this effect with other known determinants of international comovement.

ITI and **FTI** are highly correlated (with a correlation coefficient of about 0.9). Therefore, to include both, we orthogonalize them.[25] Moreover, we standardize the two measures to have mean zero and standard deviation of unity. Column (4) then includes both measures and finds that both explain equity comovement. Interestingly, the importance of **ITI** surpasses that of **FTI**. A one standard deviation increase in **ITI** (**FTI**) is associated with a 24% (8%) of a standard deviation increase in RCORR.

Next, column (5) includes time fixed effects. This is an important check because in the existing literature, the relevance of the standard measure of openness (exports plus imports over GDP) for equity comovement, if any, has been found to vanish once common time trends of equity comovement and trade are considered (Bekaert et al., 2016). By contrast, column (5) shows that both measures of trade remain economically and statistically significant even after controlling for time

[25]We use orthogonalization employing the modified Gram-Schmidt Procedure. The procedure computes Q of the QR decomposition, $A = QR$, where the columns of Q are the orthonormal bases. In our case, we simply have two variables **ITI** and **FTI** and therefore we compute $Proj_{ITI}(FTI)$, projecting the **ITI** vector orthogonally onto the line spanned by the **FTI** vector, to construct an orthogonal vector, $u_2 \equiv Vec_{FTI} - Proj_{ITI}(FTI)$, with normalization, $\tilde{u_2} \equiv \frac{u_2}{\|u_2\|}$. Our results are robust to reversing the order of orthogonalization.

fixed effects. (Table 9 shows that the results also hold when including a deterministic time trend instead.)

Finally, columns (6) and (7) include our complementary GVC-based measure, **VA** (Value Added). $VA^{exp}_{i,j,t}$ and $VA^{imp}_{i,j,t}$ differ in that the former is denominated by exporter GDP, whereas the latter is denominated by importer GDP. This measure accounts for indirect trade flows as well. (The two measures actually do not correlate strongly, which is why we can include both in the regressions.) We find that **VA** is also associated with equity comovement, and the quantitative impact is similar to that of **ITI**. In what follows, we first present our results using **ITI** and **FTI**, and then provide robustness checks using VA.

4.2 Extensions

While the results so far establish a link between equity comovement and our measures of real integration, it is still possible that the relation would be subsumed by other factors driving both trade and equity comovement. To probe for this possibility, we next control for relevant socioeconomic variables. These controls include the geographical distance between two countries, contiguity between countries, and variables related to their colonial relationships in the past. Alternatively, we proxy for these pair-dependent socioeconomic relationships by country pair fixed effects, c_{ij}.

[Insert **Table 3**]

Table 3 presents the results. For comparison, Column (1) repeats the baseline regression from Table 2. Column (2) shows that higher equity comovement occurs when there is shorter geographical distance.[26] Additionally, as seen in column (3), when a country pair has the same official language, equity comovement is higher. Column (4) adds country fixed effects and column (5) replaces socioeconomic proxies by country pair fixed effects.[27] In all specifications, our main measure, **ITI**, remains statistically significant. The economic significance of the effects is also quite stable across specifications. A one standard deviation higher intermediate goods trade linkage is

[26] This finding of a gravity effect in comovement is in line with prior literature that did not control for bilateral trade, such as Flavin, Hurley, and Rousseau (2002). Distance is a main determinant of cross-border capital flows; see, e.g., Bottazi, Da Rin, and Hellmann (2005) and Lane and Milesi-Ferretti (2002).

[27] Lucey and Zhang (2010) find more comovement between countries with smaller cultural distance. Aggarwal, Kearney, and Lucey (2012) and Bottazi, Da Rin, and Hellmann (2016) find that cultural distance and trust among nations, respectively, matter for international financial investment decisions. Country-pair fixed effects can control for these factors.

associated with a 9% to 13% of a standard deviation higher correlation between the two equity markets. This is about one fourth to one third of the effect of distance between countries, a sizable effect.

Next, in Table 4, we test the explanatory power of real integration against variables that proxy for financial integration, Total Asset Holdings, Total Equity Holdings, and Total Debt Holdings. We standardize these variables to mean zero and standard deviation of unity to facilitate comparison of the effect sizes. As these three variables are highly correlated ($\rho = 0.6 - 0.8$), we separately include them in specifications from column (2) to (4).

The main finding is that our real integration measure **ITI** consistently relates positively to equity comovement. Financial integration is also positively associated with equity comovement. The economic significance of the real-integration measure turns out to be even stronger than that of financial integration, by a factor of 2 to 3. This suggests that real integration is an important force behind global asset comovement. This force has remained veiled in the existing literature because prior work has relied on relatively crude aggregate trade measures and has not considered the importance of modern global value chains.

Column (6) adds Cycle (from Section 3.3). It is not obvious ex ante what sign to expect for this variable. On the one hand, the coefficient on this variable might be negative, if asset prices tend to move together during recessions and if linked countries enter recessions together. On the other hand, a country that grows faster than in the past few years may be more tightly linked to the world markets more generally. We find positive coefficients of Cycle for both exporter and importer countries, though only the former is significant, and even that significance vanishes once controlling for realized volatility.

Next, we take into account that the correlation between two countries could be driven by crisis periods in one of the two countries and could also mechanically depend on (the ratio of) volatilities. Therefore, in column (6), we add the two realized volatility (RV) measures. (We use the convention to call country i the exporter and country j the importer.) Even after controlling for the possible impact of volatility, **ITI** remains a significant determinant of bilateral equity correlations.

Finally, column (7) includes all control variables introduced in this table. The coefficient on the real integration measure **ITI** remains highly significant and of similar size.

[Insert **Table 4**]

Next, we consider the role of trade intensity in subsamples among countries and across time. For these tests, we use the fixed effects specification to maximize the sample size, but results are similar when using country characteristics, including financial integration measures, for which we have fewer observations.

In Table 5 we find that higher trade intensity is positively associated with higher equity comovement most consistently for Advanced Economy (AE) country pairs. By contrast, both among emerging market economy (EME) countries (column (1) and between AE and EME countries (column 3), the effects are weaker. This is reasonable given the fact that EMEs have started playing larger role in global supply chain only over the past decade or so. Further, we eliminate some concerns that our results are driven by large countries such as the US by Column (4) and the concern that our results are driven by intra-trade within trade unions such as the EU by Column (5). Column (6) instead shows results for the sample of only European countries.

[Insert **Table 5**]

Finally, we test the stability of the main results in subsamples split by time periods. In Table 6 we find that higher trade intensity positively is associated with higher equity comovement consistently in every subsample. The economic significance is stronger in the latter samples, though, which is consistent with the fact that equity comovement shows higher variation in the latter periods (recall Figure 4).

[Insert **Table 6**]

5 Additional results and robustness

In this section, we present several additional results and robustness checks.

Trade intensity measure based on value added. First, we run the same regression models as in our baseline, but we use Value Added **VA** as the trade intensity measure. The basic goal of this exercise is to see if taking account of indirect trade flows - ie. the aforementioned third counztry effects - between countries may alter the results. Results reported in Table 7 indicate that the Value Added variable also enters statistically significantly in all specifications. Thus, in a qualitative sense, the main conclusions also hold true when using this alternative measure of international trade.

[Insert **Table 7**]

Fama-MacBeth regressions. Second, we estimate Fama-MacBeth regressions to test the explanatory power of our GVC measures in a cross-sectional setting common in the asset pricing literature. Table 8 shows the results. Columns (1) and (2) use **ITI** as the explanatory variable, whereas (3) and (4) use **VA** (Value Added). Columns (2) and (4) replace the dependent variable by the one-period ahead stock market comovement. In these specifications, we are hence investigating if there is predictive content in our GVC variables for stock-market comovement *in the cross-section*.

Throughout the specifications, our GVC-based trade intensity variables remain statistically significant. This suggests cross-sectional variations in trade intensity across pairs of countries matter for cross-sectional variations in asset comovement. Further, it means that the effects are not just contemporaneous, but that there is also predictive content in the sense of a higher trade intensity in a given year giving rise to higher asset comovement in the next year. This finding is of particular relevance from a practitioner's perspective, as it suggests that international asset allocation decisions may benefit from taking changes in trade-intensity into account.[28]

[Insert **Table 8**]

Deterministic time trend. In another robustness exercise, we replace time fixed effects with a time trend as in Bekaert et al. (2016), see Table 9. Throughout all specifications, our main variable **ITI** remains statistically significant. By contrast, the variable Total Asset Holdings that captures bilateral financial interlinkages shows slightly weaker statistical significance in comparison with Table 4 with time fixed effects.

