Exports and Volatility Spillovers*

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Abstract

Firms that participate in international markets, be it through exporting, importing or setting up foreign subsidiaries tend to be more volatile than their domestic counterparts. In this paper we ask whether the higher volatility of stock returns of exporting firms spills over to firms that only sell domestically. We utilize weekly data for the universe of manufacturing firms listed in the Tokyo Stock Exchange over the period 2000-2015 to investigate this question. We find evidence of substantial spillovers of volatility occurring among exporters and non-exporters. Our results also show that — consistent with a workhorse model of trade with stochastic volatility — there is an important asymmetry in volatility spillovers. The spillovers from exporters to domestic firms are on average twice as large as the spillovers in the opposite direction.

Keywords: Volatility; Spillovers; Stock Returns; Exports; Japan.
JEL classification: F36, F14, G15.

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1 Introduction

As financial markets have become progressively more interdependent, the possibility that shocks originating in far-away places spread rapidly across countries wreaking havoc in local asset markets has become a permanent source of worry for policymakers and investors. There is indeed an extensive body of literature devoted to identify the extent to which economic crisis are transmitted internationally across real and financial linkages.[1] At the same time, a small but growing body of work with a more microeconomic perspective has found that internationally engaged firms are more volatile across a range of performance measures (e.g. sales, employment, stock returns) than firms that only sell domestically.[2]

In this paper we seek to bring together these two strands of the literature, and ask whether the higher volatility that characterizes exporting firms is transmitted to domestic firms through their inter-dependence in domestic product and factor markets. Thus, our aim is to shed light on the domestic diffusion of international shocks. As Ehrmann et al. (2011) note, the transmission channels through which shocks dissipate across financial markets are still not well understood.

To illustrate the mechanism we study, take the standard Melitz (2003) model of international trade with heterogenous firms. In this model, an increase in the profitability of exporting (e.g. due to a bilateral tariff reduction) increases the demand for labor for exporters, pushing up wages and thereby lowering the profitability of domestic firms. Similarly, via the trade-balance market clearing condition, the expansion of domestic exports is compensated by an increase in imports, which intensifies the level of competition, hurting once again firms that only operate domestically.

We illustrate the existence of volatility spillovers in a standard dynamic general equilibrium model of trade with heterogenous firms along the lines of Alessandria and Choi (2007) and Fillat and Garetto (2015), which incorporates firm-destination-specific stochastic volatility in demand shocks, following Arellano et al. (2011) and Fernández-Villaverde et al. (2015). In the model exporting entails substantial sunk entry costs (Roberts and Tybout, 1997), which result in exporting firms being more volatile than their domestic counterparts, as shown by Riaño (2011) and Fillat and Garetto (2015). Our main contribution relative to the previous literature, is to show that in

[1] See e.g. Forbes and Rigobon (2002), Forbes (2004), Brooks and Del Negro (2004), Corsetti et al. (2005), Ehrmann et al. (2011), and the survey by Pericoli and Sbracia (2003), among many others.

[2] See Buch et al. (2009), Riaño (2011), Vannoorenberghe (2012), Girma et al. (2015) and Kurz and Senses (2016).

general equilibrium, the higher volatility of exporters is in turn transmitted to domestic producers in general equilibrium.

We utilize high-frequency (weekly) data on stock returns for the universe of manufacturing firms listed in the Tokyo Stock Exchange. In previous work, Girma et al. (2015) have shown that both exporters and multinational Japanese listed firms are more volatile than domestic firms in terms of their stock returns. Moreover, and in line with a large body of literature in finance, Girma et al. (2015) find strong evidence of time-variation in the volatility of firm returns. We use the methodology developed by Diebold and Yilmaz (2009) and Diebold and Yilmaz (2012) to measure volatility spillovers from exporters towards domestic firms. This involves estimating a bivariate VAR model of the conditional volatility (which has been estimated in a previous stage using a GARCH model) of returns of a value-weighted portfolio of firms constructed based on their export status and carrying out a generalized forecast error variance decomposition (Pesaran and Shin, 1998). We also estimate a larger VAR system including the volatility of the S&P-500 index, as a measure of global volatility, as well as the conditional volatilities of the nominal Yen/Dollar exchange rate and the volatility of listed banks.

