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Exports and Innovation: Evidence from Antidumping Duties Against Japanese Firms

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Abstract: *By conducting a difference-in-difference analysis, we examine how the targeted exporters adjust their innovative activities in the face of the negative export shock inflicted by the policy experiments of the antidumping cases in the United States market during 1991–2008. We construct the novel micro-dataset, combining the targeted firms by antidumping duties and firm-level patenting as a measure of innovative activities. We found that the antidumping-targeted firms respond to the negative export shock by allocating more innovation activities to expand international patents at the cost of domestic innovation. This resource allocation of innovative activities is more prominent when the initial export intensity is high.*

Keywords: antidumping duties, innovation, exporting, Japanese firms, resource allocation, patent

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Executive Summary

Antidumping duties have become one of the primary forms of trade protection worldwide, and the large magnitudes of the duties imposed can dramatically change trade flows and adversely affect exporters by shifting the benefits towards protected domestic firms. With the recent mounting of tensions between China and the United States (US) due to the US administration's new foreign policy stance, it is expected that antidumping trade protection laws and activity will continue to evolve and will be one of the more important future issues for the World Trade Organization and the global policy community. We examine this theme by exploring the innovation activities of Japanese firms hit by antidumping duties by the Government of the US during 1991–2008, by combining the relevant antidumping cases from the Global Antidumping Database, patents from the Institute of Intellectual Property Patent Database, and firm accounting data from the Ministry of the Economy, Trade and Industry.

Table 1: Antidumping Cases in Industry (Frequency: More Than One Case)

PRODUCT (specified in the GAD)	*Freq.*	*%*
Steel wire nails	5	5.32
Polyester filament fabric	4	4.26
All-terrain vehicles	3	3.19
Ball bearings	3	3.19
Cellular telephones	3	3.19
Forklift trucks	3	3.19
Glycine	3	3.19
Micro disks	3	3.19
Microwave ovens	3	3.19
Brass sheet/strip	2	2.13
Butt-weld pipe fittings	2	2.13
Certain steel valves	2	2.13
Chlorinated isocyanurates	2	2.13
Electrolytic manganese dioxide	2	2.13
Granular polytetrafluoroethylene resin	2	2.13
Large newspaper printing presses	2	2.13
Minivans	2	2.13
Polyvinyl alcohol	2	2.13

Polyvinyl alcohol	2	2.13
Portland cement	2	2.13
Sodium azide	2	2.13
Spun acrylic yarn	2	2.13
Stainless steel wire rod	2	2.13
Structural steel beams	2	2.13
Unfinished mirrors	2	2.13
TOTAL	94	100

Freq. = frequency, GAD = Global Antidumping Database.
Notes: Based on the cumulated number of antidumping cases against Japanese firms by the Government of the United States.
Source: World Bank, Global Antidumping Database.
https://datacatalog.worldbank.org/dataset/temporary-trade-barriers-database-including-global-antidumping-database/resource/dc7b361e (accessed 25 September 2015)

We find that being directly hit by antidumping duties led to a substantial reduction in innovation by exporters, but only with respect to domestic patents. On the other hand, the propensity to apply international patents through the Patent Cooperation Treaty increases even after the post-antidumping imposition, especially for firms named in the antidumping orders. This indicates that internal innovative resources are allocated in favour of international patents due to the antidumping duties: exporters may become more cost-conscious once hit by antidumping duties and allocate more resources to international patents, away from domestic innovation.

We can thus derive the following policy implications from Japanese experience. First, antidumping limits market access to exporters, leading to lower innovation propensity. Second, notwithstanding the diminished incentive to innovate, exporters who remain in the export market tend to increase the quality of innovation in the face of antidumping. Combined with the existing studies on the effects of antidumping on protected local firms, the benefits of antidumping for local firms are transitionary. In the longer term, the temporary benefits can work against the protected firms if exporters sustain innovative activity to stay competitive in the market. Our findings support this policy prediction. That is, the temporary benefits damage the competitiveness of local protected firms in the long run, while offering incentives for exporters to exert efforts on innovation.

1. Introduction

Antidumping duties are duties levied on imported products considered sold at 'less than fair value' at the domestic market. Due to the predatory nature of dumping, these temporary protection measures are put in place to offset the potential 'injury' to domestic industries. The number of antidumping cases filed with the World Trade Organization (WTO) has been increasing, as has the number of new antidumping duty users in new countries such as India, Argentina, Mexico, Brazil, and New Zealand, in addition to traditional users such as the United States (US) and the European Union in recent years. Amid the escalating US–China trade war, use of this protectionism measure is expected to be on the rise globally.

