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企業の海外取引拡大が国内供給企業に与える影響

遠藤 正寛

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Institute for Economic Studies, Keio University
2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan
ies-office@adst.keio.ac.jp
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【要旨】

・ある企業の海外取引拡大が、その企業への国内供給企業の業績にどのような影響を与えるか調べた。
・傾向スコアマッチングによって比較する国内供給企業を選び、差の差推定によって影響を分析した。
・ある企業の輸出や輸入の拡大は、国内供給企業の業績に影響を与えているという仮説は、強くは支持されなかった。
・この結果の考えられる原因の一つは、企業が海外取引を拡大させても、国内仕入額をあまり変化させないことにある。

遠藤 正寛
慶應義塾大学商学部
〒108-8345
東京都港区三田2-15-45
endoh@fbc.keio.ac.jp

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The Impact of Firms' International Trade on Domestic Suppliers

Masahiro Endoh *
Keio University

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Abstract

Empirical studies have demonstrated that both firms' exports and imports increase their productivity, although it may have different upstream effects on domestic firms. This study revisits the propagation of trade effects through interfirm transactions by improving the methods of previous empirical analyses in three ways. First, it uses stricter criteria for sampling firms in order to estimate the effects without bias from other international transactions. Second, it deals with the indirect impact of trade shocks on various indices of upstream suppliers, such as the possibility of closure, the number of workers, and productivity. Third, it employs a one-to-one propensity score matching combined with a difference-in-differences approach, a method that controls both buyers' and sellers' characteristics. Results show that there is no systematic trade effect on upstream seller firms, and that most of the trade impacts on business performance variables of seller firms are statistically insignificant. One possible reason is that firms that increase their exports or imports do not sufficiently change their purchase of material and intermediate goods from domestic non-associated firms, a supposition that is supported by the empirical analysis. The result suggests that the economic impact of firms' international trade on upstream suppliers is more nuanced than just a substitute or complement between international and domestic trades.

Keywords: Buyer-seller network; Closure; Employment; Exports; Imports

JEL codes: F14; F61; L14

*Endoh: Faculty of Business and Commerce, Keio University, 2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan (e-mail: endoh@fbc.keio.ac.jp; tel: (+81)-3-5427-1277). This research was supported by grants-in-aid from the Japan Society for the Promotion of Science, Scientific Research (C), No. 16K03651, and from Zengin Foundation for Studies on Economics and Finance. The author appreciates Yukako Ono and Katsumi Tanabe for their valuable comments. Tokyo Shoko Research, Ltd. gave me a generous support for the study. The use of statistics prepared by the Japanese Ministry of Internal Affairs and Communications and the Japanese Ministry of Economy, Trade and Industry was under their authorization and guidance. The usual disclaimer applies.

1 Introduction

Empirical studies have demonstrated that firms derive benefit from the export of their products through the increase of productivity and sales (Atkin et al., 2017; Munch and Schaur, 2018; and Garcia-Marin and Voigtländer, 2019). It is also established that firms' import of intermediate goods has a positive effect on importing firms via learning, variety, and quality effect (Amiti and Konings, 2007; Kasahara and Rodrigue, 2008; Goldberg et al., 2010; and Topalova and Khandelwal, 2011). While both exports and imports positively affect firms which engage directly in trading activity, there is a legitimate concern that it may affect upstream domestic firms differently. Considering the dense web of domestic buyer-seller networks, the ripple effect of trade shocks from downstream to upstream firms through these links is also an important aspect of various trade effects. Though this view is well recognized, the propagation of trade effects through interfirm transactions has not been empirically investigated in any countries, with the exception of Belgium and Japan, due to limited data availability.

In Japan, two private credit reporting companies compile buyer-seller link data individually. Based on these data, some studies explore the indirect effects of trade shocks from exporters or importers on upstream seller firms. For exports by downstream firms, Fujii (2017) summarized that, although direct exporters only account for less than two percent of all Japanese firms, more than half of firms indirectly export by selling to direct exporters in one or two transaction links. He also showed the statistical significance of shocks to direct exporters propagating to indirect exporters. For imports by downstream firms, one may expect a negative impact on upstream seller firms due to the direct displacement effect when offshoring buyer firms replace some domestic suppliers with foreign suppliers. However, Furusawa et al. (2018) showed that Japanese firms which start offshoring tend to sever fewer links with upstream suppliers and add more nearby suppliers, producing differentiated inputs. In addition, Ito and Tanaka (2014) found that overseas expansion by Japanese manufacturing firms does not negatively affect the employments of manufacturing workers in upstream supplier firms. Moreover, they proved that expansion into non-Asian areas increases the total number of supplier employees. Although Ito and Tanaka (2014) did not explicitly examine international trade by downstream firms, the authors explain the possible causal link between trade activity in their overseas business and the

employment of upstream firms.[1]

These findings are pioneering in the understanding of how the impact of international trade pervades domestic firms through interfirm transactions. This path is worth exploring; the majority of domestic firms are connecting to foreign markets through firm-to-firm linkages, even though there is only a handful of direct exporters or importers in countries (Fujii, 2017, for Japan and Tintelnot et al., 2018, for Belgium). Still, however, there is some room for improvement in the appropriate estimation of the indirect trade impact. One of the concerns is that some factors what previous studies have not fully paid attention to would contaminate their estimation results. For example, in the case of examining how the decision to start importing or to increase imports by downstream firms affect business performance in upstream firms, the estimation results could be biased if the possible simultaneous export shocks from downstream firms are not taken into consideration. Another concern is the ranking of upstream seller firms with respect to their business performance. As Fujii et al. (2017) described in the case of manufacturing exports in Japan, the distributions of sales and labor productivity are ordered for direct-, indirect-, and non-exporters. This means that larger or more productive upstream sellers tend to form links with downstream trading firms. This endogeneity of the buyer-seller linkage would also produce biased results.

This study intends to improve on the methods of previous empirical analyses and expand on the outcome variables of interest in three ways. First, I employ more strict criteria for choosing firms that are subjected to examination in order estimate the effects, unbiased by other international transactions. Second, this study deals with the indirect impact of trade shocks on various indices of upstream suppliers, such as the possibility of closure, the number of workers, and productivity. Third, a more appropriate method of estimation is employed. The empirical strategy chosen for this study is a one-to-one propensity score matching (PSM) combined with a difference-in-differences (DID) approach, with the intention of controlling both observable and unobservable variables. The treatment group is composed of upstream seller firms whose

[1] In Belgium, the other exception, the buyer-seller data originates from the annual declarations of deliveries by VAT-registered businesses to the Belgian tax administration. Dhyne et al. (2015) and Dhyne and Duprez (2017) depicted the outline of the dataset. Tintelnot et al. (2018) constructed the theoretical model of the gains from trade and the endogenous network formation, and quantitatively examined the impact of import prices on real wages, using the Belgian data.

main downstream buyers increase their international trade, whereas the control group consists of upstream seller firms whose main buyers are all domestic firms, conducting neither international trade nor foreign direct investment (FDI).

The remaining part of this paper is organized as follows: Section 2 explains the methodology for estimating the impact of trade shocks on upstream non-associated firms. Section 3 describes the data used for the present research. Section 4 presents the results and the argument for the findings. The supposition proposed in the previous section to interpret the results is supported empirically in Section 5. Lastly, Section 6 summarizes the research.

2 Methodology

The aim of this study is to evaluate the difference in outcome variables of interest between the treatment group and the control group after controlling for observable and unobservable variables, other than international trade shocks, from downstream firms. Two types of shocks are examined in this study: the increase of import and export values, both including the launch of international trade. I choose upstream supplier firms for a treatment group and a control group according to the international activities of their main downstream buyer firms. The control group is composed of seller firms whose main buyers do not conduct any international trade and FDI. Upstream firms that sell their products to downstream firms, which expand the values of international trade during the analysis period, are in the treatment group.

The PSM-DID approach has crucial benefits for this study. PSM addresses the issue that both the internationalization status of downstream firms and other characteristics of business activities in the firms of interest are saliently different between the treatment group and the control group, and these differences in business activities partly explain the outcome variables. In the dataset used in this study, upstream firms in the treatment group tend to have more value added per worker and more major buyers, as I explain later. These factors then serves in favor of firms' survival, for example, because high productivity improves competitiveness and a large number of customer firms serves as a safety net. In order to control the observable difference between the control and treatment groups, each treated firm is paired with a counterpart control firm, both having similar possibilities of being a treated firm based on their characteristics, and

the treatment effect is obtained from the difference in outcome between the two firms.

Some previous studies such as Hijzen et al. (2011) and Brucal et al. (2019) employ DID in addition to PSM for evaluating the impact of firms' internationalization on their own economic outcome. They utilize the benefit of DID that it eliminates the influence of constant and unobservable elements of these firms by focusing on the difference in the trend of variables of interest, such as exports, employment, and environmental performance, before and after the internationalization decision. This study applies DID to supplier firms because their time-invariant factors are hard to observe, and probably directly affect their business outcome and indirectly affect them through the formation of links between upstream suppliers and downstream buyers, which is endogenous and determined by factors on both sides of firms (Sugita et al., 2017; and Furusawa et al., 2018).

The present study considers the launch and the increase of international trade by buyer firms as sources of indirect internationalization shocks on supplier firms. Each indirect shock from imports and exports potentially has both negative and positive effects on existing domestic supplier firms, and I present some possible causality for interpreting the estimation results. Since it is difficult to predict which effect dominates, I juxtapose some possibilities below and introduce some empirical results obtained from previous studies.