Both our benchmark and augmented specifications show that volatility spillovers are substantial at different forecast horizons. To be precise, a shock to the volatility of returns of the portfolio of exporters in our sample accounts for between 40 to 53% of the error variance in forecasting the volatility of returns for the portfolio of domestic firms over a month. We also find evidence of volatility spillovers from domestic firms to exporters, although these tend to be about half of the size of spillovers originating from exporters. Volatility spillovers from exporters dissipate over time, but still account for 20% of the forecast error of the volatility of non-exporters after 6 months. Estimating our model using 6 month rolling-window samples shows that the magnitude of the spillovers has remained quite stable over time and does not appear to vary along the business cycle.

Our results are closely complementary to those of Forbes and Chinn (2004), who find that bilateral trade are the most important determinant of cross-country linkages in stock markets. We show that intra-industry forces such as product and factor market competition result in domestic firms, i.e. those that only sell their output in the local market, becoming more volatile through their interaction with globally-engaged firms in the same industry. Our results are also relevant to inform the debate on the potential gains of international portfolio diversification (Heston and

Rouwenhorst, 1994; Griffin and Andrew Karolyi, 1998; Brooks and Del Negro, 2004; Bekaert et al., 2009). If operating in international markets is associated with a higher volatility of stock returns – as Girma et al. (2015) find for Japanese manufacturing firms – the extent to which an investor can reduce the variance of a portfolio that combining stocks of domestic firms and exporters operating in the same industry will be lowered if the latters volatility spills over onto the former.

The rest of the paper is organized as follows. Section 2 sketches a model that illustrates how product market competition results in volatility spilling over from exporters towards domestic firms, the mechanism that we analyze in the paper. Section 3 describes our data and empirical specifications. Section 4 presents our main results and robustness checks. Finally, Section 5 concludes.

2 A Simple Model of Exporting and Volatility Spillovers

The world consists of two symmetric countries, home and foreign. We denote foreign variables by an asterisk. Each country is populated by a mass L of atomistic households, who supply one unit of labor inelastically at the prevailing wage.

Preferences. The representative consumer maximizes the expected discounted sum of utility,

$$U = E_0 \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right], \tag{1}$$

where C_t denotes final consumption, and $\beta \in (0, 1)$ is the subjective discount factor. We assume that instantaneous utility takes the form, $u(C) = C^{1-\gamma}/(1-\gamma)$, where $\gamma > 0$ is the coefficient of relative risk aversion.

Following Alessandria and Choi (2014), we assume there is a one-period nominal bond denominated in units of the home final good — thus, the bond pays one unit of home's final good in the next period. Let B_t denote the bond holdings of home consumers and Q_t its nominal price. Choosing home's final good as the numeraire, $P_t = 1$ implies that $P_t^* = 1$ and $B_t = B_t^* = 0$ (i.e. balanced trade), given our assumption of symmetric countries. Every period, home consumers face the following budget constraint (foreign consumers face an analogous constraint):

$$C_t + Q_t B_t = W_t L + B_{t-1} + \Pi_t, \tag{2}$$

where W_t is the wage prevailing at home and Π_t denotes the dividend payments from home firms.

Final Good Production. The consumption good C, which is non-tradable, is produced under perfect competition using a continuum of differentiated domestic and imported intermediate goods:

$$Y_t = \left(\int_0^1 \left(q_{dt}(\omega)\right)^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}\omega + \int_{\omega \in \Omega_x^*} \left(q_{xt}^*(\omega)\right)^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}\omega \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{3}$$

where $q_{dt}(\omega)$ and $q_{xt}^*(\omega)$ denote domestic and imported intermediate inputs respectively and $\epsilon > 1$ is the elasticity of substitution between intermediate inputs. Since trade in intermediate inputs is costly, home's final-good production incorporates only a subset Ω_x^* of intermediate inputs that are produced and exported from foreign, while utilizing the complete range of locally-produced inputs.

Intermediate input demand is given by:

$$q_{dt}(\omega) = Y_t P_t^{\epsilon-1} [p_{dt}(\omega)]^{-\epsilon}, \tag{4}$$

$$q_{xt}^*(\omega) = Y_t P_t^{\epsilon-1} [p_{xt}^*(\omega)]^{-\epsilon}, \tag{5}$$

where $p_{dt}(\omega)$ and $p_{xt}^*(\omega)$ denote respectively the price of domestic and intermediate inputs, Y_t is the total value of home's final goods, and P_t is the ideal price index, defined as:

$$P_t = \left(\int_0^1 \left(p_{dt}(\omega)\right)^{1-\epsilon} \mathrm{d}\omega + \int_{\omega \in \Omega_x^*} \left(p_{xt}^*(\omega)\right)^{1-\epsilon} \mathrm{d}\omega \right)^{\frac{1}{1-\epsilon}}. \tag{6}$$

