Granular Comovement*

Julian di Giovanni
Universitat Pompeu Fabra
Barcelona GSE
CREI and CEPR

Andrei A. Levchenko
University of Michigan
NBER and CEPR

Isabelle Méjean
Ecole Polytechnique
and CEPR

December 4, 2014
PRELIMINARY AND INCOMPLETE

Abstract

This paper investigates the role of individual firms in international business cycle comovement using data covering the universe of French firm-level sales, bilateral imports and exports, and cross-border ownership over the period 1991-2007. Because internationally connected firms are systematically larger than non-internationally connected firms, the firms directly linked to foreign countries represent 10% of all firms, but 45% of all value added. After controlling for firm and country effects, trade in goods with a particular foreign country is associated with a significantly higher correlation between a firm and that foreign country. By contrast, there is no significant relationship between multinational linkages at the firm level and comovement with foreign GDP. The impact of direct trade linkages has significant aggregate implications. Directly connected firms account for two-thirds of the observed aggregate comovement. Without those linkages the correlation between France and foreign countries would fall by about 0.1. These results are evidence of transmission of business cycle shocks through direct trade linkages at the firm level, and of the important role of granularity in international business cycle comovement.

JEL Classifications: F44, F61, F62

Keywords: Comovement, International Trade, Firm-Level Shocks, Large Firms

*We would like to thank Eda Gulsen for expert research assistance. E-mail (URL): julian.digiovanni@upf.edu (http://julian.digiovanni.ca), alev@umich.edu (http://www.alevchenko.com), isabelle.mejean@polytechnique.edu (http://www.isabellemejean.com).

1 Introduction

The international business cycle exhibits two prominent features. First, there is significant positive business cycle comovement between countries. And second, country pairs that are more closely linked through goods trade or multinational production exhibit greater comovement. Taken at face value, these two facts coupled with ever greater economic integration appear to suggest that shocks are transmitted across countries through trade and multinational linkages. Working predominantly with aggregate models and data, the literature has struggled to provide convincing empirical evidence of cross-country transmission of shocks, and to develop quantitative frameworks that can successfully replicate the features of business cycle comovement observed in the data.

Until now the literature has by and large not studied the properties of cross-border comovement at the firm level, or its aggregate implications. By contrast, an emerging research agenda in closed-economy macro has argued convincingly that modeling and measuring shocks at the micro level (to firms and sectors) is essential for understanding aggregate fluctuations. Gabaix (2011), di Giovanni and Levchenko (2012), and Carvalho and Grassi (2013) develop models in which aggregate fluctuations arise from shocks to individual firms, because the firm-size distribution is extremely fat-tailed (Zipf's Law). Acemoglu et al. (2012) and Carvalho and Gabaix (2013) argue that sectoral shocks lead to aggregate fluctuations through interconnections between sectors. Di Giovanni et al. (2014) and Atalay (2014) provide corresponding empirical evidence on the role of shocks to firms and sectors in aggregate fluctuations.

If large firms and firm-to-firm linkages matter for aggregate fluctuations, a natural conjecture is that they will matter as much if not more for cross-border comovement. Larger firms are disproportionately more likely to trade internationally and own affiliates in foreign countries. Indeed, in most countries international trade flows are dominated by only a handful large firms. If transmission of shocks through trade and multinational linkages leads to positive aggregate comovement, it should first be detectable at the firm level.

This paper provides a forensic account of international comovement at the firm and aggregate level using data covering the universe of French firm-level production, destination-specific imports and exports, and cross-border ownership over the period 1991-2007. To set the stage, we start with the observation that the aggregate business cycle correlation between France and another country is simply an appropriately weighted sum of the firm-level correlations with that country. Some French firms will exhibit direct linkages to the

foreign country, through importing from it, exporting to it, or cross-border ownership of affiliates. The aggregate business cycle correlation between France and each country can thus be written as a sum of two terms: the part due to the directly connected firms, and the part due to the not directly connected firms. Working with a set of 10 large trading partners of France, we show that the large directly connected firms are important in accounting for aggregate comovement. For a typical foreign partner country, the directly connected firms represent only about 10% of all firms in our dataset. However, they account for 45% of total value added.

This decomposition is evidence that the combined firms with direct linkages to a particular foreign country are large enough to affect aggregate outcomes in France. Next, we establish that the direct linkages indeed serve as a conduit for the transmission of foreign shocks. We estimate a specification inspired by Frankel and Rose (1998), that relates comovement with foreign GDP at the firm level to firm-level direct linkages. Because the sample includes many firms and countries, estimation controls for firm and country effects, which absorbs the common aggregate shocks affecting France and each foreign country, and allows us to identify the effects from the differences in correlation across countries for the same firm. Trade linkages at the firm level are significantly associated with increased comovement between an individual firm and the country with which it trades. An import link increases the correlation by 0.01, and an export link by 0.002. This is large relative to the average correlation between an individual firm and foreign GDP, which is 0.02 for directly connected firms, and zero for non directly connected ones. By contrast, after controlling for country effects, multinational links do not have a robust positive association with comovement at the firm level.

Finally, we build up to the aggregate implications of these micro-level estimates. The directly connected firms are unconditionally more correlated with the foreign country. Together with the fact that they account for almost half of the aggregate value added, this implies that the directly connected firms account for two-thirds of the aggregate business cycle correlation observed in the data. We then use the conditional relationship between direct connections and firm-level correlations to compute the change in the aggregate correlation between France and each foreign country that would occur if direct linkages at the firm level disappeared. The aggregation exercise combines information on the change in the correlation at the firm level with firm-level weights. On average, if direct linkages at the firm level were severed, the aggregate correlation would fall by 0.1. Since the observed correlations between France and its main trading partners are at most 0.35 over this period,

this is a sizeable change.

Our paper contributes to the literature on international business cycle comovement. An important research agenda, going back to Backus et al. (1995), attempts to understand the positive GDP correlation across countries using representative firm models in which all shocks are aggregate. Later developments in this literature explore the role of the production structure, such as input-output linkages (Burstein et al., 2008; Arkolakis and Ramanarayanan, 2009), or firm heterogeneity (Ghironi and Melitz, 2005; Alessandria and Choi, 2007) but have similarly been confined to considering only the role of aggregate productivity shocks in generating cross-country business cycle comovement.

The landmark paper by Frankel and Rose (1998) establishes that country pairs that trade more with each other exhibit more correlated business cycles. While this robust empirical regularity has been confirmed repeatedly in subsequent studies, the literature has struggled to understand it. Kose and Yi (2006) and Johnson (2014) show that even quite sophisticated IRBC models fail to capture this relationship, dubbing it the "trade-comovement puzzle." The literature on multinationals and international business cycle comovement is more limited, but shares a similar feature. Kleinert et al. (2012) show that French regions that contain more multinationals from a particular foreign country are more correlated with that country. However, Cravino and Levchenko (2014) show that the observed multinational presence alone cannot generate the level of positive comovement found in the data.

While the existing empirical literature has focused almost exclusively on aggregate GDP correlations, this paper explores the transmission of shocks internationally at the firm level, and derives the aggregate implications based on micro-level estimates. In this respect, it shares some features with recent papers by Kurz and Senses (2013), Boehm et al. (2014), and Cravino and Levchenko (2014), who perform related exercises.

The rest of the paper is organized as follows. Section 2 lays out the conceptual framework and the empirical exercises performed in the paper. Section 3 describes the data, and Section 4 the results. Section 5 concludes.

2 Conceptual Framework

Total value added X_t by all French firms in year t is by definition given by: $X_t \equiv \sum_{f \in I_t} x_{ft}$, where x_{ft} is defined as the value added of firm f in year t, and I_t is the set of firms f operating at t. The growth rate of aggregate value added is then defined simply as $\gamma_{At} = X_t/X_{t-1} - 1$, where we assume that X_{t-1} and X_t are the aggregate value added of

all firms that exist both at $t-1$ and t, i.e. we restrict attention to the *intensive margin* of aggregate value added growth.[1]

The growth rate of aggregate sales can be written as a function of individual firm growth rates and firm shares:

$$\gamma_{At} = \sum_f w_{ft-1}\gamma_{ft}, \tag{1}$$

where γ_{ft} is the growth rate of value added of firm f, and w_{ft-1} is the share of f's value added in total French value added.

The object of interest is the correlation between French aggregate growth and foreign GDP growth. Let $\gamma_{\mathcal{C}t}$ be the GDP growth of a foreign country $\mathcal{C}$ between $t-1$ and t. This correlation is given by:

$$\rho\left(\gamma_{At}, \gamma_{\mathcal{C}t}\right) = \frac{\text{Cov}\left(\gamma_{At}, \gamma_{\mathcal{C}t}\right)}{\sigma_A \sigma_{\mathcal{C}}}, \tag{2}$$

where $\sigma_{\mathcal{C}}$ is the standard deviation of country $\mathcal{C}$ growth.

