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Abstract

This paper uses high-frequency data for publicly-listed Japanese manufacturing firms over the period 2000 to 2010 to show that a greater reliance on foreign market sales increases the conditional volatility of firms' stock returns. The two margins of global engagement we consider, namely, exports and sales via foreign affiliates, have both a positive and economically significant effect on firm-level volatility, although an increase in the intensity of sales through foreign affiliates has a stronger effect on volatility than a similar change in firms' export intensity. We also uncover evidence consistent with the notion that firms' need to use external finance to cover the substantial costs involved in reaching foreign consumers is an important channel through which firms' participation in international markets increases their exposure to economic uncertainty.

Keywords: Volatility, Stock Returns, Exports, FDI, External Finance Dependence, Japan.

JEL classification: F36, F14, F23, G10.

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1. Introduction

It is hard to overstate the impact of economic uncertainty on individual firm decisions. In response to greater volatility, firms behave more cautiously in their investment and employment decisions and in turn become less responsive to policy stimuli (Leahy and Whited 1996; Bloom et al. 2007; Bloom, 2009; Bloom et al. 2014). Higher volatility also weakens firms' ability to raise external finance (Froot et al. 1993; Rountree et al., 2008), and increases both risk premia and the probability of default (Adrian and Rosenberg, 2008; Arellano et al., 2011), to give but a few examples.

Given the important role that volatility can play on firm-level outcomes and in light of the strong perception among the general public that globalization increases economic uncertainty (Scheve and Slaughter, 2004), in this paper we attempt to answer the following question: does a firm's greater reliance on sales in foreign markets — what we refer to as 'global engagement' — affect its volatility? Economic theory does not provide an unequivocal answer to this question. On the one hand, servicing foreign markets could allow firms to lower their volatility by diversifying away country-specific demand shocks. On the other hand, the volatility-reducing effect produced by geographic diversification can be counteracted when there are substantial barriers entailed in reaching foreign customers (e.g. sunk costs of opening a foreign production facility or higher working capital requirements involved in exporting and FDI). Since the costs associated with different margins of global engagement differ substantially in nature and magnitude, a key objective of this paper is to investigate whether firm-level volatility is affected differently by changes in the intensive margin of exports and sales conducted by foreign affiliates.

We utilize data for publicly-listed Japanese manufacturing firms for the period 2000 to 2010 to conduct our analysis, and use excess stock returns as the underlying performance variable to estimate firm-level volatility, following an extensive literature in finance and macroeconomics (see e.g. Schwert, 1989; Campbell et al., 2001; Comin and Philippon, 2006; Bloom et al. 2007, among many others). Stock

returns are of direct concern to firms' investors because they reflect markets' expectations of future cash flows, but they are also highly correlated with establishment-level measures of total factor productivity (Bloom et al., 2014) and are a strong leading indicator for industrial production and GDP growth at the aggregate level (Fama, 1990; Beaudry and Portier, 2006).

To preview our results, we find a robust and positive relationship between a firm's intensity of global engagement and the conditional volatility of its excess stock returns. Both changes in export and foreign affiliate sales intensity have a positive and economically significant impact on firms' conditional volatility of stock returns — although the effect of the latter is quantitatively stronger. To be more precise, a one standard deviation change in the share of total sales accounted for by exports, increases the annualized conditional volatility of stock returns between 8.5 and 11.2%; a change of similar magnitude in the intensity of sales through foreign affiliates produces an increase in volatility of 9.1 to 13.5%. This finding suggests that a ranking of firms' volatility based on the margin used to reach foreign customers is akin to that established by Helpman et al. (2004) for the first moment of firm-level productivity. This result is consistent with that of Fillat and Garetto (2014), who find that US multinational firms are riskier than exporters and that these in turn are riskier than domestic firms.

We also find that the positive relationship between global engagement and volatility is primarily driven by firms characterized by high requirements for external financing. This result is consistent with the recent literature that documents the high finance-intensity across different margins of global engagement, for instance due to the longer lag between production and the receipt of sales revenue that characterizes export transactions (Amiti and Weinstein, 2011; Manova, 2013) or because the largely irreversible costs associated with setting up and operating multinational subsidiaries require external financing (Desai et al. 2004; Bilir et al. 2015). Our results are robust to the use of an instrumental variables approach that seeks to control for the potential endogeneity of the intensity of firms' global engagement.

Our paper makes three novel contributions to the literature studying the relationship between globalization and volatility. This is, to the best of our knowledge, the first paper to investigate empirically how exports and sales via foreign affiliates affect firm-level volatility; previous work by Buch et al. (2009), Riaño (2011) and Vannoorenberghe (2012) has only considered the role of exports, while Nguyen and Schaur (2012) and Kurz and Senses (2013) study both export and import margins.[1] Exploring whether a greater reliance on affiliate sales affects firm-level volatility and whether its effect differs from that of exporting is crucial given the quantitative importance of horizontal FDI as a margin of global engagement. Antràs and Yeaple (2013) report that sales by multinational subsidiaries are on average three times as large as export sales for large US firms, while we find a corresponding 42% premium for Japanese manufacturing firms. Moreover, as Ramondo et al. (2014) also point out, sales to unaffiliated parties constitute by far the most important margin of operation for affiliates located abroad.

We also depart from the existing literature in international trade in making use of high-frequency (monthly) data on excess stock returns rather than yearly sales or employment data to estimate firm-level volatility. The low-frequency data typically available in surveys conducted at the firm/establishment-level forces researchers to estimate volatility using rolling standard deviations. This approach is problematic for several reasons: (i) it assumes that volatility is constant within the estimation window, a feature which is inconsistent with the extensive literature documenting the salient time-series variation of volatility (see e.g. Schwert, 1989; Campbell et al., 2001; Bloom, 2014); (ii) measured volatility is also highly sensitive to the breadth of the rolling window used in the estimation (Comin and Philippon, 2006); and crucially, (iii) this method underestimates volatility when, as is often the case, episodes of high volatility are short-lived (Bachmann et al., 2013). We overcome these limitations by fitting firm-specific ARCH-type models to estimate volatility, taking advantage of the high frequency of stock returns data. Our empirical strategy

[1] Similarly, di Giovanni and Levchenko (2009) and Caselli et al. (2014) have studied the link between exports and volatility at the industry and aggregate-levels respectively. Neither of them considers the role of sales conducted by foreign affiliates in shaping sectoral or aggregate volatility.

also offers the additional advantage of providing us with an estimator of firm-level volatility *conditional* on the information available up to that point in time, thus offering a forward-looking measure of volatility over the asset holding time period rather than a historical average.

Over the last two decades, research in international trade has identified a host of robust relationships between a firm's participation in foreign markets and the first moment of a wide range of performance indicators. Namely, firms that export or engage in foreign direct investment have been found to be on average, larger, more productive, and more capital, skill and R&D-intensive than firms serving exclusively domestic markets (see Bernard et al., 2007; Antràs and Yeaple, 2013, and references therein). Much less is known, however, about the extent to which global engagement affects the second moments of firm-level outcomes. Similarly, the finance literature studying the determinants of stock returns volatility (e.g. Schwert 1989; Pástor and Veronesi, 2003; Wei and Zhang, 2006; Fink et al., 2010) has not considered the role played by firms' internationalization strategies. Thus, this paper helps to bridge the gap between these two expanding research fields by providing empirical evidence on the robust links that exists between globalization and volatility at the firm level.

Besides the availability of high-quality data, Japan constitutes an excellent laboratory to study the relationship between global engagement and the volatility of firms' stock returns. The sample period that we consider is characterized by a high level of economic turbulence, including two domestic recessions in 2001-02 and 2004, as well as the 2008-09 global financial crisis. De Veirman and Levin (2012) document a sharp increase in firm-level earnings, employment and sales volatility during the deep recession that hit Japan between 1998 and 2002 and a subsequent decline in volatility following the export-led recovery that took place in the middle of the decade. At time of the 2008-09 global financial crisis, an event which hit Japanese exports particularly hard (Eaton et al., 2011), both aggregate and firm-level volatility rose sharply again, but this spike quickly subsided in less than one year. At the same time, deeper trade integration with China and the US has significantly increased the importance of external

markets for Japanese producers (OECD, 2011), although a substantial number of large, publicly-listed manufacturing firms remain highly dependent on domestic sales.

The rest of the paper is organized as follows: Section 2 summarizes the theoretical framework guiding our empirical analysis. Sections 3 and 4 describe our data and empirical identification strategy respectively. Our main results and robustness checks are presented in Section 5; Section 6 concludes.