Intermediate Good Production. Intermediate good producers are monopolistically-competitive, producing their output using a 1-1 technology, with labor being the only input. These firms can sell their output domestically (d) or export it to the rest of the world (x). We assume that all intermediate producers have the same marginal cost of production, but are heterogeneous in terms of their idiosyncratic destination-specific demand shocks $\{z_{jt}(\omega)\}$, $j \in \{d, x\}$. We assume that firm-destination specific shocks exhibit stochastic volatility, following Fernández-Villaverde et al. (2015):

$$\log z_{jt} = \lambda_j \log z_{j,t-1} + \sigma_{jt} \xi_{jt}, \quad \xi_{jt} \sim \mathcal{N}(0,1) \tag{7}$$

$$\log \sigma_{jt} = (1-\rho_j) \log \sigma_j + \rho_j \log \sigma_{j,t-1} + \eta u_{jt}, \quad u_{jt} \sim \mathcal{N}(0,1). \tag{8}$$

Export is costly. Firms need to incur a fixed sunk cost S_x when they start to export, but only need to pay F_x, with $F_x < S_x$, if they have exported in the previous period (Baldwin and Krugman, 1989; Roberts and Tybout, 1997; Alessandria and Choi, 2007; Fillat and Garetto, 2015). Moreover, export sales are subject to an iceberg transport cost $\tau > 1$. Let $y_t \in \{0, 1\}$ denote a firm's export status in period t, with $y_t = 1$ if a firm exports in period t and 0 otherwise. Home exporters faces a downward-sloping demand abroad:

$$r_{xt}(\omega) = A_x z_{xt}(\omega) p_{xt}(\omega)^{1-\epsilon}, \quad A_x > 0. \tag{9}$$

The only difference with their domestic demand (4) is that the pricing decision of Home's intermediate good producers do not influence aggregate expenditure nor the price index in the rest of the world (see Demidova and Rodríguez-Clare, 2009, 2013).

Firms' problem. An intermediate good producer's state vector $\mathbf{s}$ consists of its previous-year export status, y_{-1}, as well as domestic and export demand shocks and their respective variances: $\mathbf{s} \equiv (z_d, \sigma_d, z_x, \sigma_x)$. Intermediate good producers' problem can be partitioned into a static and a dynamic component. In any given period, a firm charges a constant mark-up above its marginal cost domestically, i.e. $p_{dt}(y_{-1}, \mathbf{s}) = \frac{\epsilon}{\epsilon-1} w_t$, while charging the same price augmented by the transport cost τ if it exports, $p_{xt}(y_{-1}, \mathbf{s}) = \tau p_{dt}(y_{-1}, \mathbf{s})$.

At each point in time, a firm needs to choose whether to export or not, i.e. $y \in \{0, 1\}$ based on its previous-year export status y_{-1} and the realization of demand shocks and their variances. Thus, the dynamic programming problem of an intermediate-good producer can be expressed in recursive form:

$$v(y_{-1}, \mathbf{s}) = \max_{y \in \{0,1\}} \left\{ \pi(y_{-1}, y, \mathbf{s}) + \mathcal{M} \int_{\mathbf{s}'} \mathcal{P}(\mathbf{s}'|\mathbf{s}) v(y, \mathbf{s}') \mathrm{d}\mathbf{s}' \right\}, \tag{10}$$

where v is the market value of a firm, $\mathcal{M}$ is the stochastic discount factor, $\mathcal{P}$ is a transition matrix for firm-destination-specific demand shifters and their volatilities and a firm's dividends are given by:

$$\pi(y_{-1}, y, \mathbf{s}) = \kappa w^{1-\epsilon} \left\{ A_d z_d + y \left[\tau^{1-\epsilon} A_x z_x - w \left(y_{-1} F_x - (1 - y_{-1}) S_x \right) \right] \right\}. \tag{11}$$

and $\kappa \equiv (\epsilon - 1)^{\epsilon-1}\epsilon^{-\epsilon}$. The solution to problem (10) is an export policy rule $\mathcal{Y}(y_{-1}, \mathbf{s})$.

General Equilibrium. A recursive stationary equilibrium is defined by an export policy rule $\mathcal{Y}(y_{-1}, \mathbf{s})$ and a vector of prices $\{w^*, P^*\}$ such that:

(i) The labor market clears at Home, and,

(ii) The current account is balanced.

