DEEP FINANCIAL INTEGRATION AND VOLATILITY

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Abstract
We investigate the relationship between foreign direct ownership of firms and firm- and region-level output volatility using a novel panel data set for European countries. We document a positive, highly robust, relationship between firm-level foreign ownership and volatility of value added. This relationship holds cross-sectionally and in panels with firm fixed effects where the relationship captures within firm variation over time. Considering domestic firms with assets in foreign countries, we document that it is international diversification, rather than the nationality of the owner, that explains this positive correlation. Our results can also be found at the aggregate-level, where we show that region-level volatility is correlated positively with foreign investment in the region. We show that this positive relation between aggregate volatility and foreign investment can be explained by the the granularity of the firm size distribution and the fact that foreign ownership is concentrated among the largest firms. (JEL: E32, F15, F36, O16)

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1. Introduction

We investigate the relationship between financial integration and volatility. Financial integration may take many forms, such as bank lending, portfolio investment, and foreign direct investment, and the impact on volatility may differ depending on the exact form of financial integration. We focus on foreign equity investment and establish stylized facts about the relationship between foreign equity investment and volatility at the firm level and at the regional level during 1996–2008. Aggregating our firm-level data to the regional level, rather than the country level, leaves us with enough degrees of freedom for testing the statistical significance of relations and allows us to use fixed effects to neutralize effects of country-level variables, such as monetary and fiscal policy.

We examine if foreign investors are relatively more willing to invest in risky firms and projects by testing if there is a positive relationship between firm-level foreign investment and firm-level volatility. We find with very high statistical significance that this is so, robust to the set of countries considered and the types of firms considered. The positive relation can be a result of foreigners investing in highly volatile firms or of foreigners tilting investment towards risky, high return, projects once they invest in a firm.[1] We do not sort out directions of causality but notice that either direction of causality requires foreign investors to be willing to accept more volatility of output. Our interpretation of the result is that foreigners are willing to accept higher volatility of domestic firms because they are diversified internationally. As a further test of the diversification story, we investigate if domestic owners with international assets also hold relatively more volatile domestic firms. We find that they do, consistent with our interpretation.[2]

We employ an extensive firm-level data set, the AMADEUS database (Analyze Major Databases from European Sources), provided by Bureau van Dijk Electronic Publishing (BvD) for the period 1996–2008. The data set encompasses all European countries, 100+ regions and 4+ million unique firms, covering the universe of listed firms and most privately-held firms. We define a measure of "deep" financial integration by calculating the share of assets in our dataset, for each region, owned by foreigners. This measure captures foreign direct investment (FDI) and portfolio equity financing.

We first study the relation between foreign ownership and firm-level volatility and document a significant positive relation between the two. We find an effect which is both statistically and economically significant: if the largest owner of a given firm is a foreign company, value added growth is 30% more volatile, where sales and operating revenue growth is 20% more volatile. We verify that this result is strongly robust and not purely cross-sectional. It survives the inclusion of firm-specific dummies with the

1. See Obstfeld (1994) and Acemoglu and Zilibotti (1997).

2. Faccio, Marchica, and Mura (2011) empirically verify, using AMADEUS data, that companies with diversified owners take more risk, as measured by return on assets.

implication that positive *changes* in foreign ownership are associated with increasing volatility.

Foreign owners are likely to own property in their domestic economy and therefore have internationally diversified assets and we interpret their higher willingness to take on risk as a reflection of this diversification. We can examine if international diversification is associated with investment in more volatile firms by testing if domestic firms who own foreign subsidiaries also are more volatile than other domestic firms. We find that such domestic firms are significantly more volatile (15% more in terms of operating revenue) implying that volatility is correlated with international diversification, per se.[3] Verifying our results from the side of foreign *assets* is of interest because there is almost no country-level evidence on this issue due to the low quality of country-level foreign asset data compared to foreign liability data from Balance-of-Payments Statistics.

Finally, we aggregate value added over the firms in a given region in our data in order to examine if the volatility of our aggregated data correlates with our measure of deep financial integration at the regional level. Alternatively, we examine if volatility of regional GDP from Eurostat correlates with deep financial integration. In both cases, we find that the micro-level patterns carry over to the "macro-regional" level. The macro-level estimates from the regional analysis, using both forms of aggregation, are economically significant, explaining about one-third of the variation in the data.

We examine *why* the micro-level relationship survives aggregation: if foreign ownership is randomly allocated across firms and firms "typically" are small, the firm-level pattern will not carry over to aggregated data due to the law of large numbers. However, if firm sizes are "granular," as put forward by Gabaix (2011), with the largest firms being so large that their volatility mechanically explains part of aggregate volatility, then we expect to see firm-level patterns carry over to the aggregate level. We estimate power laws for firm sizes for each country and we find evidence of granular firm size distributions in all countries. Further, we show that foreign ownership is concentrated in large firms. Together, these findings imply that the firm-level foreign-ownership/volatility relation should carry over to aggregated data, possibly with even higher correlations, consistent with our findings.

At the macro-level, there is an extensive literature on volatility and economic integration/development. Several theoretical papers, such as Obstfeld (1994), and Acemoglu and Zilibotti (1997), have focused on financial diversification. These models incorporate a trade-off between productivity and risk at the microeconomic level: firms (or owners) must choose between safe low-productivity production and risky high-productivity production. Firms in developed countries can pool risks via financial assets and therefore pick high-return high-risk projects more often compared to firms in financially underdeveloped countries. This type of model implies a negative relationship between aggregate and firm-level volatility but a positive relationship

3. In online Appendix B, we develop a simple model illustrating this mechanism.

between development and firm-level volatility. It also implies a steady increase in firm-level volatility and a steady decline in aggregate volatility as countries develop. Koren and Tenreyo (2013) show that firm-level volatility have declined along with aggregate volatility (see also Davis, Haltiwanger, Jarmin, and Miranda (2007)) and develop a model of technological diversification which can explain this.[4] Levchenko, Ranciere, and Thoenig (2009) find a positive effect of financial liberalization on volatility of production across industries while Kose, Prasad, and Terrones (2009) find a positive effect of financial liberalization on risk sharing, implying that consumption volatility decreases relative to output volatility and they find that output volatility increased with financial liberalization.

Micro-level studies focusing on real output volatility are rather rare. Thesmar and Thoenig (2004) find an increase in firm-level volatility for listed French companies following financial deregulation. Correa and Suarez (2009) find the opposite result—firm-level sales and employment in a sample of listed firms become less volatile after bank deregulation in the United States. Studies connecting micro and macro level observations in terms of foreign investment and volatility are non-existing till now.

Overall, we uncover a highly robust, highly significant, relation between foreign ownership and volatility. Considering the size of our data set as well as the robustness across (European) countries and types of firms, these are stylized facts that theoretical models need to confront.

The paper proceeds as follows. Section 2 describes our data. Section 3 presents our results and Section 4 concludes.

2. Data and Construction of Variables

We construct a unique data set composed of firm-level observations from AMADEUS and region-level observations corresponding to the Nomenclature of Territorial Units for Statistics of Europe (NUTS-2), provided by Eurostat. AMADEUS provides financial information, information on foreign and domestic owners of each firm, and locational information which allows us to assign firm-level data to Eurostat's NUTS-2 level regions. We focus on a homogenous sample of 16 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom, for the years 1996–2008.

2.1. Firm-Level Variables

For our 16 countries, AMADEUS lists 4.7 million firms which have at least one year with reported assets and an outcome variable—either sales, revenue, or employment. Table A.3 in the online appendix lists the exact number of firms available by year and

4. In earlier work, Koren and Tenreyro (2007) find a robust negative relation between country-level volatility and development.

variable. From the AMADEUS Financials database, we draw information for 1996–2008 and combine these data with data on foreign ownership from the AMADEUS Ownership database, using firm IDs. During this process, we lose firms for which data are not available in both samples, as documented in Table A.3.

We work with two types of samples. In the sample of *permanent* firms over a specified period, we keep all firms with outcomes non-missing in every year. In the sample of *all* firms, we allow firms to have missing outcomes at the beginning or the end of any given regression sample but we drop firms that have "holes" in the time-series.

Assets, sales, and operating revenue are measured in euros while employment is in persons. The distribution of these (logged) variables does not change much over time and is very close to normal; i.e., the distribution of the data before the log-transformation is very close to log-normal. The distribution of employment is skewed with many firms having only one employee (lawn service, painters, etc.). To limit the potential impact of outliers, we winsorize the variables before performing our empirical analysis.[5]

Volatility Measures. For robustness and comparability with previous work, we experimented with several measures of volatility. The literature on firm-level volatility, which mostly focuses on large publicly traded firms from data sets such as COMPUSTAT, uses the standard deviation of outcome growth ("SD") and this is our first measure.[6] The distribution of (winsorized) standard deviations of operating revenue is displayed in Panel A of Figure 1. The distribution is close to normal except for the pile-ups at the points of winsorizing. For small firms, measures based on standard deviations may have bad properties because, say, a firm growing from 1 to 2 employees have a growth rate of 100%.[7]

We study how volatility changes over time but, because our time-series dimension is very limited, we cannot construct rolling windows of regular standard deviations and instead we follow Morgan, Rime, and Strahan (2004) and construct a year-by-year volatility measure that can be used for panel-data analysis. First, we regress firm-level outcome growth on firm-fixed effects and year-fixed effects: $(Y_{it} - Y_{it-1})/Y_{it-1} = \varphi_i + \gamma_t + v_{it}$. The residuals v_{it} reflect how much outcome growth differs from the average growth (across all firms) in year t and from the average growth (over time) of firm i. For each firm, we use the absolute value of these residuals as our time-varying

5. Figure A.1 in the online appendix presents the distribution, with the number of firms on the vertical axis, of the logarithm of the firm-level operating revenue for four different years while Figure A-2 in the online appendix shows total assets (before and after winsorizing) and other outcomes for 2006.

