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Abstract

This paper uses Chinese customs data to investigate the trade effects of anti-dumping (AD) policies. Merging firm-level exports to firm-specific AD duties, we exploit differences across firms within products. This reduces endogeneity concerns which have plagued earlier research. Based on a firm-level gravity model, we find that, in line with literature, AD duties reduce exports, induce firm exit but do not affect producer prices. However, our strategy yields substantially larger estimates which differ strongly across sectors. More interestingly, imports to the EU react differently compared to those to the US; a finding with obvious implications for the design of AD policies. Smaller exporters are more heavily affected than larger ones, suggesting important within-industry reallocation effects. Moreover, we find evidence for trade deflection as AD duties lead to market entry of Chinese firms into third countries.

JEL-Codes: F120, F130, F140, D220.

Keywords: anti-dumping, China, trade, firm heterogeneity.

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1 Introduction

Trade protection is on the rise again and anti-dumping (AD) duties remain a common instrument in this respect, especially against China. With an average of 60 initiations per year between 2000 and 2014, the country has been the target of a quarter of global AD investigations. Given a rule change with respect to China's treatment in AD investigations in 2017, EU policy makers are demanding to move closer to the US system, which is characterized by significantly higher AD duties compared to the EU - a difference that we put into perspective. Against the background of this reawakened interest in trade protection in general and AD in particular, it is all the more important to obtain unbiased estimates of the effect of AD duties on exports.

This paper uses Chinese customs data to investigate the effects of AD duties on exporters, exploiting differences in duties across different firms exporting the same product with the hope to minimize endogeneity concerns which have afflicted previous work. As a first step, we use simple theory to derive a firm-level gravity equation. This framework imposes some structure which helps uncovering potential sources of endogeneity and motivates the empirical strategy. We argue and demonstrate empirically that existing firm-level estimations which fail to include the appropriate fixed effects are indeed subject to omitted variable bias.

Focusing on the EU and the US, we find that the effect of AD duties differs strongly between the two. Although trade elasticities cannot be distinguished at conventional levels of statistical significance at the firm-level, extensive margin effects do differ. Overall, the estimated average trade effect of US anti-dumping policies on Chinese exporters is stronger than that of EU policy. Another contribution of the paper is a sectoral comparison of the effects of AD duties. In line with theory, we find that the effect of AD duties differs strongly across sectors, suggesting that average treatment effects hide significant heterogeneity.

Trade dampening effects are stronger for smaller firms, implying a shift in exports from small to large exporters. These reallocation effects may well reduce the protective effects that AD-duties have on firms in the importing countries. Finally, this paper is the first to look at trade deflection following AD at the firm-level. We find that Chinese firms increasingly enter new markets following AD investigations in the EU and the US. In addition, we find evidence for falling average export prices to third countries following US duties, accompanied by an increase in average export quantity.

The causes and consequences of dumping have interested economists for quite some time.[1] Indeed, the effects of AD duties on exporters are the subject of an extensive

[1]See for example Ethier (1982); Brander and Krugman (1983); Dixit (1988); Gruenspecht (1988);

body of research.[2] Blonigen and Park (2004) have constructed a dynamic pricing model in which the development of export prices and AD duties depends on the exporter's ex ante expectations of AD enforcement. The authors set out conditions under which exporters pass duties on to consumers in excess of 100% so as to reduce duty levels in subsequent periods.[3] Their empirical findings support the model's prediction. A static model constructed by Blonigen and Haynes (1999) predicting pass through rates of up to 200% is confirmed empirically by the same authors, who find AD pass-through rates of 160% (Blonigen and Haynes, 2002).

These findings are in contrast to those of Lu et al. (2013), who empirically examine the effects of US AD duties on Chinese exports and who find no significant effects on producer prices, indicating 100% pass-through. While the authors do not seek to explain this seeming contradiction with the literature, our paper sheds some light on the issue by accounting for China's status as a NME. In addition, the authors do not look at composition effects. While surviving firms may increase or decrease prices, Melitz (2003) suggests exit of firms with high marginal costs, which would push average prices down. In order to help disentangling these channels, we look at the within firm price variation as well as the change in average prices.

Indirect evidence for the effect of duties on export prices is given by Gourlay and Reynolds (2012), who find that US duties paid by Chinese exporters decreased on average by 28.1% following the First Administrative Review. This indicates that Chinese exporters do increase their prices following the imposition of duties. In contrast, Nita and Zanardi (2013) find a small increase in average EU duties paid by Chinese exporters following the First Interim Review, indicating further dumping.

Regarding the effect of AD duties on export volumes, Staiger and Wolak (1994) find that the initiation of an AD investigation in the United States significantly lowers imports. Prusa (1997, 2001) finds that US AD duties reduce exports to the United States by up to 50% (50% - 70% for named countries), while Egger and Nelson (2011) only find small negative effects. Carter and Gunning-Trant (2010) find strong negative effects of AD duties on trade volume in the agricultural sector. Looking at the European Union, Messerlin (1989) finds that AD measures reduce imported quantities by 40%. Effects of comparable magnitude are estimated by Lasagni (2000) as well as by Konings et al. (2001). Baran (2015) finds strong and long lasting negative impacts of final EU AD duties on imports, while withdrawn and rejected cases affect imports only for the duration of provisional measures. Extending the sample of AD imposing countries to so called "new

Staiger and Wolak (1992); Clarida (1993); Blonigen and Wilson (2010)

[2] Overviews of the AD literature are provided by Blonigen and Prusa (2003a, 2016) and Nelson (2006).

[3] The associated welfare loss is examined by Gallaway et al. (1999) and Blonigen and Prusa (2003b).

adopters", Vandenbussche and Zanardi (2010) find trade chilling effects of AD duties on bilateral trade flows. While most studies have focused on either EU or US AD duties, we contribute by examining effects of EU and US AD duties simultaneously, thus permitting a comparison of their effectiveness in reducing import volumes and inducing price adjustments. Beyond that, our data structure allows us to use country-time fixed effects to account for changes in multilateral resistance terms (Baier and Bergstrand, 2007).

For China, Lu et al. (2013) show that while the initiation of an AD case does not have any effect, a one percentage point increase in preliminary (final) US AD duties reduces Chinese exports to the United States by 0.27% (0.6%). These results are driven by the intensive as well as by the extensive margin.[4] However, the authors' estimates of intensive margin effects may be subject to several biases. We base our estimation on a firm-level gravity equation, exploring an additional identification channel in order to obtain unbiased estimates. Lu et al. (2013) argue that duties cause less productive firms to exit the market, leaving only the productive ones behind. In support of that, Jabbour et al. (2016) find that Chinese exporters reduce their exports to the EU following the imposition of EU AD duties. However, they do grow larger and more productive. Our results indicate that exit could also be caused be different duties applied to different firms. Chandra and Long (2013) find evidence that AD duties reduce exporter productivity.

All of these studies look at aggregate effects of duties on prices and export volumes, ignoring potential heterogeneity across individual sectors. In fact, Feenstra (1989) finds very different pass-through rates of tariffs and exchange rates for Japanese cars, trucks and motorcycles in the United States, ranging from 0.6 to unity. The author credits this variation to differences in demand, cost structures, institutions and the degree of competition across industries. For example, Feenstra observed incomplete pass through for trucks as increased competition meant exporters had to reduce f.o.b. prices in order not to lose market share. In contrast, motor cycles exhibited complete pass through as prices were already close to marginal cost, leaving no room to manoeuvre.

If such differences can occur within an individual (transport) industry, it is not unreasonable to expect similar heterogeneity across industries when it comes to AD duties.[5] Vandenbussche and Zanardi (2010) take a first step in this direction in their estimation of the effect of AD duties on exports by successively excluding iron and steel, chemicals, textiles and agricultural goods from their estimation. We extend this research strand by

[4]Besedeš and Prusa (2013) also find US AD to induce firm exit.

[5]Other reasons for variation across industries can be political (larger industries have greater bargaining power when it comes to pushing through AD protection (Baldwin, 1985)), behavioral (firms and industries learn how to best pursue AD (Morck et al., 2001; Blonigen, 2006)), or sectoral interdependence (AD action in one product raises costs for downstream firms so that these also ask for AD protection (Hoekman and Leidy, 1992; Feinberg and Kaplan, 1993)).

simultaneously estimating AD effects for individual sectors.

Regarding third-country effects of AD policy, Bown and Crowley (2007) find that the imposition of US AD duties on Japanese exports increases the country's exports of affected products to third countries by 5 - 7% (trade deflection). Looking at the Vietnamese footwear industry, Nguyen et al. (2016) find that EU duties on these goods increase Vietnamese exports to the US. Similarly, Baylis and Perloff (2010) find that Mexican exports of tomatoes to Canada increased significantly following the imposition of US AD duties on tomatoes against Mexico.

Evidence is mixed when it comes to China. While Chandra (2016) also finds evidence for trade deflection, Lu et al. (2013) find no such effects. One reason for this difference in findings could be that Chandra (2016) uses annual data, whereas Lu et al. (2013) use monthly data, so that results might reflect differences in short- and long-run responses. Bown and Crowley (2010) look at the effect of more general EU and US import restrictions against China and find no systematic evidence of increased exports to third countries. In contrast, they find some evidence for reduced exports to third countries. We expand the literature by also studying trade deflection at the firm-level, examining the effect of AD duties on both the number of exporters as well as firm sales to third countries. We also look at export prices to third countries.

The remainder of this paper is structured as follows. After briefly describing the AD mechanisms, Section 2 presents the model on which we base our estimation. This is followed by a discussion of our estimation strategy and the data used (Section 3). Section 4 contains our empirical results, followed by robustness checks in Section 5. Section 6 concludes.

2 Conceptual Framework

2.1 Some Remarks on the Institutional Setup

The WTO defines "dumping" as selling a product at a price below its normal value (GATT, 1947; WTO, 1994). For exporters from countries with market economy status (MES),[6] this means that the importer is permitted to impose AD duties whenever export prices (net of transport costs) in the importing country are below the exporting country's domestic market prices or, if price data are not available, production costs (European Union, 2009; United States Government Accountability Office, 2006).[7] Traditionally, AD duties are

[6]These are almost all WTO member states.

[7]Under this definition, a producer is found to dump if she sells a product at the same price at home and abroad, as the export price used to determine the dumping margin excludes transport costs. See Hindley (1988) or Detlof and Fridh (2006) for a more detailed discussion.

associated with higher prices, and thus lower export volumes, because firms have an incentive to increase prices in an effort to reduce the gap between export and domestic prices and thus reduce AD duties following reviews in consecutive periods (Feenstra, 2008). This means that the consumer price increases by more than the duty, implying a pass-through rate greater than 100%.

For countries with non-market economy status (NMES), AD duties work more like tariffs. This is because the dumping margin is calculated as the difference of average export prices and production costs and prices in a third country with MES (European Union, 2009; United States Government Accountability Office, 2006; United States International Trade Commission, 2016).[8] As average export prices, rather than individual company prices are used, firms have no incentive to adjust prices to avoid the duty, unless they have significant market power or unless a few large exporters are able to collude and jointly raise prices to induce a reassessment of dumping margins.

China is a special case since, as of 2017, it is still classified as a NME by both the European Union and the United States.[9] However, the European Union grants individual Chinese exporters market economy treatment (MET) if they can prove that they are active in a market economy environment, in which case individual company export and production prices are used to calculate the dumping margin (Felbermayr et al., 2016). Alternatively, companies may also apply for individual treatment (IT) which means that individual rather than average export prices are used to calculate the dumping margin. If companies fail to qualify for one of these firm-specific treatments, they are subject to a product-wide duty that is the same for all firms exporting a particular product. Similarly, cooperating exporters to the United States may receive individual treatment. In the United States, MET can only be granted to an entire sector, something that has not yet happened. AD duties imposed against MET and IT firms are significantly below those imposed against NMES firms (see Figure 1 further down).

