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International Trade and Domestic Production Networks

FUJII Daisuke
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FUJII Daisuke
USC Dornsife INET and Research Institute of Economy, Trade and Industry

Abstract

This paper considers a model of international trade with a domestic interfirm production network, which gives rise to the emergence of indirect exporters. These indirect exporters do not export but supply goods and services to exporters, and hence, their value added is exported indirectly. Using the data of Japanese interfirm transaction networks and international trade, the features of indirect exporters are investigated. More than half of firms are connected to foreign markets within two transaction links, and manufacturing and wholesale sectors account for the largest shares of both direct and indirect exporters. A strict ordering of many variables such as sales or employment exists in direct, 1st-degree indirect, 2nd-degree indirect, and non-exporters. A significant and positive propagation effect is confirmed. Shocks to exporters, whether positive or negative, propagate to their domestic suppliers and decay as they travel through supply chains. The 1st-degree indirect exporters receive 2%−3% additional sales growth and 1%−1.5% for 2nd-degree indirect exporters. If a firm supplies to an intense exporter, the magnitude is larger. This suggests the importance of tracing indirect value-added exporters when considering the effect of trade liberalizations on firm size distributions or industry dynamics.

Keywords: Indirect exports, Networks, Global supply chains, Value-added trade, Propagations
JEL classification: D22, D57, D85

[1]This study is conducted as a part of the project “Dynamics of Inter-organizational Network and Geography” undertaken at the Research Institute of Economy, Trade and Industry (RIETI). This study utilizes the micro data of inter-firm transaction collected by Tokyo Shoukou Research (TSR) which is provided by RIETI, and the questionnaire information based on the “Basic Survey of Japanese Business Structure and Activities” which is conducted by the Ministry of Economy, Trade and Industry (METI). The author is grateful for helpful comments by Yukiko Saito (RIETI) and Discussion Paper seminar participants at RIETI and USC.

1 Introduction

The prosperity of modern economy is in part bolstered by its complex production networks. In many sectors, the share of intermediate goods is more than 50% in the total cost of production. In the context of international trade, this network structure of domestic production clouds the picture of real exporters. For instance, Toyota is one of the largest Japanese exporters. Since an automobile is manufactured using thousands of parts, it purchases many goods and services from domestic suppliers. These domestic suppliers are typically small and do not export. Yet, their value added is embedded in Toyota cars and exported to foreign markets. In almost all trade models and statistics, these domestic suppliers are classified as non-exporters. Nevertheless, due to the indirect exporting of value added, they are not insulated from foreign shocks. Any foreign or trade shocks that affect Toyota may propagate to those domestic suppliers. This paper considers a model of international trade with a domestic interfirm production network, which gives rise to the emergence of indirect exporters.

Many of the standard trade models with heterogeneous firms derive their implications from the relative advantage of becoming exporters to non-exporters. Yet, if firms are connected via production networks, a non-exporter can be exporting its value added to foreign markets via exporters. This fact dampens the implications of standard trade models. For example, Melitz (2003) models the interaction between trade liberalization and industry dynamics to explain resource reallocation following a trade policy. With heterogeneous firms and long-run equilibrium, when a country moves from autarky to open economy, more productive and larger firms benefit since they can export to foreign market and expands their size whereas small firms exit even from the domestic market since they cannot compete against foreign products penetrating the domestic market. In the long run, resources used for small firms will be transferred to large firms and reallocation occurs. In these models, firms are assumed to be independent from a supply chain perspective. However, if there is a intermediate good and interfirm production network, many indirect exporters emerge as discussed above. This makes the distinction between exporters and non-exporters fuzzy and dampens the implications of many trade models. Hence, it is critical to analyze the features of indirect exporters and how foreign shocks propagate to the domestic market via production networks. The current research answers these questions.

Using a large-scale Japanese interfirm transaction network data, this paper uncovers the features of indirect exporters. Even though the share of direct exporters in terms of the number of firms is very small, the share of indirect exporters is substantial due to the size and well-connectedness of direct exporters. More than half of firms are connected to foreign

markets within two supply chain links. Manufacturing and wholesale sectors account for the largest shares of both direct and indirect exporters. Construction and service sectors have large shares of indirect exporters. These sectors are typically thought as non-tradable sectors, but if we extend our definition of exporting, they account for significant shares as well. A strict ordering of many variables such as sales or employment exists in direct, 1st-degree indirect, 2nd-degree indirect, and non-exporters.

A significant and positive propagation effect is confirmed as well. For year 2005, direct exporters grew more compared to other firms. This positive sales growth was transmitted to the domestic suppliers who provided value added to those exporters. Moreover, the propagation effect decays along the supply chain. In any measure of exporting, 1st-degree indirect exporters received 2.3$\sim$3% additional sales growth and 1$\sim$1.4% for 2nd-degree indirect exporters. If a firm supplies to an intense exporter whose export share is more than 10% of total sales, the magnitude of the propagation is larger. No sectoral heterogeneity was confirmed for the first order propagation.

This research is related to several strands of literature. First, it is connected to the literature of value-added trade. As pioneered by the effort of constructing World Input Output Database (see Timmer et al. (2015)), many trade economists started to disentangle the international flows of value added. Caliendo and Parro (2014) estimate the welfare effect of NAFTA considering indirect propagation effect to non-tradable sectors via sectoral input-output tables. Though they share the same idea as the main claim of current research, their focus is at industry levels. It is known that there is large heterogeneity in firm-to-firm production network within industries. To elucidate the relationship between interfirm network and trade is the main contribution of this paper. Another strand of literature focuses on the role of wholesalers in indirect exporting such as Ahn et al. (2011), Bernard et al. (2014), or Akerman (2014). These papers restrict their attention to the case where wholesalers purchase tangible goods and export them to foreign markets. Fujii et al. (2016) conduct similar analysis as this research but they also focus on manufacturing-wholesale pair links. Unlike these papers, the current research treats indirect export in a broader sense. Another growing literature studies the propagation of shocks via production networks. Carvalho et al. (2014), Barrot and Sauvagnat (2016), Boehm et al. (2016) all examine how exogenous shocks caused by natural disasters travel via transaction networks both domestically and internationally. This research focuses on foreign shocks such as exchange rate movement as the source of shocks and studies how they travel to domestic suppliers.