2. Global Engagement and Firm-level Volatility

The aim of this section is to provide a brief discussion of potential mechanisms through which a firm's extent of global engagement might influence its volatility in order to guide our empirical analysis.

Selling its output in foreign markets is an inherently risky activity for a firm. During the time it takes to complete an international transaction, an exporter is exposed to, among other things, adverse movements in exchange rates or demand, payment default and customs-related disruptions. Relying on sales through foreign affiliates, alternatively, can make firms vulnerable to unexpected changes in regulations and political instability. Nevertheless, even if foreign demand is more volatile than domestic sales, firms can reduce their volatility by selling abroad as a result of a portfolio diversification effect, provided that destination-specific shocks are not too highly correlated. Hirsch and Lev (1971) find early support for the hypothesis that diversification of export sales helps to stabilize firms' sales. More recently, Buch et al. (2009) also find that German exporters have less volatile sales than their domestic counterparts.

Participating in international markets, however, is a costly activity; firms need to incur substantial investments in logistics, market research and distribution arrangements before being able to reach foreign customers. The exact nature of these costs has important implications for the relationship

between operating in foreign markets and firm-level volatility, and can even overturn the volatility-reducing effect generated by the international diversification of sales. Riaño (2011) shows that if the costs required to start exporting are sunk, exporters are more volatile than domestic firms — even when producers are risk-averse. This follows because exporters are reluctant to stop selling abroad in response to negative shocks in order to avoid re-incurring the entry costs in the future. Vannoorenberghe (2012) finds that when firms have increasing marginal costs of production, a U-shaped relationship arises between a firm's export intensity and the volatility of its sales. In this case, the cost advantage that a firm achieves by rebalancing its domestic and export sales in response to demand shocks outweighs the diversification effect for high-intensity exporters.

The models discussed above treat exporting as the only margin of global engagement available to firms. Setting up a foreign subsidiary (engaging in horizontal FDI), however, allows a producer to sell its output abroad while avoiding the international shipment of final goods. Because sales by multinational firms' foreign affiliates are substantially larger than export sales — particularly for large firms in developed countries — it is of great interest to explore if the means through which firms serve foreign buyers affect firm-level volatility differently.

The proximity-concentration theory, the workhorse model studying firms' choice between exporting and foreign direct investment, suggests that the tradeoff between these two margins of global engagement is determined by a comparison between the higher variable (transport) costs associated with exporting and the larger fixed cost of setting up and operating a foreign affiliate facility (Helpman et al., 2004).

On the one hand, if the costs of establishing a subsidiary abroad are to a large extent irreversible, then the resulting hysteresis implies that firms serving foreign markets using horizontal FDI will be more volatile than those choosing to rely on exports, following an argument analogous to that in Riaño (2011)

discussed above. Fillat and Garetto (2014) provide evidence in support of this mechanism. They establish that US multinational firms are riskier in the sense that the *level* of their stock returns exhibits a higher covariance with aggregate consumption growth than that of exporters, which are in turn, riskier than domestic firms.

On the other hand, the higher variable costs that characterize export transactions could result in exporters being more volatile than firms engaged in horizontal FDI. This would be the case if the longer lag between production and receipt of revenues combined with higher project risk, the probability that the importing party will default on an order's payment, increases the cost of working capital for exporters, hampering their ability to access external finance and tightening credit constraints. Amiti and Weinstein (2011) find that Japanese exporters, and particularly those shipping their goods by sea, are more sensitive to financial shocks (e.g. the deterioration of the balance sheet of the bank providing export credit to an exporter) than firms using foreign subsidiaries. Thus, relying more intensively on foreign affiliates than on exports to serve foreign markets might, by shortening delivery and payment lags, improve a firm's ability to hedge its exposure to foreign shocks and lower its volatility. Conversely, if firms rely extensively on external borrowing to finance the costs of setting-up and operating foreign affiliates, we could also witness a strong and positive relationship arising between volatility and the intensity of sales accounted for foreign affiliates for firms with high external finance requirements.

So far we have reviewed mechanisms through which a firm's choice of whether to sell its output abroad and the means to reach foreign customers can affect the volatility of its performance. It is also possible, however, that the underlying sectoral or country-level volatility faced by a producer in a given destination shapes its decision of what mode of operation to use to sell there. Conconi et al. (2013) find that when facing riskier markets, Belgian firms rely primarily on exports as a more cost-effective way to learn about their profitability abroad before establishing foreign affiliates. Likewise, Ramondo et al. (2013) show that both output volatility and cross-country output correlations are significant predictors

of the ratio of exports to affiliate sales across countries for US multinationals.[2] Thus, it is crucial that in our empirical analysis we control for the second moments of the destination markets that firms sell to.

Lastly, it is important to emphasize that producers are not only exposed to external shocks on their demand side by selling their output abroad as we investigate in this paper, but also through their costs, e.g. by importing intermediate inputs and capital or splitting their production process across countries (offshoring) — as firms increasingly engage in global production sharing, input-output linkages can facilitate the international transmission of shocks, thereby influencing firm-level volatility. Nguyen and Schaur (2012) find that both exporting and importing increase the volatility of sales for Danish firms in a similar magnitude, while Kurz and Senses (2013) find that the intensive margin of imports has a stronger impact on the volatility of firms' employment for US firms.

We have highlighted several channels through which the extent of global engagement can affect firm-level volatility: substantial irreversible costs to establish a presence in foreign markets, higher working capital requirements, and longer cash conversion cycles can increase the volatility of firms that rely intensively on foreign sales; the potential diversification of country-specific demand and supply shocks can, on the other hand, produce the opposite result. We have also shown that the importance of these mechanisms differs markedly according to the mode of operation that a firm chooses to serve foreign markets, although existing theories of the trade-off between exporting and horizontal FDI provide ambiguous predictions regarding how differences between these two margins of global engagement affect firm-level volatility. We now proceed to explore the relationship between global engagement and the volatility of stock returns from an empirical perspective.

[2] The theory does not necessarily predict that higher volatility in destination markets always induces firms to favour exporting over horizontal FDI. Using a version of the proximity-concentration model incorporating uncertainty about a firm's productivity growth, Sala and Yalcin (2014) show theoretically that greater uncertainty induces firms to favor foreign market entry via horizontal FDI rather than through exporting.

3. Data

The dataset we use consists of 1,474 manufacturing firms listed in the Tokyo Stock Exchange observed over the 132 months spanning the period January 2000-December 2010. The firms in our sample are large and important for the Japanese economy as a whole; they account for more than 60% of manufacturing employment and a substantial share of the firms engaged in exporting or multinational activities across the period of analysis.[3] Table 1 provides the precise definition and sources of the variables used in our analysis.

As far as the microeconomic literature on globalization and volatility is concerned, the use of conditional returns volatility is one important innovation of our paper. Previous work studying the relationship between exporting and the volatility of firm-level sales or employment which relied on low-frequency yearly data, used unconditional rolling standard deviations to measure volatility (Buch et al., 2009; Riaño, 2011; Vannoorenberghe, 2012; Kurz and Senses, 2013). This estimator has serious drawbacks. It imposes volatility to be constant within the estimation window by construction, over-smooths volatility because it does not capture volatility changes taking place within a year, and produces very little time-series variation.[4]

Let p_{it} denote the stock price of firm i in period (month-year) t, and $\tilde{r}_{it} \equiv \log(p_{it} + d_{it}) - \log(p_{it-1})$, its corresponding monthly return including dividends d_{it}. Following Campbell et al. (2001), define the excess stock return relative to the 2-digit industry I to which firm i belongs to as $r_{it} = \tilde{r}_{it} - \sum_{i \in I} \omega_{it} \tilde{r}_{it}$, where ω_{it} denotes firm i's share in the industry's market value in the same period. Our

[3] According to Basic Survey of Japanese Business Structure and Activities there were approximately 6,000 exporting firms (out of which 4,000 were manufacturing firms) and 2,500 firms that owned foreign affiliates (Survey on Overseas Business Activities) on average during our period of study. Table 2 below shows that 875 firms in our sample exported or sold their output through foreign subsidiaries at least once over the same period.

[4] Notice that the estimated volatilities for two consecutive time periods differ only by the two data points in each limit of the estimating window.

dependent variable is defined as the (log) monthly conditional volatility of a firm's excess stock returns, which we obtain by fitting an ARCH-type model for each firm in our sample. A detailed description of the procedure that we use to estimate the conditional volatility of stock returns is provided in Appendix A, but suffice to say that we consider several variants, such as a highly robust GARCH (1,1) (Hansen and Lunde, 2005), a pure ARCH model and an EGARCH model that allows for asymmetric effects of positive and negative shocks to stock returns. For each firm in our sample we select the appropriate model for the conditional variance using the Akaike information criterion as well as specification tests on the existence of serial correlation in both the standardized residuals and square residuals (Tsay, 2005).