6. We calculate firm outcome growth as the rate of change (rather than log-differences because growth-rates at the firm-level often are so large that the usual logarithmic approximation is a bad approximation to the growth-rate.

7. In the working paper version of this article, we verify that the results are robust to using the coefficient of variation ("CV") as an alternative measure of volatility.

volatility measure: $\text{SD}_t \equiv |v_{it}|$. Intuitively, the SD_t measure is the one year equivalent of the standard deviation measure, SD.[8]

Foreign Ownership. The AMADEUS Ownership database contains detailed information on owners of both listed and private firms including name, country of residence, and type (e.g., bank, industrial or financial company). The database refers to each record of ownership as an "ownership link" and BvD traces a link between two entities even when the ownership percentage is very small (sometimes less than 1%). For listed firms, very small stock holders are typically unknown.[9] We compute *Foreign Ownership* (FO) as follows. For a firm i, FO_i is the sum of all percentages of direct ownership by foreigners. For example, if a Company A has three foreign owners with stakes 10%, 15%, and 35%, respectively, FO for this company is 60%. Owners of unknown origin (typically small) are assigned to the home country. Panel B of Figure 1 shows the distribution of foreign ownership in 2002.

The distribution is concentrated around 0 with less than 1% of firms 100% foreign owned (fully-owned affiliate of multinationals or greenfield investment). There is a noticeable spike in the number of firms around 50% ownership which likely reflects the desire of large investors to obtain a controlling share over 50%.[10]

Other Measures of Ownership. We measure each firm's *Foreign Minority Ownership* (FMO) by computing the sum of all percentages of foreign direct ownership after excluding the largest stake in the company; *Domestic Minority Ownership* (DMO) is computed analogously, for domestic owners. If a Company A has two foreign owners with stakes 50% and 15%, and two domestic owners with stakes 25% and 10%, the largest owner for this company is foreign (with stake 50%), FMO is 15%, and DMO is 35%. We define a binary variable *Largest Owner is Foreign* (LOF) taking the value unity if the largest owner is foreign and zero otherwise.[11] The majority of these firms have a foreign ownership share of 100% while few firms have a foreign ownership share under 40% and there is a spike around 50%.

8. Using data from the ZEPHYR database, we dropped firms involved in a full merger or acquisition when the merger resulted in spuriously high growth for the acquirer. The number of firms involved in M&A activity as defined in ZEPHYR is, however, a small fraction of our sample so our results do not depend on whether we drop such firms or not.

9. Countries have different rules for when the identity of a minority owner needs to be disclosed; for example, France, Germany, the Netherlands, and Sweden demand that listed firms disclose all owners with more than a 5% stake, while disclosure is required at 3% in the United Kingdom, and at 2% in Italy. See Schouten and Siems (2010).

10. In the online appendix, Figure A.3 presents the distribution of foreign ownership for different years while Figure A.4 presents the distribution of foreign ownership for the subset of firms with strictly positive foreign ownership.

11. In the rare case of a tie between the largest foreign and the largest domestic investor, we assign the value 1 to the LOF-dummy. Figure A.5 in the online appendix shows the distribution of foreign ownership for the sample of firms where the largest owner is foreign.

Most companies have a very small degree of minority ownership and firms are more diversified domestically than internationally.[12] Domestic minority owners' share (DMO) exhibits much more variation as can be seen from the lower right panel. Finally, we use the number of foreign and domestic owners, respectively, as alternative measures of ownership. The number of owners can also be thought of as a concentration measure.

Firm-Level Controls. We use firms' total assets as a size control because large firms potentially are better able to smooth shocks through averaging of shocks to different products, processes, etc. We control for firm age because young firms tend to be more volatile. Davis, Haltiwanger, Jarmin, and Miranda (2007) show that size and age are important determinants of firm dynamics.

2.2. Region-Level Variables

We use regional NUTS-2 level data for 100+ regions from our 16 countries. Countries with only one NUTS-2 region during the years of our analysis, such as Denmark, are left out of the regional analysis.

Regional Volatility Measures. We measure regional volatility in two ways. First, we aggregate firm-level outcomes (sales, operating revenue, value added) to the regional-level and calculate the volatility of the aggregated outcomes. Second, we calculate regional volatility using data on regional GDP from Eurostat. We use nominal GDP per capita in euros, deflated by national CPI.[13] Volatility is calculated from formulas similar to those used at the firm-level.

Deep Financial Integration. Our measure of deep financial integration is the share of aggregated assets owned by foreign investors $\mathrm{FI}_j = \sum_i \mathrm{FO}_{ij}\mathrm{TOAS}_{ij} / \mathrm{TOAST}_j$, where FO_{ij} is the percentage foreign ownership at the firm-level for a firm i located in region j and $\mathrm{TOAST}_j = \sum_i \mathrm{TOAS}_{ij}$, where TOAS_{ij} is the total assets of company i.[14]

We proxy region size by the sum of total assets of the firms in that region and, as another control, use annual average population series from Eurostat. It is important to control for region size because volatility may be lower in large regions due to averaging over a larger number of firms. These variables also partially control for selection problems in AMADEUS where some countries, such as Germany, are less likely to collect data for smaller firms.

2.3. Descriptive Statistics

Table 1 shows means, standard deviations, min and max values of our (filtered and winsorized) variables at the firm and regional levels. Volatility has a mean of 0.359

12. Online Appendix Figure A.6 presents the distribution of FMO and DMO in a given year, 2006. The upper right graph shows that among all firms with *non-zero foreign ownership*, the amount of foreign minority ownership is concentrated at ownership shares up to 20%.

13. We use the Harmonized Consumer Price Index from Eurostat.

14. Figure A.7 in the online appendix shows the distribution of this measure for two typical regions.

with a standard deviation of 0.62 with a maximum of 4.66 and a minimum very close to 0. Foreign ownership is 1.27% on average with a standard deviation of 10.8. Foreign minority ownership is typically small while domestic minority ownership is larger at 4.09% with a large standard error of 14%. Firm age is 20 years on average with a large standard deviation and a maximum of 909.[15] Average firm assets are 3.8 million euros but the standard deviation of assets is very large and the winsorized maximum is 45.8 billion euros. Average assets of foreign owned firms are much larger, 31.78 million and the maximum is 20.2 billion. Clearly foreign owned firms are typically much larger than domestically owned firms.

4.3% of all firms have some foreign ownership while 6.5% are exporters and 0.05% are listed. Exporters appear to have lower volatility on average, maybe due to diversified markets. Of firms with some foreign ownership, 25.8% are fully owned by foreigners while 17.8% are "subsidiaries;" i.e., firms with only one foreign owner. More than half of the firms with some foreign ownership have majority foreign ownership.

Panel B displays region-level statistics. The time varying volatility measure, using AMADEUS data, has a mean of 6.1% with a standard deviation of 8.5%, a minimum near 0 and a maximum of 67%. Average volatility and its dispersion is much lower when calculated from Eurostat data, likely due to the inclusion of the government sector in the regional GDP data. On average, about 7.16% of companies' assets in a region are majority-owned by foreigners, with one region have more than 50% of assets controlled by foreign majority owners). Asset-weighted foreign minority ownership is small on average while domestic minority ownership is 7.15% of assets. The average amount of assets in a given region is about 15.3 billion euros. We also report statistics that gauge the importance of the foreign owned firms for regional volatility—foreign-owned firms make up a significant share of regional economic activity as shown; 13% of the regional assets are owned by firms that have some foreign ownership with the maximum being 69%.