The paper is organized as follows. The next section describes the data used in this research. Section 3 summarizes the properties of direct and indirect exporters. Section 4

presents the evidence of upstream propagation of foreign shocks, and Section 5 concludes.

2 Data

Two sources of data are used in this study: one for interfirm transaction networks and the other for the panel of firm-level export. This section describes the data sets and provides some summary statistics.

2.1 Interfirm Transaction Network

The data on buyer-supplier transaction networks and basic firm demographics are retrieved from the database of Tokyo Shoko Research (henceforth TSR). TSR is a credit reporting company and collects financial information of Japanese firms to assess their credit scores. Firms are surveyed by TSR and provide their information in the course of obtaining credit reports on potential suppliers and customers or when attempting to qualify as a supplier. The annual data sets compiled in 2006, 2011, 2012, and 2014 are provided to the author by RIETI. Information of some firms is outdated, and those observations are dropped based on the date surveyed in later sections. On average, the dataset covers about a million firms from all sectors. Compared to the census, the TSR data is under-sampled in very small firms.[1] Nonetheless, the TSR data captures almost all economic activities in Japan. This comprehensive nature of the data allows us to directly measure the propagation of shocks to small firms, which is the main goal of this paper.

Information on firms' financial statements and other demographics is retrieved from the TSR Company Information Database. For each firm, we have the information on its name, company code, address of headquarters, four-digit Japanese Standard Industrial Classification (JSIC) code, year of establishment, credit scores, number of employees, sales and profits of the most two recent periods available. Firms whose fiscal duration is not 12 months are dropped from the sample. In addition to these items, the 2014 data reports whether each firm exports or imports. Although this is a dummy variable and does not give the dollar value of international trade, it is used to identify direct exporters and importers.

What makes the TSR data very unique is its large-scale interfirm transaction network, which is contained in the TSR Company Linkage Database. Firms report their suppliers, customers, and major shareholders up to 24 firms. In spite of this truncation threshold, we

[1] See Carvalho et al. (2014) for more detailed comparisons of firm size distributions between TSR and census data.

can capture the interfirm network quite well by merging self- and other-reported data. For instance, many firms may identify one large firm as their customer. From the large firm's perspective, those firms are other-reported suppliers. In this way, we record more than 24 partners for some firms. A small number of hub firms have several thousand links. For example, the 2014 data uncovers that the top supplier has more than 12,000 customers and top customer has more than 10,000 suppliers. Following the literature of graph theory, in-degree and out-degree are used to refer to the number of suppliers and customers respectively. Note that the link information is only binary (whether a link exists or not) and does not give the dollar amount of the transaction. Nevertheless, the 2006 data contain the ranking of partners by their importance. This information can be used to weight the transaction links from a reporter's perspective. We can also put different weights on self- and other-reported links depending on the specifications.

2.2 Firm-Level Export

The second data source is the Basic Survey of Japanese Business Structure and Activities (henceforth Kikatsu), which is collected and maintained by Japan's Ministry of Economy, Trade and Industry (METI). This is an annual survey data conducted by METI to acquire a collective and quantitative understanding of the conditions of Japanese businesses. The data covers enterprises with 50 or more employees and whose paid-up capital is over 30 million yen (about 300,000 USD) from mining, manufacturing, wholesale, retail and other service sectors. The closing date of the survey is March 31st, which means that variables are of a previous fiscal year. In the 2014 data, there are 30,217 firms. Although the number of firms is small compared to the census or TSR, these large firms account for almost all value added and exports in Japan. The data set contains basic information of each firm (name, address, 3-digit JSIC, sales, employees etc.) and detailed information of financial statements and balance sheets including annual volume of exports and imports by destination regions. This research focuses on these firm-level export data. A panel data set from 2004 to 2014 is used. In Section 4, this data set is merged to the TSR data to measure the magnitude of foreign shock propagations to domestic suppliers through production networks.

3 Features of Indirect Exporters

This section investigates the features of both direct and indirect exporters using the 2014 TSR data. Firms are categorized into the following mutually exclusive groups:

- Direct exporters (D): Firms that directly export to foreign markets
- 1st-degree indirect exporters (1E): Firms that do not export but at least one of their customers exports
- 2nd-degree indirect exporters (2E): Firms that are not in the above two groups but one of their customers' customers exports
- Other firms (O): Other firms who need at least three downstream links to reach an exporter

From a supply chain perspective, firms become more distant from foreign markets in the listed order. This paper does not restrict attention to manufacturing-wholesaler pairs for indirect exports, and thus considers more general indirect trade. Some domestic manufacturers use wholesalers to export their final products. This is a clear example of indirect exporting. Yet, there are many other cases where a domestic firm's value-added is exported indirectly. For instance, Japanese automakers have thousands of domestic suppliers who themselves do not export. Their parts are embedded in final products and exported via automakers. From this viewpoint, services or construction sectors, which are considered as non-tradables, can export their value-added indirectly. This broader definition of indirect exporting is the focus of this research. The above categorization captures a large set of indirect exporters since firms are grouped as either 1E or 2E if they have at least one connection to an exporter. Also, we do not know how much of their supplied value is exported since it is virtually impossible to obtain the value-added decomposition of the final products. Nevertheless, we confirm systematic patterns of many variables according to those groups. In this section, firms are also classified into one of these five sectors: 1) manufacturing, 2) construction, 3) wholesale, 4) retail, and 5) services according to their 2-digit JSIC.[2]

From the full sample, firms that were surveyed before 2012, whose fiscal duration is not 12 months, and whose sales data is not available are dropped. Also, firms whose in-degree and out-degree are both zero are excluded since this research focuses on the propagation through interfirm networks.[3] This leaves us a sample of 984,763 firms. Figure 1 displays the shares of each type of exporters. Only 1.7% of firms are engaged in direct exporting. However, 21.3% of firms, which is more than 10 times of direct exporters, are categorized as 1st-degree

[2]Manufacturing (01-05, 09-32), construction (06-08), wholesale (50-55), retail (56-61), services (all other firms). Agriculture, food, and textiles are included in the manufacturing sector. Since their share is very small, this is not an issue even though their nature of production is different from that of manufacturers.