2.2 Deriving a Firm-Level Gravity Equation

In order to guide our estimation strategy and to get a better understanding of potential endogeneity issues involved, we incorporate dumping into what probably is the simplest model of firm heterogeneity. We do not aim to make a theoretical contribution here. Dumping in the legal sense - i.e. exporting a good at a price below "normal value" - is

[8] This is because it is assumed that domestic prices are distorted and thus do not reflect supply and demand, e.g. due to state subsidies. The European Union uses analogue (third-country) prices and costs to construct the normal value (reference price). The Unites States use surrogate (third-country) input prices but estimate production costs using (average) production functions of the exporter. A comparison of different countries' methodologies is provided by Detlof and Fridh (2006).

[9] The EU abandoned NMES for WTO members in December 2017 (European Parliament, 2017).

easy to capture in a Melitz (2003) type model. We can then use this framework to identify the determinants of bilateral firm-level exports that need to be controlled for.

The representative consumer in country j gains utility from consuming varieties ω (product-firm combination hf) of different products h imported from country i (China) according to the utility function $U_j = \prod_{h=1}^{H} \left(\int_{\Omega_{hj}} q(\omega)^{\frac{\sigma_{hj}-1}{\sigma_{hj}}} d\omega \right)^{\frac{\sigma_{hj}}{\sigma_{hj}-1}\mu_{hj}}$, with Cobb-Douglas preferences across products h such that $\sum_{h=1}^{H} \mu_{hj} = 1$ for each j.[10] The elasticity of substitution between varieties σ_{hj} is allowed to vary by destination country j and product h.

This implies the following firm-level demand equation:

$$q_{hfijt}(\varphi) = \mu_{hj} Y_{jt} \frac{(p_{hfijt}(1 + T_{hfijt}))^{-\sigma_{hj}}}{P_{hjt}^{1-\sigma_{hj}}}, \tag{1}$$

where Y_{jt} is the income of consumers in country j at time t, μ_{hj} is the share of Y_{jt} spent on good h, P_{hjt} is the product-specific price index in country j at time t and T_{hfijt} is the ad valorem AD duty imposed by country j on imports from China (i) of product h produced by firm f at time t. The producer price (excluding the AD duty) $p_{hfijt}(\varphi)$ charged by firm f for product h sold to destination country j at time t is

$$p_{hfijt}(\varphi) = \frac{\sigma_{hj}}{\sigma_{hj} - 1} \frac{c_{hfit} \tau_{hijt}}{\varphi_{hfit}}. \tag{2}$$

As usual, the price depends on the elasticity of substitution σ_{hj}, iceberg transport costs $\tau_{hijt} \geq 1$ and productivity φ_{hfit}.[11] We view unit production costs c_{hfit} as functions of wages, the cost of capital, the cost of materials, and potentially also of product or firm-specific subsidies. These components vary across different dimensions. Overall, this means that costs of production vary at the product-firm-time dimension. It follows that the export value $x_{hfijt}(\varphi) = p_{hfijt}(\varphi) q_{hfijt}(\varphi)$ is given by

$$\Rightarrow x_{hfijt}(\varphi) = \frac{\mu_{hj} Y_{jt}}{P_{hjt}^{1-\sigma_{hj}}} \left(\frac{\sigma_{hj}}{\sigma_{hj} - 1} \frac{c_{hfit} \tau_{hijt}}{\varphi_{hfit}} \right)^{1-\sigma_{hj}} (1 + T_{hfijt})^{-\sigma_{hj}}, \tag{3}$$

[10] This set-up borrows from Chaney (2008) with the difference that we do not include a homogeneous good.

[11] $\tau_{hiit} = 1$

which can be log-linearized to yield a firm-level gravity equation:

$$\ln\left(x_{hfijt}(\varphi)\right) = \ln\left(\mu_{hj}\right) + \ln\left(Y_{jt}\right) - \sigma_{hj}\ln\left(1+T_{hfijt}\right) \\ +(1-\sigma_{hj})\left(\ln\left(\frac{\sigma_{hj}}{\sigma_{hj}-1}\right) + \ln\left(c_{hfit}\right) + \ln\left(\tau_{hijt}\right) - \ln\left(\varphi_{ihft}\right) - \ln\left(P_{hjt}\right)\right). \quad (4)$$

In order for the model to constitute an appropriate framework for our empirical analysis, dumping needs to be both possible and profitable. In Section A.1 in the Online Appendix, we propose two types of dumping behavior which can be replicated within the Melitz world: tougher competition in China's export market as reflected by a higher demand elasticity, and the presence of distortions that artificially lower production costs. Both configurations are very relevant in the case of China.

2.3 Strategic Price Setting

The above model allows us to make predictions regarding the effects of AD duties on Chinese exporters. From Equations (1), (2) and (3) it can be seen that following the imposition of AD duties, firm export quantity and export value fall, while producer prices remain unchanged. Profits go down, forcing the least profitable firms to exit the market once they are no longer able to recover fixed export costs.

The absence of endogenous markups and of reciprocal dumping may put in doubt the usefulness of the Melitz model for our purposes. However, the literature and our own work do not suggest that Chinese firms adjust their prices. Moreover, as discussed above, the NMES regime does not provide exporting firms with incentives to adjust prices strategically in order to lower duties. Even under the MET and IT regime, there are conditions under which firms do not adjust prices. First, Gourlay and Reynolds (2012) argue that for many firms, applying for an administrative review - or even for MET in the first place - is very costly. If these costs outweigh the increase in profits from adjusting prices and thus receiving a lower duty in the long run, it might be optimal for firms to just take duties as given. Second, asking for a reduction of duties requires exporters to raise producer prices. Since duties respond to such price increases with a lag of several years (duties are recalculated based on past prices), this implies a temporary increase in consumer prices by more than the level of the duty. Depending on the degree of competition in the industry, such price increases - even if only temporary - may not be feasible.

Another popular framework to think about dumping duties is the Melitz and Ottaviano (2008) model in which markups are endogenous and reciprocal dumping occurs. This framework does not give rise to a log-linear firm-level gravity equation and, thus, is not useful to guide our empirical strategy. Nonetheless, it offers an interesting way to rationalize the stability of producer prices in the face of anti-dumping policy. As sketched in Section A.2 of the Online Appendix, uncertainty regarding the AD regime may be key to explain why we (and the literature) do not find producer prices to react to AD duties.

In particular, the model is consistent with the following predictions. First, prices under AD will be higher than prices in the absence of AD. However, it will not be optimal for firms to raise prices to fully eliminate the duty. Second, under uncertainty, prices will be larger than in the absence of AD but lower than under certain AD. Hence, the firm raises prices even before becoming subject to AD.[12] Third, if fixed costs of applying for a review following the imposition of AD are prohibitively high, the firm may not raise prices at all. The increase in prices following the AD duty will thus be smaller than expected because firms will already have raised prices and because they will never raise prices sufficiently to fully eliminate the duty. If some firms don't adjust prices at all due to the associated fixed costs, it is not unreasonable to observe no significant change in average prices empirically.

3 Estimation Strategy, Identification and Data

3.1 Firm-level Gravity

Following the firm-level gravity equation (4), our baseline specification is

$$\ln Y_{jhft} = \sum_{c}^{N_c} \beta_c \ln(1 + Duty^c_{jhft}) + \nu_{jhf} + \nu_{jht} + \nu_{hft} + \epsilon_{jhft}, \tag{5}$$

with $c \in \{EU, US, other\}$, where $\ln Y_{jhft}$ is the natural logarithm of export value, price or quantity at the destination country-product-firm-time level, and $Duty^c_{hfjt}$ is the AD duty (value added). As we want to know whether the effects of AD duties vary by duty imposing countries, we nest AD duties by imposing countries.[13] ν_{jhf}, ν_{jht} and ν_{hft} are country-product-firm, country-product-time and product-firm-time fixed effects,[14] respectively and ϵ_{jhft} is an error term.

The fixed effects are motivated by the firm-level gravity equation (4), which informs

[12] Blonigen and Park (2004) argue that firms typically act under uncertainty as the imposition of AD duties also depends on factors exogenous to the exporter such as the industry structure and the strength of lobbies in the importing country. Sandkamp (2018) shows that export prices of non-targeted exporters increase following the imposition of AD duties against exporters in other countries. In the context of this model, this could constitute probability updating of firms' regarding AD duties.

[13] Nesting is chosen over the alternative of running separate regressions for each country and product group in order to allow for better comparability of estimated coefficients and enable testing for equality.

[14] To implement all three-dimensional fixed effects simultaneously, we use the STATA command "reghdfe" provided by Correia (2016).

us about potential sources of omitted variable bias. In the model, AD duties imposed against China vary by product, firm, destination country and time. Hence all explanatory variables varying across the same dimensions should be examined closely. In particular, we can divide the variables on the right hand side of the equation into demand side and supply side variables. Demand side variables are μ_{hj}, Y_{jt} and P_{hjt}. It is reasonable to assume that these may vary with the AD duty T_{hfijt} as higher imports - which may or may not be caused by dumping - may increase the probability of an AD duty being implemented as well as its size. Bown and Crowley (2013) show that the likelihood of AD duties increases with the size of import.

Not accounting for demand side effects may thus lead to an underestimation of the true treatment effect. To see this, consider a standard difference-in-differences approach as employed by Lu et al. (2013), in which the change in exports of the treatment group is compared to the change in exports of the control group. This methodology relies heavily on the common trends assumption. If products subject to AD are characterized by larger underlying growth rates than the control group, it is possible that export growth of these treated products is lower than it would be without the AD duty but still higher than that of the control group. The estimated treatment effect would be smaller than the true treatment effect.

Lu et al. (2013) approach this problem by using a synthetic control group. Instead of using the entire population of exports as the control group, the authors use only exports of HS6 products that are in the same HS4 product group as the treated goods subject to AD duties.[15] They thus examine how treated exports react to AD duties relative to similar products. While this should reduce the bias, we show further down that it is by no means eliminated.

Instead of using a synthetic control group, our data structure allows us to control for demand side variables directly using country-product-time fixed effects, which completely eliminates the bias. This is possible because of the different AD duties faced by MET (IT) and NMES exporters. It means that different firms exporting the same product to the same country receive different duties, allowing the exploitation of within product across firm variation to estimate the treatment effect. If all firms exporting the same product received the same duty, it would be impossible to control for time varying factors specific to country-product combinations.[16] Country-product-time fixed effects also take into account time-varying multilateral resistance terms (Feenstra, 2008) which is necessary

[15]The authors also construct an artificial control group using matching. However the estimated coefficients are very similar.

[16]As we only have information on firm-specific duties for the EU and the US, we can only estimate treatment effects for these two economies. In other specifications we are less restrictive to allow treatment effects of AD duties imposed by other countries to be estimated.

since the sample includes several destination countries.

Beyond our fixed effects specification it is essential to control for firm-specific AD duties. Figure 1 below illustrates that MET (IT) duties are significantly lower than NMES duties. Incorrectly assigning the higher product wide duty to firms that in reality receive lower duties due to MET (IT) would lead to attenuation bias and thus an underestimation of the treatment effect. Given the non-negligible market share of these firms (Figure A.2 in the Appendix), distortions caused by not controlling for MET (IT) duties may be significant.

Regarding the supply side, costs c_{hfit} including potential product or even firm-specific subsidies and productivity φ_{ihft} can be controlled for using product-firm-time fixed effects. All other explanatory variables vary at a higher level of aggregation and are thus also controlled for. Given China's transition from cheap manufacturing goods to more advanced products, product-firm-time fixed effects also enable us to control for product-specific time trends.