Unfortunately, working with equation (1) directly to produce a decomposition of the aggregate correlation (2) is impractical because time-varying weights w_{ft-1} make the stochastic process (1) difficult to analyze.

Instead, we work with a closely related set of stochastic processes:

$$\gamma_{At|\tau} = \sum_f w_{f\tau-1}\gamma_{ft}. \tag{3}$$

For a given τ, $\gamma_{At|\tau}$ is a stochastic process in which weights $w_{f\tau-1}$ are fixed over time at their $\tau-1$ values, and combined with growth rates from period t. Naturally, when $\tau = t$, the "synthetic" aggregate growth rate $\gamma_{At|\tau}$ coincides with the actual aggregate growth rate γ_{At}. The correlation between $\gamma_{At|\tau}$ and foreign GDP growth can be written as:

$$\begin{aligned}
\rho\left(\gamma_{At|\tau}, \gamma_{\mathcal{C}t}\right) &= \frac{\text{Cov}\left(\gamma_{At|\tau}, \gamma_{\mathcal{C}t}\right)}{\sigma_{A\tau}\sigma_{\mathcal{C}}} \\
&= \frac{\text{Cov}\left(\sum_f w_{f\tau-1}\gamma_{ft}, \gamma_{\mathcal{C}t}\right)}{\sigma_{A\tau}\sigma_{\mathcal{C}}} \\
&= \frac{\sum_f w_{f\tau-1}\text{Cov}\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right)}{\sigma_{A\tau}\sigma_{\mathcal{C}}} \\
&= \frac{\sum_f w_{f\tau-1}\sigma_f\sigma_{\mathcal{C}}\rho\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right)}{\sigma_{A\tau}\sigma_{\mathcal{C}}} \\
&= \sum_f w_{f\tau-1}\frac{\sigma_f}{\sigma_{A\tau}}\rho\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right),
\end{aligned} \tag{4}$$

[1] In earlier work using these data (di Giovanni et al., 2014) we show that the extensive margin is not quantitatively important for fluctuations at the business cycle frequency.

where σ_f is the standard deviation of γ_{ft}, and $\sigma_{A\tau}$ is the standard deviation of $\gamma_{At|\tau}$.[2]

While simply an identity, Equation (4) states the key premise of the paper: the aggregate correlation between the French economy and another country is a weighted sum of the firm-level correlations, times the relative standard deviation of the firm to the aggregate. We proceed by analyzing first the properties of the individual firm-level correlations $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$, and then the consequences of aggregation across firms.

2.1 Micro Evidence

Equation (4) emphasizes that the aggregate business cycle correlation between the French economy and foreign countries is a function of the individual firm-level correlations and these firms' weights in the total French economy. We start by establishing whether the direct trade and multinational linkages at the firm level to a particular foreign country are associated with a higher correlation between the firm and that foreign country. To that end, we estimate the following specification:

$$\rho(\gamma_{ft}, \gamma_{\mathcal{C}t}) = \alpha + \beta_1 EX_{f,\mathcal{C}} + \beta_2 IM_{f,\mathcal{C}} + \beta_3 AFF_{f,\mathcal{C}} + \beta_4 HQ_{f,\mathcal{C}} + \delta_f + \delta_{\mathcal{C}} + \eta_{f,\mathcal{C}}. \quad (5)$$

In equation (5), the correlation between a firm and a foreign market $\mathcal{C}$ is related to binary indicators of whether the firm exports there ($EX_{f,\mathcal{C}}$), imports from there ($IM_{f,\mathcal{C}}$), is a French multinational with affiliates in $\mathcal{C}$ ($AFF_{f,\mathcal{C}}$), or is an affiliate of a foreign multinational headquartered in $\mathcal{C}$ ($HQ_{f,\mathcal{C}}$). Importantly, the specification admits both firm and country effects, allowing for a precise identification of transmission of shocks through direct linkages.

The specification is inspired by Frankel and Rose (1998), but leads to qualitatively new insights relative to the traditional cross-country empirical model. First, estimation at the firm level reveals the micro underpinnings of the aggregate relationship. Observing cross-border links at the firm level allows us to establish with forensic precision the role of trade and multinational links in international comovement. Second, comparing firms within the same country and including country and firm fixed effects addresses a common critique of Frankel-Rose style regressions: inability to control for common shocks (Imbs, 2004). Since all firms in this specification are in France, country effects will absorb the common shocks affecting France and country $\mathcal{C}$. As a result, we can establish convincingly that trade and multinational linkages are indeed a source of transmission of shocks, rather than simply a stand-in for the presence of common shocks.

[2]The approach of constructing aggregate moments under weights that are fixed period-by-period follows Carvalho and Gabaix (2013) and di Giovanni et al. (2014), who apply it to variance decompositions.

2.2 From Micro to Macro

Next, we investigate the macroeconomic implications of these micro findings. The aggregate correlation as written in (4) is additive in the individual firm-level correlations with foreign GDP, and thus can be decomposed easily into the various components. Since we are interested in the impact of individual firms on aggregate correlations, we can decompose the summation of idiosyncratic shocks into two sets of firms: the directly connected and the not directly connected to a particular country:

$$\sum_{f} w_{f\tau-1}\gamma_{ft} = \sum_{f\in I_{\mathcal{C}}} w_{f\tau-1}\gamma_{ft} + \sum_{f\in I_{\mathcal{C}}^{c}} w_{f\tau-1}\gamma_{ft}$$

where $I_{\mathcal{C}}$ is the set of firms that satisfy at least one of the four criteria included in estimating equation (5): (i) export to $\mathcal{C}$; (ii) import from $\mathcal{C}$; (iii) is a French affiliate of a multinational based in $\mathcal{C}$; or (iv) is part of a French multinational that has affiliates in $\mathcal{C}$. Correspondingly, $I_{\mathcal{C}}^{c}$ is the complement of that set of firms. Then, the aggregate comovement decomposes additively into two components, one due to the directly connected firms, and the other due to the rest:

$$\rho\left(\gamma_{At|\tau}, \gamma_{\mathcal{C}t}\right) = \frac{\sigma_{I_{\mathcal{C}}\tau}}{\sigma_{A\tau}}\rho\left(\sum_{f\in I_{\mathcal{C}}} w_{f\tau-1}\gamma_{ft}, \gamma_{\mathcal{C}t}\right) + \frac{\sigma_{I_{\mathcal{C}}^{c}\tau}}{\sigma_{A\tau}}\rho\left(\sum_{f\in I_{\mathcal{C}}^{c}} w_{f\tau-1}\gamma_{ft}, \gamma_{\mathcal{C}t}\right), \tag{6}$$

where $\sigma^2_{I_{\mathcal{C}}\tau} = \text{Var}\left(\sum_{f\in I_{\mathcal{C}}} w_{f\tau-1}\gamma_{ft}\right)$ is the variance of the combined sales of the directly connected terms, and similarly for $\sigma^2_{I_{\mathcal{C}}^{c}\tau}$.

By bringing in information on firm weights $w_{f\tau-1}$, this additive decomposition will provide the first glimpse of whether the directly connected firms combined are a large enough segment of the economy to play an appreciable role in aggregate comovement. Of course, this decomposition yields only part of the answer: the direct component can be large either because the directly connected firms are large, or because they are more correlated. Estimates of equation (5) provide the means of separating the two.

For each directly connected firm, we can compute the predicted change in its correlation with country $\mathcal{C}$ if it were no longer connected with $\mathcal{C}$:

$$\widehat{\Delta\rho}\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right) = -\widehat{\beta}_1 \mathbb{1}\left(EX_{f,\mathcal{C}} = 1\right) - \widehat{\beta}_2 \mathbb{1}\left(IM_{f,\mathcal{C}} = 1\right) - \widehat{\beta}_3 \mathbb{1}\left(AFF_{f,\mathcal{C}} = 1\right) - \widehat{\beta}_4 \mathbb{1}\left(HQ_{f,\mathcal{C}} = 1\right). \tag{7}$$

As an example, if firm f only exported to $\mathcal{C}$ and had no other links, the predicted change in the correlation between f and $\mathcal{C}$ is simply $-\widehat{\beta}_1$. The formulation (7) allows for every

combination of different types of direct links, and turns off all the existing ones at the same time.