Annual export sales figures are obtained from Datastream and Bloomberg. The latter also provides information on firms' export intensity (exports sales/total sales) with further breakdown into four aggregate export destinations: Asia, Europe, North America and Others.

Sales generated from operations in foreign countries excluding export sales, our measure of horizontal FDI (denoted HFDI hereafter), are obtained from Datastream. Bureau van Dijk's Orbis database is used to obtain information on the geographic distribution of sales by foreign subsidiaries. Other firm-level control variables including monthly market value, quarterly measures of financial performance (returns on assets), as well as age and leverage (measured at a yearly frequency), are also sourced from Bloomberg and Datastream.

Table 1: Variable definition and data sources

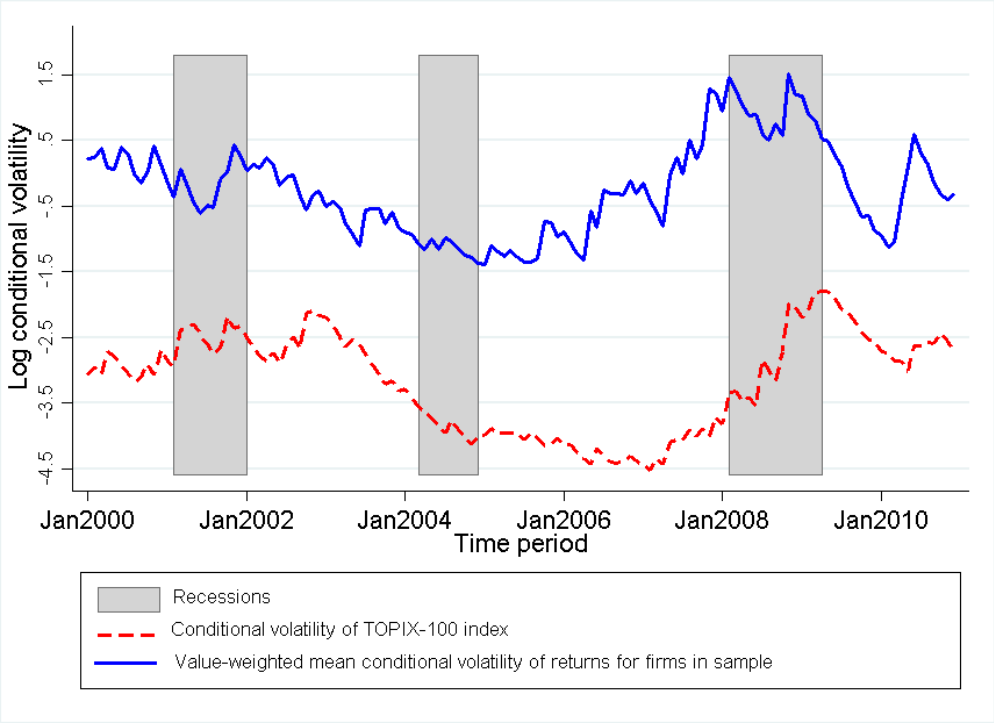
Variable	Definition	Data sources	Data frequency
Excess stock returns	Change in stock price including dividends received for a firm minus SIC2 industry value-weighted average return	DATASTREAM & BLOOMBERG for raw data; and own estimation	Monthly
Conditional volatility of excess stock returns	Log volatility of a firm's monthly excess return (relative to SIC2 industry average) estimated from a firm-specific ARCH-type model (see Appendix A for more detail).	DATASTREAM & BLOOMBERG for raw data; and own estimation	Monthly
Export intensity	Export sales/total sales, with further breakdowns into four export destinations, viz. Asia, Europe, North America and Others.	DATASTREAM and BLOOMBERG	Yearly
HFDI intensity	Sales by foreign affiliates/total sales	DATASTREAM & ORBIS.	Yearly
Size	Log of a firm's total assets which is the sum of total current assets, long term receivables, , investment in unconsolidated subsidiaries, other investments, net property plant and equipment and other assets	DATASTREAM	Yearly
Leverage	[(Long Term Debt + Short Term Debt & Current Portion of Long Term Debt) / Common Equity]*100	DATASTREAM	Yearly
Returns on assets	[(Net Income before Preferred Dividends + ((Interest Expense on Debt-Interest Capitalized) * (1-Tax Rate))) / Average of Last Year's and Current Year's Total Assets]*100	DATASTREAM	Quarterly
Age	Log of years since incorporation	ORBIS	Yearly
Market value	Log of (market Price-month end*total number of shares outstanding)	DATASTREAM and BLOOMBERG	Monthly
Investment rate in foreign subsidiaries	Change in total fixed assets of foreign subsidiaries relative to total assets with further breakdowns into four main geographic areas, viz. Asia, Europe, North America and Others	ORBIS	Yearly
External finance dependence dummy	=1 if (capital expenditure-cash flow)/capital expenditure) is above median value of 0.33, 0 otherwise	DATASTREAM and own calculations	Yearly
Exchange rate conditional volatility	Log of monthly conditional volatility of USD/Yen exchange rate estimated from a GARCH (1,1) model	BLOOMBERG and own estimation	Monthly
Conditional volatility of destination stock markets	Log of monthly conditional volatility of export/HFDI destination country stock market estimated from a GARCH (1,1) model multiplied by an indicator variable that takes the value 1 if a firm sells its output in a given destination in that period. The following indices are used as proxies for foreign destinations' stock markets: S&P 500 index (North America); DAX index (Europe); KOSPI index (Asia) and ASX index (Other)	DATASTREAM & BLOOMBERG and own estimation	Monthly
Export-weighted conditional covariance between Japanese and destination stock markets	Log of destination-specific export-share-weighted monthly conditional covariance between Japanese and export destination countries stock markets obtained via multivariate GARCH (1,1) regressions. The following indices are used as proxies for foreign destinations' stock markets: S&P 500 index (North America); DAX index (Europe); KOSPI stock index (Asia) and ASX index (Other)	DATASTREAM & BLOOMBERG and own estimation	Monthly
FDI-weighted conditional covariance between Japanese and destination stock markets	Log of destination-specific foreign-sales-share-weighted monthly conditional covariance between Japanese and FDI destination countries stock markets obtained via multivariate GARCH (1,1) regressions. The following indices are used as proxies for foreign market conditions: S&P 500 index, (North America); DAX index (Europe); KOSPI index (Asia) and ASX index (Other)	BLOOMBERG for raw data; and own estimation	Monthly
Time period:	January 2000-December 2010 (132 months)		
Number of firms:	1,474		

Figure 1 presents the value-weighted average conditional volatility of stock returns for the firms in our sample and contrasts it with the conditional volatility of the TOPIX-100 index of the Tokyo Stock Exchange, which includes all the firms listed in the Tokyo Stock Exchange's First Section (i.e. the largest firms listed in the exchange), over the sample period. The conditional volatility of returns across our sample of manufacturing firms follows a similar time-series pattern to that of the TOPIX-100, but is always higher, since the latter index is broader in its scope, including companies operating in banking and finance, transportation, real estate, services and public utilities. Conditional volatility displays substantial variation over time (Schwert, 1989; Campbell et al., 2001), but unlike the case of the US, no secular trends are apparent (Comin and Philippon, 2006; Davis et al., 2007). Volatility starts high during the 2001-2002 domestic recession, subsiding during the export-led recovery of the middle of the decade; it starts to rise again in 2007 and spikes dramatically during the 2008-09 global financial crisis. Following a similarly quick reduction after 2009, it reaches comparable levels to those observed at the beginning of the decade.

The distribution of firms in our sample across global engagement modes is presented in Table 2. Approximately 60% of firms export or use foreign affiliates and among these, the majority (64%) utilizes both margins of global engagement at some point during this period.[5] Although a non-negligible share of firms only reach foreign markets through exports, very few firms rely exclusively on foreign affiliates. The extent of global engagement among our sample of publicly-listed firms is substantially higher than what is observed in more representative firm-level surveys for Japan. Kimura and Kiyota (2006) using data from the Basic Survey of Japanese Business Structure and Activities, which includes all firms with more than 50 employees or with capital in excess of 30 million Yen, find that only 24% of firms export or own foreign subsidiaries.

[5] Global engagement status is also highly persistent. Among the 562 firms that engage at least once in exporting or horizontal FDI, 272 utilize both margins in every year of the sample period.