[Insert **Table 9**]

[28] We leave questions around optimal asset allocation for future research.

Accounting for time-varying expected returns when measuring comovement. Finally, we run a robustness exercise based on an alternative measure of stock market comovement that is purged of the effects of time-varying expected returns. It is well-known in asset pricing that stock market returns can vary due to changes in risk premia and cash flow news (Campbell and Shiller (1988b), Fama and French (1989)). Our simple conceptual framework posits that GVC-induced comovements of international stock markets owe to comovements in profits and hence cash flows, while it abstracts from the role of risk premia. As a robustness exercise, we now investigate to what extent our results could be driven by returns being an amalgam of these two sources.

To this end, we strip the fluctuations in risk premia from the return series of individual country indices and use these "purged" series when we construct our comovement measure. We do so by first running classical predictive regressions for stock market returns in a panel setup (results for this intermediate step are presented in Table IA.4 of the Appendix). The set of country-level predictors includes classical variables such as the price-to-book ratio, the dividend yield, the term spread and the short-term interest rate (stochastically de-trended) in the respective country.[29] As variables that are common to all countries, we also include the VIX and the variance risk premium that have also been found to be strong short-term predictors for stock market excess returns (see, e.g. Bollerslev and Zhou, 2009). The aforementioned variables have been considered as state-variables in capturing expected return variation in the extant literature.

[Insert **Table 10**]

Table 10 reports the results where we replace our left-hand side variable with a measure of comovement that relies on purged returns, that is, the residual from the predictive regression. These results are reported from column (2) onwards. For the sake of comparison, column (1) includes the results for our baseline comovement measure RCORR that is constructed from the raw country index returns. While the coefficient on our main variable ITI is somewhat smaller in column (2) based on the modified comovement measure ('Residual'), it still emerges as the most powerful variable in explaining stock market comovement. FTI, while also significant in the baseline specification, loses its significance in the richer specification with additional controls. The results also confirm the relevance of the value added trade intensity measure in explaining international

[29]See, e.g., Ang and Bekaert (2007); Campbell and Shiller (1988b); Fama and French (1989).

stock market comovements. It retains its significance also when the regression includes the bilateral Total Asset Holdings, which captures financial interlinkages across countries. All in all, these findings confirm the importance of global production linkages in explaining international stock market comovements.

6 Conclusion

Amidst ongoing trade tensions between the world's major economies, a global pandemic that has exposed massive vulnerabilities in global supply chains, and the looming need to factor in carbon emissions into international trade agreements, it is more evident than ever that the future will hold profound changes for the international organisation of production and consumption.

Against this background, the results of this paper imply that evolving real integration will also reshape the behavior of international asset markets. Specifically, we have shown that novel, theory-guided measures of final goods and input-output linkages play an important role in explaining global stock comovement. Higher trade intensity as captured via our newly proposed granular measures predicts a higher equity comovement. This result is robust to controlling for proxies of financial integration. Our finding overturns previous dismal results in the literature that had documented only weak relations between international trade and asset price comovement. Our key finding – the importance of intermediate trade intensity in linking aggregate stock returns and trade – is in line with higher global substitutability of factor inputs and outputs and higher international competition on interim stages of production.

Given the continuous evolution of international commerce and its geographical and sectoral composition, our findings have important implications for international asset pricing and portfolio management. Taking account of developments and disruptions in global supply chains (such as Brexit, the US-China trade war, and the ongoing pandemic) is increasingly important from a portfolio management viewpoint. While such events are typically analyzed from the narrow perspective of their impact on the stock prices of directly exposed firms, our analysis highlights that, in fact, also global diversification strategies are heavily affected by them.

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Appendix A: Solutions

Proof. of Proposition 2.1.

Intuitively, every firm sells on all export markets e, and the total profits of all firms located in country c is equal to the sum over the profits of all the firms that produce in this market. export market e, it holds that total profits $\pi_{c,t}$ of all firms located in c are equal to

$$\pi_{c,t} = (\sigma - 1)^{-1} \varphi_{c,t}^{(\sigma-1)} \left(\sum_{s \epsilon C} \left(w_{s,t} \tau_{s,c}^{I} \right)^{-(\rho-1)} \right)^{(\sigma-1)/(\rho-1)} \sum_{e \epsilon C} \left(d_{e,t} \right)^{\sigma} \tau_{c,e}^{-(\sigma-1)} \tag{15}$$

where $\varphi_{c,t} \equiv \left(\sum_{f \epsilon F_C} \varphi_{f,t}^{(\sigma-1)} \right)^{1/(\sigma-1)}$ is the productivity aggregator in c.

The change in profits is equal to

$$\widehat{\pi}_{c,t} = \frac{\dot{\pi}_{s,t}}{\pi_{c,t}} = \sum_{s \epsilon C} \frac{\partial \pi_{c,t}}{\partial w_{s,t}} \frac{\dot{w}_{s,t}}{\pi_{c,t}} + \sum_{e \epsilon C} \frac{\partial \pi_{c,t}}{\partial d_{e,t}} \frac{\dot{d}_{e,t}}{\pi_{c,t}} + \frac{\partial \pi_{c,t}}{\partial \varphi_{c,t}} \frac{\dot{\varphi}_{c,t}}{\pi_{c,t}}.$$

Each of the sub-terms in the first summation solves to

$$\frac{\partial \left(\sum_{s \epsilon C} \left(w_{s,t} \tau_{s,c}^{I} \right)^{-(\rho-1)} \right)^{(\sigma-1)/(\rho-1)}}{\partial w_{s,t}} \frac{\dot{w}_{s,t}}{\pi_{c,t}} = -\left(\sigma - 1 \right) \gamma_{c,s,t} \widehat{w}_{s,t},$$

where by (3), $\frac{\left(w_{s,t} \tau_{s,c}^{I} \right)^{-(\rho-1)}}{\sum_{s \epsilon C} \left(w_{s,t} \tau_{s,c}^{I} \right)^{-(\rho-1)}} \equiv \gamma_{c,s,t}$ is the cost share of input goods from s in the production of goods from c. Each of the sub-terms in the second summation solves to

$$\frac{\partial \pi_{c,t}}{\partial d_{e,t}} \frac{\dot{d}_{e,t}}{\pi_{c,t}} = \sigma \frac{\left(d_{e,t} \right)^{\sigma} \tau_{c,e}^{-(\sigma-1)}}{\sum_{e \epsilon C} \left(d_{e,t} \right)^{\sigma} \tau_{c,e}^{-(\sigma-1)}} \widehat{d}_{e,t},$$

where by (1), $\frac{\left(d_{e,t} \right)^{\sigma} \tau_{c,e}^{-(\sigma-1)}}{\sum_{e \epsilon C} \left(d_{e,t} \right)^{\sigma} \tau_{c,e}^{-(\sigma-1)}} \equiv s_{e,c,t}$ is the share of all sales by firms from c that accrues on market e. The last term is trivially equal to $\left(\sigma - 1 \right) \widehat{\varphi}_{c,t}$. ■

Shocks, linkages, and the comovement of profits

We next illustrate profit comovement in a two-by-two case featuring country 1 and 2. All variables are indexed by $x_{\exp orter,importer}$. For any shock, it holds that

$$\begin{aligned} \widehat{\pi}_1 &= \sigma \left(s_{1,1} \widehat{d}_1 + s_{1,2} \widehat{d}_2 \right) - \left(1 - \sigma \right) \left(\gamma_{1,1} \widehat{w}_1 + \gamma_{1,2} \widehat{w}_2 \right) + \widehat{\varepsilon}_1 \\ \widehat{\pi}_2 &= \sigma \left(s_{2,1} \widehat{d}_1 + s_{2,2} \widehat{d}_2 \right) - \left(1 - \sigma \right) \left(\gamma_{2,1} \widehat{w}_1 + \gamma_{2,2} \widehat{w}_2 \right) + \widehat{\varepsilon}_2 \end{aligned}$$

Final good linkages create comovement because firms that sell final goods on the same markets are commonly affected by fluctuations in demand in this market. For simplicity, assume $\widehat{\varepsilon}_1 = \widehat{\varepsilon}_2 =$

0 and $\widehat{w}_1 = \widehat{w}_2 = 0$ thus eliminating the idiosyncratic element and the impact of input linkages. It holds that

$$\begin{aligned} cov(\widehat{\pi}_1, \widehat{\pi}_2) &= cov(\left(\sigma s_{1,1}\widehat{d_1} + \sigma s_{1,2}\widehat{d_2}\right), \left(\sigma s_{2,1}\widehat{d_1} + \sigma s_{2,2}\widehat{d_2}\right)) \\ &= \sigma^2 \left(s_{1,1}s_{2,1}var\left(\widehat{d_1}\right) + s_{1,2}s_{2,2}var\left(\widehat{d_2}\right) + \left(s_{1,1}s_{2,2} + s_{1,2}s_{2,1}\right)cov\left(\widehat{d_1}, \widehat{d_2}\right)\right) \end{aligned} \tag{16}$$