Stock market returns in this model are defined as follows:

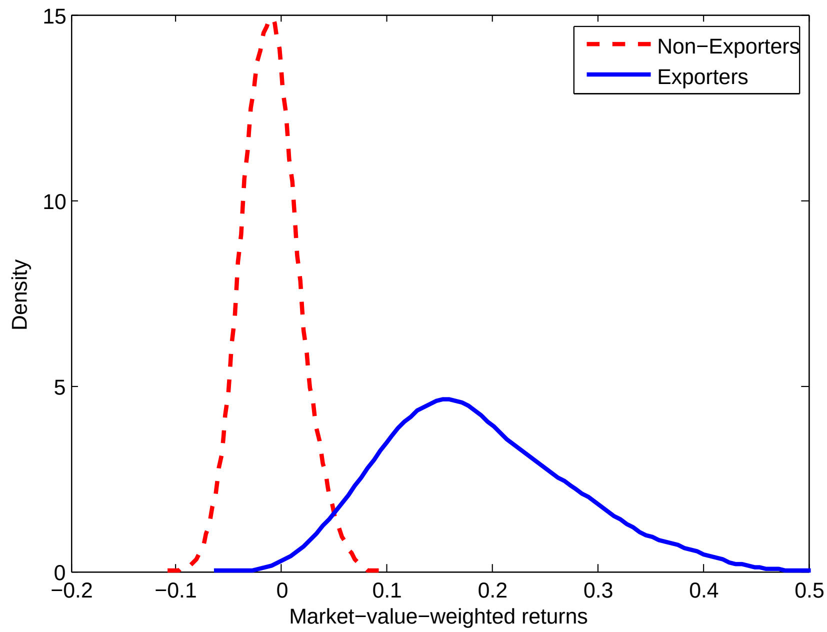
$$\mathrm{R}(y, \mathbf{s}) = \frac{\pi(y_{-1}, \mathbf{s})}{v(y_{-1}, \mathbf{s})}.$$

Solution and Parametrization. We solve the model using a value function iteration algorithm. We parametrize the fixed and sunk costs in the model in order to match the share of exporters observed in our sample (23%). We set the same persistence in the level of shocks and their variance across destination markets, namely, we set $\lambda_j = 0.7$ and $\rho_j = 0.1$; the variance of the variance, η_j is set to 0.01.

In order to highlight the main predictions of the model, we simulate 10,000 firms and compute the return of a value-weighted market portfolio of firms based on their export status. As has been pointed out before by Riaño (2011) and Fillat and Garetto (2015), the existence of sunk costs associated with a firm's decision to start to export increase the volatility of a firm's performance. The hysteresis induced by the sunk costs makes managers reluctant to stop exporting when profitability falls, because the option value of waiting for it to improve outweighes the cost of re-incurring the entry costs again. This effect is evident in Figure 1, which displays the distribution of market-value-weighted stock returns for exporters and non-exporters. Even though the stochastic process governing domestic and export demand shifters have the same parameters, the volatility of stock returns is substantially higher for exporters than for firms that only sell domestically.

We next use the methodology developed by Diebold and Yilmaz (2009) and Diebold and Yilmaz (2012) (which is explained in more detail in the next section) in the simulated data generated by the model. We find that volatility spillovers from exporters account for 15-20% of the forecast error variance of the conditional volatility of non-exporters. Conversely, domestic firms exert a negligible effect on the volatility of returns of exporters. In the next two sections we show that the existence of volatility spillovers from exporters to domestic firms and the larger magnitude of these spillovers when originating from exporters are also found in our dataset of Japanese manufacturing firms.

Figure 1: Stationary Distribution of Stock Returns by Export Status



3 Data and Empirical Specification

Data

We use weekly data for the universe of manufacturing firms listed in the Tokyo Stock Exchange between 2000:w1 until 2015:w52. We construct two market-value-weighted portfolios of firms based on their export status $j \in \{d, x\}$. We estimate an ARMA model for the conditional mean of excess stock returns and a GARCH(1,1) model for the conditional volatility of each portfolio, h_t^j. Predicted conditional volatilities are annualized as $100 \cdot \left(\sqrt{52 \cdot \hat{h}_t^j}\right)$.