Parallel to the increase in antidumping cases, empirical studies have been undertaken to understand the effects of antidumping on distorted domestic prices, mark-up rates, directions of trade, and performance of the protected firms as well as targeted foreign firms (Blonigen and Prusa, 2003; Konings and Vandenbussche, 2005; 2008; Pierce, 2011; 2013; Chandra and Long, 2013; Lu et al., 2013; Sun and Lee, 2017). While significant insights have been gained from the extensive studies on the various impacts of antidumping measures, much less is known about the corresponding impacts on innovative activities in response to such negative export shocks. In principle, the larger the (export) market, the more profitable it is for firms to invest in innovative activities that underscore their productivity for expansion (Schmookler, 1966). Since the imposition of antidumping duties effectively shrinks the export market size of foreign firms by raising the costs of market access to the benefit of domestic firms (Koning and Vandenbussche, 2008), it is expected that the prospects for innovation along with expected profitability are reduced for exporters. The episodes of antidumping duty imposition therefore provide a unique context to study how exporters adjust their innovative activities in the face of *negative* shocks in the export market size. Our study is the first to examine the direct impacts of these shocks on patenting as a measure of innovation. In the literature of innovation economics, market size is usually proxied by the demand side, and the literature in that area is limited to the drugs and pharmaceutical industry (Acemoglu and Lynn, 2004; Dubois et al., 2015). We thus add to this strand of literature by exploiting policy

changes in market access for exporters; our estimation strategy is less subject to the identification problem isolating the supply-side responses to the demand side.

We examine this theme by exploring the innovation activities of Japanese firms that were hit by antidumping duties by the US government during 1991–2008 by combining the relevant antidumping cases from the Global Antidumping Database (GAD), patents from the Institute of Intellectual Property (IIP) Patent Database, and firm accounting data from the Ministry of the Economy, Trade and Industry (METI). Based on this combined dataset, our primary objective is to clarify the firm innovation dynamics in response to antidumping duties systematically, using a difference-in-differences (DiD) approach.

We find that being directly hit by antidumping duties led to a substantial reduction in innovation for exporters, measured by the number of new patents filed and forward citation received once we account for firm characteristics in the patent production function. This resulting drop in innovation is especially pronounced for domestic patents aimed at the local Japanese market, while the propensity to apply international patents through the Patent Cooperation Treaty (PCT) increases even after the antidumping duty imposition, especially for those firms named in the antidumping orders. This indicates that internal innovative resources are allocated in favour of international patents due to antidumping duties: exporters may become more cost-conscious once hit by antidumping duties, and may allocate more resources towards international patents and away from domestic innovation. While the data limitations prevent us from exploring further, we report some evidence to suggest that exporters with high export intensity increase the rate of international patenting.

The next section provides an institutional context of antidumping in the US market and discusses how this paper fits into the literature related to innovation studies and trade policy. Section 3 presents our identification strategy followed by a description of the data-matching procedure between the global antidumping database, and patent and citations data from the IIP. Section 4 presents the estimation results followed by concluding remarks in section 5.

2. Institutional Setting[1] and the Effects of Antidumping

The effects of antidumping duty imposition on the innovation capacity of targeted firms are driven by two intertwined factors. First, the negative export shock directly decreases the market size that exporters serve, limiting the prospect for innovation rents. This may lower incentives for firms to invest in innovative activities. Of course, this impact depends on the importance of the market to exporting firms, and exporters can mitigate such a reduction in the market size by employing mitigating strategies.

Most studies look at the impact of antidumping duties on import-competing firms and industries (Pierce, 2011). Few papers have investigated the impact of antidumping on the targeted firms in foreign countries from the angle of exporters' pricing behaviour (Blonigen and Park, 2004), export-destination diversification (Bown and Crowley, 2006; 2007) and foreign direct investment strategies for accessing foreign markets (Blonigen, 2002).

Our study is closely related to that by Lu et al. (2013), which examines the responses of exporting firms in the case of US antidumping duties imposed on Chinese exporters. This study matches monthly transaction-level trade data from the China Customs Data with data on antidumping investigations by the US. The main findings suggest that less productive Chinese exporters are more likely to exit the US market, and single-product direct exporters are more likely than multi-product direct exporters to exit as well. By extending a study by Lu et al. (2013), we also investigate the responses of Japanese exporters in reaction to antidumping investigations. In contrast to Lu et al. (2013), our dataset (detailed below) covers firm-level information to investigate firm innovation performance.

[1] This section will be developed by summarising the institutional setting for the antidumping policy in the US (for an extensive review see Blonigen and Prusa, 2003).