If, on the other side, $\widehat{d_1} = \widehat{d_2} = 0$, it holds that

$$\begin{aligned} cov(\widehat{\pi}_1, \widehat{\pi}_2) &= cov(-(1-\sigma)\left(\gamma_{1,1}\widehat{w}_1 + \gamma_{1,2}\widehat{w}_2\right), -(1-\sigma)\left(\gamma_{2,1}\widehat{w}_1 + \gamma_{2,2}\widehat{w}_2\right)) \\ &= (1-\sigma)^2\left(\gamma_{1,1\gamma 2,1}var\left(\widehat{w}_1\right) + \gamma_{1,2}\gamma_{2,2}var\left(\widehat{w}_2\right) + \left(\gamma_{1,1\gamma 2,2} + \gamma_{1,2\gamma 2,1}\right)cov\left(\widehat{w}_1, \widehat{w}_2\right)\right) \end{aligned} \tag{17}$$

In both cases, comovement is increasing in real integration as long as transportation costs are positive and consumption and production are home-biased. In the full case (still assuming $\widehat{\varepsilon}_1 = \widehat{\varepsilon}_2 = 0$),

$$\widehat{\pi}_1 = \sigma s_{1,1}\widehat{d_1} + \sigma s_{1,2}\widehat{d_2} - (1-\sigma)\gamma_{1,1}\widehat{w}_1 - (1-\sigma)\gamma_{1,2}\widehat{w}_2$$
$$\widehat{\pi}_2 = \sigma s_{2,1}\widehat{d_1} + \sigma s_{2,2}\widehat{d_2} - (1-\sigma)\gamma_{2,1}\widehat{w}_1 - (1-\sigma)\gamma_{2,2}\widehat{w}_2$$

$$\begin{aligned} cov(\widehat{\pi}_1, \widehat{\pi}_2) = \; & \sigma^2 s_{2,1}s_{1,1}var\left(\widehat{d_1}\right) + \sigma^2 s_{1,1}s_{2,2}cov\left(\widehat{d_1}, \widehat{d_2}\right) \\ & -(1-\sigma)\gamma_{2,1}\sigma s_{1,1}cov\left(\widehat{d_1}, \widehat{w}_1\right) - (1-\sigma)\gamma_{2,2}\sigma s_{1,1}cov\left(\widehat{d_1}, \widehat{w}_2\right) \\ & \sigma^2 s_{1,2}s_{2,1}cov\left(\widehat{d_2}, \widehat{d_1}\right) + \sigma^2 s_{1,2}\sigma s_{2,2}var\left(\widehat{d_2}\right) \\ & -(1-\sigma)\gamma_{2,1}\sigma s_{1,2}cov\left(\widehat{d_2}, \widehat{w}_1\right) - (1-\sigma)\gamma_{2,2}\sigma s_{1,2}cov\left(\widehat{d_2}, \widehat{w}_2\right) \\ & -(1-\sigma)\gamma_{1,1}\sigma s_{2,1}cov\left(\widehat{w}_1, \widehat{d_1}\right) - (1-\sigma)\gamma_{1,1}\sigma s_{2,2}cov\left(\widehat{w}_1, \widehat{d_2}\right) \\ & +(1-\sigma)^2\gamma_{1,1}\gamma_{2,1}var\left(\widehat{w}_1\right) + (1-\sigma)^2\gamma_{1,1}\gamma_{2,2}cov\left(\widehat{w}_1, \widehat{w}_2\right) \\ & -(1-\sigma)\gamma_{1,2}\sigma s_{2,1}cov\left(\widehat{w}_2, \widehat{d_1}\right) - (1-\sigma)\sigma s_{2,2}\gamma_{1,2}cov\left(\widehat{w}_2, \widehat{d_2}\right) \\ & +(1-\sigma)^2\gamma_{1,2}\gamma_{2,1}cov\left(\widehat{w}_2, \widehat{w}_1\right) + (1-\sigma)^2\gamma_{1,2}\gamma_{2,2}var\left(\widehat{w}_2\right) \end{aligned}$$

Further,

$$\begin{aligned} cov(\widehat{\pi}_1, \widehat{\pi}_2) = \; & \sigma^2 s_{2,1}s_{1,1}var\left(\widehat{d_1}\right) + \sigma^2 s_{1,2}\sigma s_{2,2}var\left(\widehat{d_2}\right) \\ & +(1-\sigma)^2\gamma_{1,1}\gamma_{2,1}var\left(\widehat{w}_1\right) + (1-\sigma)^2\gamma_{1,2}\gamma_{2,2}var\left(\widehat{w}_2\right) \\ & +\sigma^2\left(s_{1,1}s_{2,2} + s_{1,2}s_{2,1}\right)cov\left(\widehat{d_1}, \widehat{d_2}\right) + (1-\sigma)^2\left(\gamma_{1,1}\gamma_{2,2} + \gamma_{1,2}\gamma_{2,1}\right)cov\left(\widehat{w}_1, \widehat{w}_2\right) \\ & -(1-\sigma)\sigma\left(\gamma_{2,1}s_{1,1} + \gamma_{1,1}s_{2,1}\right)cov\left(\widehat{d_1}, \widehat{w}_1\right) \\ & -(1-\sigma)\sigma\left(\gamma_{2,1}s_{1,2} + \gamma_{1,1}s_{2,2}\right)cov\left(\widehat{d_2}, \widehat{w}_1\right) \\ & -(1-\sigma)\sigma\left(\gamma_{2,2}s_{1,1} + \gamma_{1,2}s_{2,1}\right)cov\left(\widehat{d_1}, \widehat{w}_2\right) \\ & -(1-\sigma)\sigma\left(\gamma_{2,2}s_{1,2} + \gamma_{1,2}s_{2,2}\right)cov\left(\widehat{d_2}, \widehat{w}_2\right) \end{aligned}$$

2. Case allowing for correlated shocks: $cov\left(\widehat{d}_1, \widehat{d}_2\right) = \Omega_d^2 \rho_d$, $cov\left(\widehat{w}_1, \widehat{w}_2\right) = \Omega_w^2 \rho_w$

$$\left(s_{1,1}s_{2,2} + s_{1,2}s_{2,1}\right)\sigma^2\Omega_d^2\rho_d + \left(\gamma_{1,1}\gamma_{2,2} + \gamma_{1,2}\gamma_{2,1}\right)\left(1-\sigma\right)^2\Omega_w^2\rho_w$$

define two endogeneity indices: Demand Correlation $DC_{1,2}$ and supply correlation $SC_{1,2}$

$$\begin{aligned} DC_{1,2} &= \left(s_{1,1}s_{2,2} + s_{1,2}s_{2,1}\right) \\ SC_{1,2} &= \left(\gamma_{1,1}\gamma_{2,2} + \gamma_{1,2}\gamma_{2,1}\right) \end{aligned}$$

A regression would thus yield

$$cov(\widehat{\pi}_1, \widehat{\pi}_2) = \widehat{\beta}_d FTI_{1,2} + \widehat{\beta}_w ITI_{1,2} + \widehat{\beta}_{dc} DC_{1,2} + \widehat{\beta}_{sc} SC_{1,2} \tag{18}$$

where the estimated coefficients would be:

$$\begin{aligned} \widehat{\beta}_d &= \sigma^2\Omega_d^2 \text{ and } \widehat{\beta}_w = \left(1-\sigma\right)^2\Omega_w^2 \\ \widehat{\beta}_{dc} &= \sigma^2\Omega_d^2\rho_d \text{ and } \widehat{\beta}_{sc} = \left(1-\sigma\right)^2\Omega_w^2\rho_w \end{aligned}$$

Note that $DC_{1,2}$ and $FTI_{1,2}$, as well as $SC_{1,2}$ and $ITI_{1,2}$ would be correlated by construction!

Figure 1: **Stock Market Correlations, Trade Openness, and Global Production Linkages**

The left-hand panel relates trade openness (defined as the natural logarithm of $\frac{Export_{i,t}+Import_{i,t}}{GDP_{i,t}}$) to the correlation between the stock index of country i and the world stock index (rescaled as Inverse Normal($0.5+0.5^{*}\,\hat{\rho}_{i,j,t}$)). The right-hand panel instead uses a measure of Intermediate Trade Intensity, the natural logarithm of $ITI_{i,j,t}$, averaged over country j as the variable on the horizontal axis. Details on the construction of $ITI_{i,j,t}$ are in Section 3. The sample includes 41 countries and the years 1980-2017.