Figure 1: Value-weighted Mean Conditional Volatility of Returns and Overall Stock Market Conditional Volatility



Shaded areas denote recession periods in Japan identified by the OECD (series JPNRECM from St Louis Fed FRED database). Recession periods in our sample are: 2001:2-2002:1; 2004:3-2004:12 and 2008:2-2009:4. The TOPIX-100 index is a capitalization-based index that includes all the firms listed in the Tokyo Stock Exchange's First Section, which groups all the largest firms in the exchange. It includes manufacturing firms alongside companies operating in banking and finance, transportation, real estate, services and public utilities. The conditional volatility of the TOPIX-100 index is estimated using a GARCH(1,1) specification. Appendix A describes the procedure used to estimate individual firm's conditional volatility.

An initial exploration of whether or not firms exporting and engaging in horizontal FDI differ from domestically-oriented firms in terms of the conditional volatility of their stock returns is presented in Figure 2, which plots the raw conditional volatility premium of globally-engaged firms across our sample period. Both the volatility premia of exporters and firms engaged in horizontal FDI are positive and highly significant, ranging from more than 30% in 2000 to 20% in 2010. The lower panels of Figure 2 also show that the intensity of global engagement (measured as the share of total sales accounted for by exports and sales through foreign affiliates) also influences significantly volatility premia. Figure 2 provides suggestive evidence of a strong relationship between exporting, horizontal FDI and returns

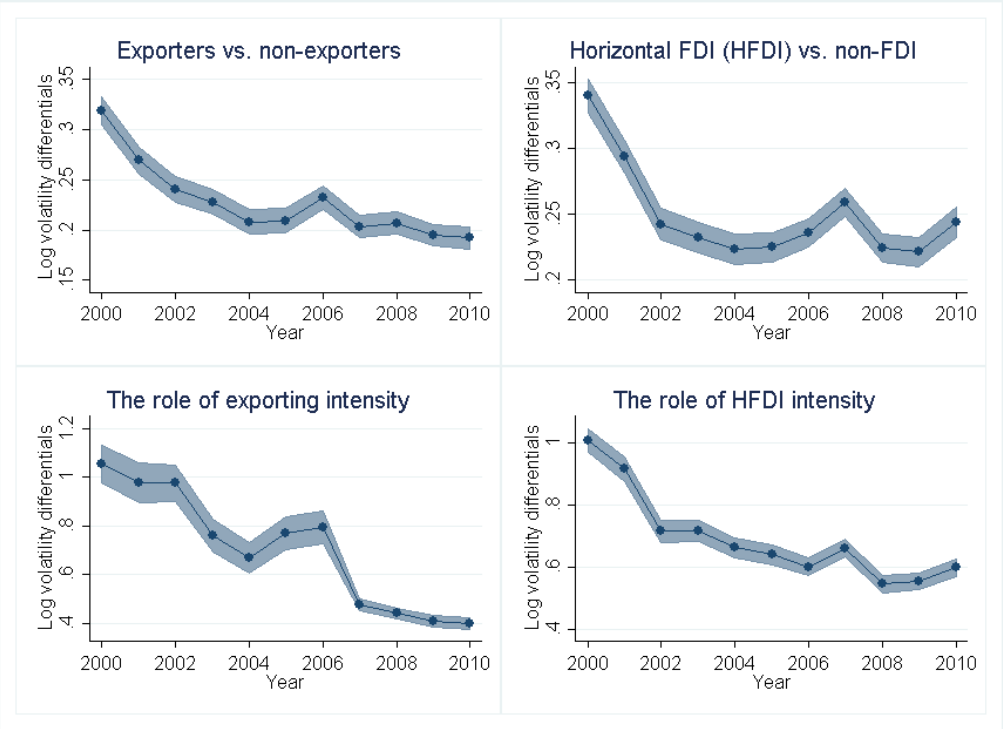
volatility. In what follows we will show that even after controlling for a host of firm-level characteristics and the potential endogeneity of the intensity of global engagement, there is a remarkably robust and positive relationship between serving foreign markets and the volatility of a firm's stock returns.

Table 2: Distribution of firms by mode of global engagement

Firm type	Number of firms	Export intensity		Horizontal FDI intensity	
		Mean	Std. Dev.	Mean	Std. Dev
Neither Horizontal FDI nor export across all years	599	-	-	-	-
Export at least once in the sample period	287	0.110	0.091	-	-
Horizontal FDI at least once in the sample period	26	-	-	0.038	0.043
Both Horizontal FDI and export at least once in the sample period	562	0.197	0.128	0.265	0.177

Table 3 reports a range of summary statistics of the key variables used in our empirical analysis. Several points are noteworthy; to start with, globally-engaged firms are not only more volatile than their domestic counterparts, but also exhibit higher stock returns. Firms conducting horizontal FDI exhibit annualized excess stock returns that are 3.1 percentage points higher than their domestically-oriented counterparts, while exporters' returns are one percentage point higher than those of domestic firms, the same ranking found by Fillat and Garetto (2014) among publicly-listed US firms. The same pattern arise when we consider returns on assets. Globally-engaged firms also tend to be larger in terms of size and market value, but are not significantly different from domestically-oriented firms in terms of leverage.

Figure 2: Volatility Premia of Globally-Engaged Firms



In the upper panels the figure reports the estimated coefficient and confidence interval of regressing the estimated firm-level conditional volatility of excess stock returns on the product of firms' exporting and horizontal FDI (HFDI) status and year dummies respectively. The lower panels display the estimated coefficient and confidence interval of regressing the estimated firm-level conditional volatility of excess stock returns on the product of firms' exporting and horizontal FDI (HFDI) intensities (i.e. the share of each global engagement margin on a firm's total sales) and year dummies respectively.

Our empirical strategy to identify the impact of exports and horizontal FDI on returns volatility crucially relies on within-firm variation in the intensity of global engagement. Column (3) of Table 3 shows that a substantial fraction of the variance of conditional volatility as well as that of exporting and horizontal FDI intensity is due to within-firm time-series variability. Moreover, column (4) shows that time-invariant firm effects and macro shocks captured via time effects are not sufficient to adequately explain volatility differences in our data.

Table 3: Summary statistics

	Mean	Std. dev.	Proportion of within variance	Proportion explained by firm and time effects	Coefficient on export dummy	Coefficient on Horizontal FDI dummy
	(1)	(2)	(3)	(4)	(5)	(6)
Excess stock returns	0.000	0.103	0.993	0.000	0.001***	0.003***
Conditional volatility of excess stock returns	-0.907	1.576	0.924	0.001	0.632***	0.642***
Export intensity	0.257	0.215	0.522	0.348		
Horizontal FDI intensity	0.287	0.188	0.146	0.018		
Size	17.549	1.538	0.017	0.000	1.352***	1.892***
Leverage	0.219	0.181	0.185	0.025	-0.004	-0.000
Returns on assets	1.725	7.086	0.554	0.031	0.712***	1.334***
Age	3.755	0.832	0.037	0.004	0.183	0.205***
Market value	9.779	1.770	0.072	0.022	1.592***	2.243***
External finance dependence dummy	0.498	0.500	0.753	0.000	0.033***	0.027**
Cond. volatility USD/Yen	-3.737	0.124				
Cond. volatility N. American stock market	-0.110	0.255				
Cond. volatility European stock market	0.393	0.677				
Cond. volatility Asian stock market	0.089	0.255				
Cond. volatility other-destinations stock market	0.190	0.340				

Firm-year-month observations: 180,122. Column 4 reports the R squared of a regression of the respective variable with respect to firm and time fixed effects. Columns 5 and 6 report the estimated coefficient of a bivariate regression of the corresponding variable in each row of the table with respect to export and horizontal FDI dummies respectively. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4. Empirical Identification Strategy

Baseline Model

In this section, we describe the empirical approach used to identify the effect of global engagement on stock returns volatility. We specify the following baseline model of the determinants of volatility with firm-specific heterogeneity and year and month effects:

$$ln\sigma_{it} = GLOB'_{it-12}\alpha + X'_{it-12}\beta + DV'_{it}\gamma + f_i + f_t + \varepsilon_{it.} \quad (1)$$

In the above equation i and $t \in \{2000:1, \ldots, 2010:12\}$ index firms and month-year periods respectively. The dependent variable is the log of monthly conditional volatility of a firm's excess stock

returns;[6] $GLOB_{it-12}$ consists of two variables measuring the extent of firm-level global engagement, namely, exports and horizontal FDI sales intensities; therefore, the vector α is the main set of coefficients of interest. X_{it-12} is a vector of control variables that are commonly used to explain cross-sectional differences in the volatility of stock returns; these include firm's age, size (total assets), leverage and returns on assets (ROA) (see e.g. Pástor and Veronesi, 2003; Wei and Zhang, 2006; Fink et al., 2010). All these variables are lagged one year to mitigate any endogeneity concerns not accounted for by firm and time fixed effects in the model. DV_{it} is a vector that includes the contemporaneous conditional volatility of the nominal Japanese Yen/US dollar exchange rate, in addition to stock market conditional volatilities in the foreign destinations served by a firm. Unobserved, time-invariant firm-specific heterogeneity which is correlated with the regressors is captured by f_i, and f_t is a vector of year and month effects designed to capture aggregate shocks and seasonal patterns; ε_{it} is a random error term which is allowed to exhibit cross-sectional and temporal dependence. It is important to account for these two sources of potential correlation of the error term because stock returns display substantial cross-sectional and time-dependence both in their first and second moments (Andersen et al., 2001; Vuolteenaho, 2002). In order to address this issue, we use the covariance matrix estimator proposed by Driscoll and Kraay (1988) to compute standard errors. This estimator is appropriate in the present context because unlike typical micro panels, our dataset has a large time dimension.