Table 1 presents summary statistics for each of our constructed portfolios. The main characteristics of the two groups of firms conform to the stylized facts established in the existing literature. Namely, exporters are larger (in terms of their market capitalization), exhibit higher returns and are more volatile than their domestic counterparts (Bernard et al., 2007; Fillat and Garetto, 2015;

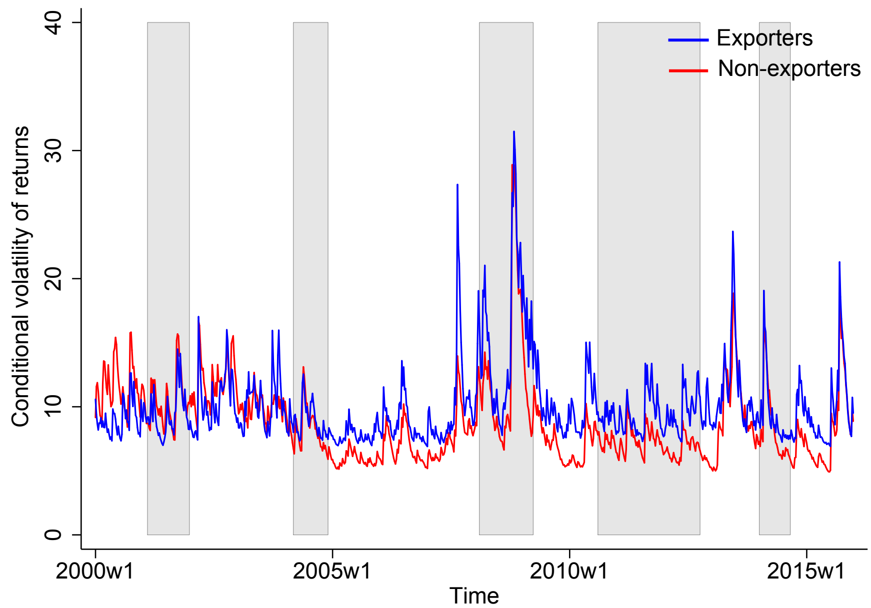
Table 1: Descriptive Statistics

	Non-exporters		Exporters	
	Mean	Std Dev	Mean	Std Dev
Stock return	-0.013	2.890	0.013	2.577
Log volatility	2.785	0.887	2.859	0.725
Log market value	11.612	3.625	13.363	3.600
Log spillover term exporters	2.347	0.649	2.353	0.647
Log spillover term non-exporters	2.165	0.666	2.194	0.670
Number of firms	1,858		551	
Observations	1,247,345		448,512	

Girma et al., 2015).

Figure 2 displays the evolution of the conditional volatility of stock returns for our export-status-based portfolios throughout our period of study. Volatility exhibits a high degree of time-series variation and large spikes during recessions (Schwert, 1989; Bloom, 2014). Although the volatility of returns for both types of firms show a substantial degree of comovement, it is also apparent that the volatility of exporters has been systematically higher than that of non-exporters since 2005.

Figure 2: Conditional Volatility by Export Status



The figure plots the conditional volatility of returns of the portfolios composed by domestic firms and exporters. Conditional volatility is estimated using a GARCH(1,1) model using weekly data for the period 2000w1-2015w52. 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:m2-2002:m1; 2004:m3-2004:m12; 2008:m2-2009:m4; 2010:m8-2012:m9 and 2014:m1-2014:m8.

Empirical Specification

Benchmark Specification. In order to identify the existence of volatility spillovers occurring between exporters and non-exporters, we make use of the methodology proposed by Diebold and Yilmaz (2009) and Diebold and Yilmaz (2012). In our benchmark specification, estimate a reduced-form bi-variate VAR model for the conditional volatility of stock returns for our export-based portfolios, $y_t = (h_t^x, \ \ h_t^d)'$:

$$y_t = \sum\nolimits_{i=1}^{p} \Phi_i y_{t-i} + \varepsilon_t, \quad \varepsilon \sim (0, \Sigma), \tag{12}$$

where Φ_i are 2×2 matrices of coefficients to be estimated and ε_t is an error term with covariance matrix Σ.