3. Empirical Analysis

We start by examining the relation between firm-level ownership and volatility. We focus on value added, operating revenue, and sales. Value added is our preferred measure because GDP is the sum of the value added of agents in the economy and while we do not have all agents in the economy, aggregating over the value added of the firms that we do have, results in a significant fraction of regional GDP. Sales are often used to study volatility, so we briefly show results for sales, but besides value

15. We checked on some of the firms of very high age and it appears that some European firms indeed are extremely old. The oldest firm is an Italian publishing house in Rome "A.T.S. Italia Editrice S.R.L." while the hotel "Hotel Pichlmayrgut Gmbh & CO KG" in Austria is incorporated in 1117 according to AMADEUS. The latter date corresponds to the date given on the coat of arms displayed at the hotel's WEB-page (www.pichlmayrgut.at).

added we, due to data availability, mainly show results for operating revenue which behaves quite similarly to sales.[16]

3.1. Firm-Level Specifications and Results

We regress volatility of firm outcomes on indicators of foreign and domestic ownership and firm size and age. We include country (or region, see online Appendix A) and sector dummies implying that these regressions solely exploit firm-level variation. The firm-level regression data are winsorized at the 99% level to remove large outliers.[17]

3.1.1. Cross-Sectional Regressions. We estimate cross-sectional regressions using various samples for calculating volatility and foreign ownership. The majority of the results are presented for firm-level volatility measured over 2002–2008 and ownership variables measured in 2002. We first perform a specification search. We consider a regression of volatility on the share of foreign ownership and a semi-logarithmic regression of log-volatility on (the share of) foreign ownership (where the logarithmic transformation downweigh large values). We further examine the validity of the semi-logarithmic form by including a quadratic term in foreign ownership, as in two following models:

$$VOL_{ijc}\left[\log(VOL_{ijc})\right] = \mu_c + \mu_s + \alpha FO_{ijc} + \beta FO_{ijc}^2 + \mathbf{X}'_{ijc}\delta + \varepsilon_{ijc}, \quad (1)$$

$$VOL_{ijc}\left[\log(VOL_{ijc})\right] = \mu_c + \mu_s + \alpha \log(1 + FO_{ijc}) + \mathbf{X}'_{ijc}\delta + \varepsilon_{ijc}, \quad (2)$$

where VOL_{ijc} is volatility of firm i in region j in country c. μ_c is a country or region-specific constant and μ_s is a set of industry dummies that are based on the firm's primary industry code at the 2-digit NACE level. FO_{ijc} is percent foreign ownership, and $\mathbf{X}'_{ijc}$ is a vector of controls, namely, firm size and age. In equation (2), a number 1 is added to foreign ownership before taking logs, because many firms have zero foreign ownership. FO is measured in percent, so that the addition of unity have little effect (except on the very smallest ownership shares) on the interpretation of α as the elasticity of volatility with respect to the ownership share.[18]

The results of Ordinary Least Squares (OLS) regressions of equations (1) and (2) are displayed in Table 2 with the left-hand side being volatility in panel A and log-volatility in panel B. The first seven columns display results for value added and the last seven columns display results for operating revenue.

16. Sales are not available for firms in Denmark, Ireland, Norway, and the United Kingdom. We also briefly show results for employment, which is less appropriate for our purposes since many European countries have labor regulations aimed at limiting employment volatility.

17. Direct inspection of the raw data reveals occasional large errors, such as numbers coded in, say, kroners, rather than in the millions of kroners claimed in the documentation.

18. If we did not add unity, we would need to truncate very tiny ownership shares as $\log(x)$ tends to minus infinity for x approaching 0.

We first verify that volatility significantly declines unconditionally with firm size in columns (1) and (8) and with firm age in columns (2) and (9). Columns (3) and (10) show that, unconditionally, volatility of value added increases significantly with foreign ownership while volatility of operating revenue declines. Columns (4) and (11) demonstrate that the relations are not linear in the foreign ownership share as the quadratic term is negative and highly significant. Columns (6) and (12) show that when we condition on size and age, the relation between volatility and foreign ownership is robustly increasing and concave for both value added and operating revenue. This leads us to substitute the quadratic form with the logarithmic in columns (7) and (13). Comparing panels A and B, we see a more significant relation between volatility and foreign ownership in panel B and as the log-log specification is also a priori attractive because it downweighs outliers and provide simple elasticities, we proceed with this specification.

The correlation between foreign ownership and volatility will partly be due foreign owners' production choices. Foreign owners may have more influence the larger their ownership share is but if they already are majority owners, further increases in ownership will not increase their influence as they are likely to have almost full control already. We therefore examine the role of majority ownership. We define LOF_{ijc} as a dummy that takes the value 1 if the largest owner is foreign and we estimate the relation

$$\begin{aligned}\log(VOL_{ijc}) = \mu_c + \mu_s + \alpha\, LOF_{ijc} + \beta \log(1+FO_{ijc}) \\ +\gamma LOF_{ijc} \cdot \log(1+FO_{ijc}) + \mathbf{X}'_{ijc}\delta + \varepsilon_{ijc}\,.\end{aligned} \tag{3}$$

This relation allows us to test if the correlation of foreign ownership with volatility changes when the majority owner is foreign together with the incremental effect of foreign ownership over majority ownership. For minority foreign owned companies, the marginal effect of log foreign ownership is β, while for majority foreign owned companies, the marginal effect is $\beta+\gamma$. For robustness, we estimate the similar regression

$$\log(VOL_{ijc}) = \mu_c + \mu_s + \alpha\, LOF_{ijc} + \beta FO_{ijc} + \gamma LOF_{ijc} \cdot FO_{ijc} + \mathbf{X}'_{ijc}\delta + \varepsilon_{ijc}\,, \tag{4}$$

where the share of foreign ownership is used directly.

The results from estimating equation (4) are reported in columns (1) and (3) of Table 3 for the volatility of value added and operating revenue; respectively. We observe that $\beta+\gamma \approx 0$ implying that correlations don't increase further with foreign ownership if the majority owner is already foreign. More precisely, the semi-elasticities for firms where the largest owner is foreign implied by the results in columns (1) and (3) are 0.048 and –0.080, respectively, and the elasticities in columns (2) and (4) are 0.023 and -0.007, respectively. These numbers are economically small.[19] The coefficient to foreign ownership is 0.474 while the

19. A formal test cannot reject that the first and fourth of those elasticities are zero.

coefficient to the largest owner is foreign dummy is 0.258—the former coefficient implies that a minority owner with a 49% share has a correlation of 0.232, so there is no significant discontinuity at 50% ownership.

The results, for our preferred log-log specification in columns (2) and (4), are similar except the results indicate some jump in the correlations with majority ownership as the coefficient to the largest owner is foreign dummy is 0.205, for value added, while the coefficient to log foreign ownership is 0.066 and 0.066*log(1+49)=0.116. The results are robust and doesn't change much if we instead use operating revenue in order to have a larger sample.

Table 4 explores if the results are robust to various choices we have made as well as explores volatility of sales and employment. Columns (1) and (2) of panel A repeats earlier results while column (3) considers the volatility of sales—sales are used in Gabaix's (2011) study of granularity of fluctuations. The impact of foreign ownership on sales is fairly similar to that of operating revenue with a larger coefficient, reflecting the operating revenue is likely to be less volatile than sales. Volatility of employment, in column (4), has a low correlation with foreign ownership which, mechanically, is consistent with the coefficient to value added being higher than that to sales: if operating revenue is approximately value added plus wages and employment and wages display low variance, then the volatility of operating revenue is likely to be lower than that of value added. Because we have short samples, one may worry about the precision of the estimated standard errors, so column (5) report results with bootstrapped standard errors for operating revenue. Those standard errors are virtually similar to the clustered standard errors reported in other columns. The final column, (6), drops outliers ("trims") rather than winsorizes. Trimming is better if outliers mainly reflect errors while winsorizing, which keeps, but downweighs, the information in the outliers are better if such outliers are correctly measured large values. It is not obvious for our data which approach is better but fortunately the estimates are little affected by the choice.

In panel B of Table 4, we repeat the regressions of panel A, but ask further if domestic diversification is correlated with higher volatility by including in the regression the log-share of assets owned by domestic minority owners. The coefficient to that variable is robustly negative across all the columns. The estimated coefficient is numerically smaller than the positive coefficient for foreign minority ownership, but we do not have an interpretation of this finding.

Our interpretation of the findings regarding foreign ownership is that foreign owners are willing to take more risk in a given domestic firm because they are internationally diversified. It is reasonable to expect most foreign owners to hold foreign assets but we can not easily verify this with our data. However, we can examine this hypothesis as we can identify domestic owners who hold foreign assets, and we explore a number of specifications which include variables that capture domestic foreign ownership in Table 5 using volatility of operating revenue. Column (1) of panel A includes a dummy for whether the domestic firm holds foreign assets. The point estimate for this variable is large at 0.142 with a very large t-statistic over 12. This provides strong evidence that international diversification, rather than the

actual nationality of owners, allow owners to take more risk in the domestic firm. (It is important to keep in mind here that we use unconsolidated data, which implies that we do not examine volatility of the consolidated multinational firm; rather, we show that the domestic operations of multinational firms are more volatile.) In column (2), we instead use the log of foreign assets and find a coefficient of 0.021 with high statistical significance—if a domestic firm owns a significant part of a foreign firm, both firms are more volatile than purely domestic firms in each country. (The latter statement extrapolate our results a little, because we consider foreign assets in all countries and do not restrict the foreign asset measure to the countries we study.) In panel B of Table 5, we use the specification with a dummy for largest owner is foreign and the results regarding domestic foreign ownership are very similar to what we found in panel A.

An issue with the AMADEUS data set is that coverage varies by countries, mainly in the coverage of small firms. We, therefore, in Table 6, consider a battery of robustness checks involving different samples. In panel A, column (1), we consider exporting (typically larger) firms only—the coefficients for this, quite different, set of firms are similar, though slightly smaller. Limited liability firms in column (2) give results very close to our previous results. Column (3) considers firms that have non-zero foreign ownership and this column is not directly comparable with the other columns because we select on our variable of interest; however, we still find that volatility increases with the share of foreign ownership. Independent companies, in column (4), are similar to our base sample and firms with a single majority owner, in column (5), again give similar results with slightly lower estimates for the coefficient to foreign ownership. Excluding public firms, in column (6), results in a slightly larger coefficient to foreign ownership.