[3]There are about 600,000 firms (out of 1,560,000) that have no connections to other firms, and hence, not included in the network. Including these firms does not alter any of the qualitative results of this section.

indirect exporters. If we extend it to 2nd-degree indirect exporters, more than half of firms are categorized as direct or indirect exporters. This leverage between direct and indirect exporters comes from the larger size of direct exporters. As discussed below, direct exporters are large and well connected compared to other firms. Even though their share in terms of the number of firms is small, many other firms are connected to these large exporters.

Table 1 lists the number of each type of exporters by sectors. From the second column, we can see that manufacturing and wholesale are the main exporting sectors accounting for more than 80% of all exporters. As expected, construction, retail, and services sectors have a very small number of direct exporters. Yet, the third and fourth columns show that many of the firms in these "non-tradable" sectors are connected to exporters within two links. Especially, construction sector captures large shares of 1E and 2Es as it is the largest sector in terms of the number of firms. Figure 2 shows the sectoral decomposition of each type of exporters. Manufacturing and wholesale sectors have larger shares of both direct and indirect exporters. More than half of constructors are indirect exporters whereas most of the retailers are non-exporters. Because retail sector is the final outlet to consumers, it is not likely that their customer firms are exporting. From the view of supply chains, retail sector is the furthest from foreign markets. The figure tells us that if we just focus on standard trade statistics, which only record direct exports, we may miss many of the value-added indirect exporters in construction and services sectors.

Figure 3 summarizes the features of direct and indirect exporters. The distributions of four variables (sales, employment, in-degree and out-degree) are compared between different exporter groups. In any measures, there is strict ordering from D, 1E, 2E and O. Fujii et al. (2016) also present the same results focusing on manufacturers and 1st-degree indirect exporters. A new result is the difference between 1E and 2E, and 2E and O. In the top left panel of Figure 3, we can see that there is a sizable difference between 1E and 2E, but not much difference between 2E and O. In terms of size distributions, tracking second-degree and higher order indirect exporters does not make much difference.

4 Foreign Shock Propagations

This section examines whether shocks from international markets propagate to domestic suppliers through exporters. If indirect exporters are exporting their value added via direct exporters, they are not insulated from foreign shocks. For example, when Toyota expands its production scale due to the depreciation of Japanese yen, it may demand more inputs

from domestic suppliers, and their sales may increase. This propagation effect may cascade to those suppliers' suppliers, and so on. If this is the case, we cannot conclude that non-exporters are isolated from foreign shocks. Rather, it is important to distinguish domestic firms based on their distance to foreign markets in supply chains (1st-degree, 2nd-dgree, and so on) when considering the effects of trade liberalization or exchange rate policies on heterogeneous firms. In a standard model of interfirm production network, the elasticity of substitution between inputs determines the magnitude of the propagation factor. This section aims to unveil whether there exists such propagations, and if so how much. I focus on the effect of exchange rate fluctuations on exporters' sales as a source of shocks, but other factors that affect only exporters cannot be excluded from the analysis. Regardless of the actual source of shocks, exporters' differential growth rates are exploited to test the existence of propagations.

I focus on the years 2005 and 2010 for which we have both TSR and Kikatsu data. Kikatsu is used to identify exporters and their export intensity, and TSR data is used to identify their domestic suppliers (indirect exporters). Exporters experienced positive and negative shocks in 2005 and 2010 respectively due to different exchange rate movements, hence comparing these two years may tell us if there is any asymmetry in propagation patterns. The main specification is a simple difference-in-difference regression in which treated firms are indirect exporters. This is similar to the empirical model considered in Carvalho et al. (2014) and Barrot and Sauvagnat (2016) though they use natural disasters as sources of exogenous shocks.

4.1 Differential Growth of Direct Exporters

I first explore the effect of exchange rate movement on exporters' sales. The year 2005 was preceded by the years of Japanese yen depreciation as can be seen in Figure 5.[4] During that time frame, the total export volume had been rising. Due to the J-curve effect of international macroeconomics, the effect of contemporaneous currency depreciation is ambiguous, and can be negative on export revenue.[5] Yet, considering the series of depreciation, exporters are expected to have a positive impact on sales compared to other firms. There are 28,340 firms

[4]The data is retrieved from Bank of Japan's statistics website. Real effective exchange rate (REER) is adjusted by inflation and the composition of destinations currencies based on trade volumes. Since this is an index, a decrease means the depreciation of yen.

[5]The J-curve effect states that the effect of depreciation or devaluation on current export sales is likely to be negative since price (exchange rate) is reflected instantly whereas it takes time for volume to adjust. Over time, the export volume increases and dominates the price effect if the foreign demand elasticity is larger than one.

in the 2005 Kikatsu data set. Of this sample, 5,995 firms are exporters and 6,211 firms are importers, but 4,095 firms are engaged in both exporting and importing. This is presented in Table 2.

Firm-level sales growth rates between 2004 and 2005 are regressed against exporter and importer dummies along with other control variables. Exporter dummy is one if a firm reports a positive export value. Net exporter dummy is one if a firm exports but does not import. Importer dummy is defined in the same manner. Intense exporter dummy is one if the share of export in total sales is more than 10%. About a third of total exporters are classified as intense exporters. The number of employees and total asset (both in logs) are included to control the effects of size and financial leverage. In all specifications, 2-digit JSIC fixed effect and prefecture fixed effect (prefecture where the firm's headquarters is located) are included to control industry and regional heterogeneity. Table 3 summarizes the results. Throughout all regressions, log of employment is positive and significant implying that there is a scale merit on sales growth.[6] The first two columns show that exporters have a higher growth rate but not importers. When both are included together (column 3), exporter's effect is positive and importer's effect is negative as expected, and they are both significant. If we focus on net exporters and importers only, we still see a positive and significant effect of net exporters. The last column adds intense exporter dummy, whose coefficient is estimated to be positive and significant. The positive effect of exporters may come from these intense exporters. In sum, exporters show positive and significant growth compared to other firms but not importers in 2005.