Combining (7) with (4), the predicted change in the aggregate business cycle correlation between France and $\mathcal{C}$ if all cross-border links were severed is:

$$\widehat{\Delta\rho}\left(\gamma_{At|\tau}, \gamma_{\mathcal{C}t}\right) = \sum_{f} w_{f\tau-1} \frac{\sigma_f}{\sigma_{A\tau}} \widehat{\Delta\rho}\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right). \tag{8}$$

For simplicity, this calculation assumes that the severing of the direct links does not have an impact on volatilities either at the firm or the aggregate level, or on firm weights.

3 Data and Basic Patterns

The empirical analysis conducted in this paper relies on several firm-level databases. The main object of interest is the correlation between French and foreign GDP growth. At the most disaggregated level, it is measured using a database that covers the universe of French firm sales and value added over the period 1991-2007. The dataset is described in detail in di Giovanni et al. (2014). Importantly, it covers the entire French economy, manufacturing and non-manufacturing sectors included. We augment it with information on each firm's direct trade and multinational linkages, disaggregated by foreign partner country. Namely, we use Customs data to recover bilateral export and import flows, at the level of each individual firm. Finally, information on the firm ownership linkages is taken from the *LIaisons FInancieres* (LIFI) database, an administrative dataset that provides information about the ownership and nationality of the parent company of firms located in France. Together, these two datasets provide firm-level information on all possible direct links to each individual foreign country, whether through cross-border trade or multinational production. Finally, note that we do not have any information at the plant level.

The value added data, as well as additional variables, come from the balance sheet information collected from firms' tax forms. The original dataset is quasi-exhaustive. However, the amount of information that has to be provided to the fiscal administration differs according to the firm's size. Namely, the French tax system distinguishes three different regimes, the "normal" regime (called BRN for *Bénéfice Réel Normal*), the "simplified" regime (called RSI for *Régime Simplifié d'Imposition*) that is restricted to smaller firms, and the "micro-BIC" regime for entrepreneurs.[3] Throughout the exercise, "micro-BIC"

[3]Under some conditions, firms can choose their tax regime. In 2010, an individual entrepreneur can decide to enroll in the "micro-BIC" regime if its annual sales are below 80,300 euros. Likewise, a firm can choose to participate in the RSI rather than the BRN regime if its annual sales are below 766,000 euros (231,000 euros in services). Those thresholds are adjusted over time, but marginally so.

and "RSI" firms are excluded. We do not have enough information for "micro-BIC" firms. We also exclude "RSI" firms, both because their weight in annual sales is negligible and because it is difficult to harmonize these data with the rest of the sample. In 2007, those firms represented less than 4% of total sales and about 11% of total employment. Thus, our sample represents the bulk of the aggregate French economy. In this sample, it is possible to classify firms according to the sector in which they operate, using information on their NAF code.[4]

The information collected by the tax authorities is combined with the firm-level export and import data from the French customs authorities. The datasets can be merged using a unique firm identifier, called SIREN. On top of the firm dimension, the customs data also detail trade flows by their country of destination (for exports) or the country of origin (for imports). This is what makes it possible to investigate the heterogeneity of trade linkages within firm across different foreign countries. The customs data are also quasi-exhaustive. There is a declaration threshold of 1,000 euros for annual exports to and annual imports from any given destination outside the European Union. Below the threshold, the customs declaration is not compulsory. Since 1993, intra-EU trade is no longer liable for any tariff, and as a consequence firms are no longer required to submit the regular customs form. A new form has however been created that tracks intra-EU trade. Unfortunately, the declaration threshold for this kind of trade flows in much higher, around 150,000 euros per year in 2010. A number of firms continue declaring intra-EU trade flows below the threshold however, either because they don't know ex ante that they will not reach the 150,000 Euro limit in a given fiscal year, because they apply the same customs procedure for all export markets they serve, or because they delegate the customs-related tasks to a third party (e.g., a transport firm) that systematically fills out the customs form. Below-cutoff trade flows missing from customs data imply that we might underestimate the contribution of direct trade linkages as a driver of aggregate comovements.[5]

[4] "NAF", *Nomenclature d'Activités Française*, is the French industrial classification. Our baseline analysis considers the level of aggregation with 60 sectors. This corresponds to the 2-digit ISIC (Revision 3) nomenclature. We drop NAF sectors 95 (domestic services), and 99 (activities outside France). We also have to neglect the banking sector due to important restructuring at the beginning of the 2000s that makes it difficult to follow individual firms. The NAF nomenclature has been created in 1993, as a replacement for the "NES" (Nomenclature Economique de Synthèse). Data for 1990–92 are converted into the NAF classification using a correspondence table.

[5] We can judge how many exports we are missing by comparing exports declared on tax forms to exports declared to customs. It appears that the problem is relatively minor. In 10% of firm-year observations, the tax form reports exports but the customs data do not. These observations account for 7% of overall exports. On average, the total exports reported in the tax form but missing from customs (413,000 euros per year) are an order of magnitude smaller than average exports in the whole sample, which are 3,056,000.

Finally, the LIFI data is used to recover information on i) whether each French firm is an affiliate of a company headquartered in a particular foreign country, or ii) whether each firm is or belongs to a French company that owns foreign affiliates in a particular foreign country. The LIFI database is constructed by the French statistical institute (INSEE). It is not exhaustive, but it has a good coverage. All firms with more than 500 employees or a turnover above 60 millions euros, whatever their sector of activity, are included in the survey. Moreover, the information is complemented with two additional administrative sources that allow integrating a large number of smaller groups. According to the French statistical institute, a firm is an affiliate of a group if the latter has the (direct or indirect) majority of voting rights. Using this definition, INSEE identifies firms that own affiliates abroad, together with the nationalities of those affiliates. When the French firm is identified as affiliate of a foreign company, the nationality of the group is recorded as well.

The firm-level correlation coefficients are measured using the time dimension of the value added data, at the firm-level. On the other hand, the empirical strategy does not require to use the time variability of measures of each firm's direct links with each destination country. To construct the dummies for whether a firm exports ($EX_{f,C}$), imports ($IM_{f,C}$), has affiliates in the destination ($AFF_{f,C}$) or is an affiliate of a foreign multinational firm ($HQ_{f,C}$) the time dimension is thus collapsed. Namely, in the baseline analysis the dummy is set to one whenever the firm satisfies the corresponding condition over at least one year in the period of observation.[6]

Figure 1 plots the growth rates of aggregate value added (and sales), exports, and imports, together with the growth rate of GDP from IMF's International Financial Statistics, and total exports and imports from IMF's Direction of Trade Statistics. The aggregates in our sample of firms mimic the aggregate data from standard sources quite well.

Table 1 presents the basic stylized facts on the composition of the sample. Panel A reports the summary statistics for the whole economy, and Panel B for the manufacturing sector only. The first two columns report the number of observations and the number of firms in the dataset. There are about 800 thousand firms in total, and nearly 7 million firm-year observations. The rest of the panel reports the summary statistics for exporters, importers, affiliates of foreign multinationals, and French firms with foreign affiliates. These four categories are of course not mutually exclusive. The table reports the total numbers of observations and firms, the mean and median value added in each category, and the

[6]The results are robust to instead defining the dummy to equal 1 whenever the firm is connected for at least 50% of the years it is present in the sample.

percentage of total value added captured by each category of firms.

As expected, firms engaged in an international activity represent a small share of the population of French firms. Around 20% of French firms export or import. There are an order of magnitude more exporters and importers than multinational firms: about 160-170 thousand of importers and exporters, compared to 18 thousand affiliates of foreign multinationals, and 33 thousand French firms that have foreign affiliates. Each category of the internationally connected firms has larger average value added than purely domestic firms. The largest category on average is the affiliates of foreign multinationals. More novel is the information in the last column that reports the share of total value added in France that is taken up by each category of firms. These statistics have not, to our knowledge, been previously reported. It turns out that exporters account for 70% of total French value added, and importers 66%. By contrast, multinational firms account for a smaller share of economic activity, with about 20% for each foreign affiliates and French multinational category. Panel B reports the same statistics for the manufacturing sector. Not surprisingly, the shares of exporters and importers are even larger, at around 90%.

Table A1 presents the average standard deviations of firm-destination growth rates across sectors, along with the shares of each sector in total sales. The raw volatility of sales growth varies across sectors, with the standard deviation ranging from a low of 0.1489 (Health and social work) to a high of 0.3248 (Coke, refined petroleum and nuclear fuel), and a cross-sectoral mean standard deviation of 0.2593. The wholesale and retail trade sector has by far the highest share in aggregate sales, at nearly 37% of the total. While the standard deviation of sales growth, at 0.2188, is quite typical of the rest of the economy, clearly wholesale and retail trade is quite special in other ways. To establish the robustness of the results, all of the analysis below is carried out both on the whole economy and on the manufacturing sector.