First, the launch and the increase of importing intermediate goods for production in the manufacturing sector or of final goods for resale in the service sector would have a direct displacement effect: offshoring buyer firms replace some domestic suppliers with foreign suppliers. From their model of heterogeneous manufacturing firms, Furusawa et al. (2018) proposed two additional effects, an intra-industry restructuring effect and an industry composition effect, arising from the decline in marginal costs in offshoring buyers. Furusawa et al. (2018) also provided empirical evidence from Japanese buyer-seller link data which show that firms are, on average, less likely to abandon domestic suppliers after starting offshoring, presumably as a result of the fact that two indirect effects more than offset the direct displacement effect. Furthermore, their model suggested that the operating profits of offshoring buyers increase compared to those of non-importers. Previous empirical studies also demonstrated the positive effect of imports on importing firms via learning, variety, and quality effects. If these positive effects lead to

the expansion of production in offshoring buyers, their purchases of intermediate goods from domestic suppliers would not decrease.

Second, exports by downstream buyer firms in manufacturing and service sectors should have a positive effect on domestic supplier firms in general due to the positive shock of increasing sales propagating upstream through supply chains. Fujii (2017) revealed that direct exporters grew their sales more than non-exporters in Japan between 2004 and 2005, a period of depreciation for the Japanese Yen, and the positive effect was transmitted to domestic suppliers. Previous empirical studies have also established that firms which start exporting may increase their productivity. This increased productivity would have a mixed effect on upstream supplier firms. On one hand, a possible negative effect is one that would decrease supplier firms' sales and lead to their closure when downstream buyer firms increase their productivity by streamlining their production process and reducing their intermediate inputs sourced from local suppliers.[2] On the other hand, a positive effect is evident when buyer firms expand their business and increase their intermediate purchases.[3]

3 Data

I employ five sets of Japanese data for the research: buyer-seller relationship data and basic firm information from Tokyo Shoko Research, Ltd. (TSR), a private credit reporting company; *The Economic Census for Business Activity* and *The Economic Census for Business Frame* from the Statistics Bureau, Ministry of Internal Affairs and Communications; and *The Basic Survey of Japanese Business Structure and Activities* from the Ministry of Economy, Trade and Industry (METI). This section explains the characteristics of each dataset, its treatment for the analysis, and the outline of the constructed dataset.

[2]It would probably have an additional negative effect on some upstream suppliers if the remodeling of products is accompanied by their export. They would witness a cessation of supplier-buyer links because buyer firms stop using their products as intermediate inputs of new products tailored for foreign markets.

[3]I examine only the trade aspects of international economic shocks in this study. Readers might think that FDI is also an influential international shock. For example, Kimura and Kiyota (2006), Hijzen et al. (2010), and Ito (2014) empirically demonstrated that outward FDI increases source firms' productivity in Japan. Productivity in recipient firms also increases as a result of transplanting the production technology and management practices of the source firms (Matthias Arnold and Javorcik, 2009; Chen, 2011; and Havranek and Irsova, 2011, for example). It is therefore likely that inward and outward FDI by downstream buyers have a certain indirect impact on upstream suppliers. Though this aspect is intriguing, I focus on the effect of international trade in this study, because it has the direct complement or substitute linkage with domestic buyer-seller trade.

TSR has collected buyer-seller relationship data through interviews with firms to compute their credit scores. The buyer-seller dataset I used in this study is as of 2014. The dataset has 5.3 million observations, including reporter codes, partner codes, and partners' type from the perspective of reporters: seller, buyer, and stockholder. It is composed of 2.4 million observations of business partners, which interviewee firms reported to TSR as their main suppliers; 2.7 million partners, which interviewees reported as their main customers; and 0.2 million observations from stockholder reports. Since this study focuses on the economic impact of customer firms launching international activities on domestic suppliers, suppliers' perception is crucial to choose which downstream buyers are important partners. For this reason, I mainly use the 2.7 million observations of major buyers reported by sellers as buyer-seller data.[4]

Since the buyer-seller relationship data itself does not contain the firms' information such as name, address, and industry, I connect it with the basic TSR firm information data by using TSR firm codes. Geocodes are distributed to buyer and seller firms in the same way as Bernard et al. (2019) did for measuring the great circle distance between firms. Some observations are deleted from the buyer-seller link data. First, the shareholding relationships between buyers and sellers are deleted, with the intention of estimating the effect of trade impacts outside of corporate groups. Each corporate group probably decides on international economic activities for its member firms and coordinates trade shocks within itself for its collective purpose, so exogeneity of trade shocks is unlikely for upstream firms. Second, seller firms who export, import, have foreign subsidiaries, or accept investment from abroad in any year during the period 2011–2015 are not used for the analysis because their business performance is affected by their own international economic transactions. Only seller firms which are classified as domestic firms (explained later) in *The Basic Survey of Japanese Business Structure and Activities* or outside of its ambit are used in the analysis. Third, government offices are excluded.

[4]This way of constructing the buyer-seller relationship is different from Fujii et al. (2017), Furusawa et al. (2018), and Bernard et al. (2019), which used observations reported by both sellers and buyers to form buyer-seller data. In this inclusive case, the buyer-seller data are composed of 4.9 million observations, since there are 0.2 million overlapping observations from both sellers and buyers reporting their important trading partners to TSR. Duplications, which result from both sellers and buyers reporting the same transactions, constitute less than one tenth of the total main seller observations reported by buyers and main buyers as reported by sellers. Therefore, it may safely be said that there is a significant difference in recognition of important partners between suppliers and buyers, even considering the limitation that each firm was able to provide a rank-ordered list of only its 24 most important suppliers and customers. The inclusive buyer-seller dataset of 4.9 million observations also found a supplementary use as an alternative method of estimation.

Information concerning supplier firms' business activities, such as the number of workers, sales, and wages are from *The Economic Census for Business Activity*, conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications. *The Economic Census for Business Activity*, one of the Japanese fundamental statistical surveys, was launched in 2012 and is conducted almost every 5 years. It was designed to integrate some previously existing government surveys and therefore encompasses a wide range of survey items about both establishments and their head offices. It covers all establishments except individual proprietorships belonging to agriculture, forestry, and fisheries, establishments belonging to household services, and establishments concerned with foreign public affairs. The period of analysis is from February 1st, 2012, to June 1st, 2016, being the days when the first and the second surveys were conducted. The values of firms' business outcomes are converted into real values by using the Japanese GDP deflator.

Since the starting year of the DID analysis (2012) is different from the year of the buyer-seller data (2014), I use the population of firms which are recorded as doing business in both *The Economic Census for Business Activity* conducted in February 2012 and *The Economic Census for Business Frame* in July 2014. *The Economic Census for Business Frame* is a similar survey to *The Economic Census for Business Activity* and covers the same categories of establishments and firms, but its questionnaire contains fewer items. Of the 3.5 million firms which existed in February 2012 and remained in business by July 2014, 3.1 million firms survived by June 2016. That is, more than one tenth of firms closed in two years. Dependent variables for the DID estimation are constructed from the variables of interest between February 2012 and June 2016, except the variable of business closure, which records whether it occurred between July 2014 and June 2016 or not.

Buyer firms' international business activities are from *The Basic Survey of Japanese Business Structure and Activities* conducted annually by METI (hereafter, *the METI survey*). The aim of this survey is to acquire basic data on the business activities of private Japanese companies. The survey reports figures for each accounting year, which starts from April 1st of a year through March 31st of the next year for most Japanese firms. It targets companies with both a minimum capital of 30 million JPY, and with 50 or more employees. The survey cov-

ers multiple industries; although it excludes the industries involved in agriculture, fisheries, construction, transportation, medical, healthcare, and welfare. There are approximately 37,000 companies targeted, of which about 30,000 submit valid responses every year.

Two modes of international transaction by downstream buyer firms are employed as trade shocks in this study: import and export expansion, including the start of imports or exports. There are three criteria, and buyer firms need to satisfy all of them to be considered as firms of import or export expansion; (1) firms record larger import or export values in 2015 than in 2011, (2) firms are not involved in other direction of trade (for example, if firms are defined as import expansion firms, they must not engage in exporting to foreign markets) in any of the years from 2011 to 2015, and (3) firms either have no foreign subsidiaries nor accept investment from abroad in any of the years 2011–2015. Nominal trade values in *the METI survey* are converted into real values using the Japanese GDP deflator. Criteria (2) and (3) are introduced to avoid including simultaneous shocks from other types of international activities. Firms who neither export, import, have foreign subsidiaries, nor accept investment from abroad in any year in the period 2011–2015 are called domestic firms.[5]

Since there is no common firm identification system in the data from either TSR, the Statistics Bureau, Ministry of Internal Affairs and Communications, or from the Ministry of Economy, Trade and Industry, firms in these three sets of data are linked by using their phone numbers and their names and zip codes. Among the 2.7 million observations of original TSR buyer-seller link data, upstream sellers in 1.8 million observations are connected with their business activity data obtained from *The Economic Census for Business Activity*, and downstream buyers in a further 0.5 million observations are connected with their international business status data from *the METI survey*. Downstream buyers who are not recorded in *the METI survey* are treated as domestic firms.[6]

Table 1 summarizes the number of domestic buyer firms and buyer firms in the constructed

[5]Because *the METI survey* does not report the value of indirect international trade through other firms, the values of imports and exports used in the study reflect only those conducted directly by reporting firms.