In summary, our baseline specification employs a panel fixed effects framework with a large host of control variables, and exploits within-firm variation in the intensity of global engagement and stock returns volatility to identify the parameters of interest.

[6] See Table 1 for details of the construction of all variables used in this paper and Appendix A for a description of the procedure used to estimate the conditional volatility of firms' excess stock returns.

Instrumental Variables

The use of firm-specific fixed effects and lagged values of the global engagement variables should go a long way in addressing endogeneity issues in our baseline specification. Nevertheless, it is still possible that the estimation of α in equation (1) might be contaminated by endogeneity problems induced by time-varying unobservable variables that are correlated with the error term.

Accordingly, we probe the sensitivity of our results by employing a control function instrumental variables (IV) estimator proposed by Wooldridge (2008), coupled with a fixed effects formulation, which provides consistent estimates of average treatment effects in the presence of endogenous censored variables (recall that in our case the two potentially endogenous regressors, exports and horizontal FDI intensities, are censored). The details of this estimation strategy are outlined in Appendix B. However, some of the key features of this estimator are worth noting. The IV estimator (i) can handle more than one endogenous censored variables; (ii) readily adjusts the standard errors for using generated regressors; (iii) allows the treatment effects and the endogenous variable to be arbitrarily correlated — a useful feature of correlated random coefficients models — and (iv) offers a test for the exogeneity of the censored endogenous regressors.

In our empirical implementation we use two-year lagged values of exporting and FDI intensity, and the following three additional instruments:

(i) **Export destination weighted firm-specific exchange rate shocks in the previous year (i.e. lagged by twelve months)**. This is constructed as the weighted average of the firm's export destinations exchange rate (Δe_{dt-12}) , where the weights are the historical (previous three years average) share of total export sales sold in the relevant destination ($\bar{\mu}_{id}^{EXP}$). Formally, this is defined as:

$$Z_{it}^{EXP} \equiv \sum\nolimits_{d \in D} \bar{\mu}_{id}^{EXP} \Delta e_{dt-12} \, .$$

To make matters clear, the weight are *not* the share of exports in total sales (lagged values of a firm's destination-specific intensity of global engagement), but the proportion of exports to a specific destination (i.e. a measure of the relative importance of a market for the firm's exports). Due to data limitations we use four destination markets indexed by d, namely Asia, Europe, North America and Others. The exchange rate shocks Δe_{dt-12} are calculated as the nominal exchange rate depreciation of Japanese Yen vis-à-vis the destination market's currency.[7]

(ii) **Horizontal FDI-weighted firm-specific exchange rate shocks in the previous year.**

This is constructed in the same way as the export-weighted exchange rate discussed above, but with weights, $\bar{\mu}_{id}^{HFDI}$, defined as the historical (previous three years) proportion of sales accounted for by overseas affiliates in each destination market *d*; formally this is given by:

$$Z_{it}^{HFDI} \equiv \sum\nolimits_{d \in D} \bar{\mu}_{id}^{HFDI} \Delta e_{dt-12} \, .$$

Our approach of exploiting variation in global engagement induced by exogenous firm-specific exchange rate shocks to identify the impact of the former on volatility follows Park et al. (2010) and Bloom et al. (2014). It is well established that both exports and foreign direct investment are both strongly responsive to movements in exchange rates (see Berman et al., 2012 and Russ, 2007); we posit, however, that conditional on firm-level fixed effects, exchange rate volatility and the rest of the control variables, exchange rate shocks affect returns volatility only through their effects on the intensity of foreign sales carried out through exports and horizontal FDI.

[7] We use the Korean Wan as the reference exchange rate sales to Asian markets, Euro for Europe, US Dollar for North America and the Australian Dollar for Other destinations, since Australia is the largest export destination market for Japan outside Asia, Europe and North America; see http://www.jetro.go.jp/en/reports/statistics/

(iii) **One-year lagged foreign affiliates' fixed investment rate,**

$$Z_{it}^{I} \equiv \sum_{d \in D} \left(\frac{INV_{idt-12}}{K_{it-12}} \right),$$

where INV_{idt-12} is investment in fixed assets by the firm's foreign affiliates in destination market d and K_{it-12} denotes the firm's total assets. Here we make the plausible identifying assumption that conditional on fixed effects, overseas affiliates' fixed investment decisions made a year earlier do not have a direct effect on current volatility, but through their impact on foreign sales.

It is important to note that it could be the case that unobservable dimensions of global engagement such as a firm's utilization of imported inputs or reliance on intra-firm trade, could potentially be correlated with our excluded instruments. Therefore, caution is required when interpreting our IV estimates as providing the causal effect of an increase in global engagement on the volatility of returns. Nonetheless we will report a variety of specification tests to ensure the econometric validity of our instruments.

5. Main findings and discussion

We start by discussing our findings from estimating equation (1) via the fixed effects panel estimator with cross-sectionally and serially correlated errors.

Baseline specification

The estimates from the baseline model are reported in column (1) of Table 4. Regarding the effect of our control variables, we establish a robust and positive relationship between firm size and financial performance (return on assets) and the conditional volatility of returns. In contrast, leverage has a negative impact on volatility, providing some evidence that the ability to attract external finance inspires higher confidence regarding future streams of earnings. Firm's age exerts a negative but insignificant effect on conditional volatility. In line with the literature that documents the significant

effect of exchange rate movements on firm equity (Dominguez and Tesar, 2006) — we find that a 10% increase in the conditional volatility of the Yen/USD exchange rate is associated with a 1.1% increase in returns volatility, everything else constant. Destination-specific stock market volatilities, on the other hand, have a small and for the most part insignificant effect on volatility after controlling for the volatility of the exchange rate.

Table 4: Conditional volatility of stock returns and global engagement

	Baseline model	Outlier robust	Weighted regression	With global engagement dummies	Unconditional volatility
	(1)	(2)	(3)	(4)	(5)
Export intensity	0.117***	0.072***	0.125***	0.116***	0.067**
	(0.037)	(0.016)	(0.013)	(0.036)	(0.031)
Horizontal FDI intensity	0.140***	0.049***	0.151***	0.173***	0.079*
	(0.025)	(0.018)	(0.024)	(0.030)	(0.046)
Size	0.041**	0.033***	0.045***	0.041**	-0.032
	(0.019)	(0.008)	(0.007)	(0.019)	(0.021)
Leverage	-0.100***	-0.067***	-0.108***	-0.100***	0.338***
	(0.037)	(0.018)	(0.019)	(0.037)	(0.032)
Return on assets	0.003***	0.003***	0.003***	0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Age	-0.006	-0.028***	-0.012	-0.005	-0.003
	(0.014)	(0.006)	(0.010)	(0.013)	(0.011)
Exchange rate volatility	0.108*	0.160***	0.109***	0.107*	0.338*
	(0.054)	(0.033)	(0.017)	(0.054)	(0.172)
Export dummy				-0.006	
				(0.013)	
Horizontal FDI dummy				-0.027*	
				(0.015)	
North American stock market volatility	0.003	0.007***	0.004**	0.004	-0.004*
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
European stock market volatility	-0.006**	-0.004***	-0.007***	-0.006**	0.000
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Asian stock market volatility	-0.000	-0.000	0.001	0.000	0.002
	(0.002)	(0.001)	(0.002)	(0.002)	(0.004)
Other stock markets volatility	0.002	0.001	0.001	0.002	-0.001
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Observations	163,823	163,823	160,282	163,823	163,820

Panel fixed effects estimates with standard-errors adjusted for cross-sectional dependence and within-firm serial correlation. Standard errors in parenthesis. All specifications include firm, year, and month-specific fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In what follows we confine our discussion to the global engagement variables which are the main focus of this study. Estimates reported in column (1) of Table 4 indicate that a higher intensity of global engagement has a positive and significant impact on the conditional volatility of firms' stock returns. The intensive margin of both margins of exporting and sales through foreign affiliates exert a large positive effect on firm-level volatility: a one standard deviation (approximately 0.21) increase in exporting intensity is associated with a 2.46% increase in monthly volatility, which in turn translates into a 8.5% rise in annualized volatility.[8] The same increase in the intensity of sales through foreign affiliates is in turn associated with a 9.12% higher annualized volatility.