A final source of bias needs to be discussed. In their firm-level estimation, Lu et al. (2013) only control for product and time fixed effects (the country dimension is redundant since they only use Chinese exports to the US). While this approach constitutes the desired difference-in-differences specification at the product-level, it does not represent a time invariant dummy identifying the treatment group at the firm-level. Instead, the product fixed effect captures several firms receiving differential treatment. The result is a biased estimator of the duty coefficient. This is because firms receiving product-specific treatment are subject to larger AD duties (Figures 1 and A.1 in the Appendix) and have, on average, lower export volumes than firms subject to individual firm-specific AD duties (Figure A.3). The AD duty may thus simply identify firms that were smaller to begin with rather than a causal effect, resulting in an overestimation of the intensive margin effect of AD duties on firm exports. A proper difference-in-differences estimation hence also requires country-product-firm fixed effects. The estimated coefficient of the AD duty tells us how a given firm changes its exports of a particular product to a particular country, if this product becomes subject to AD duties.

Finally, Equation 4 also suggests that different products react differently to AD duties as σ_{hj} can be product-specific.[17] We therefore also nest AD duties by sector.[18] Here it is particularly important to control for country-specific product-time trends, as otherwise

[17]Beyond the Melitz model, in the Melitz and Ottaviano (2008) framework, Bagwell and Lee (2015) show that individual exporter responses to tariffs depend on several parameters, including the distribution of marginal cost, transport cost, firm-specific marginal costs, degree of product differentiation between varieties and entry costs. As these parameters differ across industries (Cebeci and Fernandes, 2012; Bremus et al., 2013; Spearot, 2013), AD duty elasticities are very likely to vary across different industries within a country, as well as across firms and duty imposing countries.

[18]A list of sectors is provided in Table A.1 in the Appendix.

there is a risk that our treatment variables simply capture sector-specific trends. The corresponding estimation specification is

$$lnY_{jhft} = \sum_{c}^{N_c} \sum_{sector=1}^{N_{sector}} \beta_c \ln(1 + Duty_{jhft}^{c,sector}) + \nu_{jhf} + \nu_{jht} + \nu_{hft} + \epsilon_{jhft}, \quad (6)$$

where $c \in \{EU, US, other\}$.

3.2 Data and stylised Facts

We use annual export data at the firm-product-destination-country (HS8 digit) level for the years 2000 – 2009, provided by the Chinese customs office. From this dataset we use exports to 193 countries, 22 of which impose AD duties against China.[19] Information on bilateral AD duties comes from the World Bank's Global Anti-Dumping Database (Bown, 2015), from which we extract information for 330 AD cases against China, including 51 US AD cases as well as 43 EU cases. These are only cases that received a final AD duty.[20] AD duties can be at the HS6, HS8 or HS10 (US only) digit level.

As products are comparable only at the HS6 digit level (Lu et al., 2013; Bown and Crowley, 2016), we match the two datasets at this level of aggregation. At this level of aggregation, there are 523/129/91 treated HS6 products subject to global/US/EU AD duties.[21] Tables A.1, A.2 and A.3 in the Appendix provide summary statistics.

The firm-level analysis requires information on firm-specific AD duties. We merge firm-specific duties with exports using firm names. As the export dataset has firm names in Chinese characters, whereas firm names in the AD dataset are in English, some information is lost in the translation process. Overall, we have successfully matched 69% (711) of Chinese firms subject to US AD duties and 84% (192) of Chinese firms subject to EU AD duties.

Panel (a) of Figure 1 summarizes average AD duty rates imposed against China by the EU and the US. It illustrates the difference in average AD duty levels between the US (156%) and the EU (42%). One reason for this difference is the so called lesser duty

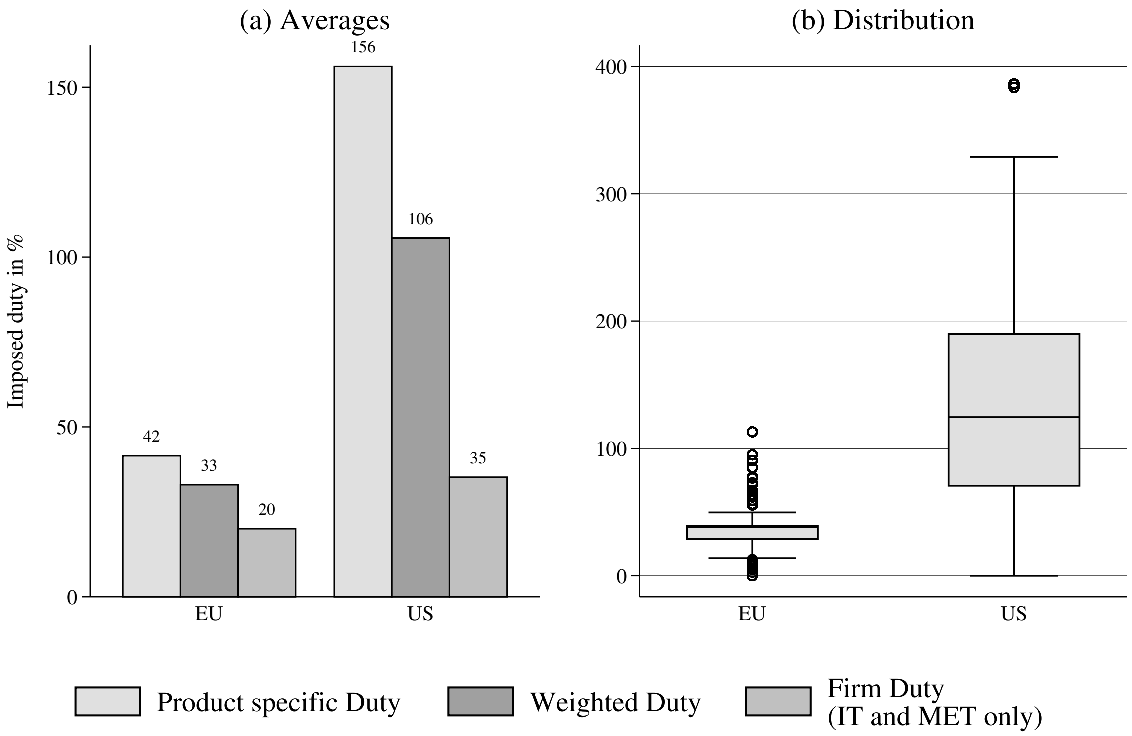
[19] These are Argentina, Australia, Brazil, Canada, Columbia, the EU, Indonesia, India, Israel, Jamaica, Japan, Korea, Mexico, New Zealand, Pakistan, Peru, Thailand, Trinidad and Tobago, Turkey, Taiwan, the US and South Africa.

[20] EU AD investigations against China may also result in the imposition of alternative trade barriers such as negotiated price undertakings (Bown and Crowley, 2016; Crowley and Song, 2015). The share of such cases in EU AD proceedings against all exporters has however decreased from 41% in 1981 - 2001 to 21% in 2002 - 2012 (Steinbach, 2014). Regarding imports from China, only 9% of investigations resulted in the impositions of price undertakings between 2002 and 2012. These are excluded from the sample.

[21] If products are treated at the HS8 product-level but we only observe trade flows at the HS6 level, we might underestimate the true treatment effect due to aggregation bias. Lu et al. (2013) show that aggregation bias is not problematic in this context.

rule applied by the EU which means that the AD duty is equal either to the dumping margin or to the injury margin of domestic companies, whichever is lower. Since the injury margin is often below the dumping margin, this practice results in lower duties. The same is true across all treated HS6 products (Figure A.1 in the Appendix). Hence, it is worth investigating the role played by this difference in duty rates when it comes to their effect on Chinese exporters.

Figure 1: AD Duty Rate against China in the EU and the US



Note: Panel (a): "Product-specific Duty" is the unweighted mean of country-wide duty levels over all affected HS6 products; "Weighted Duty" is the mean of firm-specific duty levels weighted by export value in USD; "Firm Duty (IT and MET only)" is the unweighted mean of firm-specific duties over all firm-product combinations receiving individual or market economy treatment; Panel (b): Boxplots show the distribution of ad valorem AD duties across all Chinese exporters to the EU and the US.

However, this difference is only so extreme for product-specific duties (imposed against firms with NMES). Average duties against firms receiving IT or MET are closer together (35% US and 20% EU).[22] It is thus worth looking at the effectively applied duty rate, i.e. the mean duty across all exporting firms, weighted by their export value in USD. This is also considerably below the simple product duty mean. The difference is more pronounced for the US because there are more firms receiving some form of individual

[22]Our data does not allows us to differentiate between MET and IT.

treatment per AD case in the US (3 firms per treated HS6 product) than in the EU (1). Consequently, average applied AD duties, weighted by export values, are only 106% for the US and 33% for the EU. This is also reflected in the distribution of duties across firms (Panel (b) of Figure 1). The median duty is 38% for the EU and 124% for the US.

4 Results

4.1 Endogeneity of AD Duties

In Sections 2 and 3, we stressed the importance of applying the correct fixed effects specification in order to address several sources of omitted variable bias. We now show that not doing so indeed biases the estimated coefficients. In order to do this, we start by replicating the results estimated by Lu et al. (2013).[23] The authors investigate monthly exports from China to the US in the years 2000 - 2006 to estimate effects of the different stages of an AD investigation. These are the initiation of the case (a dummy indicating whether an investigation has been launched), a preliminary duty (temporary pending the final result of the investigation) that is the same for all firms exporting the affected product and a final duty that may be firm or product-specific. The authors limit the control group to only include HS6 products that are in the same HS4 product category as products subject to AD duties.[24] Finally, the authors estimate semi-elasticities, regressing the log of exports on the duty rate.[25]

Column (1) of Table 1 replicates the firm-level estimation results by Lu et al. (2013). It reports results from regressing firm export values in USD on the three AD variables as well as product and firm fixed effects. The initiation coefficient is not significantly different from zero, indicating that launching an AD investigation does not affect export value. The estimated coefficient of preliminary (final) duties is significantly negative, indicating that a one percentage point increase in preliminary (final) AD duties reduces firm-level exports of the affected product by 0.08% (0.26%). All coefficients are comparable to Lu et al. (2013).[26]

[23]Note that their sample differs from our preferred sample. To ensure replicability of their results, we use the sample investigated by Lu et al. (2013) in this subsection and switch to our preferred sample in the next subsection.

[24]They also construct an alternative control group using matching. However, the estimated coefficients are very similar.

[25]In line with our model our preferred specification estimates elasticities. However, for better comparison with the results of Lu et al. (2013), we stick to semi-elasticities for now.

[26]The initiation coefficient in Lu et al. (2013) is negative but insignificant. The coefficient for preliminary duties is identical. The coefficient for final duties is slightly less negative. However, we would not expect a perfect match for the final duty coefficient as this depends on the successfully merged firm-specific duties which most likely will not be the same. The coefficients are however in the same order of

Table 1: The Effect of AD Duties on Firm Export Value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Importers	US only	US only	US only	US only	US only	US only	US only	all countries	all countries
Products	HS4 control	HS4 control	HS4 control	HS4 control	HS4 control	HS4 control	HS4 control	all products	all products
Initiation	0.0025	-0.0950***	-0.0061		-0.0341				
	(0.0268)	(0.0348)	(0.0251)		(0.0369)				
Preliminary	-0.0008***	-0.0013***	-0.0000		-0.0006***				
AD Duty	(0.0002)	(0.0002)	(0.0002)		(0.0002)				
Final	-0.0026***	-0.0027***	-0.0003*	-0.0118***	-0.0014***	-0.0023***	-0.0026***	-0.0017***	-0.0435**
AD Duty	(0.0002)	(0.0003)	(0.0002)	(0.0008)	(0.0003)	(0.0005)	(0.0007)	(0.0005)	(0.0181)
Observations	707,100	406,718	406,718	406,718	406,718	406,718	406,718	28,558,296	28,145,387
R^2	0.1734	0.1405	0.6952	0.1617	0.5452	0.7071	0.8150	0.8339	0.8347
Product FEs	YES	YES	NO	NO	YES	NO	NO	NO	NO
Time FEs	YES	YES	YES	NO	NO	NO	NO	NO	NO
Product-Firm FEs	NO	NO	YES	NO	NO	YES	YES	YES	YES
Product-Time FEs	NO	NO	NO	YES	NO	YES	YES	YES	YES
Firm-Time FEs	NO	NO	NO	NO	YES	NO	YES	YES	YES
Clusters	127,658	41,725	41,725	41,725	41,725	41,725	41,725	3,656,326	3,618,802

Note: Dependent Variable: ln firm export value in USD. AD Variables: Initiation (dummy) preliminary and final AD duty rate in percent; Surviving firms only. (8) and (9): EU and other countries' duties controlled for but not reported. (9): Product-specific duties excluded. Robust standard errors clustered by (Country-)Product-Firm in parenthesis, Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs in (8) and (9). *** p<0.01, ** p<0.05, * p<0.1.