[6]I assume that downstream buyer firms that are not recorded in *the METI survey* only constitute a fraction of internationalized firms and there is little risk of biased results by treating them all as domestic firms. This view is informed by the evidence that, on average, exporting firms and FDI firms are significantly larger than other firms in terms of the number of employees, as recorded by Bernard et al. (2007) for the United States, Mayer and Ottaviano (2008) for European countries, and Wakasugi et al. (2014) for Japan. The conservative dataset, which includes only buyer firms successfully connected with *the METI survey*, is additionally used for a robustness check.

Table 1: The number of domestic firms and firms of trade expansion

	Domestic			Trade expansion	
	Total	TSR data	METI survey	Import	Export
Total	312,042	301,611	10,431	784	627
Manufacturing	55,564	51,178	4,386	444	466
Wholesale & retail	59,060	55,180	3,880	272	115
Other industries	197,418	195,253	2,165	68	46

Notes: Domestic firms from the "TSR data" indicate that these firms are in buyer-seller relationship data from TSR and are classified as domestic firms because they are not connected with *the METI survey*. Domestic firms from the "METI survey" mention the firms which are in *the METI survey* and do not engage in any international economic transactions.

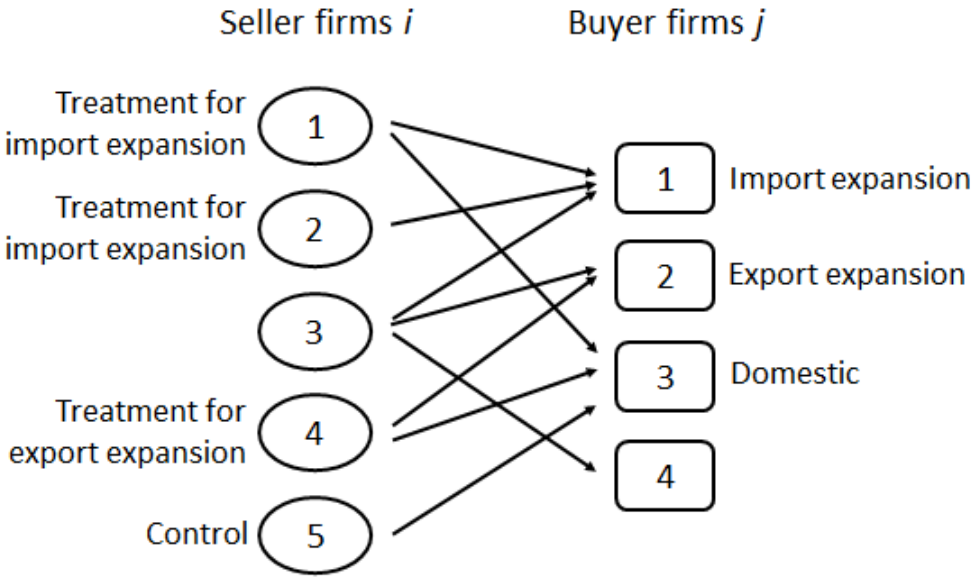
dataset which expand their international trade in manufacturing, wholesale and retail, and other industries. The total number of domestic buyer firms is 312,042, of which 301,611 are classified as domestic because they are not connected with *the METI survey*. The balance of 10,431 firms are also classified as domestic because they have no record of international economic activities in *the METI survey*.

The number of firms which increase their imports and exports from 2011 to 2015 are 784 and 627, respectively, based on *The METI data*. Trade shocks from manufacturing firms and wholesale and retail firms to upstream firms are examined separately, to account for the possibility that the substitute or complementary relationship between domestically sourced goods and internationally traded goods differ among industries.[7] Firms with trade expansion are very rare in other industries. This industry group is not used as a source of trade shocks to upstream seller firms because the sample is very small and still contains heterogenous characteristics.

In this study, seller firms in both treatment and control groups are chosen with a strict criterion, and any upstream firms which sell products to any downstream firm, other than firms of interest and domestic firms, do not qualify for inclusion in the treatment and control groups. This is explained in Figure 1. For the downstream buyer firms, firm 1 is a firm which increases imports from 2011 to 2015 and does not export anything, does not have any foreign subsidiaries,

[7]The impact of export shocks from downstream firms may not systematically differ between manufacturing firms and wholesale and retail firms. One reason for this similarity is that the majority of manufacturing exporters probably export many products that they do not produce, so they partly assume the role of wholesalers and retailers. Bernard et al. (2019) called these complementary export activities "carry-along trade" and reported that carry-along trade products represent as much as 30 percent of export value in Belgium.

Figure 1: Treatment and control groups



and does not accept any investment from abroad in any years 2011–2015, therefore is entitled to be an import expansion firm. Using the inverse of the same criteria, firm 2 is called an export expansion firm. Firm 3 is a domestic firm which does not engage in any of the four aspects of international economic activities. Firm 4 does not fall into any of three categories because, for example, it exports its final goods or it accepts inward FDI from a foreign firm.

On the upstream seller firms' side, seller firm 1 has two main buyers: firm 1 (import expansion) and firm 3 (domestic). Seller firm 1 is entitled to be in the treatment group for estimating the impact from a downstream firm which increases imports, because it sells only to import expansion firms and domestic firms. Seller firm 2 also qualifies to be in the treatment group for import shock, because it sells only to firm 1 (import expansion). However, seller firm 3 is not used for the analysis, because it additionally sells to both firms 2 and 4, which would result in a shock from extending export and other international activities to seller firm 1 which would contaminate the impact from an import expansion firm. Upstream firm 4 sells only to buyer firm 2 (export expansion) and firm 3 (domestic), and seller firm 4 is therefore in the treatment group for estimating the impact from a downstream firm increasing its imports. Upstream firm 5 is in the control group, because it sells only to domestic firm 3.

Table 2 reports the descriptive statistics of the variables used in the estimation regarding upstream seller firms. I employ four variables for the logit estimation of the propensity score of selling to downstream buyers which expand either imports or exports: value added per worker, the number of buyers, average distance, and the average of buyers' sales. They are logarithmic and use February 2012, the starting period of the analysis, as the base. Value added per worker is the value added for a seller firm, which is the sum of the operating profit, wages, rent, depreciation, and paid tax, divided by its number of workers. The number of buyers is the number of main customers that seller firms report to TSR. Average distance is the simple average of the distance from each seller firm to its main customers. The average of buyers' sales is the simple average of sales values to its main customers. Upstream seller firms are divided into three groups in Table 2 based on the industries they belong to: manufacturing, wholesale and retail, and others. This is because these groups have different characteristics concerning the four independent variables, and they are supposed to have different industrial shocks. Manufacturing seller firms have the largest average distance to and the largest average sales to their main customers, whereas value added per worker is the largest in the wholesale and retail industries. In other industries, the number of buyers and average distance are the smallest on one hand, while the number of seller firms is exceptional on the other hand.

In addition, Table 2 reports descriptive statistics of five variables, of which the difference between the control and treatment groups are of interest. Closure is the dummy which equals one if the seller firm stops operation for any reason between July 2014 and June 2016. The other four variables are the rate of their changes between February 2012 and June 2016 for buyer firms which operate their business in July 2014 and survive to June 2016. For each of these four variables, the mean is distinctly larger than the median (P50), and the standard deviation is very large compared to the mean. Therefore, in order to reduce the effects of extreme values on the results, especially in higher percentiles, observations of the higher and lower five percentiles of the four variables are deleted from the data in the following analyses.

Table 2: Summary statistics of upstream seller firms

	# obs.	Mean	S.D.	P1	P5	P50	P95	P99
Manufacturing								
Ln value added per worker	84,422	1.474	0.736	−0.769	0.275	1.527	2.529	3.126
Ln number of buyers	84,422	1.124	0.770	0.000	0.000	1.099	2.303	2.639
Ln average distance	84,422	4.093	1.696	−1.176	1.144	4.492	6.236	6.754
Ln average of buyers' sales	84,422	3.183	2.465	−2.408	−0.995	3.288	6.907	7.785
Closure	84,422	0.082	0.274	0	0	0	1	1
D (number of workers)	77,505	0.025	0.593	−0.688	−0.444	0.000	0.541	1.333
D (sales per workers)	77,505	0.328	39.039	−0.745	−0.471	0.033	1.006	2.646
D (wages per workers)	77,505	0.352	48.051	−0.867	−0.627	−0.037	1.161	4.001
D (value added per workers)	77,505	0.702	32.780	−1.363	−0.751	0.025	2.198	7.654
Wholesale & retail								
Ln value added per worker	74,505	1.621	0.806	−0.654	0.337	1.635	2.874	3.662
Ln number of buyers	74,505	1.144	0.788	0.000	0.000	1.099	2.398	2.708
Ln average distance	74,505	3.610	1.940	−2.303	0.265	3.834	6.216	6.827
Ln average of buyers' sales	74,505	2.914	2.686	−3.065	−1.691	3.165	6.864	7.820
Closure	74,505	0.091	0.288	0	0	0	1	1
D (number of workers)	67,723	0.033	1.016	−0.714	−0.500	0.000	0.667	1.667
D (sales per workers)	67,723	0.295	11.855	−0.797	−0.525	0.016	1.128	3.533
D (wages per workers)	67,723	0.335	15.248	−0.909	−0.678	−0.047	1.291	6.859
D (value added per workers)	67,723	0.593	28.576	−1.422	−0.808	−0.013	2.530	8.649
Other industries								
Ln value added per worker	253,667	1.363	0.809	−1.096	0.016	1.423	2.512	3.315
Ln number of buyers	253,667	0.991	0.736	0.000	0.000	1.099	2.197	2.485
Ln average distance	253,667	3.320	1.826	−2.303	0.514	3.172	6.189	6.798
Ln average of buyers' sales	253,667	3.005	2.918	−3.270	−1.877	3.231	7.125	9.342
Closure	253,667	0.077	0.267	0	0	0	1	1
D (number of workers)	234,111	0.065	0.968	−0.750	−0.500	0.000	0.833	2.167
D (sales per workers)	234,111	0.479	19.665	−0.819	−0.552	0.097	1.772	4.992
D (wages per workers)	234,111	0.530	15.377	−0.919	−0.736	−0.015	2.169	8.570
D (value added per workers)	234,111	1.021	37.588	−1.368	−0.769	0.102	3.371	11.568

Notes: This table shows summary statistics for four variables used in the logit estimation of the propensity score as independent variables and five variables of outcome, of which the difference between the treatment and control groups are of interest. "Ln (variable)" means the logarithm of the variable in February 2012. Closure equals one if the seller firm stops operation between July 2014 and June 2016. "D (variable)" represents the rate of change of the variable from February 2012 to June 2016 for seller firms which survive from July 2014 to June 2016. Observations are on seller firm-level, and include all seller firms in the constructed dataset.