4.2 Upstream Propagation to Indirect Exporters

4.2.1 The Case of Yen Depreciation (2005)

To examine the upstream propagation effect from direct exporters to their domestic suppliers (indirect exporters), the 2005 TSR data is merged with 2005 Kikatsu data to obtain customers' export information. To adjust the time frame with Kikatsu data, firms that were surveyed before 2005 were discarded (most of the firms were surveyed at March 2005, which corresponds to the Kikatsu closing date). Firms whose fiscal duration is not 12 months or whose sales data is not available are also dropped. The resulting sample consists of 537,287 firms with 3,701 direct exporters. Of these exporters, there are 1,141 net exporters (no importing) and 1,212 intense exporters (export to sales ration is more than 10%). Define 1st-

[6]Remember that firms in Kikatsu data are larger compared to all firms. There is robust empirical evidence on higher growth rates of very small or young firms as in Haltiwanger et al. (2013).

and 2nd-degree indirect exporters as before. Three types of exporter and indirect exporter groups are considered in the regression analysis. In addition to 1E and 2E, 1NE, 2NE, 1IE, and 2IE are used to denote firms that supply to net exporters and intense exporters respectively. Table 4presents the number of each type of indirect exporters. For the standard definition, 88,090 and 137,839 firms are identified as indirect exporters. This accounts for more than 40% of firms in the sample. By definition, net and intense exporters are subsets of exporters, and so are their indirect exporters.

The following regression equation is estimated to measure the upstream propagation effect of foreign shocks to indirect exporters

$$\Delta Sales_i = \beta_0 + \beta_1 FirstIE_i + \beta_2 SecondIE_i + \gamma Controls_i + \epsilon_i$$

where $FirstIE$ and $SecondIE$ are dummies for 1st- and 2nd-degree indirect exporters. As explained in Section 3, a firm cannot have $FirstIE$ and $SecondIE$ to be one at the same time. The control variables include employment, in-degree, out-degree (all in logs), and age. Two-digit JSIC and prefecture fixed effects are included for all specifications. Table 5 presents the baseline results. All estimated coefficients are significant at 1% level. In all cases, the coefficient of employment is positive whereas that of age is negative; larger and younger firms have higher sales growth rates. Also, the coefficient of in-degree is negative while that of out-degree is positive. From columns 1 through 4, we can confirm positive propagation effects to indirect exporters. Column 4 tells that 1st-degree indirect exporters on average have 2.3% higher sales growth rate, and 2nd-degree indirect exporters have 1% higher growth rate compared to non-exporters. The propagation is positive, significant, and decays as it travels through production networks. Columns 5 and 6 consider a narrower definition of indirect exporters (those who are connected to net exporters only). If we compare (4) and (6), we can see that net exporters are the source of stronger propagation as they are expected to receive stronger foreign shocks. Another definition of exporters, intense exporters, is considered in (7) and (8). Intense exporters inject even more powerful propagations. If one of a firm's customers is an intense exporter, the firm's sales growth rate is 3% higher compared to other firms, and 1.4% for the 2nd-degree indirect exporters. Since net and intense exporters are subsets of regular exporters, columns 9 and 10 estimate how much additional propagation comes from these different types of exporters. It is confirmed that intense exporters account for a large part of upstream propagation to domestic firms.

Is there any sectoral heterogeneity of propagation factors? To answer this question, sectoral interactions (manufacturing, construction, wholesale, and service) are added to above

regression model. These are the suppliers' (indirect exporters') sector. Retail sector is used as a reference level. Table 6 shows the results. The first two columns are of exporters, next two columns are net exporters, and the last two columns are intense exporters. For the 1st-degree propagation, no sectoral heterogeneity is confirmed. In column 1, service sector is negative but not so significant. For the 2nd-degree effect, manufacturing sector exhibits a negative interaction effect on propagation factors. If the 2nd-degree supplier to an exporter is a manufacturer, the upstream propagation effect is dampened.

4.2.2 The Case of Yen Appreciation (2010)

Now, the same regression analyses are repeated for year 2010, which was preceded by a period of Japanese yen appreciation. Table 7 presents the estimated results for the differential growth of exporters and importers. Contrary to the case of yen depreciation in 2005, exporters received adverse shocks in 2010. Column 3 of Table 7 shows that exporters' sales shrunk by 3.9% and importers' sales expanded by 0.9% compared to other firms. Columns 4 and 5 also indicate the negative and positive shocks for exporters and importers respectively. The coefficients in column 5 tell us that intense exporters suffered from even larger negative shocks.

The estimated results for upstream propagation are displayed in Table 8. Columns 1 through 4 show that indirect exporters were negatively affected in 2010, and the shock was larger for the 1st-order indirect exporters. Like the previous results, there exists positive and significant upstream propagation, and it decays as it travels through supply chains. The baseline results of column 4, after controling many other variables, indicate that 1st- and 2nd-degree indirect exporters' sales declined by 2.5% and 2.0% on average respectively in 2010. The estimated coefficients of control variables are similar to the previous results. From column 6, we see that the same propagation pattern exists for net exporters, but the magnitude of shocks are smaller unlike the case of 2005. Columns 7 and 8 show that the upstream propagtion is larger for the 1st-degree intense indirect exporters, but about the same for the 2nd-degree indirect exporters compared to columsn 1 through 4.

The estimated coefficients of propagation in this section are summarized in Figure 5. In any case, the 2nd-order effects are smaller compared to the 1st-order. Domestic suppliers that are connected to intense exporters receive larger propagation effects. The propagation effect is always positive (negative shock of direct exporters leads to the sales drop of indirect exporters) and significant. Since direct exporters are disproportionately large and well-connected, this implies there exists a potentially substantial impact of foreign shocks to

domestic firms, which standard trade models cannot capture.