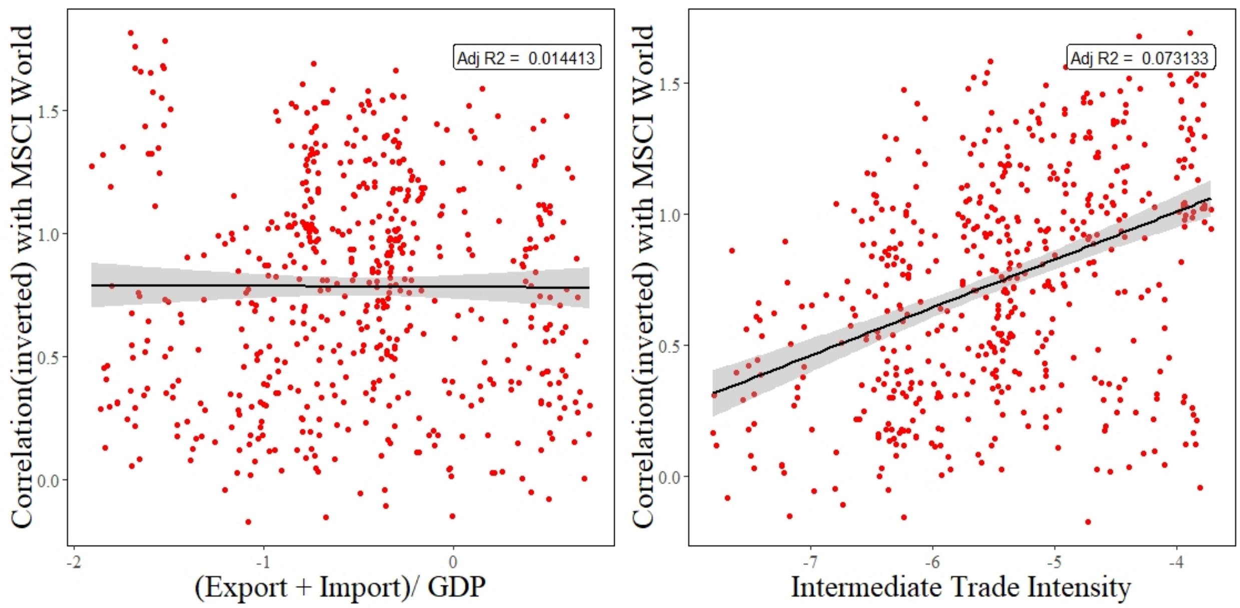
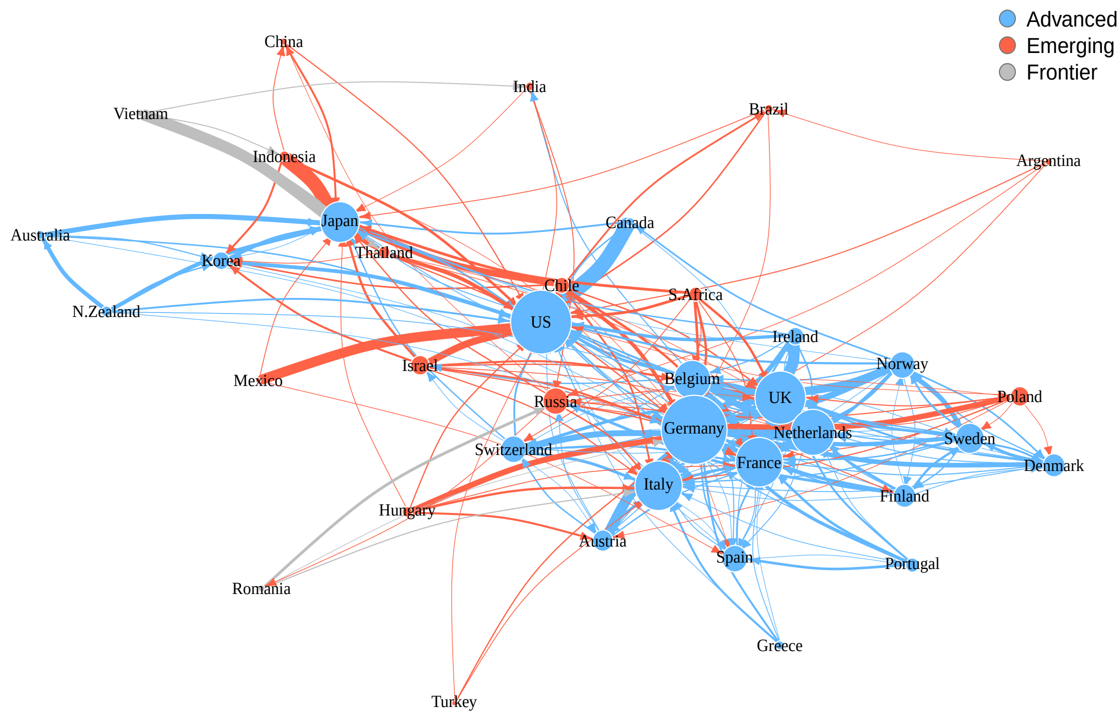
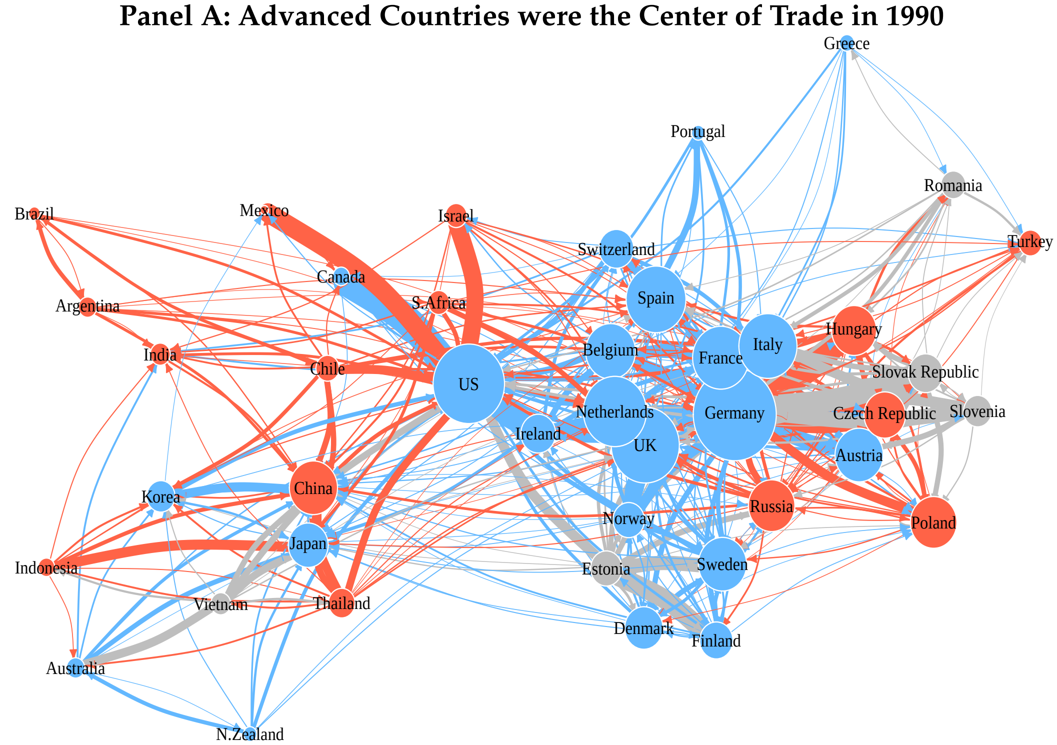


Figure 2: **Global Value Chains and Intermediate Goods Exports**

This figure visualizes the network of global value chains using intermediate goods exports in 1990 and in 2006. Both series are denominated by exporter GDP. The edges are colored based on the country group of the exporter country. Arrows indicate the direction of exports. The size of each node is determined by its degree (that is, the number of connections it has to other nodes). The graphical positions of nodes are drawn with the Fruchterman-Reingold layout algorithm.