3. Empirical Strategy

We empirically examine the above hypothesis by exploiting the exogenous antidumping policy shock against Japanese exporters to the market access in the US and its impacts on innovation. The effects of the antidumping policy present a methodologically ideal setting for a DiD analysis from the viewpoint of the affected firms. The DiD method is frequently used to study the effect of policy changes in the observational data when one is unable to assign subjects randomly into a treatment group versus a control group. By assuming that trends in the comparison group represent trends in what would have happened to firms in the treatment group in the absent of treatment, the DiD method identifies a causal treatment effect as the before-to-after difference for the treatment group, by differencing out trends from the comparison group. The DiD analysis thus removes observed and/or unobserved differences between the treated and control groups, provided that those differences remain fixed over time (the parallel trend assumption). Our treated firms are those affected by antidumping duties and the control group consists of those firms unaffected by antidumping but still operating in the same industry. Hence, our identification strategy relies on the comparison of outcome variables (innovation) vis-a-vis control groups before and after antidumping investigation.

Table 2: Descriptive Statistics, Treated Versus Control Groups

Year	*Sample*	*Treatment*	*Mean no. of domestic patents*	*Mean no.* of forward citations (5-year)	Mean no. of international patents	Mean no. of employees	Mean capital intensity	Export intensity	Export intensity (N. America)	Export intensity (Asia)	Export intensity (Europe)	No. of firms
							(¥ million)	(%)	(%)	(%)	(%)	
1991	1	1	386	472	1	10,488	9,473	7.69	2.06	3.39	1.44	56
1991	1	0	376	498	1	12,256	9,291	8.51	2.61	3.16	1.72	28
1991	2	1	14	17	0	708	3,358	6.05	1.26	3.46	0.84	4,007
1991	2	0	14	17	0	820	6,046	3.26	0.59	1.97	0.41	2,281
1991	3	1	20	24	0	925	3,506	7.83	1.88	4.21	1.21	2,678
1991	3	0	10	12	0	617	4,941	2.97	0.37	1.97	0.30	3,610
2008	1	1	387	289	29	7,357	12,224	7.72	2.02	3.48	1.45	60
2008	1	0	421	289	23	10,188	12,734	9.56	3.04	3.32	1.98	22
2008	2	1	16	10	1	588	4,252	6.97	1.37	4.13	0.95	4,377
2008	2	0	15	10	1	683	6,111	3.60	0.64	2.20	0.48	2,771
2008	3	1	23	14	1	758	4,632	9.02	2.06	4.96	1.38	2,902
2008	3	0	11	7	1	534	5,198	3.37	0.42	2.31	0.35	4,246

Notes: Sample refers to the different sample selection (explained in section 3). In Sample 1, a treatment of one denotes the group of firms whose name was mentioned in antidumping investigations and had antidumping duties imposed upon them (antidumping affected group), and zero for the control group (named but on whom antidumping duties were not imposed). In Sample 2, a treatment of one denotes the group of exporters operating in industries that were subject to antidumping duties, whereas a treatment of zero denotes the group of exporters that operate in industries unaffected by antidumping. In Sample 3, we restrict the sample of those exporters to North America and defined a treatment like the case of Sample 2; a treatment of one denotes the group of exporters that operate in industries subject to antidumping duties, whereas a treatment of zero denotes the group of exporters that operate in industries unaffected by antidumping. Citations refer to the number of citations collected in a 5-year window (up to 2013) to patents filled by firm i in year t. Mean capital intensity is the mean of the firm-level book value of capital divided by the number of employees, expressed in ¥ million. Export intensity is the ratio of exports to sales. Export intensity to North America, Europe, and Asia is the ratio of exports to each destination market divided by total exports.
Source: Author.

The benchmark analysis considers the following DiD specification:

$$\ln(PAT)_{it} = \alpha_0 + \alpha_1 AD_{it}^{name} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

where *PAT* is the outcome variable for firm *i* and year *t*. AD^{name} represents the group of treated firms *i* whose name was mentioned in antidumping investigations and had antidumping duties imposed on them in year *t*.[2] This indicator variable presents the main DiD effects of the antidumping policy in force on the innovation outcome for firm *i*.

The above antidumping dummy misses the variation that each antidumping-affected firm faces a different level of final ad valorem tariffs. We construct the interaction term between antidumping protection and the level of duty rates to evaluate the effects of the antidumping protection level on the innovation of targeted firms after antidumping duties were imposed on them (AD_{it}*$Rate_i$). We also note that, according to the WTO sunset clause, antidumping duty is only temporary protection, in principle, and typically lasts for 5 years, although it can be reviewed and renewed at the end of the 5 years if protected firms expect that the injury and dumping will continue after the protection phase has elapsed (marked as 'revoke' in the GAD). We explore the dynamic effects by creating separate time dummies for the first year up to 10 years since the year in which the antidumping duties were imposed.