5 Conclusion

As a modern economy is characterized by its complex production networks, it is important to identify who are the real exporters of value added when considering the effects of trade liberalization or open macro policies. Many of the standard trade models with heterogeneous firms derive their implications from the relative advantage of becoming exporters to non-exporters. Yet, if firms are connected via production networks, a non-exporter can be exporting its value added to foreign markets via exporters. This fact dampens the implications of standard trade models. Almost all firms are connected to a large production network in the domestic market. Hence, it is critical to analyze the features of indirect exporters and how foreign shocks propagate to the domestic market via production networks. This research answers these questions.

Using the Japanese interfirm transaction network data, the current paper uncovers the features of indirect exporters. Even though the share of direct exporters in terms of the number of firms is very small, the share of indirect exporters are substantial due to the size and well-connectedness of direct exporters. More than half of firms are connected to foreign markets within two transaction links. Manufacturing and wholesale sectors account for the largest shares of both direct and indirect exporters. Construction and service sectors have large shares of indirect exporter. These sectors are typically thought as non-tradable sectors, but if we extend our definition of exporting, they account for significant shares as well. A strict ordering of many variables such as sales or employment exists in direct, 1st-degree indirect, 2nd-degree indirect, and non-exporters.

A significant and positive propagation effect is confirmed as well. For year 2005, direct exporters grew more compared to other firms. This positive sales growth was transmitted to the domestic suppliers who provided value added to those exporters. Moreover, the propagation effect decays along the supply chain. In any measure of exporting, 1st-degree indirect exporters received 2.3$\sim$3% additional sales growth and 1$\sim$1.4% for 2nd-degree indirect exporters. If a firm supplies to an intense exporter, the magnitude is larger. No sectoral heterogeneity was confirmed for the first order propagation. The direction of propagation does not change when exporters receive opposite shocks.

The sizable share of indirect exporters and significant propagation effect lead us to reconsider the definition of exporters. It is critical to keep track of how value added flows to

foreign markets. In a political debate of joining Trans-Pacific Partnership (TPP), only the direct effect on exporters (or exporting sectors) are discussed, yet other firms that are typically treated as non-exporters are also affected by indirect linkages. The properties of those indirect exporters and how foreign shocks propagate through production networks should be investigated further to correctly address trade policy implications.

References

Ahn, JaeBin, Amit K. Khandelwal, and Shang-Jin Wei (2011) "The Role of Intermediaries in Facilitating Trade," *Journal of International Economics*, Vol. 84, No. 1, pp. 73–85.

Akerman, Andres (2014) "A Theory on the Role of Wholesalers in International Trade Based on Economies of Scope," *Working Paper*.

Barrot, Jean-Noel and Julien Sauvagnat (2016) "Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks," *Working Paper*.

Bernard, Andrew B., Emily J. Blanchard, Ilke Van Beveren, and Hylke Vandenbussche (2014) "Carry-Along Trade," *NBER Working Paper 18246*.

Boehm, Christoph, Aaron Flaaen, and Nitya Pandalai-Nayar (2016) "Input Linkages and the Transmission of Shocks: Firm-Level Evidence from the 2011 Tōhoku Earthquake," *Working Paper*.

Caliendo, Lorenzo and Fernando Parro (2015) "Estimates of the Trade and Welfare Effects of NAFTA," *The Review of Economic Studies*, Vol. 82, No. 1, pp. 1–44.

Carvalho, Vasco M., Makoto Nirei, and Yukiko U. Saito (2014) "Supply Chain Disruptions: Evidence frmo the Great East Japan Earthquake," *RIETI Discussion Paper Series 14-E-035*.

Fujii, Daisuke, Yukako Ono, and Yukiko U Saito (2016) "Indirect Exports and Wholesalers: Evidence from interfirm transaction network data," *RIETI Discussion Paper Series 16-E-068*.

Haltiwanger, John, Ron S Jarmin, and Javier Miranda (2013) "Who creates jobs? Small versus large versus young," *Review of Economics and Statistics*, Vol. 95, No. 2, pp. 347–361.

Melitz, Marc J. (2003) "The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity," *Econometrica*, Vol. 71, No. 6, pp. 1695–1725.

Timmer, Marcel P., Erik Dietzenbacher, Bart Los, and Robert Stehrer (2015) "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production," *Review of International Economics*, Vol. 23, pp. 575–605.

Tables

	# of firms	#of D	# of 1E	# of 2E	# of O
manufacturing	159117 (16%)	7238 (42%)	69537 (33%)	48392 (17%)	33950 (7%)
construction	327667 (33%)	210 (1%)	46349 (22%)	128709 (44%)	152399 (33%)
wholesale	128093 (13%)	7253 (42%)	36310 (17%)	38863 (13%)	45667 (10%)
retail	114225 (12%)	587 (3%)	6869 (3%)	14000 (5%)	92769 (20%)
services	255661 (26%)	1838 (11%)	50819 (11%)	60016 (21%)	142988 (31%)
All	984763 (100%)	17126 (100%)	209884 (100%)	289980 (100%)	467773 (100%)

Table 1: Sectoral breakdown of exporters (shares are in parentheses)

		Import	
		No	Yes
Export	No	20,229	2,116
	Yes	1,900	4,095

Table 2: Number of exporters and importers in 2005

	(1) sales growth	(2) sales growth	(3) sales growth	(4) sales growth	(5) sales growth
exporter	0.0061*		0.0102**		0.0054
	(0.0037)		(0.0042)		(0.0045)
importer		-0.0037	-0.0083**		-0.0087**
		(0.0035)	(0.0040)		(0.0040)
net exporter				0.0120**	
				(0.0053)	
net importer				-0.0065	
				(0.0051)	
intense exporter					0.0178***
					(0.0063)
log of employment	0.0110***	0.0109***	0.0109***	0.0109***	0.0111***
	(0.0024)	(0.0024)	(0.0024)	(0.0024)	(0.0024)
log of total asset	0.0016	0.0024	0.0019	0.0020	0.0016
	(0.0018)	(0.0018)	(0.0018)	(0.0017)	(0.0018)
constant	0.0659	0.0615	0.0659	0.0649	0.0680
	(0.0879)	(0.0879)	(0.0879)	(0.0879)	(0.0879)
2-digit JSIC FE	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Observations	17,740	17,740	17,740	17,740	17,740
R-squared	0.052	0.052	0.052	0.052	0.052