4 Indirect trade effects on upstream firms

4.1 Closure of seller firms

Table 3 summarizes the effect of trade shocks from downstream buyer firms on upstream seller firms in terms of the probability of their survival between July 2014 and June 2016. It is called the baseline result regarding firm closure. There are 12 combinations of cases for PSM: two cases of trade expansion (import and export) interacted with three types of seller industries (manufacturing, wholesale & retail, and others) and two types of buyer industries (manufactur-

ing and wholesale & retail).

All four of the variables employed to obtain propensity scores are assumed to have larger values for firms in the treatment group than those in the control group, for the following reasons: First, based on the finding that importing and exporting firms with higher capabilities tend to match with each other (the positive assortative matching described by Sugita et al., 2017) and that firms which start offshoring inputs from foreign suppliers displace the less productive domestic suppliers in the same industry (the direct displacement effect described by Furusawa et al., 2018), it is assumed that upstream seller firms with high value added per worker connect with buyer firms with high productivity, which are likely to conduct international economic transactions. Second, the more main buyers a seller has, the higher the probability that it will connect with import or export expansion firms. Third, accepting the premise that a buyer firm trading with foreign markets has a lower cost of communication with partners located further geographically, and regardless of whether they are foreign or domestic, an upstream firm selling goods to international firms tends to have a longer average distance than firms which only sell to domestic downstream firms. Forth, sales in importing and exporting firms are expected to be larger than those in domestic firms, based on the finding in Bernard et al. (2007) for manufacturing in the United States. Table 3 states that all four independent variables are larger in the treatment group in all 12 cases.

Table 3 reports the average treatment effect on the treated (ATT). ATT is the average difference between the outcomes of the matched pairs of firms. It is demonstrated in the table that neither import expansion shock nor export expansion shock from downstream buyer firms have a statistically significant effect on the probability of upstream seller firm closure in any of 12 the cases, except the case of import shock from import expansion manufacturing firms to seller firms in other industries. In this case, ATT is positive, meaning the increase of probability to close, and the coefficient is significant at the 95 percent level.[8]

[8]The upstream trade impacts from downstream manufacturing industry and from wholesale and retail industries do not show distinctive differences from each other, both in imports and exports. For the export side, it may reflect carry-along trade (Bernard et al., 2019) conducted by Japanese manufacturing firms, which causes trade shocks from the two groups of firms to resemble each other.

Table 3: Trade shocks on closure in upstream firms

Trade shock	Import expansion						Export expansion					
Upstream sellers	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others
Downstream buyers	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.
Difference of dep. var.												
Unmatched	-0.019^{*}	-0.004	0.031^{**}	0.014	0.024^{**}	0.023^{*}	-0.021^{*}	0.025	-0.008	0.007	-0.009	0.016
(Std. err.)	(0.010)	(0.013)	(0.015)	(0.013)	(0.012)	(0.012)	(0.011)	(0.016)	(0.016)	(0.020)	(0.011)	(0.017)
ATT	-0.022	-0.016	0.041^{*}	0.015	0.036^{**}	-0.002	-0.014	0.017	0	0.019	-0.013	0.043^{*}
(Std. err.)	(0.014)	(0.018)	(0.023)	(0.019)	(0.017)	(0.020)	(0.014)	(0.025)	(0.021)	(0.027)	(0.015)	(0.024)
# treated	727	493	345	460	497	452	643	296	336	210	607	231
# untreated	32,444	32,444	42,514	42,514	203,263	203,263	32,444	32,444	42,514	42,514	203,263	203,263
Likelihood to switch												
Ln value added per worker	0.087^{*}	-0.025	0.169^{**}	0.042	0.127^{**}	0.104^{*}	0.034	-0.050	0.326^{***}	0.115	0.139^{***}	0.082
(Std. err.)	(0.052)	(0.062)	(0.072)	(0.061)	(0.059)	(0.062)	(0.059)	(0.086)	(0.075)	(0.094)	(0.058)	(0.092)
Ln number of buyers	0.484^{***}	0.730^{***}	0.574^{***}	0.543^{***}	0.632^{***}	0.631^{***}	0.364^{***}	0.955^{***}	0.515^{***}	0.481^{***}	0.585^{***}	0.631^{***}
(Std. err.)	(0.056)	(0.067)	(0.074)	(0.064)	(0.064)	(0.067)	(0.059)	(0.086)	(0.075)	(0.094)	(0.058)	(0.092)
Ln average distance	0.061^{***}	0.346^{***}	0.217^{***}	0.391^{***}	0.262^{***}	0.341^{***}	0.080^{***}	0.363^{***}	0.131^{***}	0.360^{***}	0.197^{***}	0.439^{***}
(Std. err.)	(0.023)	(0.032)	(0.033)	(0.032)	(0.031)	(0.032)	(0.024)	(0.045)	(0.033)	(0.046)	(0.027)	(0.046)
Ln ave. of buyers' sales	0.038^{**}	0.108^{***}	-0.019	0.109^{***}	-0.073^{***}	-0.027	0.062^{***}	0.271^{***}	0.069^{***}	0.171^{***}	-0.005	-0.025
(Std. err.)	(0.016)	(0.019)	(0.023)	(0.019)	(0.018)	(0.019)	(0.017)	(0.026)	(0.023)	(0.029)	(0.016)	(0.026)
Pseudo R^2	0.018	0.080	0.036	0.080	0.030	0.040	0.015	0.141	0.035	0.077	0.025	0.049
Log likelihood	$-3{,}433$	$-2{,}356$	$-1{,}935$	$-2{,}340$	$-3{,}382$	$-3{,}085$	$-3{,}123$	$-1{,}450$	$-1{,}895$	$-1{,}223$	$-4{,}032$	$-1{,}709$

Table 3 *continued*

Balance												
Ln value added per worker												
Treated	1.422	1.387	1.675	1.609	1.422	1.427	1.390	1.401	1.758	1.647	1.435	1.425
Control												
Unmatched	1.343	1.343	1.515	1.515	1.317	1.317	1.343	1.343	1.515	1.515	1.317	1.317
(*t*-test)	(2.75)	(1.27)	(3.73)	(2.52)	(2.89)	(2.90)	(1.53)	(1.31)	(5.61)	(2.41)	(3.60)	(2.03)
Matched	1.421	1.440	1.564	1.535	1.461	1.374	1.367	1.352	1.709	1.572	1.444	1.439
(*t*-test)	(0.02)	(−1.06)	(1.93)	(1.38)	(−0.85)	(1.00)	(0.53)	(0.78)	(0.94)	(1.01)	(−0.20)	(−0.20)
Ln number of buyers												
Treated	0.983	1.178	1.253	1.260	1.242	1.260	0.933	1.333	1.227	1.230	1.223	1.264
Control												
Unmatched	0.718	0.718	0.865	0.865	0.884	0.884	0.718	0.718	0.865	0.865	0.884	0.884
(*t*-test)	(10.59)	(15.20)	(9.79)	(11.50)	(11.39)	(11.38)	(8.10)	(15.79)	(9.00)	(7.20)	(11.92)	(8.24)
Matched	0.976	1.159	1.255	1.257	1.221	1.290	0.945	1.287	1.249	1.238	1.216	1.270
(*t*-test)	(0.21)	(0.45)	(−0.04)	(0.07)	(0.48)	(−0.63)	(−0.32)	(0.85)	(−0.43)	(−0.12)	(0.19)	(−0.09)
Ln average distance												
Treated	3.776	4.623	3.834	4.480	3.799	4.093	3.823	4.813	3.702	4.481	3.747	4.341
Control												
Unmatched	3.379	3.379	2.937	2.937	3.035	3.035	3.379	3.379	2.937	2.937	3.035	3.035
(*t*-test)	(5.57)	(14.41)	(8.33)	(16.53)	(9.49)	(12.54)	(5.86)	(12.89)	(7.01)	(11.19)	(9.77)	(11.07)
Matched	3.832	4.694	3.909	4.492	3.883	4.061	3.867	4.738	3.665	4.440	3.763	4.342
(*t*-test)	(−0.65)	(−0.74)	(−0.59)	(−0.13)	(−0.80)	(0.30)	(−0.48)	(0.65)	(0.28)	(0.25)	(−0.17)	(−0.00)
Ln ave. of buyers' sales												
Treated	1.948	2.705	2.032	3.108	2.679	3.186	2.064	3.741	2.475	3.470	3.083	3.375
Control												
Unmatched	1.512	1.512	1.708	1.708	2.597	2.597	1.512	1.512	1.708	1.708	2.597	2.597
(*t*-test)	(4.91)	(11.05)	(2.28)	(11.36)	(0.61)	(4.15)	(5.84)	(16.03)	(5.32)	(9.67)	(3.97)	(3.92)
Matched	1.951	2.622	1.975	3.107	2.863	3.282	1.952	3.997	2.609	3.585	3.095	3.589
(*t*-test)	(−0.03)	(0.62)	(0.36)	(0.01)	(−1.22)	(−0.64)	(1.01)	(−1.53)	(−0.78)	(−0.57)	(−0.09)	(−1.03)