Panel A: Advanced Countries were the Center of Trade in 1990



Panel B: Emerging and Frontier Countries became intertwined in 2006

Figure 3: **Intermediate Trade Intensity and Traditional Trade Openness**

This figure shows the relation between aggregated intermediate trade intensity, which is summed over country j, and traditional trade openness. That is, the vertical axis shows $ITI_i = \sum_j \sum_t ITI_{i,j,t}$ for each country. The horizontal axis shows $\frac{Export_i + Import_i}{GDP_i} = \sum_t \frac{Export_{i,t} + Import_{i,t}}{GDP_{i,t}}$. All variables are exporter-denominated.

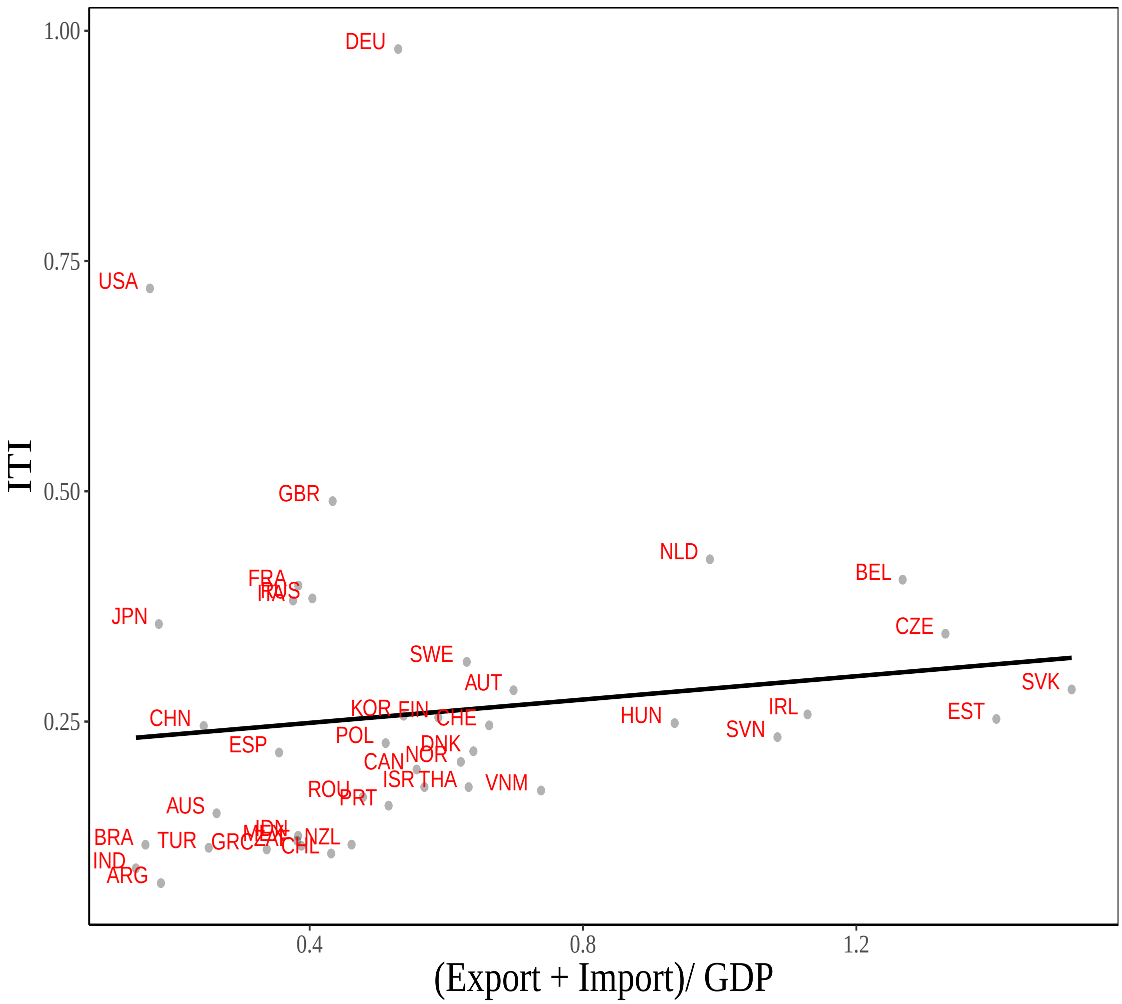
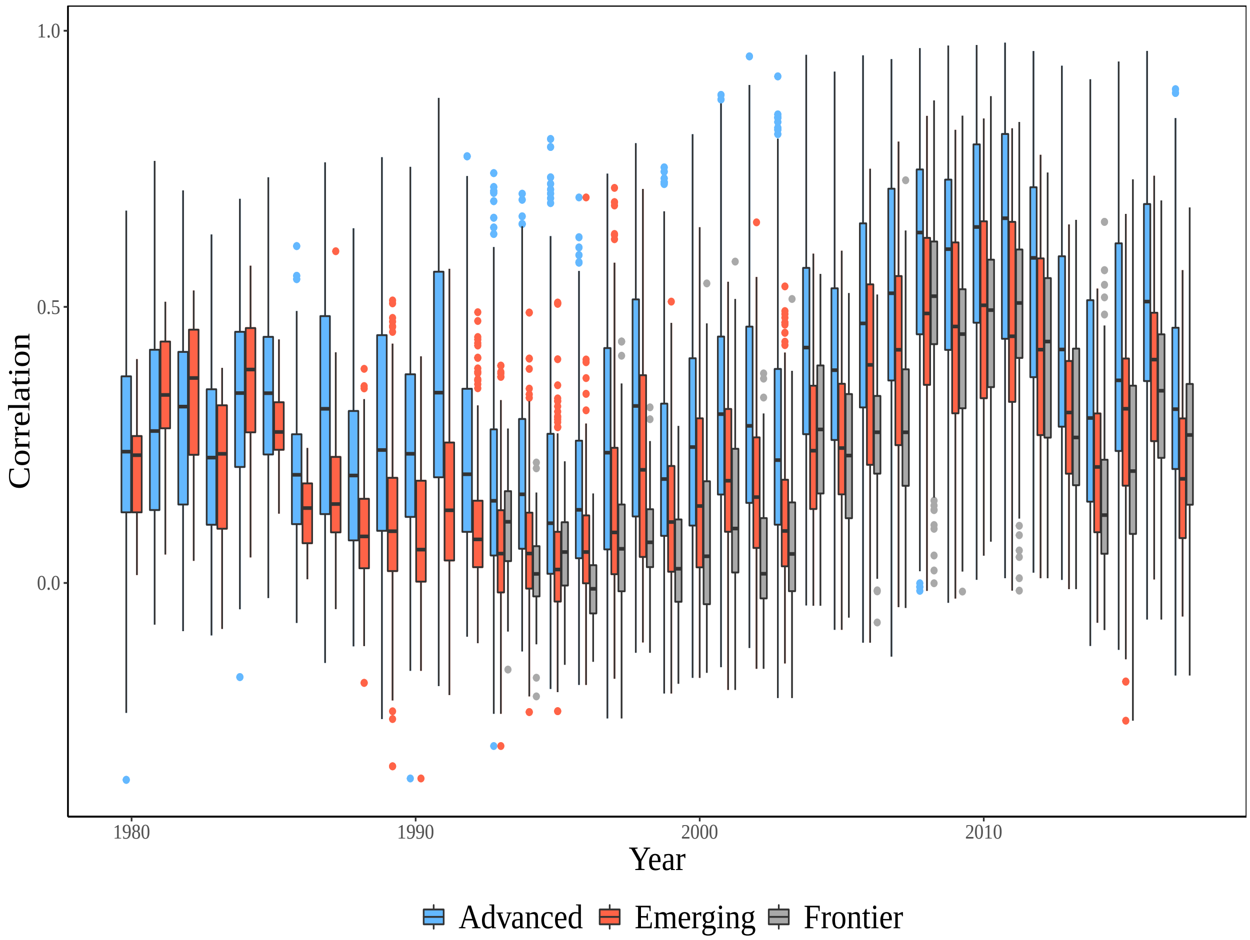


Figure 4: **Time Variation in Stock Return Comovement**

This figure shows the time variation in stock return comovement, measured by the yearly correlation between stock market indices of two countries using daily returns. The computation of correlations is detailed in Section 3. Each box is colored based on the country group of country i. Before 1992, stock indices are not available for frontier countries.