Panel B studies if differences in coverage across countries may impact on our results. Countries with good coverage only (many small firms), in column (1), give results very close to the baseline results and poor coverage countries, in column (2), give virtually similar results. We pick only emerging countries in Central and Eastern Europe in column (3), and even for this sample our qualitative results hold: the coefficient to foreign ownership is a little smaller (although similar for value added as reported in the online appendix), compared to the baseline sample.

In addition to these exercises, we built several random samples which reflect the countries economic size.[20] We repeat our main regressions using three, quite different, methods of sampling from the data in such a way that no countries are over-represented. We select three stratified samples, giving the countries weights in the sampling equal to their relative GDP. The first sample is a 3% stratified sample where the number of firms from each country is proportional to the GDP of that country (3% turn out to be number that exhausts the number of firms in the countries with the poorest coverage) and the second sample is a 25% stratified sample, where the firms from poor coverage countries are drawn with replacement (i.e., they may

20. We thank an anonymous referee for suggesting this.

enter the sample more than once). The second method has been used in the literature. Both these methods ascertains that the results are not caused by some countries being over-weighted. We suggest a third, propensity score, sampling method: if Germany has the smallest number of firms, relative to GDP, we sample the same number of firms, relative to GDP, for all other countries. However, we sample firms that are most similar to those of Germany in terms of size and assets. This is done by using propensity scores which have become a popular method to obtain observationally similar samples, but we believe this particular use of the method is new. Either of these sampling methods delivers estimated coefficients to foreign ownership that are very similar to those reported in previous tables as shown in columns (4)–(6) of panel B of Table 6. Overall, non-random sampling across countries is unlikely to be the cause of our findings.

3.1.2. Propensity Score Matching. Foreign owned firms differ systematically from other firms; for example, they are larger, older, and concentrated in certain sectors or countries. However, we can compare foreign firms to domestic firms, which are observationally similar using propensity score matching. Propensity score matching addresses a self-selection problem arising if firms' foreign-owned status is non-random. In particular, systematic correlations between foreign-ownership and other firm characteristics could lead to biased estimates. The matching procedure controls for this potential selection bias by creating an appropriate control group of domestic firms. We then repeat our regressions using this, smaller, matched sample. This is particularly relevant in our case as only a minority of firms have foreign owners. The matching proceeds as follows.

We match domestic firms with no foreign ownership to the set of firms with non-zero foreign ownership. The matching is done for the year 2002 and is based on the estimated "propensity score," the logistic probability of having some foreign ownership. We allow the probabilities to depend on firm age, total assets, country- and industry-dummies at the 2-digit NACE level. The coefficients obtained from the logistic estimation reveal, not surprisingly, that firm size is the most important determinant of foreign ownership (with a t-statistic of 175), age is a negative predictor of foreign ownership (with a t-statistic of around 9), and certain countries and sectors are significantly more likely to attract foreign ownership.

Based on the estimated propensity scores, we select the sample of firms with no foreign ownership which best match the sample of firms with non-zero foreign ownership. We apply nearest neighbor propensity score matching without replacement, a procedure which matches each firm with foreign ownership to the firm without foreign ownership that have the closest propensity scores.[21] Average age and average size are similar in the matched samples.[22]

21. We use Stata's `psmatch2` command, version 3.0.0 written by Leuven and Sianesi (2003).

22. In Figure A.10 in the online appendix, we display the frequency distributions of estimated propensity scores for firms with non-zero foreign ownership, for the matched firms with no foreign ownership, and for the un-matched firms with no foreign ownership. The sample of matched firms with no foreign ownership

The results of the volatility regression using the matched sample, in Table 7, indicate that our findings are not spurious due to certain observable characteristics being different for foreign owned firms because the results for the matched sample are very similar to those obtained using the full sample. The average effect of foreign ownership is estimated to be about 0.1—close to our un-matched estimates. We have 24,879 firms with foreign ownership in the matched sample resulting in a matched sample of 49,758 firms.

3.1.3. Dynamic Regressions. We explore the dynamic patterns in the data by using a panel of permanent firms and the specification:

$$\begin{aligned} \log(SD_{ijct}) &= \mu_i + \mu_t + \mu_c \cdot \mu_t + \mu_s \cdot \mu_t + \alpha LOF_{ijct} \\ &\quad + \beta \log(1 + FMO_{ijct}) + \gamma \log(1 + DMO_{ijct}) + \mathbf{X}'_{ijct}\delta + \varepsilon_{ijct}, \end{aligned} \tag{5}$$

where SD_{ijct} is the time-varying volatility measure for firm i in region j in country c at time t and the foreign ownership variables are time-varying and indexed similarly. μ_i is a firm-specific constant which absorbs cross-sectional differences between plants, μ_t is a time-fixed effect, and $\mu_c \cdot \mu_t$ and $\mu_s \cdot \mu_t$ are country×year (or region×year) and industry×year fixed effects. We also include country×year and industry×year dummies—if foreigners invest in countries/regions or sectors that they correctly anticipate will be volatile over the relevant years, the interacted dummies will absorb the impact of this. Of course, by including these effects we stack the cards against finding results because some sectors may become more volatile *because* they have gained in foreign diversification. If increased foreign ownership causes more volatile output, we should find a positive coefficient to foreign ownership. We cannot rule out causality in the other direction, but if we found coefficients of zero in the dynamic regressions, it would hint at no causality from foreign ownership.

Table 8 shows the results. The first column in Table 8 includes year dummies but no other dummies. Domestic cross-ownership is now estimated to be positive—an estimate which reverses sign when we include dummy variables for country×year and industry×year. This may reflect that domestic investors prefer certain sectors. Overall, the first two columns establish that the results found in the cross-sectional regressions are quite robust to the change in measure and inclusion of country×year and industry×year fixed effects.

The focus of Table 8 is columns (3)–(9), where firm-specific fixed effects are included—these fixed effects remove permanent differences between firms and therefore remove most of the variation in the data. The results are then driven by changes over time and reveal if increasing foreign ownership goes hand-in-hand with increasing volatility. It does: the largest foreign owner dummy is significant at the

displays a distribution of propensity scores that is very similar to that of firms with some foreign ownership indicating that these samples are observationally similar. The mean of log-assets in the sample with foreign ownership is 15.29 and in the matched sample of firms with no foreign ownership it is 15.33, compared to 13.69 in the sample of unmatched firms. Formally doing the balancing tests, we find that 40 out of 48 variables, that we match on, pass the test at the 5% level.

5% level with a positive sign although the coefficient is smaller than found in the cross-section. The economic effect is not that big but considering the limited time variation this coefficient is identified from, this result is about as strong as one could expect. Firm size remains significant, indicating that volatility becomes smaller as assets grow.

One may worry that the largest-owner-is-foreign dummy variable has limited time variation and we therefore also show results, in columns (6) and (9), using overall foreign ownership.[23] The dummy for largest foreign ownership takes a value of about 0.03, significant at about the 5% level. The relation between foreign ownership and volatility therefore survives in the dynamic setting but it is clearly weaker than in the cross-section. For log foreign ownership the result is similar, although significance declines when year 2008 is included.

In columns (8) and (9), we include the number of domestic owners, which we interpret as a measure of ownership concentration. We find a negative effect for domestic diversification with a t-statistic which is significant at the 10 (near 5)% level. We find a negative significant coefficient to the number of foreign owners which we interpret to mean that foreign ownership correlates with volatility but the correlation gets watered down if foreign ownership is diffuse.

3.2. Region-Level Aggregation and Results

3.2.1. Granular Size Distributions. Next, we study if the firm-level correlations survive aggregation. Foreign ownership can correlate with volatility in aggregate data for many reasons but we want to examine if aggregate volatility is a direct effect of firm level volatility. Firm-specific patterns may wash out in aggregated data due to the law of large numbers if firm size is approximately normally distributed. However, Gabaix (2011) demonstrates for listed U.S. firms, that the size distribution is "granular;" i.e., follows a power with law $P(S > x) = x^{-\zeta}$. If ζ is unity, size (S) will follow Zipf's law but as long as ζ is numerically less than 2, the size distribution will be heavy tailed with infinite variance and convergence of averages across firm to the theoretical mean will be slow. In this case, the features of individual large firms may survive aggregation in moderate sized samples.

We estimated the parameter $-\zeta$ for each of the countries in the sample and these are reported in panel A of Table 9. We find $\zeta \approx 1.3$ with little variation across countries: firm size is robustly granular in our data. If foreign ownership is relatively large in the largest firms, which directly affect aggregates, we expect to see the relation between foreign ownership and volatility survive aggregation. Columns (3)-(5) show that the average amount of foreign ownership is clearly larger in large firms, while column (6) confirms this using a regression which delivers standard errors, which we do not report, but the relation is significant in all countries.

23. We found that over a two-year period, about 17% of firms change from domestic to foreign majority owner, while about 12% changes from foreign to domestic owner, so the worry is somewhat unfounded.

Granularity can be tested at any level of aggregation and in panel B we report summaries of regressions at the regional level. These estimates have coefficients closer to minus unity on average. We do not detail the findings but clearly the regional results support the granularity hypothesis.

3.2.2. Aggregate Volatility. Figure A.8 in the online appendix compares the volatility of our aggregated data and the Eurostat data. Both measures are high in 2001 and decline in 2002; the trend for both measures is downwards although Eurostat volatility has a peak in 2003 which is not found in the AMADEUS aggregate. The volatility of the Eurostat output data is the lowest, which is intuitive as this is the average over a much larger set of firms (including the government sector).