Table 2 reports the measures of connectedness and firm-level correlations for France's 10 major trading partner countries.[7] For each country, the table presents the number of directly connected firms, the combined share of those firms in total French value added, and the mean correlation between an individual firm and the GDP growth of that country. The last three columns report the same statistics for the not directly connected firms. The table reveals the extent to which aggregate comovement is driven by large firms. On average, and for most individual countries, there are an order of magnitude fewer directly connected firms

[7]These countries are 9 of the top 10 trading partners of France plus Brazil, which we included as a major emerging market to make the sample more diverse and less dominated by European countries.

than non-directly connected firms. At the mean, there are 77 thousand directly connected, and 790 thousand not directly connected firms. However, the directly connected firms take up on average 44% of total French value added. For every single partner country, the directly connected firms are more correlated with the foreign GDP, with an average difference in correlation of 0.023 in this set of countries. The variation across countries is as expected. In the 4 countries most closely integrated with France – Belgium, Germany, the UK, and Italy – the directly connected firms account for over half of all French value added. At the other extreme, the firms directly connected to Brazil, China, and Japan account for 0.246 and 0.327, and 0.328 of aggregate French value added, respectively.

Panel B reports the same statistics for the manufacturing sector. The role of the directly connected firms is greater in this sample. On average, the directly connected firms account for two-thirds of aggregate manufacturing value added, even enough they comprise less than one-quarter of all the firms in this sample. The average correlations are slightly higher for manufacturing firms compared to the whole economy, but the difference is not large.

Table 3 further separates the directly connected firms into importers, exporters, and foreign and domestic multinationals. Once again, the categories are not mutually exclusive. There are large differences between the trading firms and the multinationals. Directly connected exporters and importers account for 32 and 37 percent of aggregate French value added for this set of foreign countries, or over three-quarters of the total value added of connected firms. By contrast, affiliates of foreign multinationals from an individual country take up 1.4% of aggregate value added. French firms with foreign affiliates account for 11.4% of aggregate value added. There are also many fewer multinational firms of both kinds than trading firms. The manufacturing sector (Panel B) yields similar results.

4 Main Results

4.1 Firm-Level Linkages and Correlations

Table 4 reports the results of estimating Equation (5). The baseline sample includes all firms, and performs the analysis on the growth rates of value added. The standard errors are clustered at the firm level. The first column presents the basic estimation without any fixed effects. All four forms connectedness are positive and strongly significant. The coefficient magnitudes are sizeable as well. Importing or exporting is associated with increases in the correlation of 0.027, being a foreign affiliate of 0.032, and having foreign affiliates of 0.015. The next column adds firm fixed effects. In this specification, the coefficients are

estimated from the variation within the same firm across the 10 partner countries. Some of the point estimates fall somewhat, but overall all 4 forms of connectedness remain positive and strongly significant.

The next column adds country effects. Given that this specification adds only 10 dummy variables to a regression with more than 8 million observations, it is remarkable how dramatically the coefficients change. The importer coefficient falls by a factor of 3, and the exporter coefficient by a factor of 10. Both multinational coefficients decrease and cease to be statistically significant. This change in the coefficient is a stark illustration of the key tension in the Frankel-Rose type estimation: disentangling transmission of shocks through trade from common shocks. Taken at face value, the Frankel and Rose (1998) result that countries that trade more are more correlated appears to suggest that trade linkages transmit shocks across countries. However, as argued forcefully by Imbs (2004), trade intensity at the bilateral country level could simply be a proxy for a greater prevalence of common shocks (see also the discussion in di Giovanni and Levchenko, 2010). By using firm-level data, we can control much better for the common shocks that affect France and its trading partners. The contrast between the specifications with and without country effects shows why it is important to do so. Without country effects (and even after including firm effects), it looks like directly connected firms are strongly correlated with the markets with which they are linked. However, it is clear that a large part of these estimated coefficients is driven by the fact that firms are more likely to establish direct links with more correlated markets. Adding country effects controls for the average correlation between French firms and each country, and reduces the estimated impact of direct connectedness considerably.

Nonetheless, column 3 shows that even after controlling for common shocks, direct trade linkages increase comovement between a firm and the foreign country. A direct importing link is associated with an increase in the firm-level correlation of 0.01, and an exporting link of 0.002. Relative to the mean correlation of about 0.02 for the directly connected firms, these coefficients are sizeable.

The rest of the table checks robustness of the results to different samples and left-hand side variables. Both firm and country effects are included throughout. Column 4 checks what happens if we only use firms for which we have at least 10 years of value added data based on which to compute the correlation with foreign countries. The sample drops dramatically, from about 8 million to just over 3 million. The importing coefficient is preserved, though the point estimate falls by almost half. The exporter coefficient is no longer positive, in fact it turns negative and significant, though small in absolute terms.

The weakening of the results is to be expected, as including firm fixed effects is extremely demanding, and our procedure requires a lot of observations to identify the effect. Losing more than 60% of the sample produces less robust results.

Column 5 reports the estimates in which we use the correlation between firm idiosyncratic shocks and foreign GDP. The idiosyncratic shocks are identified following di Giovanni et al. (2014) by extracting the sector- and destination-specific components from firm growth rates, and retaining the residual as the idiosyncratic shock.[8] The results are similar to column 3. Column 6 uses the correlation of firm sales instead of value added. The results are stronger than in the baseline. Finally, column 7 reports the results for the manufacturing sector only. The results are similar.

To summarize, direct connectedness through importing is robustly positively associated with greater comovement between a firm and foreign GDP. This effect is identified from the variation across foreign countries within the firm (i.e., by comparing the firm's correlation with a country that it trades with to its correlation with a country that it does not), and after controlling for common aggregate shocks. Thus, this result can be interpreted as robust evidence for transmission of shocks through trade. On the other hand, after controlling for common shocks, exporting has a much smaller effect (about one-fifth that of importing), and multinational presence is insignificant.

4.2 Aggregate Implications

Table 5 presents the decomposition in (6). For each country, it reports the average aggregate correlation $\rho\left(\gamma_{At|\tau}, \gamma_{\mathcal{C}t}\right)$, as well as the shares of the aggregate correlation due to the directly and not directly connected firms. The top panel reports the results for the whole economy, and the bottom panel for the manufacturing sector only.

In the whole economy, on average almost 60% of the aggregate correlation is taken up by the directly connected firms. The shares are always between zero and one, implying that the direct and indirect components always have the same sign as the overall correlation. In

[8] Di Giovanni et al. (2014) set up a simple heterogeneous firms model to show that the growth rate of firm f's sales to destination market n (which could be France or a foreign country) in sector j is given by:

$$\gamma_{fnt} = \delta_{jnt} + \varepsilon_{fnt},$$

where δ_{jnt} is the macro-sectoral shock that is common to all French firms' sales to market n in sector j, and ε_{fnt} is the idiosyncratic shock to firm f's sales to market n. After extracting the destination-specific firm idiosyncratic shock, we compute the overall firm idiosyncratic shock by weighting the destination-specific shocks by the firm-level sales shares to destination: $\varepsilon_{ft} \equiv \sum_n \omega_{fnt-1}\varepsilon_{fnt}$, where the ω_{fnt-1} is the share of sales to market n in the firm's total sales. If the firm only sells domestically, then trivially $\varepsilon_{ft} = \varepsilon_{fnt}$. We do not have a breakdown of firm value added by destination, and thus we assume that value added shares equal sales shares for firms selling to multiple markets.

the manufacturing sector, the observed correlations are on average higher, and the share taken up by the directly connected firms is larger, at 0.81 on average.

This decomposition is merely suggestive that direct links are responsible for the observed aggregate comovement. Equation (6) shows that the direct component could be large both because the directly connected firms account for the large share of the economy, and/or because they exhibit larger correlations with the foreign country. Table 2 shows indeed that both of those things are true. However, the higher correlations reported for the directly connected firms in the table are not necessarily evidence of transmission of shocks. To isolate the role of the transmission of shocks, we next make use of the econometric estimation results.

We first compute, based on each firm's connectedness values, how much its correlation with each country would change if it were no longer connected to that country, as in (7). For all firms that are not connected at all to a particular country, this change is zero. We then aggregate according to Equation (8). This equation takes into account the interaction between relative firm sizes (w_f) and connectedness: the impact on aggregate comovement would be greater, all else equal, if the connected firms take up a larger share of aggregate value added.