Notes: This table summarizes PSM results as well as those of the logit estimation of the propensity score and the balance of its independent variables before and after matching. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

Estimation results of the likelihood to switch and ATT using datasets of partially different observations are presented in Table 4. There are four sets of supplementary analyses, reported in Panels 1 to 4. Panel 1 reflects the case when the buyer-seller dataset is constructed not only from sellers' choice of their main buyers, as in the base analysis, but also from buyers' choice of their main sellers. Though the inclusive buyer-seller dataset has 4.9 million observations, and is about 80 percent larger than the dataset of only main buyers reported by sellers, the number of firms used for PSM is at most 40 percent larger than the base analysis, which is the case of seller firms in wholesale and retail industries. The logit estimation of the propensity score has similar results to the baseline result, and ATT is not statistically significant in all cases, except the case of import shock from import expansion wholesale and retail firms to seller firms in other industries, whose coefficient is significant at the 95 percent level.

Panels 2 and 3 are cases where seller firms having seemingly less trade shocks from downstream firms are deleted from the original treatment group used in the base analysis. The criteria for selecting seller firms in the treatment group are that, in each seller firm, its domestic buyer firms account for two thirds or a smaller ratio among all its main buyer firms. That is the sum of domestic firms and import or export expansion firms, as indicated in the number of firms for Panel 2 and of the sales of firms for Panel 3. They are examined to address the concern that having some seller firms which trade mainly with domestic buyers in the treatment group would weaken ATT in Table 3.

There is one ATT which has statistical significance at the 99 percent level: the import impact of downstream buyer firms in manufacturing industry on the closure of manufacturing firms in Panel 2. This panel reflects the case where each seller firm meets the criterion that its domestic buyer firms account for two thirds or less among all its main buyer firms in terms of the number for firms. However, when I use the criterion with respect to the sales of firms, the significance decreases to the 90 percent level in Panel 3. Therefore, I conclude that there is no systematic difference from the baseline results.

Table 4: Supplementary analyses for closure in upstream firms

Trade shock	Import expansion						Export expansion					
Upstream sellers	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others
Downstream buyers	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.
Panel 1. Seller firms in inclusive buyer-seller dataset												
Difference of dep. var.												
Unmatched	−0.019*	−0.004	0.024	0.017	0.023**	0.020*	−0.017	0.024	−0.003	0.013	−0.012	0.015
(Std. err.)	(0.010)	(0.013)	(0.015)	(0.013)	(0.012)	(0.012)	(0.011)	(0.016)	(0.015)	(0.020)	(0.011)	(0.017)
ATT	−0.013	−0.020	0.008	0.027	0.030*	0.039**	−0.020	0.007	−0.017	0.038	−0.008	−0.026
(Std. err.)	(0.013)	(0.019)	(0.023)	(0.019)	(0.017)	(0.018)	(0.015)	(0.026)	(0.022)	(0.027)	(0.014)	(0.028)
# treated	748	494	379	482	506	459	666	290	356	210	619	232
# untreated	37,779	37,779	60,372	60,372	214,417	214,417	37,779	37,779	60,372	60,372	214,417	214,417
Likelihood to switch												
Ln value added per worker	0.042	−0.065	0.201***	0.031	0.087	0.074	0.047	−0.050	0.280***	0.151*	0.124*	0.049
(Std. err.)	(0.051)	(0.061)	(0.068)	(0.060)	(0.057)	(0.060)	(0.053)	(0.082)	(0.071)	(0.091)	(0.052)	(0.084)
Ln number of buyers	0.401***	0.598***	0.390***	0.510***	0.615***	0.629**	0.248***	0.758***	0.417***	0.459***	0.570***	0.620***
(Std. err.)	(0.044)	(0.052)	(0.045)	(0.041)	(0.057)	(0.059)	(0.048)	(0.068)	(0.047)	(0.064)	(0.052)	(0.082)
Ln average distance	0.054**	0.326***	0.231***	0.431***	0.240***	0.344***	0.065***	0.389***	0.117***	0.331***	0.193***	0.414***
(Std. err.)	(0.023)	(0.033)	(0.033)	(0.032)	(0.030)	(0.032)	(0.024)	(0.047)	(0.033)	(0.047)	(0.027)	(0.045)
Ln ave. of buyers' sales	0.112***	0.179***	0.123***	0.210***	−0.036**	−0.002	0.137***	0.332***	0.186***	0.279***	0.021	0.013
(Std. err.)	(0.015)	(0.018)	(0.019)	(0.017)	(0.017)	(0.018)	(0.015)	(0.024)	(0.019)	(0.026)	(0.015)	(0.025)
Pseudo R^2	0.025	0.085	0.050	0.112	0.030	0.044	0.022	0.151	0.055	0.103	0.028	0.050
Log likelihood	−3,596	−2,415	−2,186	−2,496	−3,459	−3,136	−3,288	−1,445	−2,065	−1,254	−4,121	−1,726
Panel 2. Seller firms where domestic buyer firms account for 2/3 or less of the total number of their main partners												
Difference of dep. var.												
Unmatched	−0.026**	0.010	0.015	0.018	0.021	0.002	−0.003	0.034	0.012	0.027	0.002	0.037
(Std. err.)	(0.013)	(0.017)	(0.022)	(0.020)	(0.017)	(0.018)	(0.013)	(0.025)	(0.022)	(0.028)	(0.015)	(0.025)
ATT	−0.048***	0.008	0.029	0.010	0.021	−0.005	0.018	0.055	0.024	0	−0.017	0.009
(Std. err.)	(0.018)	(0.025)	(0.031)	(0.030)	(0.025)	(0.026)	(0.017)	(0.036)	(0.031)	(0.045)	(0.023)	(0.042)
# treated	484	256	174	208	242	209	436	128	170	104	289	108
# untreated	32,444	32,444	42,514	42,514	203,263	203,263	32,444	32,444	42,514	42,514	203,263	203,263
Likelihood to switch												
Ln value added per worker	0.076	0.069	0.083	0.007	0.153*	0.043	−0.005	−0.056	0.281***	0.169	0.093	0.048
(Std. err.)	(0.062)	(0.085)	(0.096)	(0.086)	(0.082)	(0.087)	(0.063)	(0.116)	(0.098)	(0.125)	(0.075)	(0.122)
Ln number of buyers	−0.297***	−0.291***	−0.478***	−0.632***	−0.520***	−0.660***	−0.418***	−0.209	−0.599***	−0.594***	−0.580***	−0.638***
(Std. err.)	(0.073)	(0.096)	(0.112)	(0.105)	(0.097)	(0.107)	(0.079)	(0.131)	(0.116)	(0.146)	(0.090)	(0.147)
Ln average distance	0.055**	0.307***	0.262***	0.315***	0.264***	0.284***	0.060**	0.297***	0.164***	0.251***	0.190***	0.383***
(Std. err.)	(0.025)	(0.039)	(0.041)	(0.039)	(0.038)	(0.041)	(0.027)	(0.057)	(0.040)	(0.054)	(0.034)	(0.058)
Ln ave. of buyers' sales	0.066***	0.130***	−0.010	0.109***	−0.081***	−0.014	0.100***	0.243***	0.085***	0.201***	−0.015	0.005
(Std. err.)	(0.019)	(0.025)	(0.029)	(0.026)	(0.022)	(0.024)	(0.020)	(0.035)	(0.029)	(0.037)	(0.020)	(0.033)
Pseudo R^2	0.006	0.039	0.025	0.055	0.020	0.027	0.012	0.060	0.028	0.060	0.016	0.039
Log likelihood	−2,507	−1,438	−1,103	−1,243	−1,833	−1,603	−2,290	−787	−1,078	−686	−2,149	−887