Table 3: Differential sales growth rates of exporters in 2005

	direct	1st-degree	2nd-degree
exporter	3,701	88,090	137,839
net exporter	1,141	36,962	136,378
intense exporter	1,212	49,900	120,818

Table 4: Number of firms in each export group

	(1) sales growth	(2) sales growth	(3) sales growth	(4) sales growth	(5) sales growth	(6) sales growth	(7) sales growth	(8) sales growth	(9) sales growth	(10) sales growth
1E	0.021***		0.026***	0.023***					0.014***	0.009***
	(0.001)		(0.001)	(0.002)					(0.002)	(0.002)
2E		0.004***	0.012***	0.010***						
		(0.001)	(0.001)	(0.001)						
1NE					0.028***	0.025***			0.007***	
					(0.002)	(0.002)			(0.002)	
2NE					0.015***	0.012***				
					(0.001)	(0.001)				
1IE							0.032***	0.030***		0.015***
							(0.002)	(0.002)		(0.002)
2IE							0.015***	0.014***		
							(0.001)	(0.001)		
in-degree				-0.003***		-0.003***		-0.003***	-0.003***	-0.003***
				(0.001)		(0.001)		(0.001)	(0.001)	(0.001)
out-degree				0.006***		0.006***		0.006***	0.007***	0.007***
				(0.001)		(0.001)		(0.001)	(0.001)	(0.001)
employment	0.019***	0.019***	0.018***	0.016***	0.018***	0.016***	0.018***	0.016***	0.016***	0.016***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
age	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.022***	0.022***	0.020***	0.028***	0.021***	0.029***	0.021***	0.030***	0.032***	0.032***
	(0.006)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.008)	(0.008)	(0.008)
2-digit JSIC FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	462,083	462,083	462,083	285,910	462,083	285,910	462,083	285,910	285,910	285,910
R-squared	0.019	0.019	0.020	0.022	0.020	0.022	0.020	0.023	0.022	0.022

Table 5: Baseline upstream propagation in 2005

	exporters		net exporters		intense exporters	
	(1)	(2)	(3)	(4)	(5)	(6)
	sales growth	sales growth	sales growth	sales growth	sales growth	sales growth
1E	0.025***		0.026**		0.027***	
	(0.007)		(0.011)		(0.009)	
1E×manufacturing	-0.010		-0.007		-0.006	
	(0.007)		(0.011)		(0.009)	
1E×construction	-0.001		-0.002		0.001	
	(0.007)		(0.012)		(0.010)	
1E×wholesale	0.006		0.007		0.015*	
	(0.007)		(0.011)		(0.009)	
1E×services	-0.012*		-0.016		-0.014	
	(0.007)		(0.011)		(0.009)	
2E		0.007		0.011**		0.010**
		(0.004)		(0.005)		(0.005)
2E×manufacturing		-0.011**		-0.008		-0.011**
		(0.005)		(0.005)		(0.005)
2E×construction		0.002		0.001		0.005
		(0.005)		(0.005)		(0.005)
2E×wholesale		-0.004		0.006		0.001
		(0.005)		(0.005)		(0.006)
2E×services		-0.001		-0.002		0.000
		(0.005)		(0.005)		(0.005)
employment	0.019***	0.019***	0.019***	0.019***	0.019***	0.019***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
age	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.023***	0.024***	0.023***	0.023***	0.023***	0.023***
	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
2-digit JSIC FE	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	462,083	462,083	462,083	462,083	462,083	462,083
R-squared	0.019	0.019	0.019	0.019	0.019	0.019

Table 6: Sectoral heterogeneity of propagation factors (2005)

	(1) sales growth	(2) sales growth	(3) sales growth	(4) sales growth	(5) sales growth
exporter	-0.0346***		-0.0391***		-0.0280***
	(0.0043)		(0.0049)		(0.0053)
importer		-0.0094**	0.0088*		0.0098**
		(0.0041)	(0.0047)		(0.0047)
net exporter				-0.0343***	
				(0.0062)	
net importer				0.0115*	
				(0.0060)	
intense exporter					-0.0370***
					(0.0071)
log of employment	0.0266***	0.0273***	0.0267***	0.0273***	0.0264***
	(0.0025)	(0.0025)	(0.0025)	(0.0025)	(0.0025)
log of total asset	0.0006	-0.0014	0.0004	-0.0015	0.0010
	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
constant	-0.1794**	-0.1692**	-0.1806**	-0.1752**	-0.1833**
	(0.0733)	(0.0734)	(0.0733)	(0.0734)	(0.0733)
2-digit JSIC FE	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Observations	23,174	23,174	23,174	23,174	23,174
R-squared	0.1687	0.1666	0.1689	0.1677	0.1698

Table 7: Differential sales growth rates of exporters in 2010

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	sales growth	sales growth	sales growth	sales growth	sales growth	sales growth	sales growth	sales growth
1E	-0.016***		-0.027***	-0.025***				
	(0.001)		(0.001)	(0.002)				
2E		-0.012***	-0.020***	-0.020***				
		(0.001)	(0.001)	(0.001)				
1NE					-0.025***	-0.019***		
					(0.002)	(0.002)		
2NE					-0.021***	-0.018***		
					(0.001)	(0.001)		
1IE							-0.031***	-0.027***
							(0.002)	(0.002)
2IE							-0.021***	-0.019***
							(0.001)	(0.001)
in-degree				-0.010***		-0.010***		-0.010***
				(0.001)		(0.001)		(0.001)
out-degree				0.000		-0.001		-0.000
				(0.001)		(0.001)		(0.001)
employment	0.015***	0.015***	0.016***	0.019***	0.016***	0.019***	0.017***	0.019***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
age	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.041***	-0.038***	-0.036***	-0.043***	-0.038***	-0.046***	-0.038***	-0.046***
	(0.005)	(0.005)	(0.005)	(0.007)	(0.005)	(0.007)	(0.005)	(0.007)
2-digit JSIC FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	710,061	710,061	710,061	446,671	710,061	446,671	710,061	446,671
R-squared	0.012	0.012	0.012	0.014	0.012	0.014	0.013	0.014