Dependent Variable

To capture innovation performance, we prepared the following measures: (i) the count of new (eventually awarded) patent applications in the firm-year observations, (ii) the count of forward citations received for (i), and (iii) the count of new international patent applications through the PCT.[3] To make this comparison easier, we denote (i) as 'domestic patents' and (iii) as 'international patents.'

[2] Several choices of post year are available (e.g. antidumping initiation year, investigation year). We chose the antidumping implementation year for present investigation.

[3] PCT patents provide a streamlined procedure for filing international patent applications for 147 member countries worldwide. Under this scheme, patent applicants interested in seeking the intellectual property protections in many countries can do so in a single application in one language that is subject to examination by the international search authority. The application is sent to each member country where the applicant is seeking the intellectual property protections for their final decisions.

The metric (i) is customarily regarded as capturing the rate of innovation (Griliches, 1986). By taking information of the trials of citations, the metric (ii) purports to capture the quality of innovation. Citations refer to all forward citations counted since the application of a focal patent in year *t*.[4] We prepared the metric without the time window[5] and another by restricting forward citations within the 5-year window. In IIP patent and citations data, the final data point is the year 2013. We capture international patents through the PCT. Patent applications through the PCT reveal the applicant's desire to seek intellectual property protections in multiple jurisdictions (otherwise, it is a costly procedure). In other words, PCT patents denote higher-value inventions compared to those with only domestic applications.

Global Antidumping Data

The micro-data source for antidumping cases against Japanese exporters is sourced from the World Bank's GAD, which covers all antidumping cases around the world from 1980 to 2015. The GAD contains detailed information on each antidumping case, such as product information, initiation date, preliminary date, preliminary determination dates and duties, and final determination dates and duties. For this analysis, we collect all antidumping cases against Japanese firms by the US government so that information can be matched to the same time coverage as the the firm-level data.

Innovation Data

Patent and citations data are cultivated from the IIP Patent File (Goto and Motohashi, 2007). They refer to patent applications sent to the Japan Patent Office. We rely on the name of patent assignees to identify the name of exporters under the antidumping duties, the time coverage, and the technology class.

After identifying the name of Japanese exporters in the GAD, we attempted the name-matching procedure between two databases. The challenge is that companies' names in the GAD are entered in English characters, while the same name in the IIP data may contain spelling differences (Japanese and/or Roman characters) and several

[4]This is normally done to minimise the arbitrariness caused by the time lag between the date of the patent applications and the date of the patent examinations.
[5]Hence, the cumulated citations up to the end point of the year coverage.

typographical variations. Thus, we first check the name in the GAD, and verify the name by checking the websites and information from both Japanese websites and global sites, if any.

Of the total 250 case-firm pairs (some firms have antidumping duties imposed upon them several times), the matching procedure identified 94 exporting firms that were named in the GAD.

Firm Accounting Data

Firm-level covariates may influence the rate and scope of innovation. These are sourced from the micro-data source of the *Basic Survey of Business Structure and Activity* conducted by Japan's Ministry of Economy, Trade and Industry (METI).[6] The original survey sample is restricted to firms with more than 50 employees and more than ¥30 million (equivalent to $300,000) in capital. The METI survey collects firms' accounting information (sales, employment numbers, research and development spending, and import and export values). The firm accounting data began in 1991, while antidumping data can cover cases prior to that year. Hence, the antidumping cases in this paper also cover cases still in force, as well as those newly created during the sample period.

Sample Selection

The canonical DiD approach uses a larger population sample to estimate the impacts of a policy treatment on the treated subset of observations. In the current context, such an approach would make it necessary to compare changes in the rate of innovation by firms subject to antidumping duties with changes in the innovation performance of other comparable firms during the same time period. However, since antidumping policies do not randomly target exporting firms, the members of the control group might differ systematically from the treated firms. We hence construct several firm samples to make a comparison between the treated and control firms.

[6]This firm-level survey is governed by statistical law in Japan. Failing to respond to the survey questions results in a fine. Hence, the survey is thought to provide reliable data.