Columns (2)-(5) of Table 4 present a robustness analysis of our main result. We first re-estimate our benchmark regression after winsorizing the top and bottom 1% of the conditional volatility to ensure that our findings are not unduly driven by outliers. The results reported in column (2) show that although the effect of both margins of global engagement falls slightly, it still remains highly significant. Since Gabaix (2011) has shown that shocks to large firms can play an important role on aggregate volatility due to the granularity of economic activity, in column (3) we weight our panel fixed effects regression by a firm's total market value so as to give greater weight to larger firms in the identification of average effects. The results from this specification are quite similar to those presented in column (1). The positive relationship between the intensive margin of foreign sales and volatility also survives the inclusion of export and foreign affiliate dummy variables in the regression (column (4)), which would control for differences between globally engaged firms and those operating in the domestic market alone. Lastly, in column (5) we use the unconditional volatility of stock returns — defined as the log of 12-month rolling standard deviation of firms' excess return over the industry average — as our dependent variable. Although the intensity of exports and horizontal FDI remain

[8] $\sqrt{12} \times 0.0246 = 0.085$.

significant, their effect on volatility falls substantially. This result illustrates the potential drawbacks of using an unconditional estimator of volatility discussed above.

Although we have stressed the disadvantages of using low-frequency data to estimate firm-level volatility and its determinants, in Table 5 we re-estimate our baseline model using annualized data. Doing so serves as a further robustness check of our results, but also allows us to compare our findings with the existing literature by estimating our model using the unconditional volatility of the growth rate of sales and employment as the dependent variable following Buch et al. (2009), Vannoorenberghe (2012) and Kurz and Senses (2013). The results presented in columns (1) and (2) of Table 5 are very much in line with our benchmark specification using high-frequency data — both margins of global engagement have a positive effect on firm-level volatility, with the intensity of sales through foreign affiliates being quantitatively larger. Using an unconditional estimate of returns volatility also yields qualitatively similar albeit less precisely estimated effects (see column (3)). Regarding other (unconditional) measures of volatility, we find the intensive margin of exports and horizontal FDI are also associated with a higher volatility of sales (see column (4)); from a quantitative standpoint, the effect of an increase in export intensity on the volatility of sales is lower than that reported by Vannoorenberghe (2012).[9] On the other hand, the results in column (5) suggest that a higher export intensity is negatively correlated with employment volatility in our sample of Japanese firms. Thus it appears that the exporting-employment volatility nexus contrasts sharply to that reported for the US by Kurz and Senses (2013). However we have to note that Kurz and Senses (2013) include small and medium unlisted firms (average employment of about 50) whereas our paper focuses

[9] Vannoorenberghe (2012) reports that an increase in a firm's export intensity from 0 to 50% leads to an increase of one-third of a standard deviation in the volatility of its total sales among French firms. In our case, the same change in export intensity is associated with 0.09 standard deviations increase in the volatility of total sales. Buch et al. (2009), on the other hand using data for the German state of Baden-Württemberg, find a smaller negative effect of export intensity on sales volatility. Namely, a one standard deviation increase in export intensity is associated with a 0.52% fall in the unconditional volatility of sales.

on large publicly listed companies (average employment of more than 3700). Nonetheless it would be interesting to further investigate this issue in the future by taking into account differences in labour market institutions between the two countries, and using comparable samples and methodologies.

Table 5: Annualized volatility and global engagement

	Baseline model	Weighted regression	Unconditional volatility	Sales growth volatility	Employment growth volatility
	(1)	(2)	(3)	(4)	(5)
Export intensity	0.360*	0.322***	0.034	0.148**	-0.447***
	(0.212)	(0.054)	(0.048)	(0.067)	(0.100)
Horizontal FDI intensity	0.785***	0.811***	0.146	0.460***	-0.328
	(0.266)	(0.095)	(0.099)	(0.152)	(0.202)
Size	0.005	0.011	0.101***	0.017	0.178**
	(0.119)	(0.028)	(0.027)	(0.054)	(0.082)
Leverage	-0.110	-0.149**	-0.238***	0.433***	1.159***
	(0.298)	(0.074)	(0.077)	(0.116)	(0.176)
Return on assets	0.001	0.001	0.012***	-0.003**	-0.003
	(0.004)	(0.001)	(0.001)	(0.001)	(0.002)
Age	0.087	0.092**	-0.085*	-0.171**	0.171
	(0.127)	(0.040)	(0.046)	(0.077)	(0.114)
Exchange rate volatility	-0.826	-0.463	0.077	0.396	-2.181
	(1.336)	(0.719)	(0.735)	(2.015)	(2.096)
North American stock market volatility	-0.004	-0.000	0.011	-0.001	-0.002
	(0.025)	(0.008)	(0.007)	(0.009)	(0.013)
European stock market volatility	0.008	0.008	-0.006	-0.001	0.016
	(0.020)	(0.005)	(0.005)	(0.007)	(0.010)
Asian stock market volatility	-0.016	-0.021***	0.012**	-0.012*	-0.010
	(0.019)	(0.006)	(0.006)	(0.007)	(0.011)
Other stock markets volatility	-0.012	-0.006	0.003	0.004	0.006
	(0.018)	(0.006)	(0.005)	(0.007)	(0.011)
Observations	13,763	13,4845	13,763	10,677	10,574

Panel fixed effects estimates with standard-errors adjusted for cross-sectional dependence and within-firm serial correlation. Standard errors in parenthesis. All specifications include firm and year-specific fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Factors mediating the relationship between global engagement and firm-level volatility

We now proceed to investigate whether the positive relationship we have identified between the intensity of global engagement and the volatility of stock returns is in turn mediated by aggregate characteristics such as the business cycle and the covariance between domestic and foreign markets as well as industry characteristics such as external finance dependence. Table 6 summarizes these results.

Table 6: Conditional volatility of stock returns and global engagement — further analysis

	Excluding recession periods (1)	With foreign Markets covariance (2)	Low external financial dependence (3)	High external financial dependence (4)
Export intensity	0.057**	0.103***	0.107	0.114***
	(0.025)	(0.032)	(0.084)	(0.038)
Horizontal FDI intensity	0.141***	0.130***	0.023	0.171***
	(0.027)	(0.026)	(0.048)	(0.028)
Size	0.047***	0.041**	0.028	0.047**
	(0.014)	(0.019)	(0.026)	(0.020)
Leverage	-0.080**	-0.101***	-0.280***	-0.031
	(0.033)	(0.037)	(0.064)	(0.041)
Return on assets	0.002***	0.003***	0.002*	0.003***
	(0.001)	(0.000)	(0.001)	(0.001)
Age	-0.005	-0.006	-0.044**	0.005
	(0.017)	(0.014)	(0.019)	(0.016)
Exchange rate volatility	0.184**	0.104*	0.012	0.149**
	(0.091)	(0.055)	(0.065)	(0.063)
North American stock market volatility	0.003	0.003	0.001	0.004
	(0.003)	(0.003)	(0.004)	(0.004)
European stock market volatility	-0.005**	-0.007***	-0.013**	-0.002
	(0.002)	(0.003)	(0.006)	(0.003)
Asian stock market volatility	-0.002	0.000	-0.007	0.002
	(0.002)	(0.002)	(0.004)	(0.002)
Other stock markets volatility	0.003	0.001	-0.001	0.004**
	(0.002)	(0.002)	(0.004)	(0.002)
Export-weighted covariance with foreign markets		0.0004		
		(0.0003)		
Horizontal FDI-weighted covariance with foreign markets		0.0002*		
		(0.0001)		
Observations	113,859	163,823	50,098	113,725

Panel fixed effects estimates with standard-errors adjusted for cross-sectional dependence and within-firm serial correlation. Standard errors in parenthesis. All specifications include firm, year, and month-specific fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Does global engagement affect firm-level volatility primarily during recessions?