As discussed in Sections 2 and 3, we suspect this estimation to be subject to two main biases. As our preferred fixed effects estimation is more restrictive, it reduces the sample size as some observations get kicked out. In order to ensure that our results are not driven by differences in sample composition, we start by running the Lu et al. (2013) specification on our restricted sample. The results are presented in Column (2) of Table 1. While the initiation coefficient now becomes negative and significant, coefficients for preliminary and final duties remain similar in magnitude.

The next step is to perform a correct difference-in-differences estimation, replacing product fixed effects with product-firm fixed effects to take into account unobserved product-firm characteristics. This allows for a causal interpretation of the coefficients as the AD variable now identifies how a given firm changes exports of a particular product if this product is subject to AD duties. There is no "selection" in the sense that AD duties identify firms with smaller export values as was the case in Specifications (1) and (2).

The results are reported in Column (3). The first thing to note is the much larger R^2 statistic (0.7) compared to Specification (2) (0.14). This confirms that - unsurprisingly - a lot of variation in firm export sales is explained by firm characteristics. All three AD coefficients are much smaller in magnitude than those presented in Column (2). While the initiation and preliminary AD duty coefficients turn insignificant, the final duty co-

magnitude.

efficient remains significant but is only one ninth the size of the estimated coefficient in Specification (2). This result shows that the specification performed by Lu et al. (2013) indeed suffers from omitted variable bias, leading to an overestimation of the treatment effect.

Following our model, we suspect another bias stemming from the omission of demand-side variables. To address this, we control for product-time fixed effects in Specification (4). Coefficients for initiation and preliminary duties cannot be estimated as these variables do not vary across firms exporting the same product. Comparing the estimated coefficient of final duties with the estimate by Lu et al. (2013) in Column (2) shows that controlling for product-time fixed effects increases the magnitude of the coefficient by a factor of five. This is again evidence for an omitted variable bias in Specification (2), this time resulting in an underestimation of the true treatment effect.

Our model also suggests the use of product-firm-time fixed effects. As the sample used by Lu et al. (2013) only includes one destination country, using product-firm-time fixed effects would eliminate all variation in AD duties and exports. However, it is possible to control for firm-time fixed effects, which we do in Specification (5). Relative to Column (2) coefficients halve in size. Once we have seen the effects of adding the three different fixed effects, Column (7) shows regression results of controlling for all three simultaneously.[27]

Having demonstrated the importance of controlling for the three sets of fixed effects using the Lu et al. (2013) sample, we can introduce the destination country (henceforth country) dimension and increase product scope. Rather than just using Chinese exports to the US, we now include exports to all countries in our dataset. We also include all traded HS6 products. We then perform a regression similar to those in Specification (7) with a few important adjustments. Since we now have a country dimension, our panel variable is the country-product-firm combination. As suggested in Sections 2 and 3, we now control for country-product-firm, country-product-time, and product-firm-time fixed effects. Note that while the country dimension was redundant in Specification (1) to (7), and country-product-firm and country-product-time fixed effects are merely the equivalent to product-firm and product-time fixed effects with a single country pair, the additional dimension allows us to control for product-firm-time, rather than just firm-time fixed effects. The regression results are reported in Column (8). While smaller in magnitude, the final duty coefficient is not significantly different from that in Column (7).

A final problem is measurement error. As described in Section 3, AD duties can be product or firm-specific. While product-specific duties can be assigned via HS code, firm-

[27]Comparing Columns (6) and (7) shows that once product-firm and product-time fixed effects are controlled for, adding firm-time fixed effects does not change the AD coefficients. However, it does increase the R^2.

specific duties are more difficult to assign without identifiers, leading to matching rates of less than 100%. If a firm receives a (low) firm-specific duty but is not matched in the data set, it is incorrectly assigned a (high) product-specific duty. The estimated coefficient suffers from attenuation bias and constitutes an underestimation of the true treatment effect. In order to eliminate this bias, we hence exclude all firm-product combinations that received product-specific treatment.[28] The estimation results are presented in Column (9). As may be expected, the coefficient increases dramatically in size.

4.2 Baseline Results

We now move on to our baseline specification (estimating elasticities rather than semi elasticities) using annual exports for the years 2000 - 2009.[29] We switch from monthly to annual data for two reasons. First of all, transactions for the years 2007 - 2009 are only availably at an annual level. Since a lot of AD investigations were launched in this period (especially in the EU), this provides a lot of additional variation for identification of the treatment effect. Second, most firms do not export every month, so that most firms are only observed infrequently. Aggregating up to the annual level provides a more balanced panel. The disadvantage of using annual data is that we cannot differentiate between initiation, preliminary and final duties any more, since all three stages typically take place within one year. Given that our estimation strategy precludes the estimation of treatment effects for initiation and preliminary duties anyway, forgoing the monthly dimension does not affect our ability to estimate a treatment effect.

Table 2 presents our baseline results estimated using Equation (5). Column (1) shows that Chinese firm exports fall following the imposition of AD duties. In particular, a one percent EU (US) AD duty increase is associated with a 7.5% (4.8%) fall in exports.[30] Within the model, this correlation can be interpreted to be causal. Despite the difference in magnitude, EU and US coefficients are not statistically different from each other, indicating that exports to the EU do not react more sensitively to the imposition of AD duties than exports to the US.

[28]This procedure also tackles aggregation bias. Some AD duties are assigned at a more disaggregated level than HS6, so that a treated HS6 product may actually include untreated HS8 products. This problem is reduced when focusing on duties that are specific to product-firm combinations.

[29]The regressor is thus $\ln\left(1 + \frac{Duty\ rate\ in\ \%}{100}\right)$.

[30]Given that these elasticities are estimated using within product across firm variation, it is not surprising that they are larger than if estimated at a more aggregated level. The results are broadly in line with the literature on trade elasticities (Caliendo and Parro, 2014).

Table 2: Firm Level Estimation - Elasticities - Firm-specific Duties only

	(1)	(2)	(3)
Dependent Variable	ln value	ln price	ln quantity
AD Duty EU	-7.5353***	-0.3997	-7.1355***
	(1.5936)	(0.3246)	(1.6494)
AD Duty US	-4.7992***	-0.0628	-4.7364***
	(1.5762)	(0.2734)	(1.5368)
EU = US (p value)	0.2207	0.4224	0.2851
R^2	0.8413	0.9586	0.8787

Note: AD Variable: ln (1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms and firms exporting before treatment only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 17,995,095 observations, 5,381,311 clusters

The second column of Table 2 presents price effects. In line with the optimal pricing rule in Equation (2), we find no effect of AD duties on producer prices. This indicates 100 % pass-through, meaning that AD duties are fully passed on to consumers. The final column in Table 2 presents quantity effects. It can be seen that these are very similar in magnitude to value effects, indicating that adjustments in firm export values are primarily driven by adjustments in quantity rather than adjustments in prices. Given that the coefficients in Columns (1) and (3) are both estimates of the price elasticity of demand, it is not surprising to see them being not significantly different from each other.

4.3 The Role of Firm Size

In Section 3 we have already shown that small firms are more likely to receive product-level - and thus larger - AD duties than large ones. Now we are also interested if firms of different size react differently to the imposition of AD duties. For each destination country and year, we therefore rank firm-product combinations by export value and divide them into three categories of equal size (small, medium and large). These are then interacted with AD duties.

Columns 1 and 3 of Table 3 show that the effect of AD duties on export value and quantity declines with firm size, indicating that large firms react less sensitively to AD duties than small firms. The difference between the coefficients for the individual size clusters is statistically significant

Table 3: Duty interacted with Firm Size

	(1)	(2)	(3)
Dependent Variable	ln value	ln price	ln quantity
AD Duty EU x small	-14.7694***	-0.2613	-14.5080***
	(2.0719)	(0.5658)	(2.0844)
AD Duty EU x medium	-11.2412***	0.0450	-11.2861***
	(1.7196)	(0.3850)	(1.7827)
AD Duty EU x large	-5.3170***	-0.5967*	-4.7203***
	(1.5223)	(0.3239)	(1.5445)
AD Duty US x small	-12.1460***	-0.1615	-11.9845***
	(2.7361)	(0.4834)	(2.7199)
AD Duty US x medium	-7.5355***	0.0557	-7.5912***
	(2.0890)	(0.2627)	(2.0661)
AD Duty US x large	-3.5262*	-0.0690	-3.4572*
	(1.9722)	(0.2744)	(1.9440)
R^2	0.8408	0.9586	0.8783

Note: AD Variable: ln (1 + AD Duty Rate/100) interacted with firm size clusters. Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms and firms exporting before treatment only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 18,060,430 observations, 5,396,449 clusters.

Price effects reported in Column (2) are insignificant for all size clusters except for large firm exporting to the EU. Here the coefficient is significantly negative, indicating that these firms absorb parts of the AD duty.

Against the background of the correlation between firm size and productivity observed in the literature, this implies that given the same AD duties, productive firms' exports decline by less than those of less productive firms. Taken together with the aforementioned negative correlation of firm size and AD duties, AD action may intensify competition as productive exporters expand relative to less productive ones.

4.4 Decomposition: Extensive versus Intensive Margin

Next we want to see how results at the firm-level extend to the product-level. The change in total exports at the product-level X_{jht} can be decomposed into a change in the number of exporters exporting a particular product to a particular country n_{jht} (extensive margin) as well as a change in the average firm export value (intensive margin) which in turn can be decomposed in the change in average export prices $\bar{p}_{jht}$ and quantities $\bar{q}_{jht}$:

$$\ln X_{jht} = ln\ n_{jht} + ln\ \bar{p}_{jht} + ln\ \bar{q}_{jht}.$$

As both dependent variable and AD duties now only vary across country, product and time, we have to adjust our estimation strategy. As we can no longer use firm-specific AD duties, we need to use one single AD duty per affected HS6 product. One possibility is to use the product-specific duty. This may however lead to attenuation bias as the product-level exports would incorporate exports of firms receiving low duties. As these will be larger than they would be if these firms had received the higher product wide duty, incorrectly associating high export - low duty firms with the high duty through aggregation would underestimate the treatment effect.

An alternative which we will use henceforth is to calculate an average AD duty over all firms exporting a given product at a point in time, weighted by the firm's export value.[31] We also have to adjust our fixed effects as the firm dimension disappears. We hence use country-product (the panel identifier), country-time and product-time fixed effects. It can be seen directly that the country dimension allows us to control for product-time fixed effects, something that is not possible when restricting the sample to a single country pair. Nevertheless, there may still be omitted variable bias following the omission of country-product-time specific demand side control. We hence do the next best thing and use country-HS4-time fixed effects to at least account for country-specific product group trends. It provides a proxy for time varying transport costs of certain kinds of goods as well as the strength of lobbying groups in a particular industry in the destination country.