- **Sample 1**: All firms in this sample were named in the GAD. Treated firms are those with antidumping duties imposed against them, and are thus listed as 'targeted foreign firms' in the GAD. The control group includes those firms that are named, but which did not have antidumping duties imposed on them due to a lack of evidence either of dumping or of domestic injury to US firms.
- **Sample 2**: One concern is that we likely mismatched names of firms between the METI survey data and the GAD due to spelling variations. Thus, we cannot satisfactory remove the instances whereby we falsely lump together those targeted firms into the control groups. For this reason, we expand the sample to exporters (defined as at least having a positive export value during the sample period). We specify the treated group as exporters named in antidumping investigations, as well as all other exporters operating in the same 3-digit industries on which antidumping duties were imposed. The control group includes all other exporters belonging to other industries unaffected by antidumping duties.
- **Sample 3**: We further refine Sample 2 by retaining exporters to the North American market.[7] The treated group includes all exporters to the North American market (divided into those named, and other exporters in the same industries). The control group includes exporters to the North American market in other industries.

[7]The METI database only defines export destinations broadly as either North America, Asia, or Europe.

4. Results

Sample 1 (Tables 3 and 4)

We begin by applying the DiD method to Sample 1, where the treated group includes those firms named in the antidumping investigations (later found to be affirmative), and the control group includes those firms named in antidumping investigations, but on whom no antidumping duties were imposed.[8] *ADprem* is dated since the year of the preliminary dumping investigations, while *AD* is dated to the years since the antidumping duties were imposed against the treated firms. From Table 3 onwards we only use antidumping dated to the year of its imposition.

By comparing the control firms, the effects of the antidumping dummy (either preliminary or final) shows the negative impact on domestic patents and citations in Columns 1 and 4, with some statistical significance. The diagnostic test of the overall fit suggests that R^2 exceeds 95%, while F-statistics stand at a relatively lower level, especially for Columns 1–3. Once we move to regressions with the interaction term antidumping *rate*, the statistical significance of the main variable disappears (Columns 3 and 6). Interestingly, the same higher antidumping rate would increase the propensity for international patenting (Column 9), while having negative overall impacts. While we may be capturing some responses from antidumping-affected firms, the power of the regression model is low using this sample. There is some evidence that, by comparing domestic and international patents, antidumping-affected firms respond by reshuffling innovation resources within firms.

[8]The case was found to be either no evidence of dumping, or no establishment of injury to protected domestic firms.

Table 3: The Effects of Antidumping Duties on Innovation Activities of the Targeted Firms for the Period 1991–2008, Sample 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	log (num. of domestic patents)			log (num. of citations, 5-year window)			log (num. of international patents)		
$ADPrem_{it}^{name}$	-0.079*			-0.075*			-0.024		
	(0.043)			(0.040)			(0.081)		
AD_{it}^{name}		-0.084*	-0.045		-0.080*	-0.063		-0.027	-0.297***
		(0.044)	(0.070)		(0.042)	(0.067)		(0.081)	(0.112)
$AD_{it}^{name} * rate_i$			-0.001			-0.000			0.004***
			(0.001)			(0.001)			(0.001)
R-squared	0.956	0.956	0.957	0.953	0.953	0.953	0.742	0.742	0.745
F	2.725	2.696	2.697	14.288	14.260	13.573	6.982	6.976	7.688
Fixed effects	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year
N. firms	87	87	87	87	87	87	87	87	87
Obs.	1948	1948	1948	1948	1948	1948	1948	1948	1948

Obs. = observations.

Notes: This table reports difference-in-difference results of log-transformed various citations-based outcome variables (the dependent variable is shown in each column in the header) at firm-year observations, regressed on a dummy for antidumping dummy, which is dated by the year of the preliminary dumping investigations (ADPrem), the year since antidumping imposition to the treated group (AD), and year fixed effects. AD^{name} is the treated group whose name is mentioned in antidumping investigations. *Rate* is antidumping valorem antidumping duty. Standard errors are clustered by firm-level, *** denotes 1% significance, ** denotes 5% significance, and * denotes 10% significance.

Source: Author.

Table 4 presents the results of the dynamic effects up to 10 years from the imposition of antidumping duties against treated firms as compared to the control group. Combined with the findings in Table 3, this suggests that the temporary protection does not have any lingering effects on innovation for targeted firms. Any effects seem to occur within 1–2 years after the imposition of antidumping duties.