We estimate the effect of regional financial integration on aggregate volatility using:

$$\log(SD^{AGG}_{jct}) = \mu_j + \mu_t + \mu_c \cdot \mu_t + \alpha \log(1+FI)_{jct} + \mathbf{X}'_{jct}\delta + \varepsilon_{jct}\,, \tag{6}$$

where SD^{AGG}_{jct} is the time-varying standard deviation of aggregated firm outcome growth. We use value added, which can be summed over firm without double counting and for which the aggregate over our firms constitute a subset of regional GDP, and operating revenue as an approximation to value added, which is available for more firms (Gabaix (2011) uses sales). As before, μ_j is a region-specific constant, μ_t is a year-specific constant, and $\mu_c \cdot \mu_t$ is a country$\times$time dummy. FI is the asset-weighted average of the total foreign ownership (or majority foreign ownership). $\mathbf{X}'_{jct}$ is the vector of controls.

The left-most three columns of Table 10 display results for the volatility of AMADEUS aggregated outcomes while the right-most column displays results for the volatility of regional GDP from Eurostat. Using asset-weighted foreign ownership for financial integration we find a coefficient of 0.784 for value added and 0.468 for operating revenue, with sales in between. These coefficients are all significant at the 5% level. We evaluate the economic significance of the coefficient by comparing the implied variation in volatility when financial integration moves from the 10th percentile to the 90th percentile, evaluated after controlling for other regressors, in particular the dummy variables, to the actual variation in volatility.[24] We find that the 90%–10% range of integration (after controlling for other regressors) explains 12% of the 90%–10% range in the (raw) volatility data.

For volatility of GDP from Eurostat, we find a coefficient of 0.939, also significant at the 5% level which is quite similar to the result found for aggregated value added. The economic significance is that, for the last column, the 90-10 range of financial integration (after controlling for other regressors) explains about 10% of the 90-10 range of volatility. The similarity of the Eurostat results to the results using the

24. If X_{90} and X_{10} denote the 90th and 10th percentile of the residual of $\log(1+FI)$, respectively, m is mean log-volatility, and the regression coefficient is α, we consider the predicted variation to be $\exp(m+\alpha*X_{90}) - \exp(m+\alpha*X_{10})$. The variation needs to be evaluated around the mean of log-volatility because the exponential function is highly non-linear.

AMADEUS aggregate is reassuring because the Eurostat data set contains the output of all establishments in a region while AMADEUS is a sample of firms. The main drawback of our aggregation is that there are few firms in some regions and outliers can therefore potentially distort the results. Another issue is that the location of a firm's headquarters may not indicate where most of the firm's output is produced. The similarity of the two sets of results indicates that our results are not spuriously driven by these issues. In the case of Eurostat volatility, we, with high significance, find lower volatility in large populous regions, likely due to averaging over a larger number of firms.

4. Conclusion

We uncover a highly significant positive association between firm-level volatility and foreign ownership. A firm whose largest owner is foreign has about 30% more volatile valued added. The positive association between foreign ownership and volatility carries over to the regional-level where we show that our measure of financial integration can explain up to 12% of the variation in aggregate volatility. Our results also hold in dynamic regressions with firm- and region-fixed effects.

We interpret our results as a reflection of foreign investors being more tolerant of risk. The positive correlation between foreign ownership and volatility can be a result of foreigners investing in volatile firms or of foreign owners altering the production structure causing firms to be more volatile. We are not able to pin down directions of causality in this paper, but both mechanisms require foreign owners to be more tolerant of domestic firm risk than average domestic owners. To sort out if the higher risk tolerance is due to the identity of the owner (i.e., the parameters of his or her utility function) or rather due to international diversification, we test if it is international diversification, *per se*, which correlates with higher volatility. We do this by testing if domestic owners who hold foreign assets also own domestic firms with relatively high volatility. The results confirm this with high statistical significance, implying that international diversification allows owners to take more risk in the domestic firm.

Finally, we interpret the relation between our firm-level results and our "aggregate" level findings (positive correlation between volatility and foreign ownership at the regional level) using the granularity theory developed by Gabaix (2011). Volatility of large firms will directly impact the aggregate volatility if such firms are *very* large; i.e., if the distribution of firm sizes is granular (heavy tailed). We verify that the distributions are robustly granular across countries and we further show that foreign ownership is concentrated among relatively large firms. Together these findings imply that the firm-level correlations will survive aggregation.

Our results do not imply that financial integration is undesirable because of higher volatility. Foreigners likely invest in high return-high variance projects which increase growth and volatility can be seen as a side-effect. It is an important avenue for future research to fill in the many unexplored relations between foreign ownership and firm-level outcomes.

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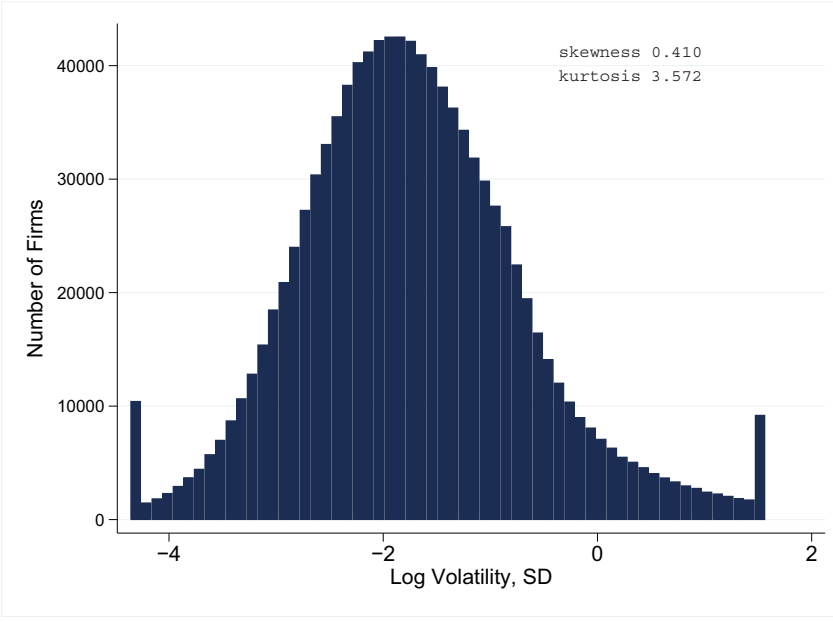
Panel A: Distribution of Volatility (Operating Revenue)



Panel B: Distribution of Foreign Ownership

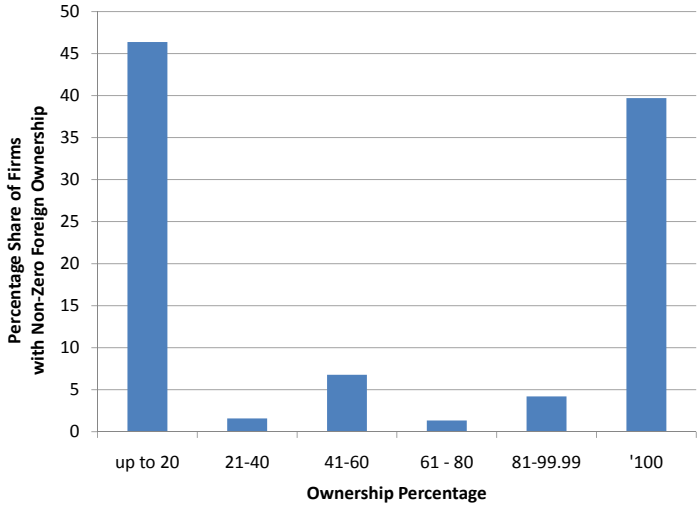


FIGURE 1. Distribution of Firm-Level Volatility and Foreign Ownership
Notes: Volatility is the standard deviation of sales-growth 2002–2008, winsorized at 1 and 99%. Distribution of Foreign Ownership is for the sub-sample of firms with non-zero foreign ownership in 2002.

TABLE 1. Descriptive Statistics

Panel A: Firm-level data

Firm Outcome	Operating Revenue (1,061,359 firms)			
	Mean	Std. Dev.	Min	Max
Volatility, SD	0.359	0.62	0	4.66
Foreign Ownership (%)	1.27	10.8	0	100
Foreign Minority Ownership (%)	0.04	1.23	0	75
Domestic Minority Ownership (%)	4.09	14	0	96
Firm Age (years)	19.9	12.1	1	909
Total Assets (million 2005 euros)	3.80	92.1	0.0010	45,809
Total Assets, Firms with Non-Zero Foreign Ownership (million 2005 euros)	31.78	219.5	0.0013	20,194

	Percent Firms	Average Volatility
	Out of All Firms (1,047,463 firms)	
Non-Zero Foreign Ownership	4.3	0.384
Exporters	6.5	0.244
Listed	0.05	0.429
	Out of Firms with Non-Zero Foreign Ownership (45,545 firms)	
100% Foreign Ownership	25.8	0.366
Foreign Subsidiaries	17.8	0.381
Largest Owner is Foreign	41.3	0.347
Foreigners Hold $> 50\%$	51.8	0.397

Panel B: Region-Level data

	Mean	Std. Dev.	Min	Max
Time-varying Volatility (AMADEUS), SD_t	0.061	0.085	0.00024	0.67
Time-varying Volatility (EUROSTAT), SD_t	0.013	0.015	0.00022	0.097
Financial Integration (%)	7.16	9.49	0	51.5
Financial Integration (Majority Owners) (%)	9.24	12.4	0	54.7
Financial Integration (Minority Owners) (%)	0.47	1.78	0	18.9
Financial Integration (Domestic) (%)	7.15	7.24	0	42.9
Total Assets (billion 2005 euros)	15.3	23.1	0.056	147
Fraction of Foreign-Owned Assets	0.13	0.15	0	0.69

Notes: The firm-level statistics are reported for the outcome (operating revenue) which gives the largest sample. "Exporters" are firms reporting non-zero export revenue. "Listed" are public companies listed on stock exchanges. "100% Foreign Ownership" are companies that are fully owned by foreigners, while "Foreign subsidiaries" are companies that are fully owned by a *single* foreign owner. "Largest Owner is Foreign" refers to firms where the owner with the largest stake is foreign, while "Foreigners Hold $> 50\%$" are companies where foreigners own more than 50%. "Fraction of Foreign-Owned Assets" is the fraction of assets owned by firms who have non-zero foreign ownership in a given region. Region-level variables are based on aggregated firm outcome (operating revenue), except for Time-varying Volatility (EUROSTAT) which is based on direct region-level data from Eurostat. See online Appendix C for detailed explanations.