Table 8: Baseline upstream propagation in 2010

Figures

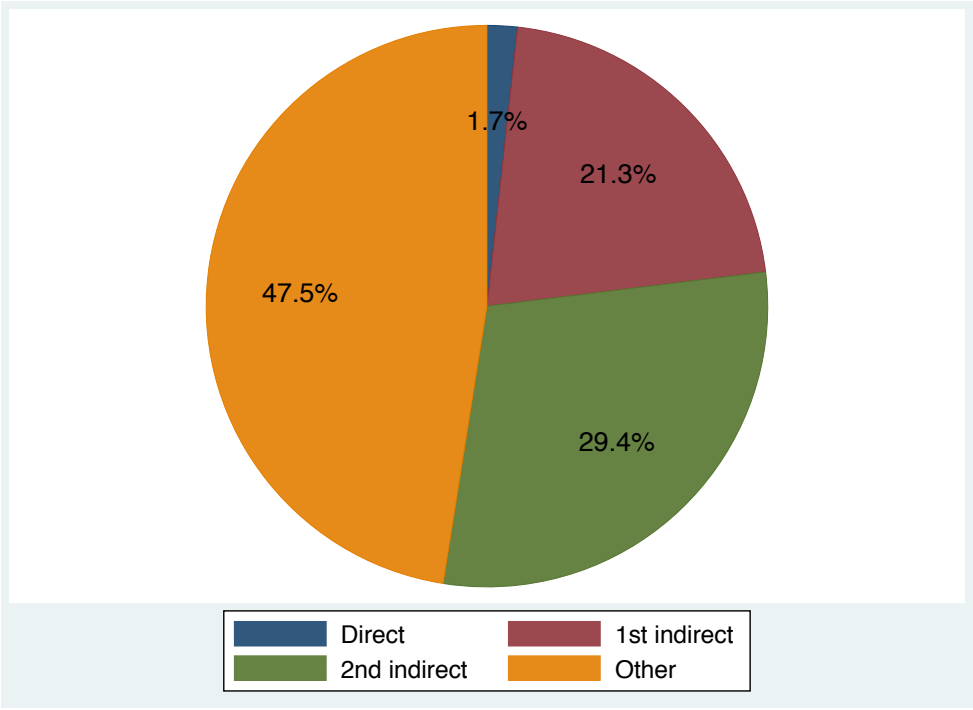

Figure 1: Shares of direct and indirect exporters

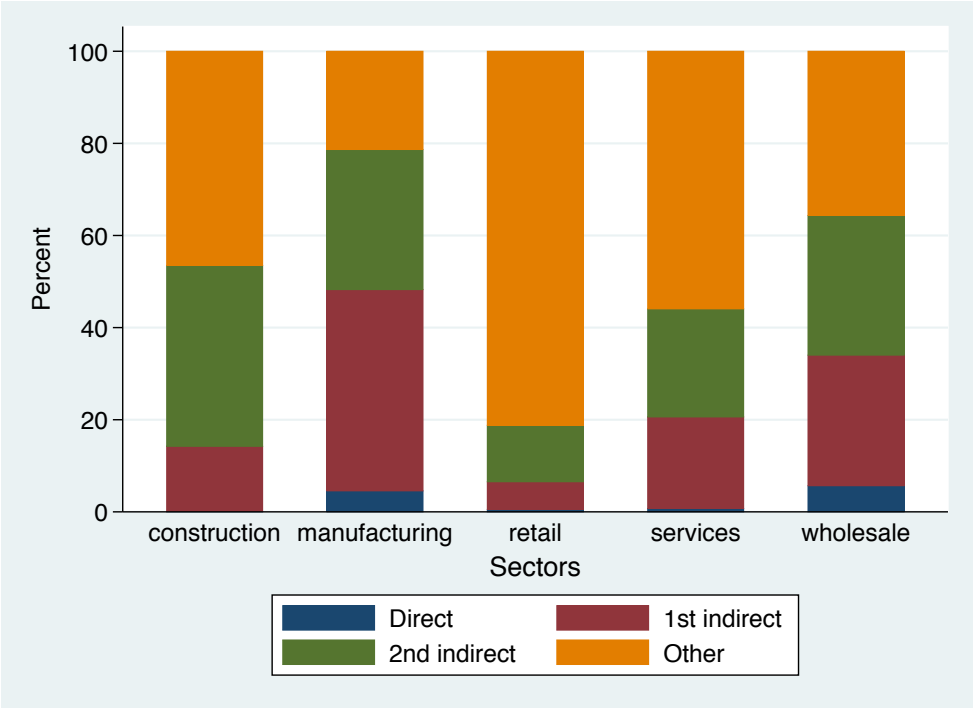

Figure 2: Sectoral shares of direct and indirect exporters