Table 4: Dynamic Effects of Antidumping Effects on Innovation, Sample 1

	(1)	(2)	(3)
	log (num. of domestic patents)	log (num. of citations, 5-year window)	log (num. of international patents)
1 year since AD	0.033	0.162*	-0.092
	(0.085)	(0.090)	(0.096)
2 years since AD	-0.070	-0.183**	0.000
	(0.086)	(0.091)	(0.105)
3 years since AD	-0.079	-0.076	0.034
	(0.075)	(0.094)	(0.108)
4 years since AD	-0.006	0.064	-0.100
	(0.044)	(0.052)	(0.075)
5 years since AD	0.066	0.065	0.013
	(0.054)	(0.064)	(0.074)
6 years since AD	-0.008	-0.026	-0.117
	(0.045)	(0.063)	(0.089)
7 years since AD	-0.023	-0.043	-0.071
	(0.063)	(0.085)	(0.071)
8 years since AD	0.020	0.083	0.127
	(0.063)	(0.095)	(0.082)
9 years since AD	0.014	-0.068	-0.104
	(0.070)	(0.093)	(0.063)
10 years since AD	0.069	0.108	0.078
	(0.075)	(0.082)	(0.101)
R-squared	0.957	0.953	0.744
F	2.251	12.425	4.822
Fixed effects	Firm; Year	Firm; Year	Firm; Year
Num. of firms	87	87	87
Obs.	1948	1948	1948

Obs. = observations, num. = number.

Notes: This table reports difference-in-difference results of log-transformed various citations-based outcome variables (the dependent variable is shown in each column in the header) at firm-year observations, regressed on a dummy for antidumping imposition to the treated group (varies across firms) and year fixed effects. ADF specifies the year of antidumping imposition in year t, and ADF^{name} is the treated group whose name is mentioned in antidumping investigations. *Rate* is ad valorem antidumping duty. Standard errors are clustered by firm-level, *** denotes 1% significance, ** denotes 5% significance, and * denotes 10% significance.

Source: Author.

Sample 2 (Table 5)

We introduce two sets of the treatment variable: one with AD^{name} as specified above, and the other $AD^{industry}$, where all other exporters operate in the same 3-digit industries hit by antidumping duties. In this sample, the overall F-statistics have significantly improved. However, in both domestic patents and citations (Columns 1–4), there are no impacts of antidumping duty imposition. Only in Columns 5 and 6, the rate of international patents increased for firms named in antidumping investigations compared to the control group. Other potentially antidumping-affected firms in the same industries have a lower level of international patenting (Column 5). The interaction term with antidumping *rate* indicates that firms named in antidumping investigations have responded positively to the higher antidumping rate.

Table 5: The Effects of Antidumping Duties on Innovation Activities of the Targeted Firms for the Period 1991–2008, Sample 2

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	log (num. of domestic patents)		log (num. of citations, 5-year window)		log (num. of international patents)	
AD_{it}^{name}	-0.071	-0.025	-0.067	-0.038	0.352***	0.052
	(0.047)	(0.077)	(0.044)	(0.071)	(0.110)	(0.114)
$AD_{it}^{industry}$	-0.012	0.016	-0.011	0.026	-0.017**	-0.008
	(0.017)	(0.026)	(0.019)	(0.029)	(0.008)	(0.014)
AD_{it}^{name} *rate		-0.001		-0.000		0.004***
		(0.001)		(0.001)		(0.001)
$AD_{it}^{industry}$ *rate		-0.000		-0.000		-0.000
		(0.000)		(0.000)		(0.000)
R-squared	0.866	0.866	0.823	0.823	0.586	0.587
F	61.941	56.142	159.820	144.623	31.828	29.257
Fixed effects	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year
Num. of firms	8904	8904	8904	8904	8904	8904
Obs.	118356	118356	118356	118356	118356	118356

Obs. = observations, num. = number.

Notes: This table reports difference-in-difference results of log-transformed various citations-based outcome variables (the dependent variable is shown in each column in the header) at firm-year observations, regressed on a dummy for antidumping imposition to the treated group (varies across firms) and year fixed effects. ADF specifies the year of antidumping imposition in year t and ADF^{name} is the treated group whose name is mentioned in antidumping investigations. *Rate* is ad valorem antidumping duty. Standard errors are clustered by firm-level, *** denotes 1% significance, ** denotes 5% significance, and * denotes 10% significance.

Source: Author.

Sample 3 (Tables 6–7):

This sample is limited to exporters to the North American market (including the US). Hence, the corresponding control group includes exporters to the North American market but operating in 3-digit industries that are not subject to antidumping duties. Similar to the results in Table 5, we continue to observe no statistical significance with regard to the imposition of antidumping duties on domestic innovation, even though the estimated sign shows negative. With regard to international patents, the positive effects on the propensity of firms to file are detected with a 1% statistical significance. The estimated coefficient suggests that being hit by antidumping duties increases the likelihood of filing international patents by 44%. When interacted with the antidumping rate, the impacts are substantially lower, but still remain positive with a 1% statistical significance.