Table 6 presents the results of computing the change in the aggregate correlation as in (8). It reports the actual correlation in the data, the predicted change in the correlation if none of the firms were connected, and the standard error for that predicted change in correlation. The aggregate effect is sizeable: on average correlation would decrease by about 0.1 if firms stopped being connected. By comparison, the actual observed correlations are about 0.35 at the maximum.

As the weights $w_{f\tau-1}$ differ from year to year, Equation (8) yields an estimate of the change in aggregate correlation for each year 1991-2007. Figure 2 plots the change in aggregate correlation for each country and each year, along with the 2-standard error bands. The first page of the figure displays the European trading partners, and the second page the non-European ones, that tend to be both less correlated and less directly connected than the European ones. The y-axis has the same scale in all plots. It is clear that there is not much difference in the aggregate correlation change with respect to the European partners, and the changes year to year are quite similar as well. This is not surprising, as the calculation does not involve country-specific information on the level of the correlation between France and these countries, and the estimated regression coefficients are not country-specific. The variation across countries is driven by the differences in the set of connected firms. Evidently,

across the top 6 European trade partners, the sets of directly connected firms are similar. There is more heterogeneity across non-European trading partners, and greater differences between non-European and European ones. All in all, both the relative similarity in levels and the time variation across countries illustrates that the directly connected firms are often the same ones across trading partners. We conjecture that this is because the set of directly connected firms is dominated by the largest trading firms that serve multiple markets. Figure 3 presents the same results for the manufacturing sector. The similarities across countries are if anything greater in this sample. This is to be expected, as the manufacturing sample is even more dominated by the large exporters than the whole economy.

An important assumption underlying this aggregation exercise is that there are no other general equilibrium interactions that change firm-level correlations when France's openness changes. In particular, the calculation assumes that (i) the change in the correlation of all directly connected firms is given by (7); and (ii) the change in the correlation of all not directly connected firms is zero. Thus, it ignores the possibility that a change in France's overall openness has feedback effects that change the firm-level correlations away from what is predicted by the micro-level regressions. These feedbacks are potentially interesting but there are no established intuitions or results that could even point to the direction of those effects. Clearly, general equilibrium feedbacks can only be analyzed within a full general equilibrium model structure, and are inaccessible to the regression estimation-type approach adopted here. Nonetheless, by combining micro-level results on changes in comovement at the firm level with information on the combined size of the connected firms, our results are informative of the size of the likely aggregate effect.

5 Conclusion

In order to understand fluctuations at the macro level, we must understand micro-level behavior. This paper applies this principle to international business cycle comovement by analyzing this phenomenon at the firm level. Because the largest firms are the most likely to exhibit direct international linkages, we show that they account for nearly half of French aggregate value added. We next show that they are more correlated with the countries to which they are directly connected through trade. Combining the two, the directly connected firms account for two-thirds of the observed aggregate correlations between France and its major trading partners, and if these direct linkages were severed, the aggregate correlations would fall by 0.1.

A clear next step in this research agenda is to model the propagation of foreign shocks

through the domestic economy beyond the directly connected firms. Understanding the interactions between the directly connected firms and the rest of the French economy through input, factor, and goods markets will be crucial for developing the full picture of interdependence between France and its trading partners.

References

Acemoglu, Daron, Vasco M. Carvalho, Asuman Ozdaglar, and Alireza Tahbaz-Salehi, "The Network Origins of Aggregate Fluctuations," *Econometrica*, September 2012, *80* (5), 1977–2016.

Alessandria, George and Horag Choi, "Do Sunk Costs of Exporting Matter for Net Export Dynamics?," *Quarterly Journal of Economics*, 2007, *122* (1), 289–336.

Arkolakis, Costas and Ananth Ramanarayanan, "Vertical Specialization and International Business Cycle Synchronization," *Scandinavian Journal of Economics*, December 2009, *111* (4), 655–680.

Atalay, Enghin, "How Important Are Sectoral Shocks?," January 2014. mimeo, University of Chicago.

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland, "International Business Cycles: Theory and Evidence," in Thomas Cooley, ed., *Frontiers of business cycle research*, Princeton: Princeton University Press, 1995, pp. 331–356.

Boehm, Christoph, Aaron Flaaen, and Nitya Pandalai Nayar, "Input Linkages and the Transmission of Shocks: Firm-Level Evidence from the 2011 Tohoku Earthquake," October 2014. mimeo, University of Michigan.

Burstein, Ariel, Christopher Kurz, and Linda L. Tesar, "Trade, Production Sharing, and the International Transmission of Business Cycles," *Journal of Monetary Economics*, 2008, *55*, 775–795.

Carvalho, Vasco M. and Basile Grassi, "Firm Dynamics and the Granular Hypothesis," October 2013. mimeo, CREI-UPF and PSE.

_ and Xavier Gabaix, "The Great Diversification and its Undoing," *American Economic Review*, August 2013, *103* (5), 1697–1727.

Cravino, Javier and Andrei A. Levchenko, "Multinational Firms and International Business Cycle Transmission," September 2014. mimeo, University of Michigan.

di Giovanni, Julian and Andrei A. Levchenko, "Putting the Parts Together: Trade, Vertical Linkages, and Business Cycle Comovement," *American Economic Journal: Macroeconomics*, April 2010, *2* (2), 95–124.

_ and _ , "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies," *Journal of Political Economy*, December 2012, *120* (6), 1083–1132.

_ , _ , and Isabelle Méjean, "Firms, Destinations, and Aggregate Fluctuations," *Econometrica*, July 2014, *82* (4), 1303–1340.

Eaton, Jonathan, Samuel S. Kortum, Brent Neiman, and John Romalis, "Trade and the Global Recession," January 2011. NBER Working Paper No. 16666.

Frankel, Jeffrey A. and Andrew K. Rose, "The Endogeneity of the Optimum Currency Area Criteria," *Economic Journal*, July 1998, *108* (449), 1009–25.

Gabaix, Xavier, "The Granular Origins of Aggregate Fluctuations," *Econometrica*, May 2011, *79* (3), 733–772.

Ghironi, Fabio and Marc J. Melitz, "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *Quarterly Journal of Economics*, August 2005, *120* (3), 865–915.

Imbs, Jean, "Trade, Finance, Specialization, and Synchronization," *Review of Economics and Statistics*, August 2004, *86* (3), 723–34.

Johnson, Robert C., "Trade in Intermediate Inputs and Business Cycle Comovement," *American Economic Journal: Macroeconomics*, October 2014, *6* (4), 39–83.

Kleinert, Jörn, Julien Martin, and Farid Toubal, "The Few Leading the Many: Foreign Affiliates and Business Cycle Comovement," September 2012. Forthcoming, *American Economic Journal: Macroeconomics*.

Kose, M. Ayhan and Kei-Mu Yi, "Can the Standard International Business Cycle Model Explain the Relation Between Trade and Comovement," *Journal of International Economics*, March 2006, *68* (2), 267–295.

Kurz, Christopher and Mine Z. Senses, "Importing, Exporting and Firm-Level Employment Volatility," 2013. FEDS Working paper 2013-44.

Table 1. Summary Statistics

	Panel A: Whole Economy				
	Obs. (firm×year)	No. firms	Value Added		
			Mean	Median	Share in total
All firms	6964577	809056	4690	650	1.00
Importers	1033739	178500	22216	3103	0.70
Exporters	895269	169921	23970	3312	0.66
Affiliates of foreign multinationals	180544	18374	33995	5527	0.19
Firms with foreign affiliates	331534	32615	19826	2412	0.20
	Panel B: Manufacturing Sector				
	Obs. (firm×year)	No. firms	Value Added		
			Mean	Median	Share in total
All firms	1139528	124687	10142	1060	1.00
Importers	386443	56586	27326	4420	0.91
Exporters	390770	57881	26350	3902	0.89
Affiliates of foreign multinationals	58824	5573	56623	11532	0.29
Firms with foreign affiliates	68242	6051	25713	4603	0.15

Notes: This table reports the summary statistics for the whole economy and the manufacturing sectors. It reports the number of firm× year observations, number of distinct firms, mean and median value added, and the share of a particular type of firm in total value added. The categories of firms are not mutually exclusive.