TABLE 2. Firm-Level Volatility: Specification Explorations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Volatility Measure	Std. dev. of firm outcome growth, SD													
Firm Outcome	Value Added							Operating Revenue						
	Panel A: Dependent variable is Volatility of firm outcome													
Log Total Assets	–.024*** (.001)				–.013*** (.001)	–.013*** (.001)	–.013*** (.001)	–.042*** (.000)				–.033*** (.000)	–.033*** (.000)	–.033*** (.000)
Log Firm Age		–.131*** (.002)			–.119*** (.002)	–.119*** (.002)	–.119*** (.002)		–.149*** (.001)			–.114*** (.001)	–.114*** (.001)	–.114*** (.001)
Foreign Ownership			.125*** (.011)	.453*** (.076)	.161*** (.011)	.589*** (.076)				–.063*** (.005)	.038 (.032)	.031*** (.005)	.308*** (.032)	
Foreign Ownership^2				–.343*** (.078)		–.447*** (.078)					–.104** (.033)		–.286*** (.033)	
Log Foreign Ownership							.034*** (.002)							.008*** (.001)
Country Fixed Eff.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Eff.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	586092	586092	586092	586092	586092	586092	586092	1061359	1061359	1061359	1061359	1061359	1061359	1061359
	Panel B: Dependent variable is Log Volatility of firm outcome													
Log Total Assets	–.044*** (.001)				–.018*** (.001)	–.019*** (.001)	–.019*** (.001)	–.099*** (.001)				–.070*** (.001)	–.070*** (.001)	–.070*** (.001)
Log Firm Age		–.284*** (.003)			–.268*** (.003)	–.268*** (.003)	–.268*** (.003)		–.415*** (.002)			–.340*** (.002)	–.340*** (.002)	–.340*** (.002)
Foreign Ownership			.261*** (.013)	.793*** (.089)	.325*** (.013)	1.040*** (.089)				–.044*** (.009)	.263*** (.065)	.176*** (.009)	.897*** (.064)	
Foreign Ownership^2				–.558*** (.092)		–.749*** (.092)					–.319*** (.067)		–.748*** (.066)	
Log Foreign Ownership							.068*** (.003)							.039*** (.002)
Country Fixed Eff.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Eff.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	586092	586092	586092	586092	586092	586092	586092	1061359	1061359	1061359	1061359	1061359	1061359	1061359

Notes: Standard errors are clustered at the firm level and reported in parentheses. *** , **, * and † denote significance at 1%, 5%, 10%, and 15% levels, resp. SD is the standard deviation of growth of firm outcome over 2002–2008. The explanatory variables are for 2002. Foreign Ownership denotes the percent ownership share that belongs to foreigners, where Log Foreign Ownership is 1+ percent ownership share. Log Firm Age is the logarithm of the difference between the end year in our sample and the date of incorporation. Operating Revenue, Value Added, and Assets are all in 2005 constant euros. Industry-fixed effects at the 2-digit NACE level. See online Appendix C for detailed explanations.

TABLE 3. Firm-Level Volatility and Foreign Ownership: Interaction Effects

	(1)	(2)	(3)	(4)
Volatility Measure	Dependent variable is Log Volatility of firm outcome Std. dev. of firm outcome growth, SD			
Firm Outcome	Value Added		Operating Revenue	
Log Total Assets	–.019***	–.019***	–.071***	–.071***
	(.001)	(.001)	(.001)	(.001)
Log Firm Age	–.268***	–.268***	–.340***	–.340***
	(.003)	(.003)	(.002)	(.002)
Largest Owner is Foreign	.258***	.205***	.241***	.201***
	(.028)	(.034)	(.020)	(.024)
Foreign Ownership	.474***		.426***	
	(.112)		(.087)	
Foreign Ownership×	–.426***		–.506***	
Largest Owner is Foreign	(.116)		(.090)	
Log Foreign Ownership		.066***		.052***
		(.012)		(.009)
Log Foreign Ownership×		–.043**		–.059***
Largest Owner is Foreign		(.014)		(.011)
Country Fixed Eff.	Yes	Yes	Yes	Yes
Industry Fixed Eff.	Yes	Yes	Yes	Yes
Obs.	586092	586092	1061359	1061359

Notes: Standard errors are clustered at the firm level and reported in parentheses. *** , **, * and † denote significance at 1%, 5%, 10%, and 15% levels, resp. SD is the standard deviation of growth of firm outcome over 2002–2008. The explanatory variables are for 2002. Largest Owner is Foreign is a dummy variable that takes a value of one if the largest owner of a given firm is a foreigner. Foreign Ownership denotes the percent ownership share that belongs to foreigners. Log Firm Age is the logarithm of the difference between the end year in our sample and the date of incorporation. Operating Revenue, Value Added, and Assets are all in 2005 constant euros. Industry-fixed effects at the 2-digit NACE level. See Appendix C for detailed explanations.

TABLE 4. Firm-Level Volatility and Foreign Ownership

Sample: All firms

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Log Volatility of firm outcome					
Volatility Measure	Std. dev. of firm outcome growth, SD					
Standard Errors	Clustered	Clustered	Clustered	Clustered	Bootstrap	Clustered
Handling Outliers	Winsorized	Winsorized	Winsorized	Winsorized	Winsorized	Trimmed
Firm Outcome	Value Added	Operating Revenue	Sales	Employment	Operating Revenue	Operating Revenue
	Panel A: Effects of Foreign Ownership					
Log Foreign Ownership	.068***	.039***	.049***	.005**	.039***	.041***
	(.003)	(.002)	(.002)	(.002)	(.002)	(.002)
Log Total Assets	–.019***	–.070***	–.070***	–.181***	–.070***	–.068***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Log Firm Age	–.268***	–.340***	–.353***	–.296***	–.340***	–.337***
	(.003)	(.002)	(.003)	(.002)	(.002)	(.002)
	Panel B: Effects of Majority/Minority Foreign Ownership					
Largest Owner is Foreign	.287***	.166***	.205***	.018**	.166***	.175***
	(.011)	(.008)	(.010)	(.007)	(.008)	(.008)
Log Foreign Minority Ownership	.045***	.039***	.039***	–.006	.039***	.046***
	(.010)	(.007)	(.008)	(.008)	(.007)	(.008)
Log Domestic Minority Ownership	–.015***	–.021***	–.009***	–.013***	–.021***	–.020***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Log Total Assets	–.018***	–.070***	–.070***	–.180***	–.070***	–.067***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Log Firm Age	–.267***	–.339***	–.353***	–.295***	–.339***	–.336***
	(.003)	(.002)	(.003)	(.002)	(.002)	(.002)
Country Fixed Eff.	yes	yes	yes	yes	yes	yes
Industry Fixed Eff.	yes	yes	yes	yes	yes	yes
Firms	586092	1061359	763370	628476	1061359	1038815

Notes: Standard errors are clustered at the firm level (column 1-4, 6) or bootstrapped (column 5) and reported in parentheses. *** , **, * and † denote significance at 1%, 5%, 10%, and 15% levels, resp. Outliers in terms of volatility estimates and Total Assets are handled by winsorizing the data ("Winsorize") or dropping the outliers ("Trimmed"). SD is the standard deviation of growth of firm outcome over 2002–2008. The explanatory variables are for 2002. Log Foreign Ownership denotes the logarithm of 1 + percent ownership share that belongs to foreigners. Largest Owner is Foreign is a dummy variable that takes a value of one if the largest owner of a given firm is a foreigner. Log Foreign Minority Ownership denotes the logarithm of 1 + the remaining percent ownership share belonging to foreigners after the share of the largest owner is excluded; Log Domestic Minority Ownership is calculated similarly. Log Firm Age is the logarithm of the difference between the end year in our sample and the date of incorporation. Sales, Operating Revenue, Value Added, and Assets are all in 2005 constant euros. For firms in Denmark, Ireland, Great Britain, and Norway, sales are not available. Employment is the number of full-time employees. Industry-fixed effects at the 2-digit NACE level. See Appendix C for detailed explanations.