Table 6: The Effects of Antidumping Duties on Innovation Activities of the Targeted Firms for the Period 1991–2008, Sample 3

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	log (num. of domestic patents)		log (num. of Citations, 5-year window)		log (num. of international patents)	
AD_{it}^{name}	-0.067	-0.024	-0.066	-0.041	0.363***	0.059
	(0.048)	(0.076)	(0.044)	(0.070)	(0.110)	(0.113)
$AD_{it}^{industry}$	-0.000	0.014	-0.009	0.012	0.015	0.026
	(0.021)	(0.033)	(0.024)	(0.037)	(0.011)	(0.018)
AD_{it}^{name} *rate		-0.001		-0.000		0.004***
		(0.001)		(0.001)		(0.001)
$AD_{it}^{industry}$ *rate		-0.000		-0.000		-0.000
		(0.000)		(0.000)		(0.000)
R-squared	0.866	0.866	0.823	0.823	0.586	0.587
F	61.892	56.034	159.834	144.620	31.792	29.246
Fixed effects	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year
Num. of firms	8904	8904	8904	8904	8904	8904
Obs.	118356	118356	118356	118356	118356	118356

Obs. = observations, num. = number.

Notes: This table reports difference-in-difference results of log-transformed various citations-based outcome variables (the dependent variable is shown in each column in the header) at firm-year observations, regressed on a dummy for antidumping imposition to the treated group (varies across firms) and year fixed effects. ADF specifies the year of antidumping imposition in year *t*, ADF^{name} is the treated group whose name is mentioned in antidumping investigations, and $AD^{industry}$ is all other exporters that operate in the industries hit by antidumping duties. Standard errors are clustered by firm-level, *** denotes 1% significance, ** denotes 5% significance, and * denotes 10% significance.

Source: Author.

In Table 7, we introduce form-specific account variables to control for other confounding factors contributing to innovation activities, namely the capital–labour ratio and the firm size proxied by the number of employees. These variables are traditionally found to be important in accounting for firms' innovation production. In addition, we note that the impacts of the imposition of antidumping duties may have heterogenous effects on innovation, depending on the degree of exposure to possible antidumping duties. We thus construct a variable measuring firm-level exposure of export intensity by three different regions (North America, Europe, and Asia) in the pre-antidumping years and hold these variables contact in the post-antidumping period. These variables are then interacted with the treatment dummies to capture the heterogenous effects depending on the intensity of exports.

The statistically significant negative effects of the imposition of antidumping duties on domestic innovation in both patents and citations emerge once firm-specific variables are controlled for. For example, the estimated coefficient in Column 1 indicates that the number of domestic patents is likely to decrease by 7%. This effect stands even after controlling for industry-wide effects as well as the interaction with the initial export intensity. As before, the propensity of firms named in antidumping investigations to file international patents increased compared to the control group, while the same propensity of other exporters in the same industries decreased (but not by a large magnitude). Interestingly, the interaction term with the region's export intensity suggests that firms with a greater exposure to export intensity in three destination markets have a higher likelihood of increasing the rate of international patents (Columns 7–9).

We speculate that the imposition of antidumping duties has prompted some kind of internal resource allocation of innovation activity, as reflected in a change in the composition of the patent portfolio of treated firms, away from domestic patenting to international patents (which exporters could use to penetrate other export markets or simply to improve the quality of innovation).

Table 7: The Effects of Antidumping Duties on Innovation Activities of the Targeted Firms for the Period 1991–2008, Sample 3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	log (num. of domestic patents)			log (num. of citations, 5-year window)			log (num. of international patents)		
log(capital/labour)	0.093***	0.092***	0.093***	0.075***	0.074***	0.075***	0.045***	0.045***	0.045***
	(0.016)	(0.016)	(0.016)	(0.022)	(0.022)	(0.022)	(0.007)	(0.007)	(0.007)
log(size)	0.271***	0.271***	0.271***	0.202***	0.201***	0.202***	0.049***	0.050***	0.049***
	(0.019)	(0.019)	(0.019)	(0.024)	(0.023)	(0.023)	(0.008)	(0.008)	(0.008)
AD_{it}^{name}	-0.068*	-0.070*	-0.067*	-0.068*	-0.068*	-0.067*	0.333***	0.329***	0.335***
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.108)	(0.108)	(0.108)
$AD_{it}^{industry}$	-0.019	-0.033	-0.017	-0.014	-0.037	-0.015	-0.019**	-0.031***	-0.020**
	(0.016)	(0.021)	(0.016)	(0.018)	(0.023)	(0.018)	(0.008)	(0.009)	(0.008)
$AD_{it}^{industry}$ *export intensity (N. America)	0.403			-0.035			0.844**		
	(0.528)			(0.556)			(0.396)		
$AD_{it}^{industry}$ * export intensity (Asia)		0.410			0.457			0.491***	
		(0.367)			(0.401)			(0.180)	
$AD_{it}^{industry}$ * export intensity (Europe)			0.481			0.056			1.397**
			(0.749)			(0.740)			(0.599)
R-squared	0.884	0.884	0.884	0.847	0.847	0.847	0.639	0.639	0.639
F	31.064	31.109	31.065	117.171	117.547	117.268	25.032	25.089	25.159
Fixed effects	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year	Firm; Year
Num. of firms	8583	8583	8583	8583	8583	8583	8583	8583	8583
Observations	99901	99901	99901	99901	99901	99901	99901	99901	99901