Table 4 *continued*

Panel 3. Seller firms where domestic buyer firms account for 2/3 or less of the total sales of their main partners												
Difference of dep. var.												
Unmatched	−0.013	0.002	0.046**	0.010	0.011	0.006	−0.019	0.026	0.012	0.018	−0.016	0.029
(Std. err.)	(0.013)	(0.015)	(0.020)	(0.017)	(0.016)	(0.017)	(0.013)	(0.022)	(0.020)	(0.024)	(0.015)	(0.023)
ATT	−0.031*	0.003	0.054*	−0.029	0.035	−0.016	−0.015	0.058	0.05*	0.007	−0.029	0.044
(Std. err.)	(0.018)	(0.022)	(0.031)	(0.027)	(0.022)	(0.025)	(0.017)	(0.031)	(0.026)	(0.036)	(0.021)	(0.033)
# treated	481	328	202	275	257	249	465	156	200	141	310	135
# untreated	32,444	32,444	42,514	42,514	203,263	203,263	32,444	32,444	42,514	42,514	203,263	203,263
Likelihood to switch												
Ln value added per worker	0.098	−0.076	0.123	0.012	0.130	0.114	−0.003	−0.077	0.325***	0.027	0.150	0.032
(Std. err.)	(0.063)	(0.073)	(0.091)	(0.077)	(0.081)	(0.082)	(0.062)	(0.105)	(0.092)	(0.108)	(0.073)	(0.110)
Ln number of buyers	0.042	0.389***	0.059	0.072	−0.028	−0.062	−0.033	0.309***	0.006	0.149	−0.151*	0.135
(Std. err.)	(0.071)	(0.081)	(0.097)	(0.083)	(0.090)	(0.090)	(0.072)	(0.115)	(0.098)	(0.114)	(0.082)	(0.120)
Ln average distance	0.034	0.291***	0.257***	0.363***	0.262***	0.327***	0.073***	0.319***	0.139***	0.323***	0.210***	0.460***
(Std. err.)	(0.026)	(0.037)	(0.040)	(0.037)	(0.039)	(0.040)	(0.027)	(0.055)	(0.040)	(0.052)	(0.035)	(0.057)
Ln ave. of buyers' sales	−0.009	0.063***	−0.086***	0.041*	−0.154***	−0.087***	0.041*	0.187***	0.023	0.128***	−0.071***	−0.087***
(Std. err.)	(0.020)	(0.023)	(0.028)	(0.024)	(0.023)	(0.023)	(0.020)	(0.033)	(0.028)	(0.034)	(0.020)	(0.032)
Pseudo R^2	0.001	0.038	0.019	0.042	0.017	0.019	0.003	0.057	0.012	0.046	0.010	0.033
Log likelihood	−2,508	−1,767	−1,259	−1,592	−1,938	−1,883	−2,435	−932	−1,257	−902	−2,299	−1,086
Panel 4. Seller firms which are connected with *the METI data*												
Difference of dep. var.												
Unmatched	−0.015	−0.000	0.026	0.009	0.021*	0.019	−0.017	0.029*	−0.013	0.002	−0.012	0.013
(Std. err.)	(0.010)	(0.013)	(0.016)	(0.014)	(0.012)	(0.013)	(0.011)	(0.016)	(0.016)	(0.020)	(0.011)	(0.018)
ATT	−0.001	−0.002	0.043*	0.009	0.002	0.040**	−0.022	0.027	0	0.052**	−0.016	−0.013
(Std. err.)	(0.014)	(0.017)	(0.023)	(0.020)	(0.019)	(0.018)	(0.015)	(0.025)	(0.021)	(0.025)	(0.015)	(0.028)
# treated	727	493	345	460	497	452	643	296	336	210	607	231
# untreated	8,719	8,719	10,093	10,093	21,069	21,069	8,719	8,719	10,093	10,093	21,069	21,069
Likelihood to switch												
Ln value added per worker	0.093*	0.004	0.206***	0.079	0.037	0.017	0.042	0.007	0.365***	0.153*	0.036	0.004
(Std. err.)	(0.055)	(0.064)	(0.074)	(0.063)	(0.059)	(0.061)	(0.056)	(0.084)	(0.074)	(0.091)	(0.053)	(0.084)
Ln number of buyers	−0.038	0.257***	0.073	0.117*	0.043	0.016	−0.164***	0.543***	0.057	0.069	−0.016	0.000
(Std. err.)	(0.061)	(0.072)	(0.082)	(0.071)	(0.066)	(0.068)	(0.064)	(0.093)	(0.082)	(0.102)	(0.059)	(0.094)
Ln average distance	0.042*	0.344***	0.132***	0.317***	0.079***	0.147***	0.064**	0.341***	0.041	0.282***	0.007	0.243***
(Std. err.)	(0.025)	(0.035)	(0.035)	(0.034)	(0.031)	(0.033)	(0.026)	(0.049)	(0.035)	(0.049)	(0.027)	(0.047)
Ln ave. of buyers' sales	−0.227***	−0.028	−0.315***	0.012	−0.173***	−0.032	−0.184***	0.253***	−0.136***	0.130***	−0.021	0.001
(Std. err.)	(0.025)	(0.026)	(0.035)	(0.028)	(0.028)	(0.028)	(0.026)	(0.032)	(0.034)	(0.040)	(0.024)	(0.040)
Pseudo R^2	0.018	0.037	0.034	0.031	0.009	0.005	0.013	0.087	0.015	0.032	0.000	0.013
Log likelihood	−2,516	−1,852	−1,464	−1,833	−2,345	−2,183	−2,312	−1,189	−1,463	−992	−2,768	−1,259

Notes: This table summarizes PSM results as well as those of the logit estimation of the propensity score. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Lastly, Panel 4 uses only upstream seller firms which are connected with *the METI survey*. This is to meet two potential issues concerning the choice of seller firms in the control group. First, part of the difference of independent variables for PSM between treatment and control groups reflects the different characteristics of the two groups of seller firms in terms of the size of their main buyers, and using PSM only may not be sufficient to control them. All seller firms in the treatment group are able to have a buyer-seller relationship with buyer firms large enough to be targets of *the METI survey* in the first place. Therefore, they possibly have some corporate strength to conduct business with such relatively large downstream buyers. Second, in the process of constructing the dataset for the present analysis, seller firms which are not connected with *the METI survey* are classified as firms in the control group. This may be a one-sided judgement, which would result in a smaller-than-actual ratio of seller firms in the treatment group than in the control group. In order to control these aspects, I use only seller firms which are connected with firms in *the METI survey* in the treatment or control groups. The ATT result shows that there is only two cases whose coefficient is statistically significant at the 95 percent level.

In sum, the ATT results in Panels 1 to 4 neither show similarity with each other in respect of ATT with some statistical significance nor any systematic difference from the base analysis. The results of the supplementary analyses do not support a conclusion that the effect of trade shocks from downstream buyer firms have an observable effect on the probability of business closure in upstream seller firms.

4.2 Other variables of seller firms

Similar to the statistical insignificance of trade shocks on firms' closure, the estimated ATT concerning trade shocks from downstream buyer firms on the number of workers in upstream seller firms is also statistically insignificant, as reported in Table 5. The variable of interest is the rate of change in the number of workers in each seller firm from February 2012 to June 2016.

Panel 1 is the results of the base analysis, using the same dataset and independent variables for the propensity score estimation as those in Table 3, except that observations of the change in

the number of workers at or higher than the 96 percentile and at or lower than the 5 percentile are deleted. There is no estimate of ATT with statistical significance of the 95 percent level or higher. Panels 2–5 correspond to the cases of Panels 1–4 in Table 4 with respect to the dataset. Again, there are few statistically significant results of ATT. There is one ATT which has statistical significance at the 99 percent level: the export impact of downstream buyer firms in wholesale and retail industries on the number of workers in firms in other industries in Panel 3. This panel reflects the case where each seller firm meets the criterion that its domestic buyer firms account for two thirds or less among all its main buyer firms in terms of the number for firms. However, when I use the criterion with respect to the sales of firms, it becomes insignificant in Panel 4. Therefore, I conclude that there is no systematic or stable trade effects from downstream buyer firms to upstream seller firms regarding the number of workers.

Lastly, trade impact on sales, wage, and value added per worker in upstream seller firms is summarized in Panels 1–3 of Table 6, respectively. These results use the same independent variables for propensity score estimation, the same dataset, and the same criteria of trimming seller firms as the baseline analysis in Panel 1 of Table 5 for the number of workers.

It is noteworthy that export expansion firms in wholesale and retail industries have a negative effect on upstream manufacturing firms in respect of sales per worker at the 95 percent significance level and value added per worker at the 99 percent significance level. The possible story behind this result is that wholesale and retail firms have developed their intra-firm manufacturing section and start exporting their own products. In other cases, however, both ATT and the unmatched results show little statistical significance, which supports the conclusion that, on average, there are little trade effects on business performance variables in upper seller firms.