Table 4 presents regression results for each of the components. Column (1) shows that a one percent increase in EU (US) AD duties is associated with a 1.4% (1%) reduction in Chinese exports of the affected product. Not surprisingly, the elasticities estimated across HS6 products are smaller than those estimated within HS6 products as the degree of competition declines. Column (2) provides the estimated coefficients of a regression of the log of the number of exporters on AD duties. Coefficients for the EU and the US are both negative and statistically significant, indicating that AD duties drive out exporters. Column (3) looks at the effect of AD duties on average firm export prices. EU and US coefficients are both not statistically different from zero. Finally, Column (4) shows the effects of AD duties on average firm export quantity. Both EU and US coefficients are negative and significant, confirming that aggregate results are driven by

[31] A potential problem with this approach is an automatic adjustment of the duty downwards as high duty firms reduce exports or exit the market and low duty firms expand. In a robustness check, we thus also use product wide duty rather than a weighted average. As expected, the estimated coefficients are slightly smaller in magnitude but remain similar.

changes in average export quantity rather than by changes in average export prices.

Table 4: Decomposition: Extensive versus Intensive Margin

	(1)	(2)	(3)	(4)
Dependent Variable	ln value	ln no. firms	ln mean price	ln mean quantity
Duty EU	-1.4391***	-0.8409***	0.0844	-0.6826**
	(0.3771)	(0.1306)	(0.1594)	(0.3197)
Duty US	-1.0051***	-0.3792***	0.0319	-0.6578***
	(0.1695)	(0.0525)	(0.0600)	(0.1583)
Duty other	-0.3764***	-0.1771***	0.0311	-0.2304***
	(0.0964)	(0.0485)	(0.0445)	(0.0850)
EU = US (p value)	0.2940	0.0010	0.7578	0.9447
R^2	0.8860	0.9454	0.9500	0.9074

Note: AD Variable: ln (1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 Observations; 293,660 clusters.

4.5 The overall Effect of AD Duties

The elasticities presented in Table 4 only show how sensitive Chinese exports react to the imposition of AD duties. They fail to show the overall impact, as this also depends on the magnitude of the AD duties which was shown to differ dramatically between the US and the EU. We thus also regress export values, prices and quantities on dummies that indicate if a duty is in place against a particular product at a certain point in time. The estimated coefficient captures both the elasticities as well as the magnitude of the duty.

The estimation results are provided in Table 5. Estimated effects of AD duties on export value (1), the number of exporters (2) as well as mean export quantity (4) remain significantly negative. However, once the magnitude of the AD duties is taken into account, EU and US duty coefficients switch places. As can be seen in Columns (1), and (4), US coefficients are now significantly larger in magnitude than EU coefficients, indicating that once the size of the duty is taken into account, US duties have a stronger trade dampening effect than EU duties. The coefficients in Column (1) can be interpreted in the way that on average the imposition of EU (US) AD duties tends to reduce exports of affected products by $100 * (e^{\beta} - 1)\% = 41\%$ (62%). Hence while the larger average US AD duties mean that the US is overall more effective in reducing Chinese imports than the EU, the larger EU elasticity as well as the greater number of firms receiving individual treatment in the US mean that the difference is not as big as may be inferred from only looking at the difference in product-level duty rates (Figure 1 above). Price effects in Column (3) remain insignificant for the EU and the US, while they turn positive and significant for other countries.

Table 5: Decomposition - Extensive versus Intensive Margin, overall Effect

	(1)	(2)	(3)	(4)
Dependent Variable	ln value	ln no. firms	ln mean price	ln mean quantity
Duty Dummy EU	-0.5196***	-0.2970***	0.0112	-0.2338**
	(0.1333)	(0.0483)	(0.0473)	(0.1168)
Duty Dummy US	-0.9574***	-0.3560***	0.0352	-0.6366***
	(0.1555)	(0.0489)	(0.0528)	(0.1452)
Duty Dummy other	-0.4899***	-0.2413***	0.0692**	-0.3178***
	(0.0788)	(0.0322)	(0.0286)	(0.0694)
EU = US (p value)	0.0327	0.3908	0.7349	0.0305
R^2	0.8860	0.9454	0.9500	0.9074

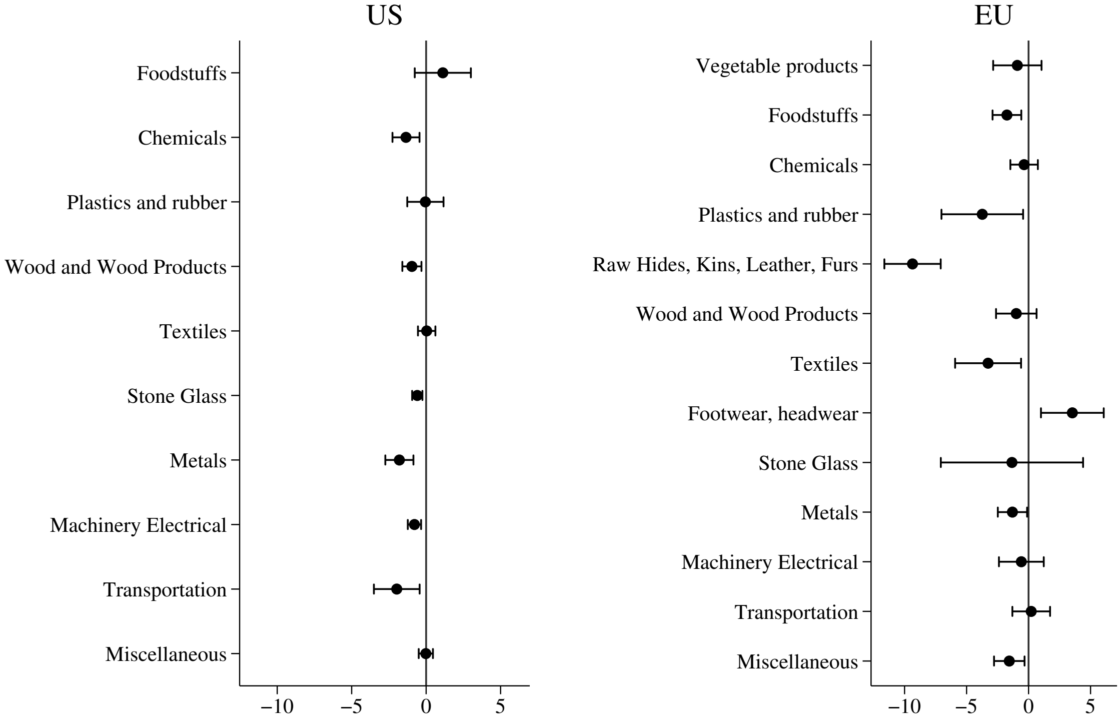
Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

4.6 Trade effects by Sector

It was suggested that exports in different sectors may react quite differently to AD duties. Following Equation (6), AD duties are nested by sector to obtain sector-specific coefficients. Figure 2 summarizes the regression results for US and EU duties at the product-level.[32] The figure reveals that aggregate elasticities hide significant heterogeneity across sectors. The results for the EU in the right panel of Figure 2 show that EU imports react very differently to AD duties compared to US imports.[33]

[32] For a full list of affected sectors see Table A.1 in the Appendix.
[33] The positive coefficient for EU Footwear and headwear products is driven by entry.

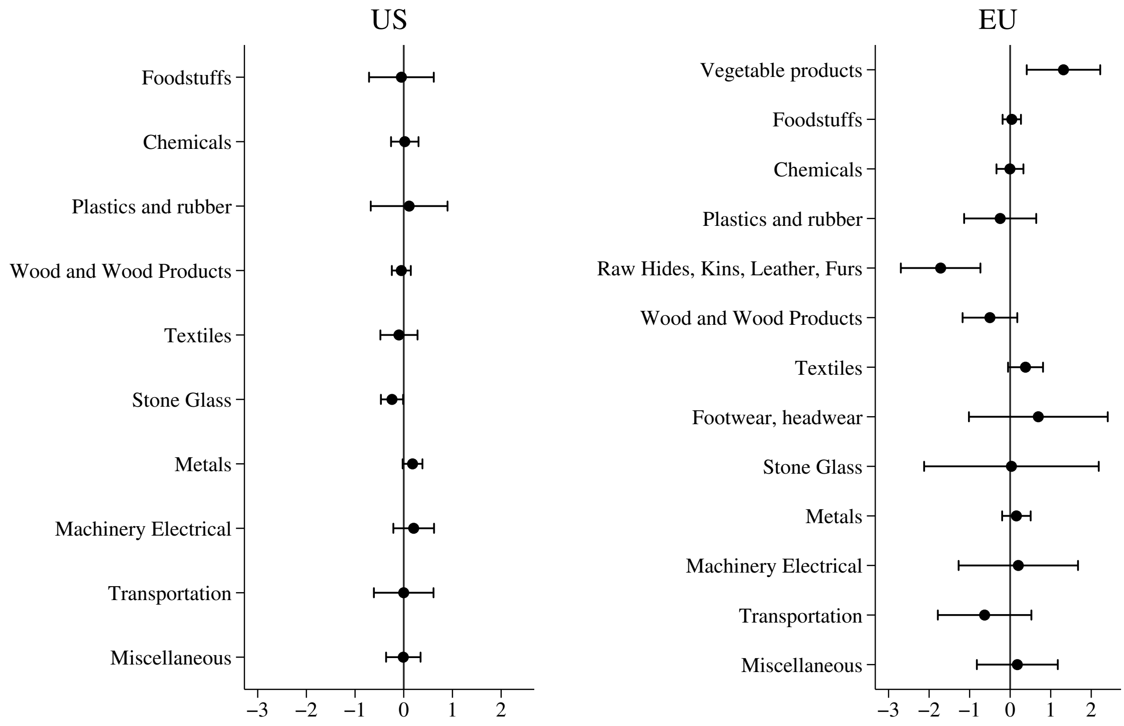
Figure 2: The Effect of AD Duties on Export Value, nested by Sector



Note: Regression of ln exports on ln (1 + Trade weighted AD Duty Rate/100), Country-Product, Country-HS4-Time and Product-Time FEs. Robust standard errors clustered by Country-Product. 293,660 clusters. 1,765,887 observations. Vertical line corresponds to zero. Sorted by sector classification.

Figure 3 shows that price effects are absent in most sectors. However, average prices rise following EU AD duties in the footwear sector and fall in the metals sector. The findings suggest that Chinese exporters react differently to duties in different sectors. One possible explanation for the positive coefficients observed in some sectors could be that these sectors either have a lot of firms receiving MET or that they are dominated by a few large exporters that are able to collude and jointly increase prices in order to reduce AD duties in subsequent periods.

Figure 3: The Effect of AD Duties on average Export Price, nested Sector



Note: Regression of ln average export price on ln (1 + Trade weighted AD Duty Rate/100), Country-Product, Country-HS4-Time and Product-Time FEs. Robust standard errors clustered by Country-Product. 293,660 clusters. 1,765,887 observations. Vertical line corresponds to zero. Sorted by sector classification.

4.7 Trade Deflection

In order to investigate the effect of a country's AD duties on Chinese exports to other countries (trade deflection), we regress Chinese export values, prices and quantities to countries other than the EU and the US on duties imposed by the EU and the US, while still controlling for the importing country's own duties.[34] As before, we restrict our sample to firms surviving the treatment, i.e. exporting to at least one country following the introduction of the AD duty.

Table 6 presents the results. The estimated value and quantity effects of EU (US) AD duties on exports to the EU (US) are similar in magnitude to those presented in Table 2. However, we do observe a significantly negative price coefficient for EU duties, indicating that Chinese firms reduce export prices to the EU following the imposition of EU AD duties. Looking at the effects of EU and US AD duties on firm-level exports to third countries, we do not find significant effects, indicating that firms do not adjust their

[34]Exports to the US are also regressed on EU duties and vice versa.

exports to third countries following the imposition of AD duties in the EU or the US.