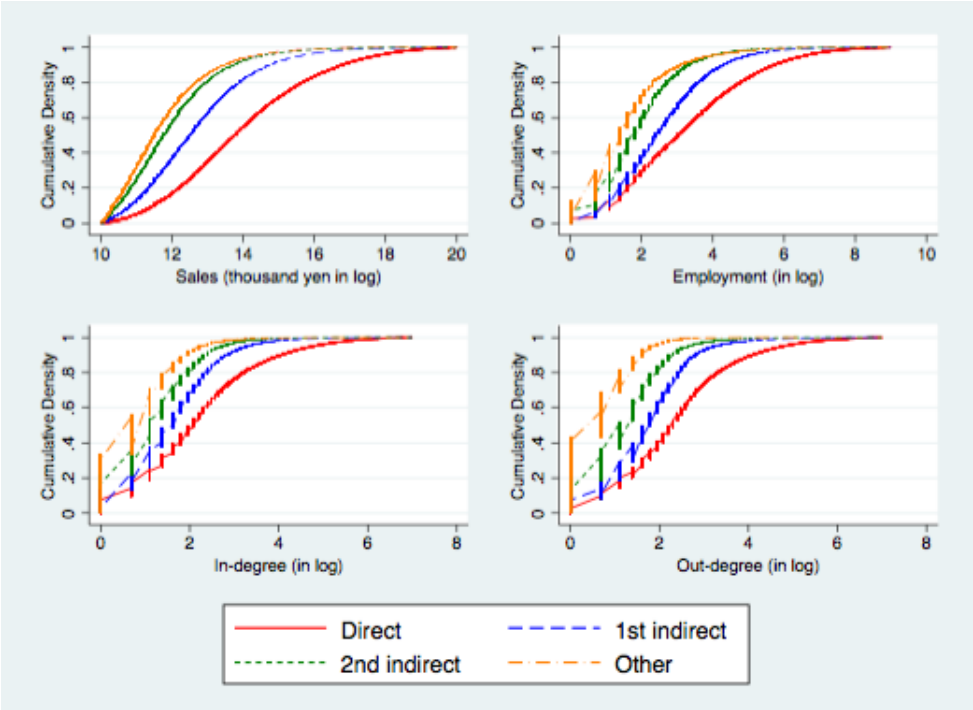

Figure 3: Empirical CDF by exporter types

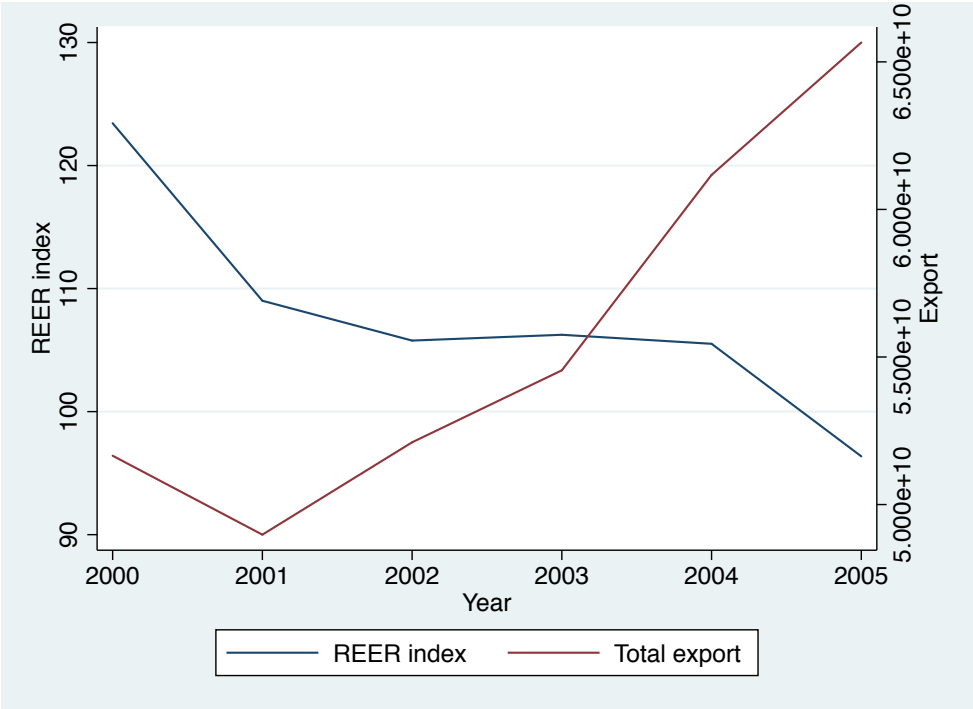

Figure 4: Real effective exchange rate index of Japanese yen

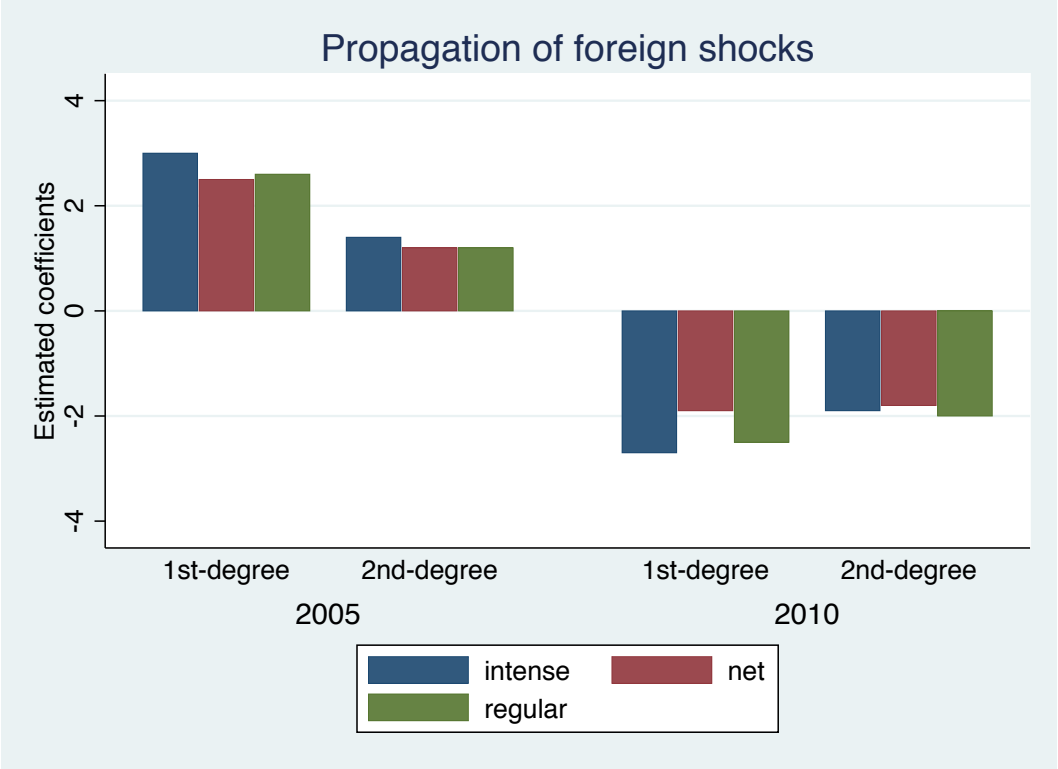

Figure 5: Upstream propagation of foreign shocks