Table 5: Trade shocks on the number of workers in upstream firms

Trade shock			Import expansion						Export expansion			
Upstream Sellers	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others
Downstream buyers	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.
Panel 1. Baseline analysis												
Unmatched	0.014	−0.009	0.019	0.010	0.000	0.024*	0.000	0.023*	0.011	−0.010	0.007	0.011
(Std. err.)	(0.009)	(0.010)	(0.013)	(0.011)	(0.013)	(0.013)	(0.009)	(0.013)	(0.013)	(0.017)	(0.011)	(0.019)
ATT	0.017	0.003	0.026	−0.012	−0.024	−0.004	0.015	0.013	−0.012	0.018	−0.028**	−0.018
(Std. err.)	(0.012)	(0.015)	(0.019)	(0.017)	(0.017)	(0.020)	(0.013)	(0.018)	(0.019)	(0.023)	(0.016)	(0.024)
# treated	606	412	274	373	400	357	552	253	284	169	518	179
# untreated	26,680	26,668	34,456	34,456	164,145	164,148	26,668	26,668	34,456	34,456	164,145	164,152
Panel 2. Seller firms in inclusive buyer-seller dataset												
Unmatched	0.013	−0.011	0.021*	0.010	−0.001	0.026**	−0.001	0.024*	0.014	−0.011	0.011	0.015
(Std. err.)	(0.008)	(0.010)	(0.013)	(0.011)	(0.012)	(0.013)	(0.009)	(0.013)	(0.013)	(0.017)	(0.011)	(0.019)
ATT	0.005	−0.002	0.017	0.004	0.026	0.019	−0.002	0.023	−0.024	−0.002	−0.001	0.021
(Std. err.)	(0.012)	(0.014)	(0.017)	(0.016)	(0.016)	(0.019)	(0.012)	(0.018)	(0.018)	(0.021)	(0.016)	(0.026)
# treated	625	413	302	387	407	364	573	248	296	167	532	180
# untreated	31,077	31,077	49,068	49,068	172,961	172,961	31,077	31,077	49,068	49,068	172,961	172,961
Panel 3. Seller firms where domestic buyer firms account for 2/3 or less of the total number of their main partners												
Unmatched	0.006	−0.032**	0.010	−0.009	−0.016	0.035*	−0.003	0.001	0.005	−0.027	−0.020	0.035
(Std. err.)	(0.011)	(0.014)	(0.019)	(0.017)	(0.018)	(0.020)	(0.011)	(0.020)	(0.019)	(0.025)	(0.016)	(0.028)
ATT	0.005	−0.013	0.024	−0.028	−0.041	0.006	0.007	0.023	0.001	−0.026	−0.002	0.090**
(Std. err.)	(0.015)	(0.021)	(0.026)	(0.028)	(0.025)	(0.029)	(0.016)	(0.029)	(0.027)	(0.034)	(0.022)	(0.039)
# treated	396	211	134	162	190	164	363	107	137	78	245	80
# untreated	26,680	26,668	34,456	34,456	164,148	164,148	26,668	26,668	34,456	34,456	164,145	164,153
Panel 4. Seller firms where domestic buyer firms account for 2/3 or less of the total sales of their main partners												
Unmatched	0.007	−0.016	0.002	0.007	−0.019	0.037**	0.000	0.016	0.003	−0.028	−0.011	0.032
(Std. err.)	(0.011)	(0.013)	(0.018)	(0.015)	(0.018)	(0.018)	(0.011)	(0.018)	(0.017)	(0.021)	(0.016)	(0.025)
ATT	−0.003	−0.015	−0.012	−0.008	−0.064	−0.010	0.006	−0.012	−0.009	−0.040	−0.030	−0.000
(Std. err.)	(0.015)	(0.018)	(0.023)	(0.023)	(0.025)	(0.027)	(0.015)	(0.026)	(0.024)	(0.031)	(0.022)	(0.035)
# treated	397	272	151	217	200	192	397	134	160	110	258	100
# untreated	26,680	26,668	34,456	34,456	164,149	164,152	26,668	26,668	34,456	34,456	164,148	164,150
Panel 5. Seller firms which are connected with *the METI survey*												
Unmatched	0.013	−0.003	0.017	0.010	−0.007	0.017	0.002	0.025*	0.014	−0.005	−0.002	−0.000
(Std. err.)	(0.008)	(0.010)	(0.013)	(0.011)	(0.012)	(0.013)	(0.009)	(0.013)	(0.013)	(0.016)	(0.011)	(0.018)
ATT	0.022*	−0.022	0.004	0.003	−0.031*	0.002	−0.002	0.039**	0.026	−0.029	0.008	−0.016
(Std. err.)	(0.012)	(0.014)	(0.018)	(0.017)	(0.017)	(0.019)	(0.012)	(0.019)	(0.017)	(0.023)	(0.015)	(0.025)
# treated	603	407	271	370	399	357	546	249	283	169	515	178
# untreated	7,230	7,225	8,146	8,147	17,186	17,223	7,219	7,184	8,146	8,146	17,184	17,223

Notes: This table summarizes PSM results. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: Trade shocks on sales, wage, and value added per worker in upstream firms

Trade shock			Import expansion						Export expansion			
Upstream sellers	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others	Mfg.	Mfg.	W. & R.	W. & R.	Others	Others
Downstream buyers	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.	Mfg.	W. & R.
Panel 1. Sales per worker												
Unmatched	−0.005	0.014	−0.004	−0.001	0.017	−0.023	0.022	−0.007	0.001	0.011	−0.039*	0.036
(Std. err.)	(0.013)	(0.016)	(0.020)	(0.017)	(0.023)	(0.024)	(0.013)	(0.020)	(0.020)	(0.025)	(0.021)	(0.035)
ATT	−0.001	0.006	0.004	−0.001	−0.028	−0.049	0.025	−0.064**	−0.024	0.005	−0.046*	0.009
(Std. err.)	(0.017)	(0.022)	(0.026)	(0.024)	(0.033)	(0.034)	(0.019)	(0.027)	(0.028)	(0.035)	(0.027)	(0.047)
# treated	618	410	278	373	412	379	557	251	281	167	527	186
# untreated	26,760	26,764	34,889	34,891	169,299	169,296	26,750	26,751	34,891	34,897	169,287	169,311
Panel 2. Wage per worker												
Unmatched	−0.007	0.025	−0.013	−0.018	−0.012	−0.038	0.016	−0.001	−0.005	−0.020	−0.003	0.053
(Std. err.)	(0.014)	(0.017)	(0.022)	(0.019)	(0.027)	(0.028)	(0.015)	(0.023)	(0.022)	(0.028)	(0.024)	(0.040)
ATT	0.007	0.058**	0.003	−0.034	−0.045	−0.060	0.005	0.011	0.040	−0.021	0.053	0.005
(Std. err.)	(0.019)	(0.024)	(0.030)	(0.026)	(0.037)	(0.037)	(0.022)	(0.032)	(0.029)	(0.036)	(0.032)	(0.057)
# treated	624	412	276	374	402	383	540	238	276	175	515	188
# untreated	26,753	26,762	34,891	34,890	169,309	169,292	26,767	26,764	34,896	34,889	169,303	169,309
Panel 3. Value added per worker												
Unmatched	−0.042*	−0.001	−0.022	−0.053	−0.006	−0.028	−0.014	−0.068*	−0.006	0.004	−0.021	0.003
(Std. err.)	(0.024)	(0.030)	(0.040)	(0.034)	(0.040)	(0.041)	(0.026)	(0.038)	(0.038)	(0.049)	(0.035)	(0.058)
ATT	−0.031	0.011	0.033	−0.057	−0.009	−0.027	−0.021	−0.160***	0.023	−0.044	−0.042	0.076
(Std. err.)	(0.032)	(0.041)	(0.048)	(0.045)	(0.056)	(0.057)	(0.035)	(0.052)	(0.052)	(0.066)	(0.051)	(0.072)
# treated	611	405	263	361	405	376	552	244	279	169	513	190
# untreated	26,767	26,769	34,904	34,903	169,306	169,306	26,755	26,758	34,893	34,895	169,305	169,307

Notes: This table summarizes PSM results. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5 Direct trade effects on downstream firms

The previous section concludes that little robust trade effects are evident from downstream buyer firms on business activities in upstream seller firms. This probably stems from the fact that trade shocks from buyer firms are weak in general or that positive and negative trade shocks to upstream seller firms are distributed randomly, with the average effect close to zero. There are some channels of trade effect propagation from downstream to upstream firms. First and foremost, the purchase of material and intermediate goods by buyer firms from seller firms is directly related to international trade by buyer firms, and the relationship between international and domestic trades is more complex than just a substitute or complement, as Furusawa et al. (2018) clarified. Similarly, trade-inducing alteration in the size of buyer firms with respect to the number of workers or sales possibly changes the volume of their business transaction with upstream seller firms. In addition, the increase of buyer firms' productivity induced by their international trade may permeate to seller firms through buyer-seller linkages. Based on the findings in the previous section, it is expected that international trade conducted by downstream buyer firms has little effect on their purchase from seller firms. This section examines this aspect by applying a PSM-DID method to downstream buyer firms. Additionally, trade effects on buyer firms' productivity and other business performance variables are investigated as supplementary analyses.

Table 7 reports the descriptive statistics of the variables used in the estimation regarding downstream buyer firms. Three variables are used for the logit estimation of the propensity score of increasing import or export by buyer firms: the number of workers, fixed assets per worker, and total factor productivity (TFP), all in logarithm to 2011. TFP is calculated by the Levinsohn–Petrin approach. I use the purchase of material and intermediate goods as a proxy for unobserved productivity shocks. All three variables are expected to have a positive effect on the logit estimation, especially in the manufacturing sector, similar to the observations of Bernard et al. (2007), Mayer and Ottaviano (2008), and Wakasugi et al. (2014). Table 2 also reports the descriptive statistics of six variables, the rate of their changes between 2011 and 2015 being applied in the DID: domestic purchase, TFP, the number of workers, sales per worker, wage per worker, value added per worker, all from *the METI survey*. Domestic purchase by a

Table 7: Summary statistics of downstream buyer firms

	# of obs.	Mean	S.D.	P1	P5	P50	P95	P99
Manufacturing								
Ln number of workers	5,598	4.959	0.754	3.970	4.060	4.804	6.415	7.390
Ln fixed asset per worker	5,590	2.112	1.022	−1.133	0.338	2.228	3.519	4.292
Ln TFP	5,558	15.440	0.531	14.026	14.589	15.439	16.295	16.768
D (domestic purchase)	5,598	−0.036	0.529	−1.743	−0.982	−0.014	0.817	1.671
D (TFP)	5,541	0.008	0.364	−0.953	−0.487	−0.008	0.568	1.187
D (number of workers)	5,598	0.028	0.221	−0.389	−0.228	0.008	0.331	0.756
D (sales per worker)	5,598	0.039	0.511	−0.476	−0.297	−0.003	0.447	1.076
D (wages per worker)	5,598	0.084	1.080	−0.597	−0.273	−0.006	0.472	2.468
D (value added per worker)	5,598	0.040	0.598	−0.524	−0.323	−0.011	0.532	1.377
Wholesale & retail								
Ln number of workers	4,935	5.234	1.003	3.951	4.078	4.990	7.196	8.380
Ln fixed asset per worker	4,933	2.003	1.095	−1.277	0.003	2.158	3.478	4.105
Ln TFP	4,908	15.467	0.488	14.259	14.706	15.460	16.251	16.681
D (domestic purchase)	4,935	−0.003	0.382	−1.239	−0.590	0.003	0.554	1.116
D (TFP)	4,890	−0.002	0.294	−0.830	−0.420	−0.005	0.424	0.885
D (number of workers)	4,935	0.069	0.446	−0.432	−0.238	0.018	0.433	1.254
D (sales per worker)	4,935	0.030	0.482	−0.528	−0.304	−0.004	0.401	0.915
D (wages per worker)	4,935	0.024	0.372	−0.553	−0.307	−0.011	0.369	1.281
D (value added per worker)	4,935	0.026	0.336	−0.489	−0.256	−0.001	0.341	0.941

Notes: This table shows summary statistics for three variables used in the logit estimation of the propensity score as independent variables and six variables of outcome between treatment and control groups, the difference of which are of interest. "Ln (variable)" means the logarithm of the variable in 2011. "D (variable)" represents the rate of change of the variable from 2011 to 2015. Observations are on the buyer firm-level.

downstream firm is defined as its purchase of material and intermediate goods from domestic suppliers, except from its associate firms. Similar to the method for seller firms, observations of the six variables belonging to the higher and lower five percentiles are deleted from the data in the following analyses.