Table 6: The Effect of AD Duties on Firm Exports to third Countries

	(1)	(2)	(3)
Dependent Variable	ln value	ln price	ln quantity
Duty EU	-7.2399***	-0.6991**	-6.5408***
	(1.7201)	(0.3452)	(1.7752)
Duty US	-4.9281***	-0.1941	-4.7340***
	(1.7262)	(0.2965)	(1.6899)
Duty EU 3rd	0.2902	-0.2152	0.5054
	(0.5387)	(0.1373)	(0.5593)
Duty US 3rd	-0.0839	0.0353	-0.1192
	(0.1307)	(0.0392)	(0.1298)
EU 3rd = US 3rd (p)	0.4998	0.0793	0.2766
R^2	0.8411	0.9597	0.8791

Note: AD Variable: ln (1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms and firms exporting before treatment only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 16,737,202 observations, 4,957,495 clusters clusters

We also examine trade deflection at the product-level, differentiating between extensive and intensive margin. As in Table 4, the dependent variable is regressed on ln (1 + Trade weighted AD Duty Rate/100). Given the way the variables "Duty EU 3rd" and "Duty US 3rd" are constructed, we however have to adjust our fixed effects specification. If a US AD duty is in place at a particular point in time against a particular product, the variable "Duty US" takes on the ln duty rate for exports to the US and zero to all other countries. At the same time, the Variable "Duty US 3rd" takes on the ln duty rate for exports to all other countries and zero for exports to the US. Consequently, given an AD duty is in force at a particular point in time for a particular product, the two variables "Duty US" and "Duty US 3rd" are perfectly collinear at the product-time dimension. Consequently, we cannot control for product-time fixed effects any more as this would lead to one of the two variables dropping out. For the same reason, we move from using country-HS4-time fixed effects towards using country-sector-time fixed effects.

Table 7 reports the results. Estimated coefficients for the direct effects of EU and US AD duties are similar to those provided in Table 4. One notable difference is the significantly positive coefficient of the EU duty in Column (3), indicating that average export prices to the EU rise following the imposition of EU AD duties. Combined with the negative EU coefficient in Column (2) of Table 6, this indicates that while surviving firms reduce export prices, AD duties may drive low price firms out of the market which may be expected if these receive higher duties.

Table 7: The Effect of AD Duties on Exports to third Countries - Decomposition

	(1)	(2)	(3)	(4)
Dependent Variable	ln value	ln no. firms	ln mean price	ln mean quantity
Duty EU	-1.2524***	-0.6632***	0.2977**	-0.8869***
	(0.3460)	(0.1729)	(0.1507)	(0.3244)
Duty US	-0.8164***	-0.2060***	-0.0301	-0.5804***
	(0.1912)	(0.0721)	(0.0531)	(0.1639)
Duty other	-0.5762***	-0.2609***	0.0303	-0.3456***
	(0.0911)	(0.0561)	(0.0405)	(0.0698)
Duty EU 3rd	0.1461***	0.1199***	0.1208***	-0.0946**
	(0.0447)	(0.0219)	(0.0219)	(0.0384)
Duty US 3rd	0.2114***	0.1704***	-0.0947***	0.1357***
	(0.0166)	(0.0077)	(0.0089)	(0.0155)
EU 3rd = US 3rd (p)	0.1799	0.0326	0.0000	0.0000
R^2	0.8012	0.8815	0.9151	0.8439

Note: AD Variable: ln (1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product and Country-Sector-Time FEs. 2,101,917 observations; 351,684 clusters.

Regarding third country effects, Column (1) shows that higher EU and US duties increase Chinese exports to other countries. This is evidence of trade deflection and in line with findings by Chandra (2016), who finds evidence of trade deflection with regard to US trade barriers against Chinese exporters. The extensive margin effects are reported in Column (2). They give evidence that firms tend to start exporting to new markets following the imposition of EU and US AD duties. This suggests that the decision of market entry is not independent across markets but may depend on capacity. Effects of US duties on average firm prices and export quantities to third countries are as expected. Average export prices to third countries fall (Column (3)) along with rising average export quantities to third countries following the imposition of US AD duties. This may indicate increased dumping activity to third countries, although we fail to find evidence for this at the firm-level.

For the EU, mean price and quantity coefficients have the opposite signs. It is however unclear whether firms exposed to EU duties increase prices and hence experience falling demand in third countries to avoid investigations in those countries. Since we do not find evidence for this at the firm-level, a selection effect is more likely, meaning that high price firms with lower sales enter new markets, thus driving average prices up and average export quantity down.

4.8 The EU Enlargement 2004 - A Natural Experiment

As demonstrated above, using an elaborated fixed effects strategy reduces omitted variable bias at the firm-level. Nevertheless, the risk of endogeneity due to reverse causality (large exports increasing the probability of receiving AD duties or their level) may not be completely eliminated, especially at the product-level. In this subsection, we hence propose a strategy based on Sandkamp (2018) to ensure exogeneity of the AD treatment also at the product-level. Namely, we use the enlargement of the European Union in 2004 as a natural experiment. When the ten accession countries joined the EU,[35] they also adopted the EU's tariffs and AD duties. Under the plausible assumption that these countries did not join the EU because of its AD policy, the treatment can be seen as exogenous from the perspective of the new member states.

Using a sub-sample of product-level exports to the ten EU accession countries for the years 2003 and 2005 (symmetric around the accession), we hence conduct a difference-in-differences estimation (Equation 7). ln exports are regressed on a time dummy (zero in 2003 and one in 2005), an AD dummy identifying the treatment group which is equal to one if the product is subject to AD duties by the EU in 2003 and 2005 and zero otherwise and a treatment dummy which is an interaction of the time and the AD dummy. The latter identifies the treatment effect. The treated products were hence not subject to AD duties in the ten accession countries in 2003 but became subject to AD duties in 2004 (and still were in 2005) simply because the countries joined the EU (cases initiated since 2004 are ignored).

$$lnY_{jht} = \beta_1 AD_h + \beta_2 Time_t + \beta_3 (AD_h \ x \ Time_t) + \epsilon_{jht} \tag{7}$$

The regression results are presented in Table 8 below. Column (1) shows results for the basic diff-in-diff estimation described in Equation 7 above. The coefficients for Time and AD are positive and statistically significant. The first indicates that exports on average increase over time. The second shows that the average value of products exported to EU accession states that are subject to AD duties in the EU is above the average value of those products not subject to AD duties in the EU. The interaction term ("AD Duty") is negative and statistically significant, indicating that exports of treated products to

[35] Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

EU accession states fell following the imposition of AD duties (relative to products not subject to AD duties). Qualitatively this result is in line with the coefficients estimated in Column (1) of Table 5 above. Quantitatively, the coefficient estimated in the experiment is larger in magnitude.

The remaining columns of Table 8 show regression results for specifications using different sets of fixed effects, similar to those used in the previous specifications. Controlling for country-product fixed effects (Column (2)) increases magnitude and significance of the treatment coefficient. While controlling for country-time fixed effects does not significantly alter the estimated coefficient (Column 3), adding HS4-time fixed effects - either separately in Column (4) or interacted with country-time fixed effects in Column (5) - increases its magnitude.

Overall the experiment provides further evidence that AD duties significantly reduce exports. The magnitude of the estimated coefficient under the most restrictive fixed effects specification is three times larger than those estimated in Table 5. It is however not clear if this is driven by the estimation strategy or the very specific sample (Eastern Europe).

Table 8: The Effect of AD Duties on Exports to EU Accession Countries

Dependent variable: ln value	(1)	(2)	(3)	(4)	(5)
AD Duty (dummy)	-0.9368**	-1.0420***	-1.0234***	-1.5769***	-1.4991**
	(0.3945)	(0.3756)	(0.3705)	(0.4594)	(0.6356)
Time	0.2955***	0.6475***			
	(0.0212)	(0.0187)			
AD	1.5398***				
	(0.3149)				
Observations	29,182	21,670	21,670	21,440	17,676
R^2	0.0041	0.8320	0.8351	0.8684	0.9058
Country-Product FEs	NO	YES	YES	YES	YES
Country-Time FEs	NO	NO	YES	YES	N/A
HS4-Time FEs	NO	NO	NO	YES	N/A
Country-HS4-Time FEs	NO	NO	NO	NO	YES
Clusters	18347	10835	10835	10720	8838

Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1.

5 Robustness Checks

5.1 Firm Level Regressions

In this section we perform several robustness checks. Detailed regression results are reported in Section B of the Online Appendix. We have shown in Table 1 Columns (8) and (9) that including firm-product combinations with wrongly assigned product-specific duties leads to attenuation bias. To see if this bias is also present in our preferred sample, we perform our baseline specification, now including product-specific duties. The results are reported in the first panel of Table 9 below. As can be seen in Columns (1) and (3), the estimated price elasticities of demand fall dramatically in magnitude relative to the coefficients reported in Table 2. The bias is stronger for the US than for the EU. This is in line with the difference in successfully matched firm-specific duties between the EU (84%) and the US (69%). Given that more US firm-product combinations are wrongly assigned a higher product-specific duty, it is not surprising to see a larger bias for the US coefficient.

An alternative explanation for the difference in coefficients when including product-specific duties could be sample selection. Some products do not receive firm-specific treatment. Excluding these might affect estimated coefficients. As a further robustness check, we thus perform once again our baseline regressions, excluding products that only receive product-specific AD duties. Firms that receive product-specific duties but export products that are also subject to firm-specific duties remain in the sample. The results are summarized in the second panel of Table 9. It can be seen that coefficients are very similar to those reported in the first panel, indicating that the jump in coefficients does not stem from a selected sample, but instead from eliminating firms wrongly associated with product-specific treatment.[36]

As we are interested in the intensive margin effects, we have dropped firms exiting or entering post treatment. However, Lu et al. (2013) only drop firms exiting following the treatment. We hence perform a further robustness test by keeping firms that only entered the market following the imposition of AD duties as well as those that left the market. The results are reported in the third panel of Table 9. Relative to our baseline results, coefficients remain similar.

In our baseline regressions, we include exports from producers as well as from trade intermediaries. In a robustness check, we perform the firm-level regression excluding all trade intermediaries (fourth panel in Table 9). Coefficients remain robust. If we only

[36]Given the use of country-product-time fixed effects, products not subject to firm-specific duties do not provide any remaining variation to identify the treatment effect.

look at exports by intermediaries[37] (fifth panel), the EU coefficient slightly decreases in magnitude while the US coefficient slightly increases, so that the two move closer together.

Table 9: Robustness Checks

	(1)	(2)	(3)
Dependent Variable	ln value	ln price	ln quantity
(I) Including product specific duties			
AD Duty EU	-2.3292***	0.2052	-2.5344***
	(0.6617)	(0.1474)	(0.6486)
AD Duty US	-0.4212**	-0.0040	-0.4172***
	(0.1692)	(0.0312)	(0.1619)
(II) Excluding products receiving product treatment only			
AD Duty EU	-2.3829***	0.2000	-2.5830***
	(0.6644)	(0.1497)	(0.6499)
AD Duty US	-0.4124**	-0.0047	-0.4077**
	(0.1691)	(0.0312)	(0.1617)
(III) Firms entering post treatment			
AD Duty EU	-7.5175***	-0.3994	-7.1181***
	(1.5916)	(0.3244)	(1.6472)
AD Duty US	-4.8946***	-0.0526	-4.8419***
	(1.5668)	(0.2740)	(1.5305)
(IV) Excluding intermediaries			
AD Duty EU	-7.0956***	-0.4530	-6.6426***
	(1.7704)	(0.3621)	(1.8373)
AD Duty US	-5.1766***	0.1731	-5.3497***
	(1.9601)	(0.2577)	(1.9165)
(V) Excluding producers			
AD Duty EU	-6.1620***	-0.3942	-5.7677***
	(1.6294)	(0.3096)	(1.6749)
AD Duty US	-5.4369***	-0.1148	-5.3221***
	(1.8265)	(0.3321)	(1.7989)

Note: For detailed tables please refer to Section B in the Online Appendix.