It is a well-established stylized fact that volatility increases during economic downturns (see Bloom 2014 and Figure 1). Moreover, Figure 2 shows that the effect of global engagement on volatility also tends to increase during recessions.[10] The results reported in column (1) of Table 6 reveal that the

[10] Our period of study spans three official recessions, two, largely domestic in origin following a deep banking crisis in the first half of the decade (Hoshi and Kashyap, 2004) and the 2008-09 global financial crisis, which despite originating abroad had a remarkably negative effect on the performance of Japanese exporters (Eaton et al., 2011).

positive relationship between export intensity and returns volatility weakens when we exclude recession periods (see Figure 1's caption for the precise dates) relative to our benchmark specification while the magnitude of the effect of horizontal FDI remains largely unchanged. This result is consistent with the fact that durable goods — which are highly sensitive to business cycle conditions — account for a substantial share of export volumes in Japan and other OECD countries (Eaton et al., 2011; Engel and Wang, 2011).

Are our results affected by the degree of covariance across international stock markets?

The potential volatility-reducing effect provided by the international diversification of sales depends crucially on the degree of covariance between domestic and foreign markets. Moreover, Bollerslev et al. (1988) show that the conditional covariance of stock returns and the market portfolio is a quantitatively important determinant of asset risk premium. We augment our benchmark specification with the conditional covariance between Japan's TOPIX index and a weighted average of stock market indices in the four broad foreign destinations available in our data, where the weights are given by each individual firm's export and foreign affiliate sales shares to each destination. The results presented in column (2) of Table 6 show that a higher export and horizontal FDI-weighted covariance between the Japanese and foreign stock markets increase the conditional volatility of returns; both the volatility premium of global engagement and larger effect exerted by the intensity of sales through foreign affiliates remain unchanged.

Is the relationship between global engagement and volatility mediated by firms' external finance requirements?

The discussion in Section 2 suggests that the cost of working capital might be higher for firms that rely more intensively on exports than on sales by foreign subsidiaries due to the longer lag between

production and receipt of revenues that characterizes international trade transactions. By potentially increasing the likelihood of experiencing a binding borrowing constraint, we expect a greater reliance on exports to have a stronger effect on the volatility of firms that face greater requirements for external finance. It is possible, however, that if the costs associated with setting-up and operating a foreign affiliate are primarily financed through external borrowing (see e.g. Desai et al. 2004 and Bilir et al. 2015), that we would also observe a positive and significant relationship between a firm's horizontal FDI intensity and volatility.

We re-estimate our benchmark specification by splitting our sample according to whether the industry in which a firm operates is characterized by a high degree of dependence on external finance. Our indicator of high external finance dependence is drawn from Hosono et al. (2013), who replicate the index developed by Rajan and Zingales (1998) using data for Japanese firms. Firms operating in industries for which only a small share of investment is financed directly from retained earnings are classified as being highly dependent on external finance (more precisely, firms that belong to industries for which the external finance index is above the median; see Table 1 for further details).

The results presented in columns (3) and (4) of Table 6 show that the volatility premium of globally-engaged firms is crucially influenced by the extent of firms' external finance requirements. We find that a greater intensity of global engagement — both on the export and horizontal FDI margins — is positively associated with a higher volatility of stock returns only for firms with high dependence on external finance; among this set of firms, the intensity of horizontal FDI activity has a larger effect on firms' returns volatility than that of exports sales, the same message delivered by our benchmark specification.

IV estimates

Table 7 reports the regression results following the instrumental variables (IV) approach for censored endogenous variables.

The first stage Tobit regression results underpinning the IV estimation are presented in Table B.1 of Appendix B; Table B.2 presents various specifications tests, all of which lend support to the IV procedure. Namely, we confirm that the excluded instruments are orthogonal to the equation's error term, with the Hansen J statistic of overidentification restrictions emphatically failing to reject the null hypothesis of exogeneity for our instruments (p-value = 0.479). Table B.2 also reports a test of model under-identification, which is essentially a test of whether the excluded instruments are relevant, i.e. that they are correlated with the endogenous regressors. Reassuringly, the Kleibergen-Paap rk LM statistic strongly rejects the null hypothesis that the equation is underidentified (p-value = 0). Furthermore, two variants of weak identification tests also show that the relevant F-statistics are sufficiently high to allay estimation and inference concerns associated with weak instruments. Finally, the null hypothesis of exogeneity of the global engagement variables is rejected in all but one of the specifications presented in Table 7.

The IV estimation produces results that are quite similar to our benchmark specification, both qualitatively and in terms of their magnitude. The estimates provided in column (1) of Table 7 indicate that a one standard deviation change in export intensity increases annualized volatility by 11.2%, while a change of the same magnitude in the intensity of horizontal FDI, in turn, results in a 13.5% increase in the conditional volatility of returns.

Table 7: Conditional volatility and global engagement — Instrumental variables estimates

	Baseline model	Weighted regression	Unconditional volatility	With foreign markets covariance	Low external financial dependence	High external financial dependence
	(1)	(2)	(3)	(4)	(5)	(6)
Exporting intensity	0.154***	0.037	0.098**	0.144***	0.128*	0.163***
	(0.045)	(0.040)	(0.049)	(0.041)	(0.070)	(0.048)
Horizontal FDI intensity	0.207***	0.475***	0.279***	0.208***	0.222*	0.154**
	(0.066)	(0.032)	(0.083)	(0.065)	(0.133)	(0.076)
Size	0.059**	0.068***	-0.027	0.059**	0.052	0.059**
	(0.026)	(0.002)	(0.025)	(0.026)	(0.033)	(0.028)
Leverage	-0.122**	-0.161***	0.378***	-0.122**	-0.279***	-0.043
	(0.048)	(0.016)	(0.036)	(0.048)	(0.075)	(0.054)
Return on assets	0.003***	0.006***	-0.003***	0.003***	0.002	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.005	0.012***	-0.012	-0.005	-0.051**	0.006
	(0.017)	(0.003)	(0.010)	(0.018)	(0.021)	(0.021)
Exchange rate volatility	0.119**	0.113**	0.418**	0.112*	0.020	0.164**
	(0.058)	(0.056)	(0.169)	(0.059)	(0.066)	(0.069)
North American stock market volatility	0.005	-0.000	-0.001	0.004	0.002	0.005
	(0.003)	(0.002)	(0.003)	(0.003)	(0.005)	(0.004)
European stock market volatility	-0.005*	0.006***	0.000	-0.007**	-0.014**	-0.000
	(0.003)	(0.002)	(0.002)	(0.003)	(0.006)	(0.003)
Asian stock market volatility	0.006**	0.010***	0.004	0.008***	-0.002	0.008***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.006)	(0.003)
Other stock markets volatility	0.006***	0.004*	0.003	0.005**	0.004	0.007***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)
Export-weighted covariance with foreign markets				0.0007*		
				(0.0004)		
Horizontal FDI-weighted covariance with foreign markets				0.0002		
				(0.0002)		
Endogeneity test (p-value)	0.002	0.215	0.000	0.000	0.025	0.000
Observations	147,413	147,413	147,410	147,413	45,169	102,244

Fixed effects IV estimates with instrumentation procedure based on Wooldridge (2008). See Appendix B for estimation details, first-stage regression results and specification tests. Standard errors in parenthesis. All specifications include firm, year and month-specific fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In columns (2)-(6) of Table 7, we redo the regressions presented in Table 6, but using the IV estimator instead. Our key results are robust under this new specification. Namely, we find that a greater intensity of global engagement is associated with a positive and economically significant increase in a firm's conditional volatility of stock returns, although an increase in the intensity of sales

through foreign affiliates has a larger effect on volatility that a similar change in a firm's export intensity. The positive association between global engagement and returns volatility is crucially mediated by firms' requirements for external finance. More specifically, our findings lend support to the notion that the high finance intensity associated with reaching foreign markets — both due to the high working capital requirements of exporting and the substantial and to a large extent irreversible costs associated with setting up and operating an affiliate abroad — result in globally-engaged firms being more volatile than their domestic counterparts.

6. Conclusions

A recurring concern among policymakers and the general public in regards to globalization is that tighter links with the rest of the world result in producers becoming more vulnerable to external shocks. This paper contributes to current research efforts to provide microeconomic evidence on the matter. In so doing, we depart from existing work that has studied the link between global engagement and volatility at the firm level in several key dimensions. Ours is the first paper in investigating if the mean by which firms reach foreign customers — exports and sales via foreign affiliates — have a differential impact on firm-level volatility. Furthermore, by focusing on publicly-listed firms, we utilize high-frequency data on stock returns to estimate forward-looking measures of conditional volatility, thereby improving upon the existing literature which relied on unconditional estimates of volatility based on low-frequency, yearly data. The use of stock returns as the underlying performance variable used to estimate volatility is also an important contribution. Stock returns are a first-order concern for investors because they incorporate the market's expectation of a firm's future profitability, but are also a key leading indicator of economic activity at the aggregate level.