Tables

Table 1: **Summary Statistics**

This table shows summary statistics of the main variables employed in the analysis. The main dependent variable, RCORR, is the time-varying pairwise correlation of two countries i and j, rescaled so as to have infinite support. **ITI** (orthogonalized) and **FTI** (orthogonalized) are orthogonalized in that order. Trade Openness is a commonly used openness measure, defined as $\frac{Export_{i,t}+Import_{i,t}}{GDP_{i,t}}$. (z) refers to the variables that are standardized. (exporter) and (importer) refer to variables being denominated by exporter GDP and importer GDP, respectively. RV and Cycle are controls for realized variance and GDP cycle. Details are found in Table IA.1. Correlations are found in Table IA.2

Variable	Obs	Mean	Std. Dev.	Min	Max	P1	P25	P50	P75	P99
Correlation	44132	.317	.244	-.357	.978	-.099	.121	.288	.486	.89
RCORR	44132	.444	.383	-.463	2.298	-.124	.152	.369	.652	1.6
ITI	70054	.006	.012	0	.175	0	.001	.002	.007	.061
FTI	70002	.005	.009	0	.12	0	0	.002	.005	.044
ITI (orthogonalized, z)	69992	0	1	-.538	13.959	-.538	-.475	-.348	.005	4.534
FTI (orthogonalized, z)	69992	0	1	-21.65	9.567	-3.194	-.22	-.105	.179	3.31
Value Added (exporter)	68068	.005	.012	0	.219	0	0	.001	.004	.056
Value Added (importer)	68068	.005	.011	0	.193	0	0	.001	.004	.054
Distance (z)	71546	0	1	-1.47	2.991	-1.391	-.975	.105	.652	2.356
RV (z)	58946	0	1	-1.647	6.838	-1.132	-.443	-.226	.042	4.676
Cycle (z)	45786	0	1	-3.884	4.631	-2.878	-.502	-.015	.508	2.811
Total Asset Holding (z)	19998	0	1	-.274	16.55	-.273	-.259	-.244	-.167	4.101
Total Equity Holding (z)	18108	0	1	-.678	19.423	-.229	-.217	-.207	-.154	4.557
Total Debt Holding (z)	17767	0	1	-.314	21.207	-.295	-.275	-.257	-.168	4.224
Trade Openness	2036	.378	.349	0	1.707	0	.084	.335	.529	1.479

Table 2: **Baseline Results**

This table shows the results of regression **(14)**. It presents the coefficients from panel regressions of stock return comovements, measured by $RCORR_{ijt}$, on raw trade intensity measures, ITI_{ijt} and FTI_{ijt}, (the first and the second rows), on orthogonalized trade intensity measures (the third and forth rows), and on its corresponding value-added components (the fifth and the sixth rows). This panel regression uses yearly bilateral data from 1980 to 2017. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Correlation	RCORR					
ITI	4.558***	7.712***					
	(7.79)	(7.29)					
FTI			11.117***				
			(7.71)				
ITI (orthogonalized, z)				0.091***	0.085***		
				(7.37)	(7.21)		
FTI (orthogonalized, z)				0.030***	0.025**		
				(3.11)	(2.55)		
Value Added (exporter)						4.992***	4.736***
						(6.10)	(5.87)
Value Added (importer)						5.188***	4.869***
						(6.59)	(6.21)
Constant	0.279***	0.381***	0.375***	0.428***	0.429***	0.373***	0.376***
	(45.15)	(38.81)	(38.10)	(48.52)	(48.44)	(37.92)	(38.75)
Observations	39,398	39,398	39,392	39,392	39,392	37,904	37,904
N of Country Pairs	1560	1560	1560	1560	1560	1560	1560
Time FE	NO	NO	NO	NO	YES	NO	YES
Adj. R-squared	0.061	0.070	0.077	0.077	0.387	0.061	0.37

Table 3: **Controlling for Socio-economic Ties and Country Fixed Effects**

This table summarizes panel regressions of stock return comovement on trade intensity measures and socioeconomic variables and fixed effects. Contiguity is whether or not the countries are neighburs. Common Official Language is 1 if primary common language is the same. (z) indicates when a variable is standardized. Columns (4) and (5), respectively, include country fixed effects and country-pair fixed effects. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)
Dependent variable:			RCORR		
ITI (orthogonalized, z)	0.085***	0.048***	0.032***	0.036***	0.037**
	(7.21)	(4.66)	(2.63)	(6.01)	(2.49)
FTI (orthogonalized, z)	0.025**	0.021**	0.014	0.013***	0.010
	(2.55)	(2.27)	(1.57)	(2.83)	(1.34)
Distance (z)		-0.112***	-0.116***	-0.093***	
		(-11.72)	(-11.96)	(-12.29)	
Contiguity			0.075		
			(1.12)		
Common Official Language			0.130***		
			(4.37)		
Common Colonizer			-0.353***		
			(-10.91)		
Colony (post 1945)			-0.255***		
			(-5.46)		
Observations	39,392	37,894	37,894	37,894	39,392
N of Country Pairs	1560	1560	1482	1482	1560
Country FE	NO	NO	NO	YES	NO
Country Pair FE	NO	NO	NO	NO	YES
Time FE	YES	YES	YES	YES	YES
Adj. R-squared	0.387	0.454	0.467	0.724	0.788

Table 4: **Controlling for Financial Linkages**

This table summarizes panel regressions of stock return comovement on trade intensity measures, controlling for measures of financial integration and other economic variables. ITI_{ijt} and FTI_{ijt} are orthogonalized. (z) indicates when a variable is standardized. $Cycle_{i,t}$ captures the current state of the macroeconomic cycle based on GDP. $RV_{i,t}$ is realized volatility. (importer) stands for the variable corresponding to the importer's $Cycle_{j,t}$ and $RV_{j,t}$ (instead of the exporter's). Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:				RCORR			
	no NA in Total Asset						
ITI (orthogonalized, z)	0.064***	0.061***	0.062***	0.063***	0.052***	0.059***	0.048***
	(7.84)	(7.47)	(7.63)	(7.82)	(6.13)	(7.24)	(6.35)
FTI (orthogonalized, z)	0.008	0.008	0.008	0.011*	-0.002	0.006	-0.002
	(1.34)	(1.31)	(1.37)	(1.81)	(-0.33)	(1.04)	(-0.37)
Total Asset Holdings (z)		0.026***			0.025**	0.054***	0.052***
		(2.75)			(2.26)	(4.48)	(4.00)
Total Equity Holdings (z)			0.011*				
			(1.72)				
Total Debt Holdings (z)				0.029***			
				(3.38)			
Cycle (z)					0.004**		0.002
					(2.41)		(1.30)
Cycle (z, importer)					0.002		-0.002
					(1.28)		(-1.00)
RV (z)						-0.012***	-0.019***
						(-3.54)	(-5.05)
RV (z, importer)						-0.012***	-0.017***
						(-3.79)	(-4.97)
Constant	0.182***	-0.009	-0.028	-0.001	-0.060	0.008	-0.038
	(3.26)	(-0.16)	(-0.44)	(-0.02)	(-0.94)	(0.16)	(-0.63)
Observations	16,059	16,059	14,974	14,447	12,622	14,381	11,157
N of Country Pairs	1,308	1,308	1,270	1,228	1,044	1,174	923
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.757	0.759	0.761	0.766	0.776	0.768	0.788

Table 5: **Subsamples: Countries**

This table summarizes panel regressions of stock return comovement on trade intensity measures, for subsamples split by composition of countries. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	RCORR					
Sample:	EME-EME	AE-AE	AE-EME	w/o US	w/o Europe	Only Europe
ITI (orthogonalized, z)	-0.006	0.088***	0.022*	0.043***	0.030***	0.044***
	(-0.19)	(5.16)	(1.86)	(4.41)	(2.64)	(3.84)
FTI (orthogonalized, z)	-0.026*	0.041***	-0.019**	0.013*	-0.020***	0.027***
	(-1.95)	(3.97)	(-2.45)	(1.86)	(-2.99)	(3.63)
Observations	4,014	14,394	7,554	37,332	23,416	15,976
N of Country Pairs	182	462	308	1,482	960	600
Country FE	YES	YES	YES	YES	YES	YES
Control	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.664	0.731	0.719	0.705	0.669	0.726

Table 6: **Subsamples: Time**

This table summarizes panel regressions of stock return comovement on trade intensity measures, for temporal subsamples. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	RCORR				
Sample:	before 1990	1995 - 2008	after 2010	after 2014	before 2008
ITI (orthogonalized, z)	0.040***	0.048***	0.065***	0.064***	0.052***
	(3.13)	(5.54)	(9.26)	(7.94)	(5.96)
FTI (orthogonalized, z)	0.017*	0.006	0.024***	0.015**	0.022***
	(1.69)	(0.92)	(4.67)	(2.28)	(3.84)
Observations	4,062	18,596	8,514	4,224	27,758
N of Country Pairs	756	1,560	1,122	1,056	1,560
Country FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Control	YES	YES	YES	YES	YES
Adj. R-squared	0.563	0.648	0.793	0.754	0.621