[37] In the customs data set, some firms are labeled as intermediaries while others are labeled as producers. Firms for which this information is missing are included in both the fourth and the fifth panel.

5.2 Product Level Regressions

Moore and Zanardi (2009, 2011) find evidence of a correlation between the use of anti-dumping and trade liberalization in general. Consequently, if AD duties correlate with tariffs, this could contribute to omitted variable bias. In our baseline firm-level regression, tariffs are controlled for through country-product-time fixed effects. This is however not the case at the product-level. In another robustness check,[38] we thus perform the product-level regression controlling for MFN tariff rates. Coefficients remain robust, with the exception of the EU AD duty coefficient for average export quantity, which turns insignificant. MFN tariff coefficients are insignificant throughout. This is however not surprising given our fixed effects specification and the limited within country variation of MFN tariffs across time.

In addition to using the weighted AD duty, we also estimate trade deflection effects using dummy regressions. Results remain qualitatively similar.

In the product-level regression (Table 4), we include country-HS4-time fixed effects. Doing this reduces the number of observations as any treated product requires an un-treated product in the same country-HS4-time dimension to be included. We hence run a more relaxed specification with country-time rather than country-HS4-time fixed effects. Coefficients for value, number of firms and mean quantity remain robust. However, average price effects become positive and significant. This can be driven either by exit of low price firms following the imposition of high AD duties or by surviving firms raising prices. The latter is however not observed in the firm-level regressions. One possible explanation would be that all firms in an industry start raising prices following the imposition of AD duties against a particular product. Given such spill over effects, one would not observe positive price effects when controlling for industry time trends using country-HS4-time fixed effects. However, the coefficients could also be driven by unobserved country and industry-specific time trends, which is why controlling for country-HS4-time fixed effects remains our preferred specification.

The same robustness test is carried our for trade deflection at the product-level. Performing dummy regressions yields qualitatively similar results.

Using weighted average AD duties for the product-level regression might give rise to endogeneity concerns. This is because firms receiving high AD duties reduce their exports, leading their AD duties receiving smaller weights in subsequent periods. To address this issue, we perform the product-level regression using product-specific duties rather than a weighted average including both product and firm-specific duties. As predicted, coefficients are smaller in magnitude as firms receiving low firm-specific duties are implicitly

[38] Detailed tables are reported in Section B in the Online Appendix.

assigned higher product-specific duties due to aggregation from firm to product-level. Nevertheless, coefficients remain similar in magnitude and significance.[39]

5.3 Results by Sector

Beyond sectoral effects of AD duties on export value and average export prices, we also examine effects on the number of exporters as well as average export quantity. Detailed regressions results (weighted duty as well as dummies) for the key sectors chemicals, metals and machinery are reported in the Online Appendix, which also provides further summary graphs, illustrating the heterogeneity across sectors.

6 Conclusions

AD duties remain a common trade defence instrument, the use of which having increased over the past decade. Given their role and controversies around them, it is essential that the effects of AD dumping duties on trade are correctly measured. We take a step into this direction by basing our estimation on a theoretical model, incorporating firm heterogeneity that informs us about potential sources of omitted variable bias. Using Chinese Customs Data on firm-level transactions, we find that existing firm-level estimations indeed suffer from two main biases that work in opposite directions.

Exploiting within product across firm variation in exports and AD duties, we identify separate treatment effects of EU and US AD duties. We find that AD duties do reduce firm export value but do not affect producer prices, so that AD duties are completely passed through to consumers. However, effects differ between the EU and the US as the number of exporters reacts more sensitively to EU duties, meaning that higher duties are required in the US to achieve the same overall effect. In addition, only comparing product-level duties overstates the difference in applied duty levels between the EU and the US. When considering the use of firm-specific duties - which is more common in the US than in the EU - and weighing duties by export volume of the affected firms, it becomes clear that the difference in effectively applied duties is smaller than commonly stated. When considering both elasticities as well as duty levels, exports to the US fall by more than exports to the EU following the imposition of AD duties. Nevertheless, the difference is smaller than implied by the difference in product-specific duties. EU duties also significantly impact firm export values, meaning that there is no need for the EU to move closer to the US system in order to protect its domestic market.

[39]Coefficients for other countries are identical as weighted averages could only be calculated for the EU and the US.

Beyond a fall in firm-level exports, falling exports at the product-level are driven by firm exit as well as a fall in average firm export quantity. Interpreted through the lens of our model and combined with the finding that small firms are affected more strongly by the imposition of duties, this implies that AD duties force out the least efficient exporters, thus increasing the overall competitiveness of Chinese exporters. All results vary significantly across sectors, indicating that a one size fits all AD policy may lead to very different effects in different sectors.

Finally, we find evidence for trade deflection at the firm-level. At the product-level, exports to third countries increase following the imposition of AD duties in the EU and the US. For both economies, this is driven by the extensive margin, as firms enter new markets following the imposition of EU or US AD duties. In addition, average export prices to third countries fall following US AD duties, implying that firms dump products to third countries. This is accompanied by an increase in average export quantities. For the EU, mean prices actually rise and average quantity falls, indicating that the composition effect (high price producers with low sales entering new markets as they are driven out of the EU) dominates. This illustrates the deep interdependence of global markets which has to be taken into account when designing new trade policies.

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Appendix

Summary Statistics

Table A.1: Distribution of global AD Cases across Sectors

	Exports (m)	Total (m)	Ratio	N hs6	N hs6 d	Cases	Revenue (m)	Ratio
Animals	17	6,522	0.00	238	1	1	26	0.00
Vegetables	19	8,609	0.00	350	2	2	7	0.00
Foodstuffs	77	11,158	0.01	204	7	8	109	0.01
Mineral Products	359	18,666	0.02	158	2	3	593	0.03
Chemicals	658	32,931	0.02	856	77	75	543	0.02
Plastics rubber	863	22,516	0.04	227	41	33	664	0.03
Raw Hides Skins	1	13,445	0.00	105	1	1	0	0.00
Wood	350	12,507	0.03	298	44	18	412	0.03
Textiles	647	108,271	0.01	900	88	34	302	0.00
Footwear headwear	514	22,438	0.02	55	19	3	107	0.00
Stone Glass	222	17,304	0.01	219	26	17	150	0.01
Metals	2,073	60,535	0.03	613	126	81	937	0.02
Machinery Electrical	1,500	314,018	0.00	875	56	40	1,017	0.00
Transportations	312	32,135	0.01	137	7	7	855	0.03
Miscellaneous	2,612	71,046	0.04	409	35	30	2,166	0.03
Service	.	1,309	.	3	.	.	0	0.00
Total	10,224	753,413	0.01	5652	532	330	7,889	0.01

Note: The table reports the average annual export value of HS6 products affected by AD, the average annual total export value, the share of export value affected by AD, the total number of HS6 products in the sample, the number of treated HS6 products, the number of AD cases, the AD revenue as well as the average annual revenue in percent of total exports.

Table A.2: Distribution of US AD Cases across Sectors

	Exports (m)	Total (m)	Ratio	N hs6	N hs6 d	Cases	Revenue (m)	Ratio
Animals	17	964	0.02	126	1	1	26	0.03
Vegetables	.	474	.	276	.	.	0	0.00
Foodstuffs	51	1,464	0.03	178	2	1	94	0.06
Mineral Products	266	1,364	0.20	142	1	1	535	0.39
Chemicals	198	4,388	0.05	806	16	13	361	0.08
Plastics rubber	456	5,891	0.08	226	11	4	424	0.07
Raw Hides Skins	.	3,245	.	75	.	.	0	0.00
Wood	197	2,958	0.07	278	22	5	361	0.12
Textiles	61	13,917	0.00	869	3	3	26	0.00
Footwear headwear	.	8,045	.	55	.	.	0	0.00
Stone Glass	92	2,840	0.03	208	2	2	118	0.04
Metals	900	10,446	0.09	594	47	15	563	0.05
Machinery Electrical	893	65,436	0.01	862	13	6	644	0.01
Transportations	246	5,450	0.05	119	2	1	828	0.15
Miscellaneous	2,309	21,101	0.11	405	9	6	2,022	0.10
Service	.	75	.	2	.	.	0	0.00
Total	5,685	148,058	0.04	5222	129	51	6,004	0.04

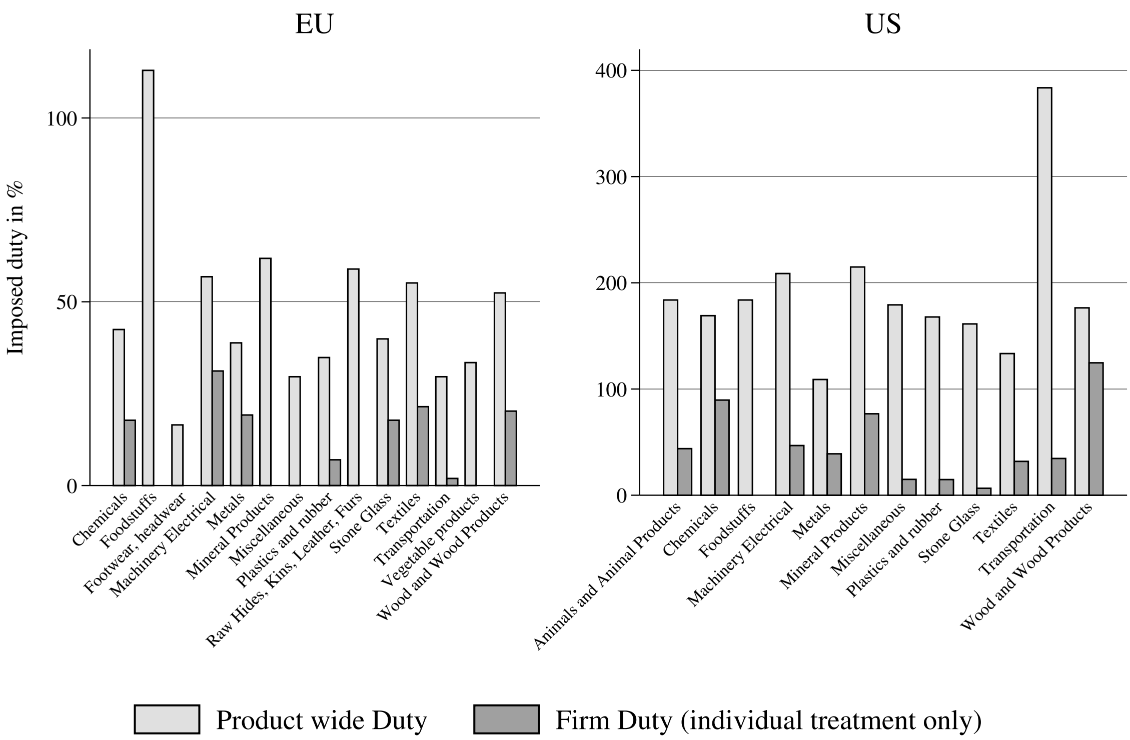
Note: The table reports the average annual export value of HS6 products affected by AD, the average annual total export value, the share of export value affected by AD, the total number of HS6 products in the sample, the number of treated HS6 products, the number of AD cases, the AD revenue as well as the average annual revenue in percent of total exports.