Table 2. Directly Connected and Not Directly Connected Firms

Panel A: Whole Economy

Country	Directly Connected			Not Directly Connected		
	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$
Belgium	114415	0.539	0.053	778806	0.461	0.026
Brazil	19770	0.246	-0.007	807392	0.754	-0.046
China	43032	0.327	-0.047	803814	0.673	-0.061
Germany	111458	0.544	0.052	777511	0.456	0.029
Spain	92859	0.486	0.040	788463	0.514	0.021
United Kingdom	83376	0.503	0.006	788803	0.497	-0.022
Italy	109547	0.514	0.060	779309	0.486	0.032
Japan	38292	0.328	-0.020	803098	0.672	-0.025
Netherlands	80859	0.487	0.055	791748	0.513	0.024
United States	74786	0.460	0.036	793844	0.540	0.018
Average	76839	0.443	0.023	791279	0.557	0.000

Panel B: Manufacturing Sector

Country	Directly Connected			Not Directly Connected		
	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$
Belgium	43846	0.812	0.067	108400	0.188	0.047
Brazil	9981	0.402	0.000	123693	0.598	-0.027
China	16649	0.448	-0.036	122901	0.552	-0.049
Germany	43557	0.824	0.059	107641	0.176	0.053
Spain	36677	0.754	0.042	113476	0.246	0.034
United Kingdom	33557	0.761	0.008	113972	0.239	-0.008
Italy	41421	0.789	0.065	109973	0.211	0.063
Japan	16699	0.519	-0.014	121405	0.481	-0.014
Netherlands	31826	0.732	0.067	115919	0.268	0.059
United States	29026	0.666	0.036	117459	0.334	0.024
Average	30324	0.671	0.029	115484	0.329	0.018

Notes: This table reports the features of directly connected and not directly connected firms for each partner countries. The columns report the number of firms, their combined share in aggregate value added (averaged across years), and the mean correlation between firm value added growth and the foreign country's GDP growth.

Table 3. Directly Connected Firms: by Connection Type

Panel A: Whole Economy

Country	Exporters			Importers			Affiliates of multinationals			Firms with foreign affiliates		
	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$
Belgium	70568	0.425	0.058	89942	0.480	0.053	2143	0.008	0.036	438	0.130	0.071
Brazil	12158	0.177	0.003	10297	0.120	-0.016	1	0.000	0.198	125	0.083	0.009
China	15261	0.184	-0.034	36060	0.220	-0.050	37	0.000	-0.080	228	0.119	-0.052
Germany	59923	0.404	0.055	95039	0.509	0.054	3267	0.024	0.064	455	0.128	0.075
Spain	52670	0.377	0.043	72970	0.411	0.038	543	0.002	0.010	552	0.132	0.053
United Kingdom	47274	0.378	0.013	65529	0.450	0.005	2938	0.021	0.001	423	0.129	0.035
Italy	54011	0.371	0.062	95213	0.473	0.060	1271	0.007	0.052	409	0.128	0.058
Japan	23443	0.234	-0.024	23613	0.262	-0.013	416	0.004	0.001	111	0.076	-0.015
Netherlands	42800	0.348	0.067	63621	0.420	0.049	2625	0.022	0.051	149	0.091	0.104
United States	43108	0.331	0.044	54526	0.394	0.032	3114	0.050	0.039	452	0.127	0.053
Average	42122	0.323	0.029	60681	0.374	0.021	1636	0.014	0.037	334	0.114	0.039

Panel B: Manufacturing Sector

Country	Exporters			Importers			Affiliates of multinationals			Firms with foreign affiliates		
	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$	No. firms	Combined share	Mean $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$
Belgium	34274	0.718	0.070	33650	0.729	0.066	693	0.014	0.069	102	0.046	0.068
Brazil	7474	0.350	0.008	4423	0.213	-0.005	0	0.000	0.000	46	0.037	0.030
China	8984	0.336	-0.033	12728	0.328	-0.035	4	0.000	-0.349	78	0.022	-0.056
Germany	30269	0.705	0.061	37391	0.786	0.060	1083	0.042	0.064	148	0.045	0.067
Spain	27078	0.665	0.048	27906	0.640	0.035	159	0.005	-0.002	146	0.050	0.081
United Kingdom	24559	0.654	0.015	26194	0.687	0.005	694	0.030	0.018	117	0.045	0.086
Italy	26815	0.657	0.070	35803	0.735	0.063	409	0.016	0.027	117	0.044	0.063
Japan	12207	0.423	-0.016	9734	0.400	-0.008	113	0.007	0.066	42	0.017	-0.034
Netherlands	22235	0.601	0.076	24218	0.637	0.062	677	0.031	0.045	42	0.035	0.100
United States	20590	0.545	0.043	20288	0.584	0.036	1091	0.092	0.028	163	0.046	0.078
Average	21449	0.565	0.034	23234	0.574	0.028	492	0.026	-0.004	100	0.039	0.048

Notes: This table reports the features of different types of directly connected firms. The columns report the number of firms, their combined share in aggregate value added (averaged across years), and the mean correlation between firm value added growth and the foreign country's GDP growth.

Table 4. Main Estimation Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline	Baseline	Baseline	>10 years per firm	Idio. Shocks	Sales	Manuf.
Dep. Var: $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$							
Importer	0.0267***	0.0293***	0.0099***	0.0049***	0.0060***	0.0143***	0.0067***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Exporter	0.0268***	0.0226***	0.0028***	-0.0021**	0.0025***	0.0095***	0.0028*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Foreign Affiliate	0.0318***	0.0225***	0.0119	0.0027	0.0133	0.0084	-0.0007
	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.015)
French Multinational	0.0145***	0.0096***	0.0023	-0.0037	0.0042	0.0006	0.0016
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Observations	8,088,384	8,088,384	8,088,384	3,188,170	8,088,270	8,670,311	1,246,559
R-squared	0.001	0.321	0.324	0.341	0.323	0.325	0.315
Firm FE	no	yes	yes	yes	yes	yes	yes
Country FE	no	no	yes	yes	yes	yes	yes
# of EX-ing firms	421216	421216	421216	265967	421208	414741	214485
# of IM-ing firms	606810	606810	606810	375267	606810	616671	232335
# of affiliates	3342	3342	3342	1996	3343	3822	1001
# of HQs	16355	16355	16355	8263	16354	17504	4923
# of firm FEs		809056	809056	318817	809056	867272	124687
# of country FEs			10	10	10	10	10

Notes: This table reports the results of estimating equation Equation (5). The independent variables are binary indicators for whether the firm imports from a country, exports to it, is an affiliate of a multinational firm from that country, or is a French multinational with affiliates in that country.

Table 5. Aggregate Correlations: Contributions of Direct and Indirect Terms

Country	Average $\rho_{A\|\tau}$ (observed)	Direct (share)	Indirect (share)
Panel A: Whole Economy			
Belgium	0.340	0.611	0.389
Brazil	-0.375	0.602	0.398
China	-0.515	0.541	0.459
Germany	0.200	0.589	0.411
Spain	0.353	0.474	0.526
United Kingdom	-0.075	0.883	0.117
Italy	0.263	0.358	0.642
Japan	-0.321	0.648	0.352
Netherlands	0.325	0.527	0.473
United States	0.249	0.689	0.311
Average	0.044	0.592	0.408
Panel B: Manufacturing Sector			
Belgium	0.584	0.917	0.083
Brazil	-0.103	0.432	0.568
China	-0.362	0.705	0.295
Germany	0.235	0.860	0.140
Spain	0.424	0.866	0.134
United Kingdom	0.222	0.984	0.016
Italy	0.391	0.837	0.163
Japan	-0.168	0.760	0.240
Netherlands	0.526	0.832	0.168
United States	0.427	0.908	0.092
Average	0.218	0.810	0.190

Notes: This table reports the results of decomposition Equation (6). The first column reports the actual correlation in the data.

Table 6. Aggregate Correlations: Contributions of Direct and Indirect Terms

Country	Average $\rho_{A\|\tau}$ (observed)	$\Delta\rho_A$	$s.e.(\Delta\rho_A)$
Belgium	0.340	-0.111	0.015
Brazil	-0.375	-0.058	0.009
China	-0.515	-0.083	0.013
Germany	0.200	-0.113	0.015
Spain	0.353	-0.103	0.015
United Kingdom	-0.075	-0.106	0.015
Italy	0.263	-0.108	0.015
Japan	-0.321	-0.075	0.009
Netherlands	0.325	-0.098	0.012
United States	0.249	-0.104	0.015
Average	0.044	-0.096	

Notes: This table reports the results of the aggregation exercise Equation (8). The last column reports the standard error associated with the estimated change in aggregate correlation.