Table 7: **Value Added as an Alternative Measure of Trade Intensity**

This table summarizes panel regressions of stock return comovement on an alternative trade intensity measure, $ValueAdded_{ijt}$. It uses the same controls introduced in prior tables. All variables are in annual frequencies. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	RCORR						
	no NA in Total Asset						
Value Added (z, exporter)	0.042***	0.041***	0.042***	0.043***	0.030***	0.057***	0.036***
	(6.44)	(6.15)	(6.24)	(6.72)	(4.13)	(4.43)	(2.87)
Total Asset Holdings (z)		0.030***			0.031***	0.059***	0.060***
		(3.10)			(2.64)	(5.37)	(5.36)
Total Equity Holdings (z)			0.014**				
			(2.08)				
Total Debt Holdings (z)				0.033***			
				(3.68)			
Cycle (z)					0.005***		0.003*
					(2.99)		(1.78)
Cycle (z, importer)					0.003*		-0.001
					(1.65)		(-0.86)
RV (z)						-0.015***	-0.022***
						(-4.09)	(-5.74)
RV (z, importer)						-0.015***	-0.020***
						(-4.41)	(-5.83)
Constant	0.538***	-0.027	-0.046	-0.019	-0.076	0.003	-0.043
	(8.57)	(-0.43)	(-0.66)	(-0.27)	(-1.10)	(0.05)	(-0.65)
Observations	14,766	14,766	13,771	13,256	11,531	13,156	10,129
N of Country Pairs	1,301	1,301	1,255	1,217	1,037	1,167	916
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.741	0.747	0.745	0.753	0.768	0.761	0.785

Table 8: **Fama-MacBeth Regressions**

This table summarizes the results of Fama-MacBeth regressions of contemporaneous and future stock comovements on our trade intensity measures and other characteristics. Coefficients are presented as time-series averages of cross-sectional regressions. Column (1) and (3) use $RCORR_t$ as the dependent variable, whereas Column (2) and (4) have $RCORR_{t+1}$ as dependent variable. Value Added is exporter based, that is denominated by exporter GDP. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. t-statistics in parentheses, *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)
Dependent variable:	RCORR			
	t	t+1	t	t+1
ITI (orthogonalized, z)	0.034 ***	0.034 ***		
	(11.38)	(11.22)		
FTI (orthogonalized, z)	0.018 ***	0.017 ***		
	(3.71)	(3.57)		
Value Added (exporter, z)			0.029 ***	0.030 ***
			(12.55)	(13.31)
Distance	-0.103 ***	-0.107 ***	-0.104 ***	-0.109 ***
	(-8.06)	(-8.78)	(-8.27)	(-8.85)
RV	-0.216	-0.173 *	-0.228	-0.187
	(-1.55)	(-1.88)	(-1.56)	(-1.88)
Cycle	-0.001	-0.039	-0.003	-0.041
	(-0.12)	(-1.56)	(-0.23)	(-1.61)
Contiguity	0.080 ***	0.087 ***	0.127 ***	0.134 ***
	(8.92)	(6.33)	(13.)	(9.84)
Common Language	0.213 ***	0.209 ***	0.208 ***	0.204 ***
	(11.28)	(10.06)	(11.62)	(10.43)
Avr. N	655	655	635	635
Adj. R-squared	0.291	0.288	0.284	0.280

Table 9: **Deterministic Trend**

This table summarizes panel regressions of stock return comovement on trade intensity measures, but replaces time fixed effects by time trends. It uses the same controls introduced in prior tables. All variables are in annual frequencies. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	RCORR						
	no NA in Total Asset						
ITI (orthogonalized, z)	0.071***	0.064***	0.068***	0.062***	0.057***	0.056***	0.059***
	(7.84)	(6.68)	(7.25)	(6.78)	(7.31)	(7.16)	(5.83)
FTI (orthogonalized, z)	0.014**	0.014**	0.013*	0.015**	0.012**	0.002	0.012*
	(2.04)	(1.98)	(1.94)	(2.15)	(2.06)	(0.28)	(1.67)
Total Asset Holdings (z)		0.041**					0.049**
		(2.57)					(2.57)
Total Equity Holdings (z)			0.020**				
			(2.27)				
Total Debt Holdings (z)				0.046***			
				(2.83)			
RV(z)					-0.007**		-0.015**
					(-2.27)		(-2.25)
Cycle(z)						0.008***	0.012***
						(4.69)	(3.96)
Observations	16,059	16,059	14,974	14,447	39,392	28,776	14,309
N of Country Pairs	1,308	1,308	1,270	1,228	1,560	1,326	1,176
Country FE	YES	YES	YES	YES	YES	YES	YES
Time Trend	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.544	0.546	0.549	0.553	0.561	0.586	0.550

Table 10: **Accounting for Time-varying Expected Returns**

This table reports results of regressions with an alternative measurement of the stock market comovement variable that accounts for variation in expected returns. For comparison purposes, Column (1) reports results based on the comovement measure constructed from the raw returns. Columns (2) through (5) instead use comovement measures based on the purged international stock returns ('*Residual*'). Specifically, the comovement measures used in these columns are constructed from the residuals of panel predictive regressions of international stock market returns on common measures capturing time-variation in expected returns (see Table IA.4 in the Appendix). Value Added is exporter-based, that is denominated by exporter GDP. Details on the construction of the variables are described in Section 3. Variables are defined in Table IA.1. R^2 is adjusted for degrees of freedom. The t-statistics, shown in parentheses, are based on standard errors clustered by symmetric country pair. *p<0.1; **p<0.05; ***p<0.01. The sample is yearly bilateral data from 1980 to 2017.

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	RCORR	Residual	Residual	Residual	Residual
ITI (orthogonalized, z)	0.060***	0.047***	0.044***		
	(8.76)	(7.22)	(5.99)		
FTI (orthogonalized, z)	0.015***	0.014**	0.009		
	(2.65)	(2.27)	(1.33)		
Value Added (z, exporter)				0.052***	0.038***
				(3.45)	(3.19)
Total Asset Holdings (z)					0.074***
					(4.89)
Cycle(z)			0.006	0.001	0.002
			(1.20)	(0.26)	(0.33)
Cycle(z, importer)			0.003	-0.002	-0.007
			(0.60)	(-0.50)	(-1.55)
RV(z)			0.007	0.008	0.001
			(0.83)	(0.92)	(0.10)
RV(z, importer)			0.004	0.004	0.010
			(0.52)	(0.50)	(1.30)
Observations	39,392	16,120	9,256	8,431	7,053
N of Country Pairs	1240	842	830	822	822
Country FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Adj. R-squared	0.706	0.563	0.588	0.584	0.598

Internet Appendix for

Global Production Linkages and Stock Market Comovement

(not for publication)

Additional Figures and Tables

Figure A-1: **Realized volatility**

This figure shows volatilities of stock returns since 1980. The left panel shows volatilities for three country groups. The right panel shows volatility for the world stock index. Volatility is measured monthly based on daily data and averaged for each year.

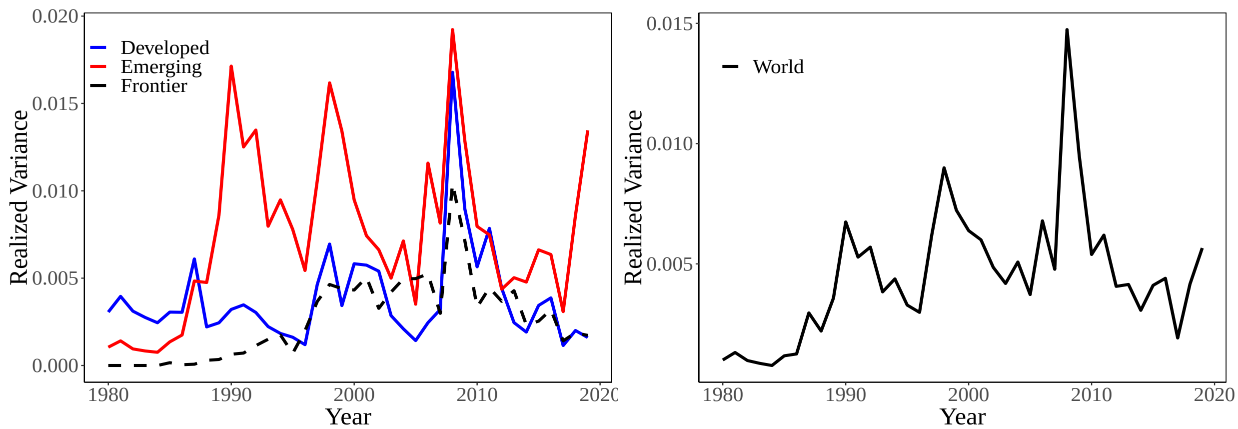


Figure A-2: **Time-variation in Coefficients**

This figure shows the coefficients from Fama-MacBeth regressions since 1980. $RCORR_{t+1}$ is the dependent variable. Cycle, Distance, Contiguity, Common Official Language, and Common Colonizer are included as control variables. Variable definitions are in Table A-1.