Our results show that a greater reliance of firms on foreign market sales, both through exports and foreign affiliates, leads to an increase in the conditional volatility of their stock returns relative to firms in the same industry. The positive effect that the intensity of global engagement exerts on firms' volatility is both statistically and economically significant: a one standard deviation increase in a firm's intensity of exports sales is associated with an increase in annualized returns volatility ranging from 8.5 to 11.2%; a similar increment in the share of sales of foreign affiliates has a larger effect on volatility (ranging from 9.1 to 13.5%). Our findings of a greater impact of horizontal FDI than export sales on volatility are consistent with the proximity-concentration theory that underscores the higher sunk costs involved in setting up a foreign affiliate facility relative to those associated with developing new export relationships.

We also uncover evidence that the positive relationship between global engagement and volatility is particularly strong for firms with high requirements for external finance. This is consistent with the notion that firms' need to use external finance to cover the substantial costs involved in reaching foreign consumers is an important channel through which firms' participation in international markets increases their exposure to economic uncertainty.

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Appendix A: Estimation of firm-specific conditional volatility

The fact that conditional volatility is not directly observable (i.e. it is a latent variable) requires us to consistently estimate it by relying on time-series models before proceeding with the panel data analysis.

For this reason we start by running separate ARCH-type models (more on this below) for each of the 1474 firms in our sample, thereby allowing complete heterogeneity across firms. We are able to do that because we have a rather atypical micro panel consisting of large T (=120). Although ARCH-type models do not provide any insight for understanding the sources of volatility, they are crucial in providing proxies for volatility, which can then be used in subsequent analysis. One can of course use an unconditional volatility measure (e.g. as monthly standard deviation), but such approach has been heavily criticized for not being forward-looking and ignoring the fact that investors are interested in the volatility of returns over the asset holding time period, not over some historical period.

As mentioned above, we estimate conditional volatility models for 1474 firms. Due to the sheer size of the sample, we started with GARCH (1,1) as a reference model since previous research has established that the GARCH (1,1) does pretty well compared to a wide range of ARCH-type models in terms of forecasting ability (Hansen and Lunde, 2005). As a competing alternative to GARCH (1, 1) we also estimate a higher-order "pure" ARCH model for each firm. After some preliminary investigation based on a small sample of firms, we choose ARCH (3) as a reasonable choice, because a more parsimonious ARCH model entails fewer restrictions to ensure that all coefficients are positive. As a third competing model, we consider a more general model that nests GARCH (1,1), namely the (exponential) EGARCH (2, 1) model. This model not only allows for two-lags of conditional variance terms, but also for asymmetric (leverage) effects between positive and negative shocks to the stock returns. While it is theoretically possible to estimate even more general models, these have their own downsides in that they require more stringent parameters restrictions which often make it difficult for the maximum likelihood procedure to converge.

We start our estimation of the three ARCH-type models with a constant-only specification for the conditional mean for the sake of model parsimony. For each of the 1474 firms in the sample, we then conduct model adequacy tests by checking for the absence of serial correlation in the standardized residuals and standardized residuals squared (e.g. see Tsay, 2005 p.109). At this stage any model with standardized residual terms that do not form sequence of i.i.d random variables is deemed inadequate and therefore discarded. Amongst the adequate models, and again for each firm, we pick the one with the lowest value of the Akaike information criterion and use the fitted values of conditional volatility variable in the subsequent panel data analysis. We find that 973 of the 1474 firms' returns series can be adequately modelled with either GARCH(1,1), EGARCH(2,1) or ARCH(3), with these models providing the best fit for 522, 231 and 220 firms respectively.

For the remaining 501 firms with serially correlated residuals, we re-estimated the three ARCH-type models but this time with higher order lag terms in the specification of the conditional mean model. After some experiment on a subsample of firms, an ARMA(4,2) model was found to be adequate in the sense of making the model residual terms behave like an i.i.d random variables. We then proceed to estimate the three ARCH-type models with the conditional mean equation specified as ARMA(4,2), and for each of the 501 firms we chose the model with the lowest value of the Akaike information criterion. This exercise reveals that GARCH (1, 1), EGARCH (2, 1) and ARCH (3) provide best fit for 222, 116 and 163 firms respectively.

Appendix B: Instrumental variable estimation with censored endogenous variables

In this appendix we outline Wooldridge (2008)'s procedure for instrumental variables estimation of average treatment effects in the correlated random coefficient model with censored endogenous variables. For ease of exposition, suppose the following simple model is of interest:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 w_i + \varepsilon_i \qquad (B.1)$$

In the above equation w represents the censored endogenous variable, and ε is the error term with E (ε | x) =0. Given a vector of excluded instruments **z**, assume that the censored endogenous variable follows the standard Tobit model:

$$w_i = max(0, \gamma_0 + \gamma_1 x_i + \gamma_2 z_i + u_i), \qquad (B.2)$$

$$u|x, z \sim \boldsymbol{\Phi}(0, \sigma^2). \qquad (B.3)$$

Where $\boldsymbol{\Phi}$ denotes the standard normal distribution function. Wooldridge (2008) shows that the following instrumentation procedure delivers consistent estimators of the parameters of interest:

(i) Estimate $\gamma \equiv (\gamma_0, \gamma_1, \gamma_2)$ and σ^2 from a Tobit of w_i on $\boldsymbol{r_i} \equiv (1, x_i, z_i)$.

(ii) Based on the above estimates construct the following three quantities:

1. $\hat{\boldsymbol{\Phi}}_i \left(\frac{r_i \hat{\gamma}}{\hat{\sigma}}\right)$,
2. $\hat{\phi}_i \left(\frac{r_i \hat{\gamma}}{\hat{\sigma}}\right)$, where $\phi(.)$ denotes the standard normal density function, and finally
3. $\widehat{\boldsymbol{w_i}} = \hat{\boldsymbol{\Phi}}_i \left(\frac{r_i \hat{\gamma}}{\hat{\sigma}}\right) + \hat{\sigma} \hat{\phi}_i \left(\frac{r_i \hat{\gamma}}{\hat{\sigma}}\right)$

(iii) Estimate the following augmented equation:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 w_i + \beta_3 w_i (x_i - \bar{x}) + \beta_4 \left(\hat{\sigma}^2 \hat{\Phi}_i\right) + \varepsilon_i, \qquad (B.4)$$

by instrumental variables or GMM method using instruments $\left[1, \widehat{\boldsymbol{w}}_{\boldsymbol{i}}, x_i, \widehat{\boldsymbol{w}}_{\boldsymbol{i}}(x_i - \bar{x}), \widehat{\Phi}_i\right]$.

This procedure also offers a simple test for endogeneity through testing for the (joint) significance of the correction term(s). In the context of our example, rejecting the null hypothesis that $\beta_4 = 0$ would support the notion that w is endogenous.

Table B.1: First-stage Tobit estimates

	Export intensity	Horizontal FDI intensity
	(1)	(2)
Exports-weighted exchange rate shock	-0.352***	-0.094*
	(0.0526)	(0.0505)
Horizontal FDI-weighed exchange rate shock	0.206***	-0.016***
	(0.0083)	(0.0053)
Foreign affiliates' investment rate	0.004	0.001
	(0.0025)	(0.0012)
Twice-lagged horizontal FDI intensity	0.144***	1.019***
	(0.0037)	(0.0031)
Twice-lagged export intensity	0.865***	0.060***
	(0.0057)	(0.0059)
Size	-0.006***	0.016***
	(0.0004)	(0.0003)
Leverage	0.034***	-0.016***
	(0.0029)	(0.0019)
Return on assets	0.001***	0.001***
	(0.0001)	(0.0001)
Age	-0.008***	0.005***
	(0.0005)	(0.0004)
Exchange rate volatility	-0.041***	-0.015***
	(0.0053)	(0.0045)
North American stock market volatility	0.015***	0.004***
	(0.0003)	(0.0003)
European stock market volatility	0.004***	0.002***
	(0.0002)	(0.0002)
Asian stock market volatility	0.024***	0.008***
	(0.0003)	(0.0002)
Other stock markets volatility	0.016***	0.007***
	(0.0003)	(0.0002)
Observations	147,413	147,413

Both specifications include year and month specific effects. Standard errors are given in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: Specification Tests

Under-identification test:	**Weak identification test**	**Implied Hansen J statistic:**
Kleibergen-Paap rk LM statistic: 89.47 [Chi-square (4) p-value=0.000]	Kleibergen-Paap rk Wald F statistic=148 [Stock-Yogo critical value= 13.97]	**2.48** [Chi-square (3) p-value=0.479]