Volatility spillovers are recovered by conducting a τ-step ahead generalized forecast error variance decomposition (FEVD) based on the estimates of model (12), i.e. $y_{t+\tau} - \mathbb{E}_t[y_{t+\tau}]$. Thus, our measure of spillovers is the fraction of the τ-step-ahead forecast error variance for the conditional volatility of portfolio j that is explained by shocks to the conditional volatility of portfolio $k \neq j$. We use a generalized FEVD proposed by Pesaran and Shin (1998), which, unlike a Cholesky-identified variance decomposition, is invariant to variable ordering:

$$\theta^g_{jk}(\tau) = \sigma^{-1}_{jj} \cdot \frac{\sum_{l=0}^{\tau}(e'_j A_l \Sigma e_k)^2}{\sum_{l=0}^{\tau} e'_j A_l \Sigma A'_l e_j}, \quad j,k \in \{d,x\}, \tag{13}$$

where A_l are the coefficients associated with the MA representation of the VAR model (12), and e_j is a unit vector that takes the value 1 in its j-th position and 0 elsewhere.

Since the generalized FEVD does not orthogonalize shocks but rather takes into account their correlation, it follows that $\sum_k \theta^g_{jk}(\tau)$ does not sum up to 1 as in the standard Cholesky-identified FEVD. Thus, following Diebold and Yilmaz (2012), we define the pairwise spillovers from portfolio j to portfolio k at horizon τ as:

$$S_{jk}(\tau) = \frac{\theta^g_{jk}(\tau)}{\sum_{\ell \in \{d,x\}} \theta^g_{j\ell}(\tau)} \in [0,1], \quad \tau = 0, 1, \ldots \tag{14}$$

We also utilize an unconditional measure of volatility to estimate spillovers. In this case, volatility is estimated using the range-based method proposed by Alizadeh et al. (2002) from the underlying daily high/low/open/close stock data to obtain a measure of weekly volatility of returns, which is annualized in the same way described above.

Augmented Model. An important concern in our benchmark specification is that our measure of volatility spillovers could be capturing a common global factor affecting the volatility of exporters and non-exporters in Japan (see e.g. Kose et al., 2003). To address this issue, we augment our simple bi-variate VAR model to include a host of factors suggested by the literature, which could drive the conditional volatility of Japanese firms.

The new variables incorporated into our VAR model are (i) the conditional volatility of returns for the S&P-500 index, (ii) the conditional volatility of the Japanese Yen/US Dollar exchange rate and (iii) the conditional volatility of listed Japanese banks. The first variable controls for world-wide changes in volatility; The volatility of the exchange rate has been shown to be an important determinant of returns volatility (Girma et al., 2015) for listed Japanese firms, and lastly, the volatility of the banking sector seeks to control for the higher intensity of use of financial services by exporters relative to domestic firms, as documented by Amiti and Weinstein (2011), Manova (2013) and Girma et al. (2015).

Microeconometric Specification. In our last specification, we rely on individual firm-level data, to estimate the following linear dynamic panel for both exporters and domestic firms separately:

$$\ln \hat{h}_{it} = \beta_0 \ln \hat{h}_{it-1} + \gamma_x \ln \text{Spillover}^x_{t-1} + \gamma_d \ln \text{Spillover}^d_{t-1} + \beta_1 \ln \text{Market Value}_{it-1} + \beta_2 T_t + f_i + u_{it}, \tag{15}$$

where $\hat{h}_{it}$ denotes the predicted conditional volatility of stock returns for firm i in week t estimated using a GARCH(1,1) model for each individual firm, Spillover^x_{t-1} denotes the conditional volatility of the return of the value-weighted portfolio of exporters excluding firm i (lagged one week), and Spillover^d_{t-1} is the analogous measure for a portfolio of domestic firms; Market Value_{it-1} is firm i's market capitalization, T_t is a linear trend, f_i denote firm-specific fixed effects and u_{it} is the error term. Standard errors are clustered at the firm level.

4 Results

Benchmark Model. Table 2 presents the results using our benchmark bi-variate specification. The main message is clear — spillovers originating from exporting firms explain a substantial share of the forecast error variance of the conditional volatility of domestic firms. Conversely — and just as predicted by the model presented in Section 2 — the volatility of domestic firms exerts a smaller role in the volatility of exporters; the magnitude of the spillover term from exporters to domestic firms is approximately twice as large across different forecast horizon. In columns (3) and (4), we augment our benchmark model with linear, quadratic and cubic trends that can flexibly account for common factors driving the conditional volatility of our two portfolios. Reassuringly, our results remain unchanged; we still find a remarkable asymmetry in the magnitude of volatility spillovers occurring among groups of firms based on their export participation status. Columns (5) and (6) replicate our benchmark exercise, but using the unconditional volatility of returns. Once again, the results remain robust to this change in specification.