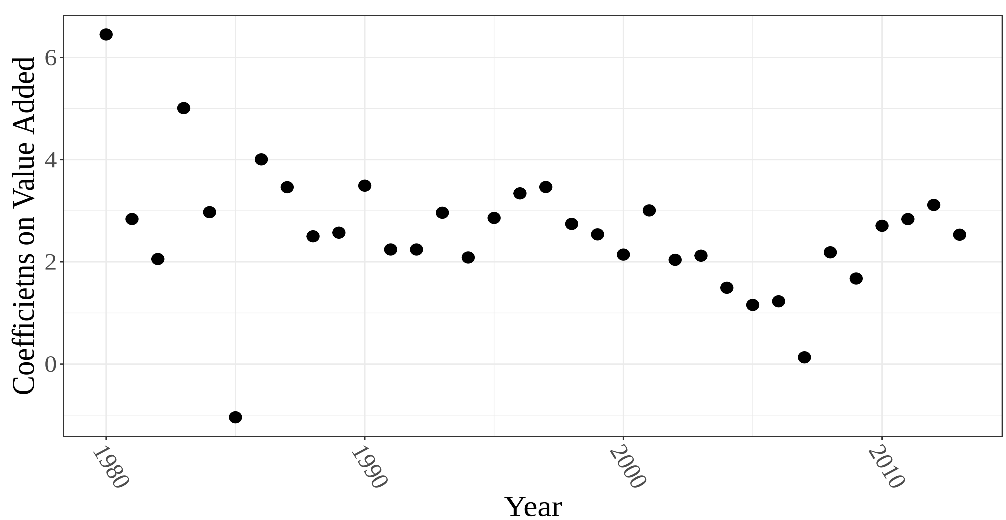


Table IA.1

Definitions (sorted alphabetically)

Variable	Definition
Colony (post 1945)	a dummy variable indicating whether the two countries have had a colonial relationship after 1945.
Common Official Language	a dummy variable indicating whether the two countries share a common official language.
Common Language (used)	a dummy variable indicating whether the two countries share a commonly used language.
Common Colonizer	a dummy variable indicating whether the two countries have had a common colonizer after 1945.
Contiguity	a dummy variable indicating whether the two countries are contiguous.
Correlation	$\hat{\rho}_{i,j,t} = \frac{\frac{1}{N(t)}\sum_{k=1}^{N(t)}(r_{i,k}-\overline{r_i})(r_{j,k}-\overline{r_j})}{\sqrt{\frac{1}{N(t)}\sum_{k=1}^{N(t)}(r_{i,k}-\overline{r_i})^2}\sqrt{\frac{1}{N(t)}\sum_{k=1}^{N(t)}(r_{j,k}-\overline{r_j})^2}}$. Using daily data to compute correlations for each year.
Cycle	Output Cycle. $Cycle_{i,t} = \frac{gdp_t}{gdp_{t-1}} - \frac{1}{5}\sum_{k=0}^{4}\frac{gdp_{t-k}}{gdp_{t-k-1}}$
Distance	from CEPII, the GeoDist Database.
FTI	$FTI_{i,j} = s_{j,i}s_{i,i} + s_{i,j}s_{j,j}$, where $s_{i,i}$ is home share of sales and $s_{i,j} = \frac{FinalExports_{i,j}}{GDP_i}$.
ITI	$ITI_{i,j} = \gamma_{j,i}\gamma_{i,i} + \gamma_{i,j}\gamma_{j,j}$, where $\gamma_{i,i}$ is home share of costs and $\gamma_{i,j} = \frac{IntermediateExports_{i,j}}{GDP_i}$.
RCORR	$RCORR_{i,j,t} \equiv Inverse\ Normal(0.5 + 0.5 * \hat{\rho}_{i,j,t})$
RV	Monthly Realized Variance. $RV_{i,t} = \sum_{d=1}^{N_{days}(t)}[log(R_{t,d-1,d})]^2\frac{22}{N_{days}(t)}$, averaged yearly. Ndays(t) is the number of trading days in a month t.
Total Asset Holdings	$\frac{TotalAssetHolding_{i,j}}{GDP_i}$
Total Debt Holdings	$\frac{TotalDebtHolding_{i,j}}{GDP_i}$
Total Equity Holdings	$\frac{TotalEquityHolding_{i,j}}{GDP_i}$
Trade Openness	$\frac{Export_{i,t}+Import_{i,t}}{GDP_{i,t}}$
Value Added	$\frac{VA_{i,j}}{GDP_i}$. $VA_{i,j}$ is value added exports that take account of indirect export via a third country, following Johnson and Noguera (2012). Value Added (exporter) is denominated by exporter GDP, whereas Value Added (importer) is denominated by importer GDP.

Table IA.2

Correlation of Variables

	RCORR	FTI	ITI	Value Added (exp)	Value Added (imp)	Asset Holdings	Equity Holdings	Debt Holdings	RV	Cycle
RCORR		0.277	0.265	0.181	0.179	0.131	0.079	0.143	-0.074	-0.089
FTI			0.934	0.65	0.684	0.242	0.21	0.235	-0.034	0.004
ITI				0.645	0.693	0.282	0.249	0.275	-0.025	0.009
Value Added (exporter based)					0.07	0.403	0.393	0.379	-0.003	0.009
Value Added (importer based)						0.008	-0.004	0.004	-0.033	0.006
Asset Holdings							0.88	0.965	-0.02	0.018
Equity Holdings								0.73	-0.029	0.034
Debt Holdings									-0.012	0.01
RV										-0.174
Cycle										

Table IA.3

Countries in the Sample

JN 42 countries
ARG, AUS, AUT, BEL, BRA, CAN, CHE, CHL, CHN, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HUN, IDN, IND, IRL, ISR, ITA, JPN, KOR, MEX, NLD, NOR, NZL, POL, PRT, ROU, RUS, SVK, SVN, SWE, THA, TUR, USA, VNM, ZAF
MRIO 41 countries
AUS, AUT, BEL, BGR, BRA, CAN, CHE, CHN, CYP, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IND, IRL, ITA, JPN, KOR, LTU, MEX, MLT, NLD, NOR, POL, PRT, ROU, RUS, SVK, SVN, SWE, THA, TUR, USA, VNM

Table IA.4: **Panel predictive regressions for international stock returns**

This table summarizes the regressions of country equity returns on conventional state-variables in the asset pricing literature such as the dividend yield (DY), price-to-book-ratio (PB), Term Spread (TERM), Short Rate (stochastically de-trended, VIX, and the Variance Risk Premium (VRP). Columns (1)-(3) use VIX, while columns (4)-(6) use VRP. Returns with a monthly horizon are used for the dependent variable. R^2 is adjusted for degrees of freedom. Newey-West robust standard-errors with 8 lags are given in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$. The sample is daily country level data from 1990 to 2017.

Dependent Variable:	Return					
	(1)	(2)	(3)	(4)	(5)	(6)
PB	-0.0116***	-0.0110***	-0.0110***	-0.0139***	-0.0127***	-0.0127***
	(0.0019)	(0.0019)	(0.0019)	(0.0020)	(0.0021)	(0.0021)
DY		0.0020	0.0020		0.0040**	0.0040**
		(0.0016)	(0.0016)		(0.0017)	(0.0017)
VIX	0.0190*	0.0180*	0.0180*			
	(0.0107)	(0.0106)	(0.0106)			
VRP				0.0127	0.0072	0.0072
				(0.0200)	(0.0199)	(0.0199)
TERM	-0.0333	-0.0362	-0.0362	-0.0117	-0.0148	-0.0148
	(0.0295)	(0.0297)	(0.0297)	(0.0308)	(0.0308)	(0.0308)
Short Rate	0.0248***	0.0247***	0.0247***	0.0325***	0.0322***	0.0322***
	(0.0095)	(0.0096)	(0.0096)	(0.0114)	(0.0114)	(0.0114)
Observations	158,589	158,589	158,589	146,051	146,051	146,051
Adjusted R^2	0.0024	0.0025	0.0025	0.0031	0.0034	0.0034

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