Table 8 reports the PSM-DID results concerning trade shocks of import or export expansion on purchases from non-associated domestic firms. Manufacturing firms and wholesale and retail firms show different characteristics regarding the three variables used for the logit estimation of the propensity score. In terms of the number of workers, firms in the treatment group have more than firms in the control group in manufacturing industries, in contrast to the wholesale and retail industries. The fixed asset per worker is substantially larger in the treatment group in manufacturing industries, whereas it is similar between treatment and control groups in the wholesale and retail industries. TFP is larger in firms in the treatment group than those in the control group in all four cases.

Table 8 shows that firms' domestic purchase of intermediate and material goods from non-

Table 8: Trade effect on domestic purchase

Trade shock	Import expansion		Export expansion	
Industries	Mfg.	W. & R.	Mfg.	W. & R.
Difference of dep. var.				
Unmatched	−0.016	0.006	0.028*	0.015
(Std. err.)	(0.017)	(0.013)	(0.016)	(0.019)
ATT	0.007	0.009	0.012	−0.016
(Std. err.)	(0.023)	(0.017)	(0.023)	(0.027)
# treated	388	291	430	119
# untreated	4,188	4,007	4,188	4,003
Likelihood to switch				
Ln number of workers	0.135*	−0.361***	0.204***	−0.477***
(Std. err.)	(0.073)	(0.073)	(0.068)	(0.115)
Ln fixed asset per worker	0.127**	−0.028	0.287***	−0.084
(Std. err.)	(0.060)	(0.055)	(0.061)	(0.078)
Ln TFP	0.156	0.893***	0.505***	1.406***
(Std. err.)	(0.115)	(0.131)	(0.113)	(0.183)
Pseudo R^2	0.006	0.029	0.034	0.059
Log likelihood	−1,321	−1,034	−1,381	−507
Balance				
Ln number of workers				
Treated	5.038	5.023	5.142	4.991
Control				
Unmatched	4.940	5.247	4.940	5.249
(*t*-test)	2.47	−3.71	5.35	−2.77
Matched	5.046	5.067	5.114	4.925
(*t*-test)	−0.13	−0.60	0.48	0.63
Ln fixed asset per worker				
Treated	2.227	2.095	2.425	2.082
Control				
Unmatched	2.077	2.016	2.077	2.015
(*t*-test)	2.78	1.20	6.77	0.66
Matched	2.190	2.012	2.448	2.086
(*t*-test)	0.56	0.95	−0.40	−0.02
Ln TFP				
Treated	15.504	15.614	15.643	15.746
Control				
Unmatched	15.423	15.446	15.423	15.446
(*t*-test)	2.94	5.86	8.40	6.76
Matched	15.528	15.630	15.642	15.722
(*t*-test)	−0.61	−0.41	0.04	0.34

Notes: This table summarizes PSM results as well as those of the logit estimation of the propensity score and the balance of its independent variables before and after matching. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

associated firms do not change to a statistically significant extent, which is presumably one of the reasons why international trade by downstream firms does not have a sufficiently strong systematic effect to be observed in the business performance of upstream seller firms. More drastic change of firms' activity, such as firms' shutdown, would produce significant, observable effect

Table 9: Trade effect on other business outcomes

Trade shock	Import expansion		Export expansion	
Industries	Mfg.	W. & R.	Mfg.	W. & R.
Panel 1. TFP				
Unmatched	−0.001	−0.013	0.006	0.023
(Std. err.)	(0.011)	(0.010)	(0.011)	(0.016)
ATT	−0.012	0.006	0.025*	0.043*
(Std. err.)	(0.016)	(0.015)	(0.015)	(0.023)
# treated	379	289	423	114
# untreated	4,181	3,993	4,181	3,994
Panel 2. Number of workers				
Unmatched	0.020***	0.014*	0.018***	−0.007
(Std. err.)	(0.006)	(0.008)	(0.006)	(0.012)
ATT	0.022**	0.021*	0.016**	−0.008
(Std. err.)	(0.009)	(0.012)	(0.008)	(0.017)
# treated	387	296	432	119
# untreated	4,194	4,002	4,192	4,003
Panel 3. Sales per worker				
Unmatched	0.019**	0.010	−0.001	0.024*
(Std. err.)	(0.008)	(0.009)	(0.008)	(0.013)
ATT	0.016	0.000	0.011	0.010
(Std. err.)	(0.012)	(0.012)	(0.011)	(0.020)
# treated	387	288	429	117
# untreated	4,193	4,011	4,195	4,006
Panel 4. Wage per worker				
Unmatched	0.002	0.003	0.002	0.014
(Std. err.)	(0.007)	(0.007)	(0.007)	(0.011)
ATT	−0.008	0.018*	−0.000	0.023
(Std. err.)	(0.010)	(0.011)	(0.009)	(0.018)
# treated	390	304	427	123
# untreated	4,188	3,993	4,193	3,999
Panel 5. Value added per worker				
Unmatched	0.001	−0.009	0.015	0.013
(Std. err.)	(0.009)	(0.007)	(0.009)	(0.012)
ATT	0.002	0.005	0.025**	0.026
(Std. err.)	(0.013)	(0.011)	(0.013)	(0.017)
# treated	389	291	429	113
# untreated	4,194	4,011	4,196	4,014

Notes: This table summarizes PSM results. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

on both their upstream and downstream firms. This is illustrated by Carvalho et al. (2020) in the case of the Great East Japan Earthquake of 2011. The present study analyses the impact of trade expansion on upstream seller firms, and it would modify the business of trade expansion firms only partially, however. This is because the effect on upstream seller firms is much nuanced.

Table 9 reports the estimated ATT of five other variables of business performance in trade expansion firms as supplementary analyses. Panel 1 is for TFP, showing positive effects in two

cases of export with statistical significance of 90 percent. Panel 2 is the number of workers. Three out of four cases indicate that the number of workers in firms increases along with an increase in their international trade, at a statistical significance of 90 percent or more. Panels 3–5 are for sales per worker, wage per worker, and value added per worker, respectively, and there are only two results among the total of 12 cases showing a positive effect, with statistical significance at 90 percent or more. There are no results showing negative impacts of international trade on firms' business performance with the same statistical significance. It is safe to say that, in general, the expansion of international trade has some positive effects, though weakly, on a certain aspect of the trading firms themselves, such as the number of workers. It corroborates the interpretation that expanding neither imports nor exports by downstream buyer firms has a ripple effect strong enough to influence their business performance of upstream seller firms through domestic buyer-seller links, whether directly by purchasing intermediate goods or indirectly by non-market interaction.

6 Concluding remarks

This study provided a comprehensive view of the propagation of trade shocks through domestic interfirm transactions from downstream buyer firms to upstream seller firms. Conservative measures were taken to sample firms to clarify the impact of trade shocks without being affected by other potential international factors. The empirical strategy employed for the present study was a one-to-one PSM with DID approach. No systematic trade effect was found on upstream seller firms in respect of the probability of business closure, the number of workers, and other business performance variables, and most of the trade impacts on them were statistically insignificant. There are a variety of possible scenarios explaining positive or negative effects of trade shocks on upstream seller firms, but this empirical result implies that these effects are not strong enough or they almost offset each other. The present study proposed one supposition: on average, firms that increased their exports or imports only marginally changed their purchase of material and intermediate goods from domestic non-associated firms, and this was supported by the empirical study results.

These findings suggest that the economic impact of firms' international trade on upstream

suppliers is more nuanced than just a substitute or complement between international and domestic trades. There are some public concern that, while the increasing international transaction affect positively on internationalized firms themselves, it may accompany the negative effect on domestic firms which have buyer-seller linkages with these large international firms but suffer the decrease of domestic transaction within these linkages. This study provides, however, little evidence of confirming this concern: the propagation of trade expansion effect through domestic buyer-seller networks does not overshadow the benefit of trade expansion itself.

Naturally, there is some room for improvement in this research. First, the number of firms in the treatment group is small compared to that in the control group. This is the disadvantage of using of strict criteria for selecting seller firms suitable to the analysis. Exploring more efficient alternative methods to observe the effect of trade shocks using information of more seller firms would help to further clarify the trade effects. Second, the temporal window of the analysis is only five years, which could be expanded. Third, I use the data of buyer-seller linkages in 2014, just one point in time. Therefore, it is not possible to distinguish the effects of cutting or creating links from trade effects. These are subjects for future study.

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