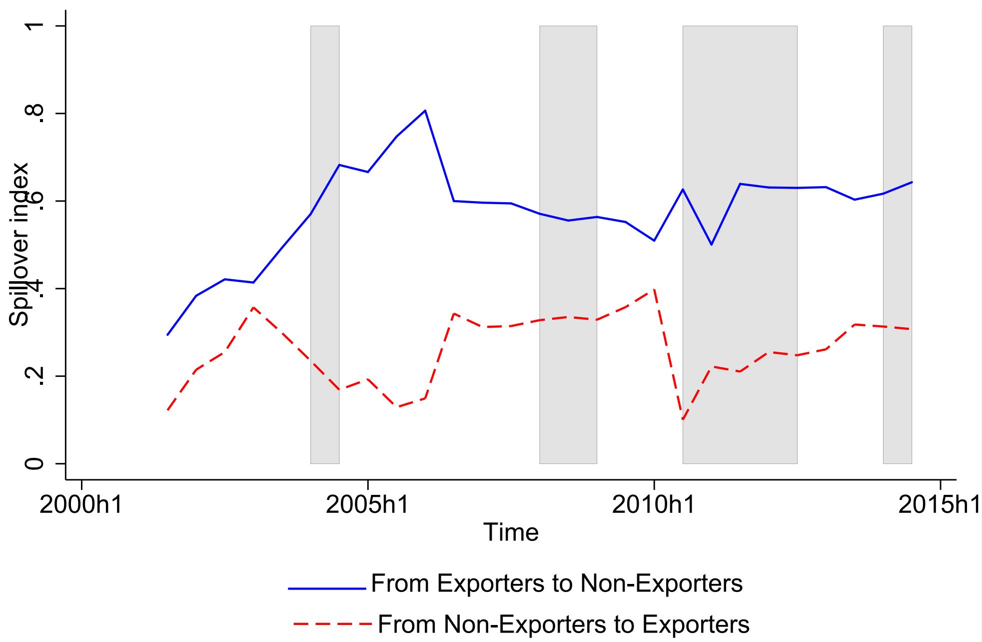
Table 2: Volatility Spillovers by Export Status — Bivariate Model

Forecast horizon	Conditional Volatility		Including Trends		Unconditional Volatility	
	$x \rightarrow d$	$d \rightarrow x$	$x \rightarrow d$	$d \rightarrow x$	$x \rightarrow d$	$d \rightarrow x$
	(1)	(2)	(3)	(4)	(5)	(6)
4	0.483	0.255	0.520	0.274	0.479	0.362
12	0.473	0.265	0.536	0.296	0.430	0.354
24	0.468	0.266	0.538	0.300	0.400	0.348

The table reports the spillover index defined in equation (14) at different forecast horizons, with $x \rightarrow d$ denoting the spillover originating from exporters affecting domestic firms, while $d \rightarrow x$ denotes the converse type of spillover using the bi-variate VAR benchmark specification. Columns (1)-(2) use the conditional volatility of returns for the two portfolios of firms constructed based on their export status; the construction of these conditional volatilities is described in Section 3. Columns (3)-(4) augment the model used in columns (1) and (2) with linear, quadratic and cubic trends. Columns (5)-(6) present results based on unconditional volatility, which is estimated using the range method proposed by Alizadeh et al. (2002).

Taking advantage of the high frequency of our data, we re-estimate our bivariate VAR model using 6-month rolling window samples, in order to examine whether the time-series patterns exhibited by volatility spillovers. Figure 3, which displays the results of this exercise, conveys two main messages. Firstly, in the early part of our sample, the magnitude of spillovers from exporters to domestic firms is not too different from that of domestic firms towards exporters. After 2005, following the strong export-led recovery after 2005 (De Veirman and Levin, 2012), the volatility spillover from exporters towards domestic firms becomes significantly greater than the spillover in the opposite direction. Secondly, volatility spillovers are quite stable over time; they do not exhibit any discernable business cycle comovement patterns.

Figure 3: Volatility Spillovers over Time



The figure plots both the spillover index from exporters towards domestic firms and from domestic firms to exporters estimated using the bivariate VAR model (12) using 6-month rolling windows. 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:m2-2002:m1; 2004:m3-2004:m12; 2008:m2-2009:m4; 2010:m8-2012:m9 and 2014:m1-2014:m8.