TABLE 5. Firm-Level Volatility and Ownership of Foreign Assets

	(1)	(2)	(3)
Dependent Variable: Log Volatility of Firm Outcome			
Volatility Measure	Std. dev. of firm outcome growth, SD		
Firm Outcome	Operating Revenue		
Panel A: Effects of Foreign Liabilities and Foreign Assets			
Log Foreign Ownership	.040***	.039***	.039***
	(.002)	(.002)	(.002)
Domestic Firm with Foreign Assets	.142***		
	(.011)		
Log Foreign Assets of Domestic Firm		.021***	
		(.005)	
Log Number of Foreign Firms Owned by Domestic Firm			.121***
			(.023)
Log Total Assets	–.071***	–.071***	–.071***
	(.001)	(.001)	(.001)
Log Firm Age	–.340***	–.340***	–.340***
	(.002)	(.002)	(.002)
Country Fixed Eff.	Yes	Yes	Yes
Industry Fixed Eff.	Yes	Yes	Yes
Firms	1,061,359	1,061,359	1,061,359
Panel B: Effects of Minority Foreign Liabilities and Foreign Assets			
Largest Owner is Foreign	.170***	.166***	.167***
	(.008)	(.008)	(.008)
Log Foreign Minority Ownership	.040***	.039***	.039***
	(.007)	(.007)	(.007)
Log Domestic Minority Ownership	–.021***	–.021***	–.021***
	(.001)	(.001)	(.001)
Domestic Firm with Foreign Assets	.144***		
	(.011)		
Log Domestic Minority Ownership× Domestic Firm with Foreign Assets		.025**	
		(.009)	
Log Foreign Assets of Domestic Firm			.021***
			(.005)
Log Total Assets	–.071***	–.070***	–.070***
	(.001)	(.001)	(.001)
Log Firm Age	–.339***	–.339***	–.339***
	(.002)	(.002)	(.002)
Country Fixed Eff.	Yes	Yes	Yes
Industry Fixed Eff.	Yes	Yes	Yes
Firms	1,061,359	1,061,359	1,061,359

Notes: Standard errors are clustered at the firm level and reported in parentheses. *** , **, * and † denote significance at 1%, 5%, 10%, and 15% levels, resp. SD is the standard deviation of growth of firm outcome over 2002–2008. The explanatory variables are for 2002, unless specified otherwise. Log Foreign Ownership denotes the logarithm of 1 + percent ownership share that belongs to foreigners. Largest Owner is Foreign is a dummy variable that takes a value of one if the largest owner of a given firm is a foreigner. Log Foreign Minority Ownership denotes the logarithm of 1 + the remaining percent ownership share belonging to foreigners after the share of the largest owner is excluded; Log Domestic Minority Ownership is calculated similarly. Domestic Firm with Foreign Assets is a dummy variable that takes a value of one if a given *domestic* company owns companies overseas in at least one year over 2002–2008. Log Foreign Assets of Domestic Firm the logarithm of 1 + average percent ownership share that belongs to a given domestic company overseas, the latter computed as the sum of all ownership stakes divided by number of overseas companies owned. Log Number of Foreign Firms Owned by Domestic Firm is 1 + the number of overseas companies owned by a given domestic company. Log Firm Age is the logarithm of the difference between the end year in our sample and the date of incorporation. Operating Revenue and Assets are in 2005 constant euros. Industry-fixed effects at the 2-digit NACE level. See Appendix C for detailed explanations.

TABLE 6. Firm-Level Volatility and Foreign Ownership: Robustness

Sample: All firms, 2002–2008

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Log Volatility of firm outcome					
Volatility Measure	Std. dev. of firm outcome growth, SD					
Firm Outcome	*Operating Revenue*					
	Panel A: Types of Companies					
Firm Sub-sample	Exporters	Limited Liability	Foreign Owned	Independent Companies	Majority stake >50%	Excluding Public Sectors
Log Foreign Ownership	.026***	.036***	.005**	.046***	.029***	.039***
	(.003)	(.002)	(.003)	(.008)	(.002)	(.002)
Log Total Assets	–.105***	–.072***	–.076***	–.071***	–.087***	–.071***
	(.002)	(.001)	(.003)	(.002)	(.002)	(.001)
Log Firm Age	–.315***	–.342***	–.346***	–.392***	–.209***	–.339***
	(.007)	(.002)	(.009)	(.006)	(.005)	(.002)
Firms	68440	973516	45545	159633	206456	1010348
	Panel B: Selection Issues					
Firm Sub-sample	Good Coverage Countries	Poor Coverage Countries	CEE Countries	3% Random Sample	25% Random Sample with Replacement	25% Random P.S.Matching Sample
Log Foreign Ownership	.039***	.035***	.023***	.057***	.067***	.045***
	(.002)	(.005)	(.006)	(.007)	(.002)	(.005)
Log Total Assets	–.070***	–.072***	–.078***	–.073***	–.074***	–.060***
	(.001)	(.003)	(.003)	(.004)	(.001)	(.003)
Log Firm Age	–.350***	–.227***	–.254***	–.238***	–.217***	–.253***
	(.002)	(.007)	(.013)	(.012)	(.004)	(.010)
Firms	987841	73518	23923	30678	265613	41252
Country Fixed Eff.	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Eff.	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at the firm level and reported in parentheses. *** , **, * and † denote significance at 1%, 5%, 10%, and 15% levels, resp. SD is the standard deviation of growth of firm outcome over 2002–2008. The explanatory variables are for 2002, unless noted otherwise. Outcomes are in in 2005 constant euros. The EXPORTERS sample consists of firms reporting non-zero export revenue in 2002. The LIMITED LIABILITY sample are public or private limited liability companies; the excluded companies correspond to partnerships, sole proprietorships, and cooperatives. The FOREIGN OWNED sample is composed of firms with non-zero foreign ownership. The INDEPENDENT COMPANIES sample consists of firms classified by BvD as "independent." These companies have no shareholder owning more than 50%. For the MAJORITY STAKE >50% sample, we drop firms where the ownership percentage of largest owner is less than 50%. The EXCLUDING PUBLIC SECTORS sample drops firms in government and public-regulated sectors, which are: Electricity, gas and water (NACE1=E), Public administration and defence, compulsory social security (NACE1=L), Other community, social and personal service activities (NACE1=O), Extra-territorial organizations and bodies (NACE1=Q). The columns Good/Poor Coverage Countries split the sample into companies from countries with relatively good AMADEUS firm coverage (Belgium, Denmark, Finland, France, Norway, Spain, Sweden, and the United Kingdom.) and from countries with relatively poor coverage (Austria, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Switzerland). Central and Eastern European (CEE) countries are Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, and Slovakia; age data is missing for Slovenia. 3% Random Sample is is a 3% stratified sample where the number of firms from each country is proportional to the GDP of that country. 25% Random Sample with Replacement is a 25% stratified sample, where the firms from poor coverage countries are drawn with replacement. 25% Random P.S. Matching Sample is a 25% propensity score, sampling method where we select a country with the smallest number of firms, relative to GDP, and then we sample the same number of firms, relative to GDP, for all other countries using propensity score matching on company size, age, industry and foreign ownership. See online Appendix D for more details on random sampling.

TABLE 7. Firm-Level Vol. and Foreign Ownership: Propensity Score Matching

	(1)	(2)
	Dependent Variable: Log Volatility of Firm Outcome	
Volatility Measure	Std. dev. of firm outcome growth, SD	
Firm Outcome	Operating Revenue	
Firm Sample	All firms	Large firms
Average Effect of	.137***	.121***
Foreign Ownership	(.006)	(.009)
	Regressions using Matched Sample	
Largest Owner is Foreign	.105***	.088***
	(.010)	(.014)
Log Foreign Minority Ownership	.029***	.024**
	(.008)	(.011)
Log Domestic Minority Ownership	–.014***	–.008
	(.005)	(.007)
Log Total Assets	–.076***	–.148***
	(.003)	(.010)
Log Firm Age	–.235***	–.165***
	(.009)	(.011)
Country Fixed Eff.	yes	yes
Industry Fixed Eff.	yes	yes
Firms	49,758	19,426

Notes: Standard errors are clustered at the firm level and reported in parentheses. *** , **, * and † denote significance at levels 1%, 5%, 10%, resp. Matching is performed by Stata psmatch2 command (version 4.0.6) on firm age, total assets, country, and industry at the 2-digit NACE level. In col (1), the matching is based on the "All firms" sample; in col (2) it is based on the "Large firms" sample. SD is the standard deviation of growth of the firm outcome over 2002–2008. The explanatory variables are for 2002. The upper panel reports the estimate of the treatment effect on the treated. In the lower panel, we estimate our main OLS specification using the matched sample. Foreign Ownership denotes the percent ownership share that belongs to foreigners. Largest Owner is Foreign is a dummy variable that takes a value of one if the largest owner of a given firm is a foreigner. Log Foreign Minority Ownership denotes the logarithm of 1 + the remaining percent ownership share belonging to foreigners after the share of the largest owner is excluded; Log Domestic Minority Ownership is calculated similarly. Log Firm Age is the logarithm of the difference between the end year in our sample and the date of incorporation. Operating Revenue and Assets are in 2005 constant euros. Industry-fixed effects at the 2-digit NACE level. See online Appendix C for detailed explanations.