Obs. = observations, N. America = North America, num. = number.
Notes: This table reports difference-in-difference results of log-transformed various citations-based outcome variables (the dependent variable is shown in each column in the header) at firm-year observations, regressed on a dummy for antidumping imposition to the treated group (varies across firms) and year fixed effects. AD^{name} is the treated group whose name is mentioned in antidumping investigations. *Rate* is ad valorem antidumping duty. Standard errors are clustered by firm-level, *** denotes 1% significance, ** denotes 5% significance, and * denotes 10% significance.
Source: Author.

Table 8: The Effects of Antidumping Duties on Research and Development Expenditures of the Targeted Firms for the Period 1991–2008

	(1)	*(2)*	*(3)*
	log (R&D expenditures)		
log(capital/labour)	0.746*	0.474***	0.473***
	(0.406)	(0.038)	(0.038)
log(size)	1.324***	1.023***	1.022***
	(0.403)	(0.046)	(0.046)
AD_{it}^{name}	-0.048	0.027	0.038
	(0.120)	(0.138)	(0.138)
$AD_{it}^{industry}$		0.040	
		(0.043)	
$AD_{it}^{industry}$*export intensity (N. America)			2.847***
			(1.073)
R-squared	0.798	0.806	0.806
F	3.351	32.250	32.558
Fixed effects	Firm; Year	Firm; Year	Firm; Year
Num. of firms	85	8583	8583
Obs.	1642	99901	99901
Sample	1	3	3

Obs. = observations, N. America = North America, num. = number, R&D = research and development.
Notes: This table reports difference-in-difference results of log-transformed various citations-based outcome variables (the dependent variable is shown in each column in the header) at firm-year observations, regressed on a dummy for antidumping imposition to the treated group (varies across firms) and year fixed effects. AD^{name} is the treated group whose name is mentioned in antidumping investigations. *Rate* is ad valorem antidumping duty. Standard errors are clustered by firm-level, *** denotes 1% significance, ** denotes 5% significance, and * denotes 10% significance.
Source: Author.

5. Conclusion

Antidumping duties have become one of the primary forms of trade protection worldwide, and the large magnitudes of the duties imposed can dramatically change trade flows and adversely affect exporters by shifting benefits towards protected domestic firms. Yet, despite the growing importance of antidumping duties in the current global trade outlook, their effects on micro-level interactions are not well understood. With tension mounting between China and the US due to the US administration's new foreign policy stance, it is expected that antidumping trade protection laws and activity will continue to evolve and will be one of the more important future issues for the WTO and the global policy community.

Japan has been one of the countries most frequently targeted for antidumping investigations by the US for many years. More recently, China has been targeted for antidumping investigations due to its increased presence in world trade. Hence, the study of how antidumping duties affect Japanese firms is not only important for policy makers in the region, but also provides a good opportunity to assess fully the impacts of antidumping duties in the context of the escalating trade war between the US and China. Understanding its full impacts on firm dynamics within the affected industries would be an extremely valuable contribution to the policy debate.

Based on a DiD framework, we found that being directly hit by antidumping duties led to a substantial reduction in innovation for exporters, measured by the number of new patents filed and forward citation received once we allow for firm-level traits. While this resulting drop in innovation is pronounced for domestic patents, international patents continue to expand after the imposition of antidumping duties, especially for those firms named in the antidumping orders. This indicates that internal resources are allocated based on the antidumping duties: exporters rationalise innovation resources by shifting them more towards international patents and diverting them away from domestic innovation. Although data limitations prevent us from exploring this topic further, we report some evidence to suggest that rates of international patenting increase amongst exporters with high export intensity.

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