Figure 1. Comparison with Aggregates, Growth Rates

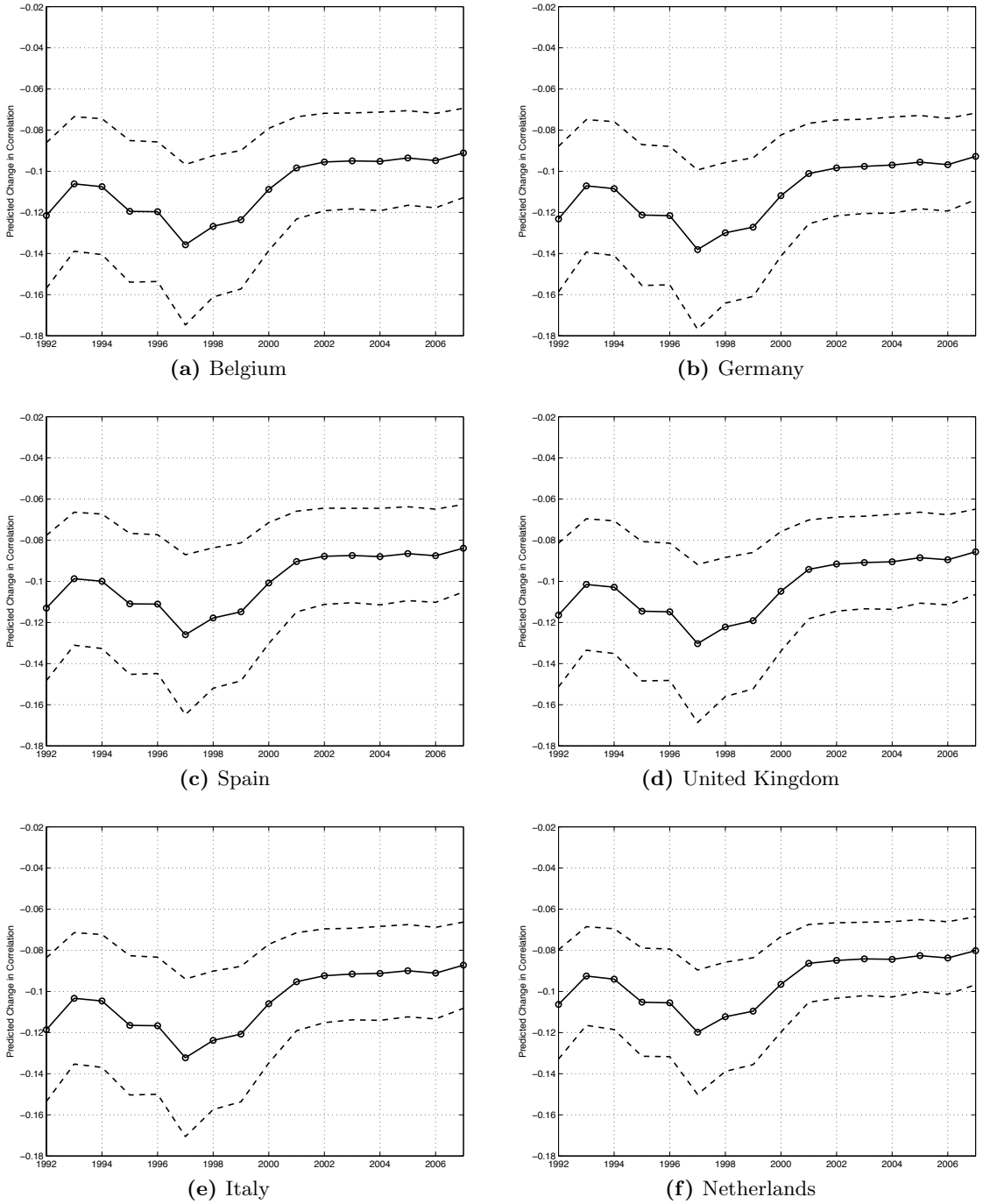
(a) Aggregate Sales, Aggregate Value Added, and GDP

(b) Exports

(c) Imports

Notes: The top panel presents the time series of the growth rates of total sales, before-tax value added, in our data and GDP sourced from the IMF International Financial Statistics. The bottom two panels present the growth rates of total exports and imports, respectively, in our sample and sourced from IMF's Direction of Trade Statistics.

Figure 2. Predicted Change in Aggregate Correlation: Whole Economy



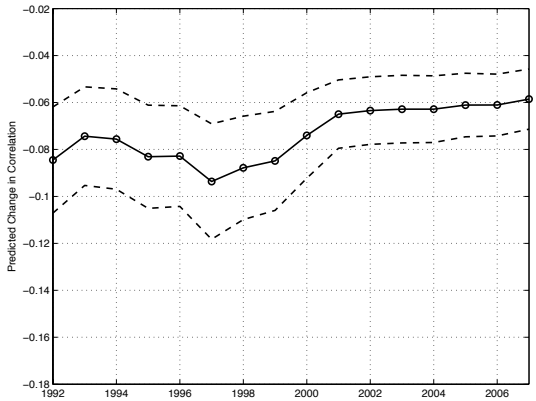
(a) Belgium **(b)** Germany

(c) Spain **(d)** United Kingdom

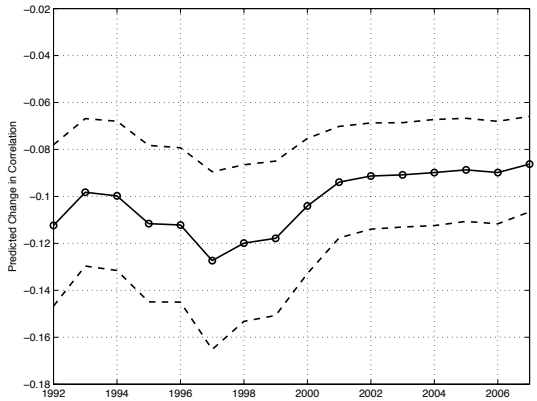
(e) Italy **(f)** Netherlands

Notes: This table plots the yearly estimates of the change in aggregate correlation between France and each country according to
for the whole economy, along with 2-standard error bands.

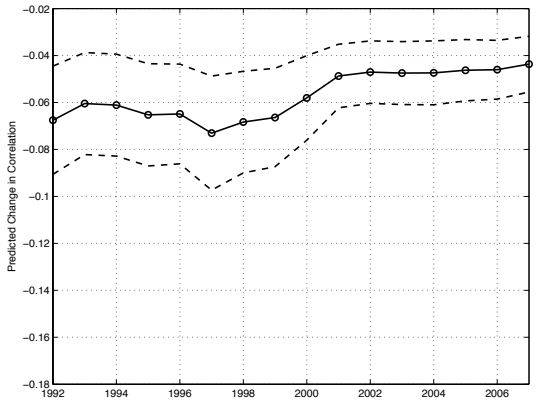
Figure 3. (cont'd) Predicted Change in Aggregate Correlation: Whole Economy