TABLE 8. Firm-Level Volatility and Foreign Ownership: Dynamics

Sample: Permanent firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Volatility Measure	Dependent Variable: Log Volatility of Firm Outcome								
Firm Outcome	Time-varying std. dev. of firm outcome growth, SD_t								
	Operating Revenue								
Estimation Period	2000-07	2000-07	2000-07	2000-08	2000-06	2000-06	2000-08	2000-06	2000-08
Interpolation of Ownership Data	yes	yes	yes	no	no	no	no	no	no
Largest Owner is Foreign	.160***	.148***	.030**	.033*	.028**				
	(.010)	(.010)	(.015)	(.018)	(.014)				
Log Foreign Minority Ownership	.008	.016*	–.006	–.004	.006				
	(.002)	(.009)	(.011)	(.013)	(.010)				
Log Domestic Minority Ownership	.002†	–.015***	.001	.002	–.001				
	(.001)	(.001)	(.002)	(.002)	(.001)				
Log Foreign Ownership						.009***	.006†	.014***	.008*
						(.003)	(.004)	(.003)	(.005)
Log Number of Domestic Owners								–.011*	–.001
								(.006)	(.009)
Log Number of Foreign Owners								–.047***	–.017
								(.017)	(.017)
Log Total Assets	–.100***	–.086***	–.006**	–.013***	–.023***	–.024***	–.013***	–.023***	–.013***
	(.001)	(.001)	(.003)	(.004)	(.003)	(.003)	(.004)	(.002)	(.004)
Firm Fixed Eff.	no	no	yes	yes	yes	yes	yes	yes	yes
Year Fixed Eff.	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country × Year Fixed Eff.	no	yes	yes	yes	yes	yes	yes	yes	yes
Industry × Year Fixed Eff.	no	yes	yes	yes	yes	yes	yes	yes	yes
Observations	2,207,365	2,172,489	2,172,489	1,203,113	2,235,264	2,235,264	1,203,113	2,235,264	1,203,113
Firms	413,725	407,640	407,640	407,646	754,126	754,126	407,646	754,126	407,646

Notes: Standard errors are clustered at the firm level and reported in parentheses. *** , **, *, and † denote significance at 1%, 5%, 10%, and 15% levels, resp. The "Permanent firms" sample excludes all firms with missing outcomes in any year of the specified estimation period. Many firms have missing ownership information in one or more years. In columns marked "yes" under "Interpolation of Ownership Data" we linearly interpolate missing foreign ownership; otherwise the estimation is performed over even years (with available ownership data) only. SD_t is a time-varying volatility measure based on firm outcome growth. Log Foreign Ownership denotes the logarithm of 1 + the percent ownership share that belongs to foreigners. Largest Owner is Foreign is a dummy variable that takes a value of one if the largest owner is foreign. Log Foreign Minority Ownership denotes the logarithm of 1 + the percent ownership share belonging to foreigners after the share of the largest owner is excluded; Domestic Minority Ownership is calculated similarly. Number of Owners give the number of foreign and domestic owners, respectively. Operating Revenue and Assets are in 2005 constant euros. Industry-fixed effects at the 2-digit NACE level. See online Appendix C for detailed explanations.

TABLE 9. Granularity of Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome for Company Size	Sales						
	Panel A: Granularity at Country Level						
Country	Power Law Coefficient (Top 200 Comp.)		Average % of Foreign Ownership (Top 200 Comp.)	Average % of Foreign Ownership (Rest of Comp.)	Average % of Foreign Ownership (Rest Top 25%)	Regression Coefficient Log Foreign Ownership - Log Size (All Comp.)	Total Number of Companies
Austria	–1.25		24.7	28.4	32.7	.134***	1404
Belgium	–1.29		27.1	1.2***	4.4***	.076***	65446
Germany	–1.46		19.9	7.0***	13.6***	.076***	24402
Denmark	–1.51		31.5	3.1***	9.4***	.105***	25508
Spain	–1.21		32.6	0.8***	2.4***	.048***	373950
Finland	–1.19		15.2	0.8***	2.6***	.050***	43949
France	–1.38		14.7	0.7***	2.3***	.050***	488009
Great Britain	–1.41		7.4	3.4***	9.5	.081***	199757
Greece	–1.34		28.2	1.6***	4.4***	.130***	18149
Ireland	–1.09		16.1	4.6***	13.5†	.122***	6626
Italy	–1.52		21.1	0.3***	0.8***	.025***	257887
Netherlands	–1.38		20.2	9.1***	16.7*	.143***	3153
Norway	–1.39		16.6	1.2***	3.4***	.052***	106269
Portugal	–1.32		18.4	0.6***	2.0***	.045***	42673
Sweden	–1.24		13.2	0.47***	1.51***	.031***	136517
	Panel B: Granularity at Region Level						
	Descriptive Statistics of the Power Law Coefficient from the Log Rank - Log Size Regression Estimated over Top 200 Companies in a Region						
Regions in Country	No. Regions	Mean	Median	St.Dev.	St.Dev./$\sqrt{N}$	Min	Max
Austria	2	–1.00	–1.00	0.14	0.10	–1.10	–0.90
Belgium	11	–1.18	–1.14	0.23	0.07	–1.74	–0.94
Germany	31	–0.95	–0.95	0.16	0.03	–1.27	–0.65
Denmark	5	–1.21	–1.23	0.24	0.11	–1.44	–0.83
Spain	15	–1.40	–1.31	0.23	0.06	–1.75	–1.15
Finland	5	–1.08	–1.13	0.15	0.07	–1.23	–0.84
France	24	–1.34	–1.33	0.16	0.03	–1.59	–0.97
Great Britain	35	–1.00	–1.03	0.18	0.03	–1.28	–0.60
Greece	10	–1.41	–1.40	0.13	0.04	–1.59	–1.23
Ireland	2	–0.93	–0.93	0.20	0.14	–1.07	–0.78
Italy	21	–1.33	–1.32	0.20	0.04	–1.76	–0.90
Netherlands	4	–1.00	–1.00	0.10	0.05	–1.11	–0.89
Norway	7	–1.35	–1.35	0.19	0.07	–1.60	–1.07
Portugal	7	–1.24	–1.24	0.22	0.08	–1.59	–0.93
Sweden	8	–1.19	–1.20	0.12	0.04	–1.34	–1.00
All Regions	187	–1.17	–1.17	0.25	0.02	–1.76	–0.60

Notes: The table presents the estimates of the the Power Law Coefficient (Gabaix 2009) for top 200 companies by size in a country (panel B) and statistics of the coefficient for top 200 companies in a region, aggregated by country (panel B). The measure of firm size is firm Operating Revenue in constant 2005 Euros. We include countries with at least 500 companies with available outcome. The Power Law Coefficient is the estimate of the slope in the regression the following form: $\ln(i-s) = \text{constant} + \widehat{\varsigma} \ln\ S_{(i)} + error$, where i is the firm's rank in terms of the measure of firm size S and the largest firm has the rank 1. The optimal shift s to reduce the small-sample bias is set to 0.5. The Average % of Foreign Ownership is the percent ownership share that belongs to foreigners in top 200 companies for which the power law regression is estimated (column 3), the rest of the companies in the country (column 4) and the rest of the companies in the top quartile (25%) of the distribution of firm sizes (column 5). *** , **, * in columns 4 and 5 denote the cases when the percentage of foreign ownership in this sub-group is significantly *lower* than the percentage of foreign ownership for top 200 firms at 1%, 5%, 10% levels, resp. Column 6 reports the coefficient from the regression of the logarithm of 1 + the percent ownership share that belongs to foreigners on the logarithm of firm size using all firms in the country; *** , **, * denote significance at 1%, 5%, 10% levels, resp. Column 7 reports the sample total number of firms in the country in our sample.

TABLE 10. Regional Volatility and Financial Integration: Aggregation

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Log Volatility of Aggregated Firm Outcome or Regional GDP				
Volatility Measure	Time-varying std. dev. of regional outcome growth, SD_t				
Aggregated Firm Outcome	Value Added	Operating Revenue	Operating Revenue		
Regional Outcome				Regional GDP per capita	
Log Financial Integration	.784**	.468**	.623**	.939**	
	(.379)	(.191)	(.297)	(.428)	
Log Region Total Assets	–4.09***	–.637	–3.807		
	(1.20)	(1.04)	(1.70)		
Log Population				–.961	
				(5.23)	
Region Fixed Eff.	yes	yes	yes	yes	
Year Fixed Eff.	yes	yes	yes	yes	
Country × Year Fixed Eff.	yes	yes	yes	yes	
Observations	150	221	150	140	

Notes: Standard errors are clustered at the region level and reported in parentheses. *** , **, *, and † denote significance at 1%, 5%, 10%, and 15%, resp. The panel regression is estimated over 2000–2008. SD_t is a time-varying volatility measure based on firm outcome growth. For regressions with volatility of Aggregated Firm Outcome we use regions with at least 50 firms; for regressions with volatility of Eurostat GDP we use regions with at least 1,000 firms. Log Financial Integration is the logarithm of 1 + the weighted average of firm-level foreign ownership percentages within a given region using firm assets as the weights. Region Total Assets is the sum of total assets of firms within a given region. Population is average annual population of the region from Eurostat. Firm-level Value Added, Operating Revenue, and Assets are all in 2005 constant euros. See online Appendix C for detailed explanations. Population data are from Eurostat.