Augmented Model

Table 3 presents the estimated volatility spillovers based on our augmented VAR model using 4 and 24-weeks forecast horizons. The results show that global volatility, proxied by the conditional volatility of returns of the S&P-500 index has a moderate effect on the volatility of our export-based portfolios, exerting a larger effect on exporters than on domestic firms. Shocks to exchange rate volatility, on the other hand, appear to have a negligible contribution to the volatility of our two groups of firms; lastly, the volatility of listed banks has an effect which is twice as large as that of global shocks, and this effect is also slightly more important for exporters than for domestic firms, in line with the findings by Amiti and Weinstein (2011) for Japanese firms.

The magnitude of volatility spillovers from exporters to domestic firms remains substantial in the extended model. Shocks to the conditional volatility of exporters contribute to explain 40% of the forecast error for the volatility of returns of domestic firms falls relative to our bivariate

Table 3: Volatility Spillovers by Export Status — Augmented Model

4-week ahead forecast

		From:				
		S&P 500	¥/$	Banks	x	d
	S&P 500	0.892	0.009	0.075	0.010	0.014
	¥/$	0.308	0.211	0.204	0.234	0.044
To:	Banks	0.033	0.001	0.596	0.228	0.142
	x	0.061	0.002	0.142	0.621	**0.174**
	d	0.057	0.005	0.131	**0.400**	0.408

24-week ahead forecast

		From:				
		S&P 500	¥/$	Banks	x	d
	S&P 500	0.701	0.002	0.256	0.003	0.037
	¥/$	0.367	0.092	0.458	0.067	0.016
To:	Banks	0.073	0.000	0.741	0.112	0.073
	x	0.118	0.001	0.378	0.391	**0.112**
	d	0.114	0.002	0.368	**0.206**	0.309

The table reports the spillover index defined in equation (14) at 4 and 24-week forecast horizons. The $(i, j)^{\text{th}}$ entry in the table denotes the fraction of the forecast variance of variable j (column) explained by shocks in the variable i (row). The rows of the table sum up to 1, given the definition of the spillover index. The additional variables included in the VAR system besides the conditional volatility of returns for exporters and non-exporters are the conditional volatility of returns for the S&P-500 index estimated using a GARCH(1,1) model, the conditional volatility of the Japanese Yen/US Dollar nominal exchange rate estimated using a GARCH(1,1) and the conditional volatility of returns for banks listed in the Tokyo Stock Exchange.

benchmark. These spillovers are again, about twice as large as those originating in domestic firms. The main difference with respect to our benchmark specification is that the size of spillovers decline more rapidly with the forecast horizon in the extended model. Still, volatility spillovers from exporters account for one-fifth of the variance in the conditional conditional volatility of returns of domestic firms after 6 months.

Exports and Volatility Spillovers: A Microeconometric View. The evidence presented regarding the existence of the volatility of exporters spilling over to domestic producers relies on a macro-econometric approach that on the one hand allows for bidirectional spillovers to exist. However, by aggregating firms into export-based portfolios, this approach might miss important micro-level heterogeneity. Thus, Table 4 presents the results of using a microeconometric approach to explore the existence of volatility spillovers.

The conditional volatility of returns for a given firm i depends on its own lagged volatility —, since this variable is highly persistent — and on the firm's size. Crucially, however, it also depends on the conditional volatility of the portfolio of exporters and domestic firms that excludes firm i. Controlling for firm fixed effects and linear trends, we find that the spillover terms have a strong and positive effect in explaining firm-level volatility. Our results show that the volatility of exporters has a stronger effect on firm-level volatility than the volatility of domestic firms. Moreover, the volatility spillover for exporters has a bigger effect in the volatility of domestic firms than the converse. All in all, spillovers originating from exporters are approximately 1.5 times larger than spillovers from domestic firms to exporters — a similar magnitude to the one reported above.

5 Conclusions

TBA

Table 4: Exports and Volatility Spillovers: A Microeconometric View

	Non-exporters (1)	Exporters (2)
Lagged volatility	0.209***	0.182***
	(0.002)	(0.003)
Lagged spillover from exporters	**0.071*** **	0.095***
	(0.002)	(0.003)
Lagged spillover from non-exporters	0.027***	**0.049*** **
	(0.002)	**(0.003)**
Market value	-0.003***	-0.008***
	(0.001)	(0.001)
Time trend	-0.0003***	-0.0001***
	(0.000)	(0.000)
Firm fixed effects	y	y
Observations	1,200,833	445,860

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the firm level.

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