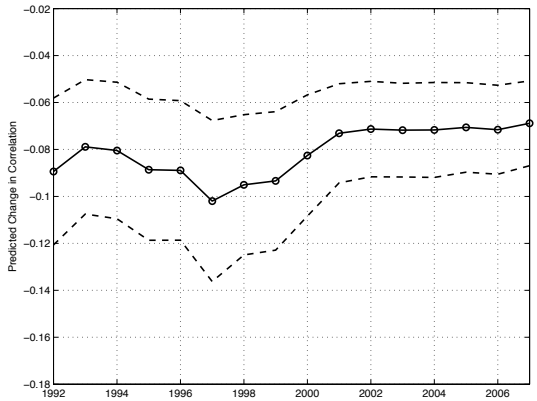
(g) Japan



(h) United States



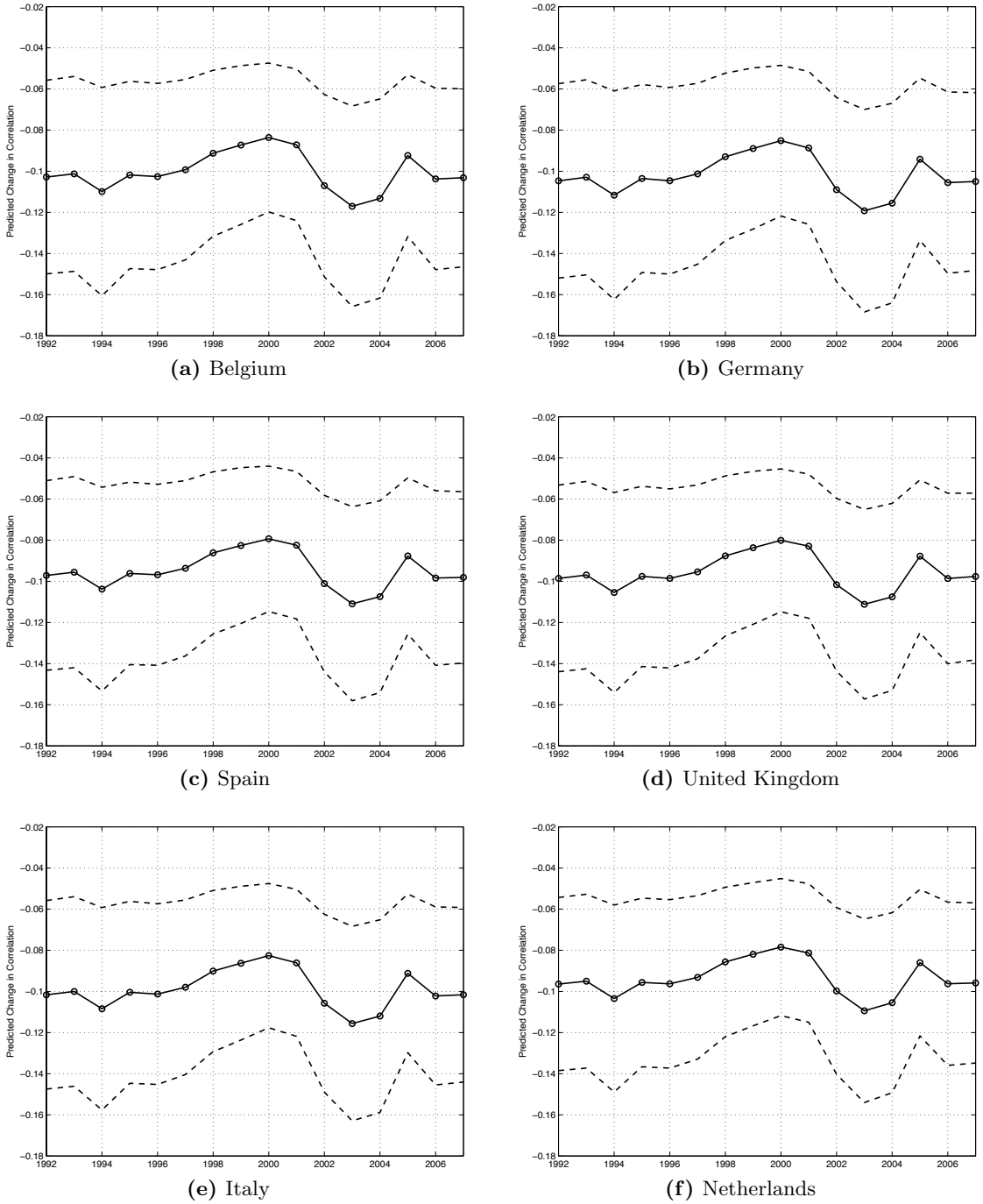
(i) Brazil



(j) China

Notes: This table plots the yearly estimates of the change in aggregate correlation between France and each country according to
for the whole economy, along with 2-standard error bands.

Figure 4. Predicted Change in Aggregate Correlation: Manufacturing Sectors



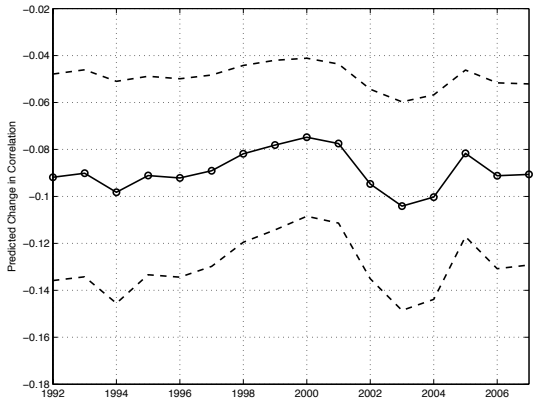
(a) Belgium **(b)** Germany

(c) Spain **(d)** United Kingdom

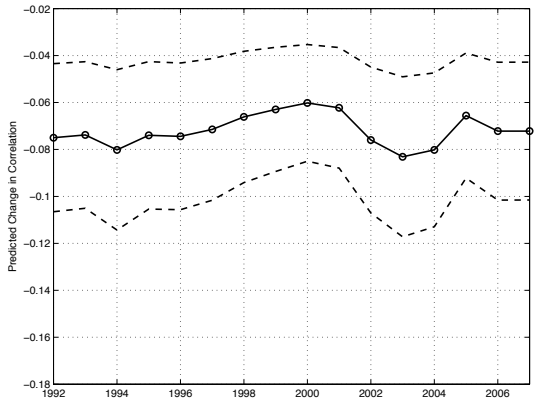
(e) Italy **(f)** Netherlands

Notes: This table plots the yearly estimates of the change in aggregate correlation between France and each country according to
for the manufacturing sector, along with 2-standard error bands.

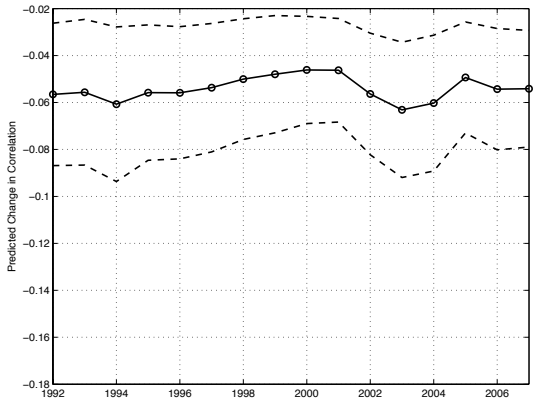
Figure 4. (cont'd) Predicted Change in Aggregate Correlation: Manufacturing Sectors



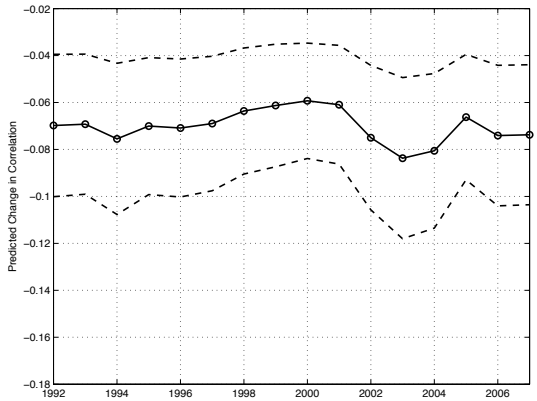
(g) United States



(h) Japan



(i) Brazil



(j) China

Notes: This table plots the yearly estimates of the change in aggregate correlation between France and each country according to
for the manufacturing sector, along with 2-standard error bands.

Table A1. Firm-Level Volatility by Sector

NAF	Sector	St. Dev.	Share	NAF	Sector	St. Dev.	Share
01-05	Agriculture, forestry and fishing	0.2389	0.0049	35	Other transport equipment	0.3232	0.0113
10-14	Mining and quarrying	0.2533	0.0037	36-37	Manufacturing n.e.c.	0.2853	0.0096
15-16	Food and tobacco	0.2340	0.0635	40-41	Electricity, gas, water supply	0.2103	0.0292
17-19	Textile, wearing apparel and leather	0.3118	0.0150	45	Construction	0.2314	0.0495
20	Wood products	0.2606	0.0049	50	Wholesale and retail trade	0.2188	0.3689
21-22	Paper products, publishing	0.2558	0.0235	55	Hotels and restaurants	0.1614	0.0141
23	Coke, refined petroleum, nuclear fuel	0.3255	0.0241	60-63	Transport	0.2033	0.0399
24	Chemical industry	0.3193	0.0421	64	Post and telecommunications	0.2425	0.0226
25	Rubber and plastics	0.3066	0.0145	70	Real estate activities	0.2102	0.0235
26	Mineral products	0.2689	0.0114	71	Rental without operator	0.2158	0.0070
27	Basic metals	0.3189	0.0129	72	Computer services	0.2695	0.0114
28	Metal products	0.2715	0.0207	73	Research and development	0.2915	0.0015
29	Machinery and equipment	0.3122	0.0203	74	Other business services	0.2384	0.0578
30	Office machinery	0.3241	0.0051	75	Public administration	0.1734	0.0003
31	Electrical equipment	0.3096	0.0111	80	Education	0.2283	0.0014
32	Radio, TV and communication	0.3161	0.0100	85	Health and social work	0.1490	0.0069
33	Medical and optical instruments	0.3017	0.0079	90-93	Personal services	0.1986	0.0164
34	Motor vehicles	0.2950	0.0332				

Notes: This table presents the standard deviations of firm-destination growth rates broken down by sector over 1991–2007. "Share" is the share of the sector in total sales. The manufacturing sector covers NAF sectors 15 to 37.