Table A.3: Distribution of EU AD Cases across Sectors

	Exports (m)	Total (m)	Ratio	N hs6	N hs6 d	Cases	Revenue (m)	Ratio
Animals	.	1,188	.	130	.	.	0	0.00
Vegetables	16	1,028	0.02	296	1	1	5	0.01
Foodstuffs	8	1,180	0.01	185	1	1	10	0.01
Mineral Products	92	1,791	0.05	143	1	1	57	0.03
Chemicals	168	6,207	0.03	819	16	13	60	0.01
Plastics rubber	313	3,674	0.09	227	5	4	80	0.02
Raw Hides Skins	1	3,049	0.00	96	1	1	0	0.00
Wood	109	2,269	0.05	285	2	2	43	0.02
Textiles	230	17,161	0.01	891	6	2	110	0.01
Footwear headwear	369	3,875	0.10	55	7	1	61	0.02
Stone Glass	42	3,031	0.01	214	5	1	15	0.01
Metals	1,042	10,846	0.10	595	35	14	315	0.03
Machinery Electrical	381	64,916	0.01	863	8	5	168	0.00
Transportations	33	7,031	0.00	121	2	1	9	0.00
Miscellaneous	254	14,750	0.02	400	1	1	75	0.01
Service	.	26	.	2	.	.	0	0.00
Total	3,058	142,021	0.02	5323	91	43	1,009	0.01

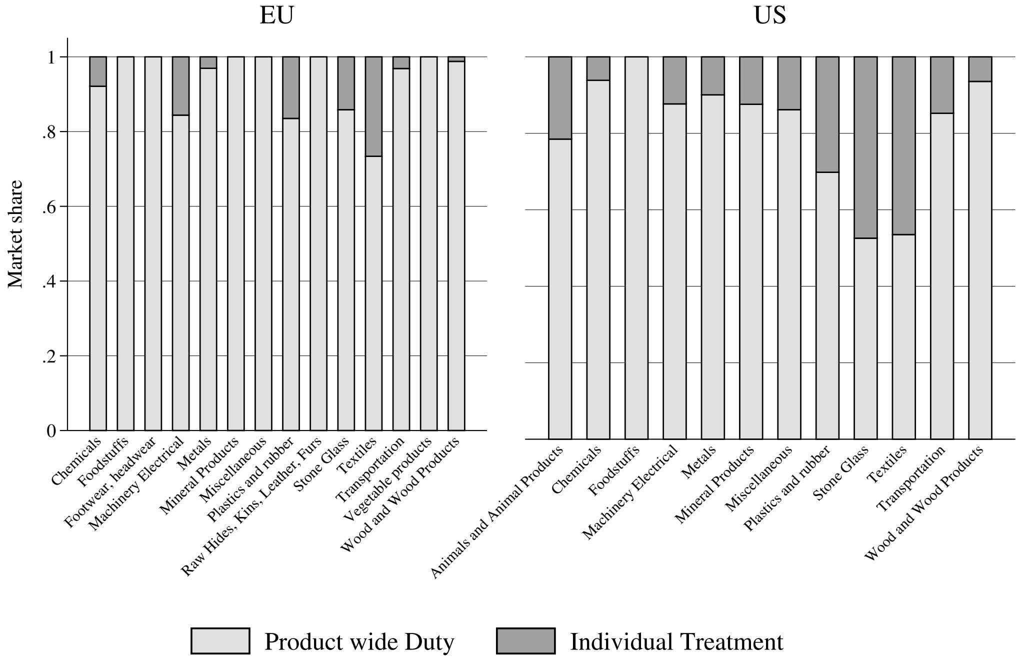
Note: The table reports the average annual export value of HS6 products affected by AD, the average annual total export value, the share of export value affected by AD, the total number of HS6 products in the sample, the number of treated HS6 products, the number of AD cases, the AD revenue as well as the average annual revenue in percent of total exports.

Figure A.1: Average EU and US AD Duties by Treatment Status and Sector



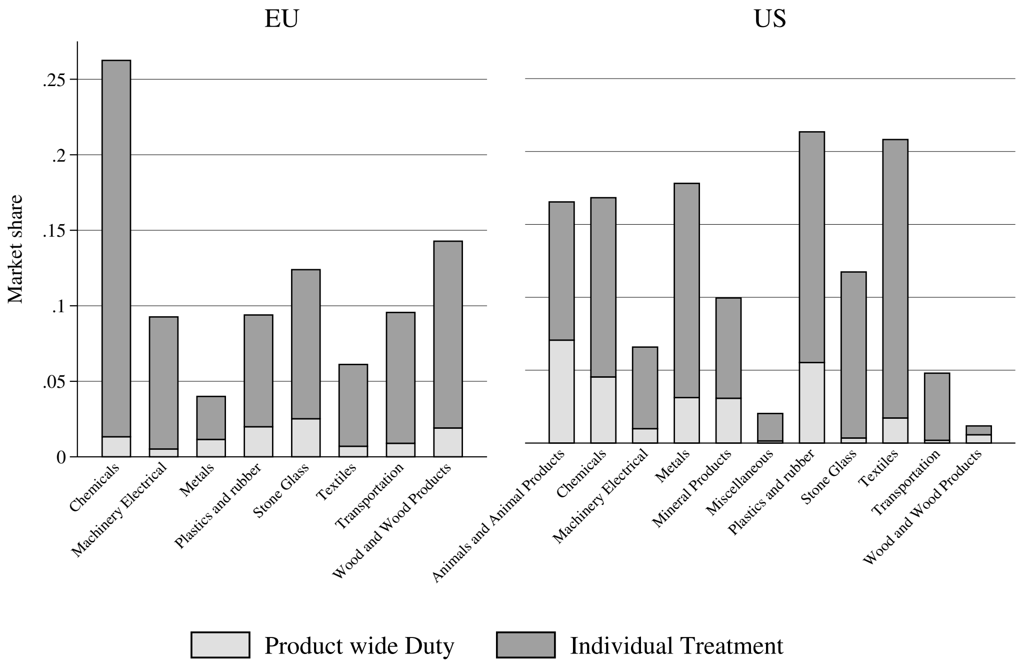
Note: Sector on the horizontal axis. Product and firm-specific duties are simple averages. Within each case and HS6 product, the firm-specific duty is below the product wide duty.

Figure A.2: Total Export Market Share of Firms exporting to the EU and the US by Treatment Status and Sector



Note: Sector on the horizontal axis. Treated products only. Export market share over entire period. Data for export market share at the firm-level comes from the Chinese customs office.

Figure A.3: Average Export Market Share of Firms by Treatment Status



Note: Sector on the horizontal axis. Treated products only. Export market share over entire period. Data for export market share at the firm-level comes from the Chinese customs office.

Online Appendix

A Details on Conceptual Frameworks

A.1 Modeling Dumping in a Melitz Model

This section shows how certain pricing decisions of firms that are consistent with the WTO's definition of dumping can be modeled within a Melitz framework. The aim of this section is not to make predictions regarding the effects of AD on firms but rather to illustrate that the resulting firm-level gravity equation is also applicable in the context of anti-dumping so that it can offer guidance for the empirical strategy.

Type1 1: Classic Dumping In line with the WTO definition, we define type 1 dumping as charging an export price below the domestic price. In the model, this can happen for two reasons:

1. Pricing to market

$$\sigma_{hj} > \sigma_{hi} \Rightarrow \frac{p_{hfijt}(\varphi)}{\tau_{hijt}} < p_{hfiit}(\varphi) \;\; since \; \frac{\partial p_{hfijt}}{\partial \sigma_{hi}} < 0.$$

Following the optimal pricing condition in Equation (2) of Section 2 of the paper, a profit maximising firm will charge an export price (adjusted for transport costs) below the domestic price whenever the elasticity of substitution is higher in the foreign market than in the domestic market. In the context of the Melitz model, this elasticity is taken as exogenously given.

2. Indirect export subsidies such as reduced fuel taxes

$$\tau_{hijt}^{distorted} < \tau_{hijt}^{true} \Rightarrow \frac{p_{hfijt}(\varphi, \tau_{hijt}^{distorted})}{\tau_{hijt}^{true}} < p_{hfiit}(\varphi).$$

Transport costs are distorted through subsidies such that they are below the "fair" transport cost used by the importer's authorities to calculate the dumping margin. Consequently, the export price adjusted by "fair" transport costs is below the domestic price. From a legal perspective, this constitutes dumping, even if the export price adjusted by the distorted transport cost is not lower than the domestic price.

Type 2: Production distortions

$$c_{hfit}^{distorted} < c_{hfit}^{true} \; but \; \frac{p_{hfijt}(\varphi)}{\tau_{hijt}} = p_{hfiit}(\varphi).$$

In this case production costs c are distorted due to distorted cost of capital r (state finance), distorted cost of material m (energy subsidies) or direct subsidies s. In this case the exporter dumps both at home and abroad. Adjusted export price and domestic price are both below the undistorted production cost and dumping cannot be identified any longer by comparing the two. Such a case justifies the use of third country prices to identify dumping. However, when using third country prices, "dumping" can also result form exporters having higher productivity φ than the third country firms used to construct the comparison price (normal value). In this case productivity differences are impossible to disentangle from unfair competition.

Both types of dumping are thus possible in the model. To investigate if dumping can be profitable, let us consider a two stage game. At stage one, firms set prices $p^* = arg\ max\ E(\pi)$. At stage two, AD duties are imposed with probability ρ_{hj}(Dumping, Injury, Causality, Lobbying,...) with $0 < \rho < 1$ exogenous from the perspective of the firm.[1] This probability varies by destination country and industry. Given an AD investigation is launched, dumping is detected if

$$\frac{p^x_{hfijt}}{\tau_{hijt}} < p^n_{hfijt} \ \ in\ which\ case\ (T_{hfijt}+1) = \frac{p^n_{hfijt}}{p^x_{hfijt}/\tau_{hijt}},$$

where p^n_{hfijt} is normal value and $\frac{p^x_{hfijt}}{\tau_{hijt}}$ is the net export price used by the investigators to calculate the dumping margin.[2] Given AD action, the exporter faces three possible treatments:

1 MET with probability α_j: $p^x_{hfijt} = p_{hfijt}(\varphi) =$ the firms own export price and $p^n_{hfijt} = p_{hfiit}(\varphi) =$ the firms own domestic price,

2 IT with probability β_j: $p^x_{hfijt} = p_{hfijt}(\varphi) =$ the firms own export price and $p^n_{hfijt} = p_{hkkt} =$ domestic price in a third country k which has MES,

3 NMES with probability γ_j: $p^x_{hfijt} = \bar{p}_{hijt} =$ the average export price across all Chinese exporters selling product h to country j and $p^n_{hfijt} = p_{hkkt} =$ price in third country k.

$\alpha_j + \beta_j + \gamma_j = 1$. Once the duty is implemented, firms sell at consumer prices $p^*_{hfijt}(1+T_{hfijt})$. At stage one, the expected duty given AD duties are imposed is:

$$E(T_{hfijt}+1)|AD = \alpha_j \frac{p_{hfiit}(\varphi)}{p_{hfijt}(\varphi)/\tau_{hijt}} + \beta_j \frac{p_{hkkt}}{p_{hfijt}(\varphi)/\tau_{hijt}} + \gamma_j \frac{p_{hkkt}}{\bar{p}_{hijt}/\tau_{hijt}}$$

Under NMES, the firm has no incentive to adjust its export price as it cannot influence the calculated dumping margin. While this is not true for MET and IT firms, we nevertheless assume price adjustments are not possible in stage two. This is realistic for several reasons. First of all, applying for a reassessment of dumping margins is a very costly and timely process so that for most firms (especially those receiving lower MET duties) it is simply not worth the effort. Second, in order to get AD duties reduced, firms first have to raise consumer prices which means that consumer prices including the AD

[1] Of course the probability of an AD investigation is not completely exogenous but is probably decreasing with the firm's export price (Ruhl, 2014). However, especially for a country with non market economy status, the probability of an AD investigation depends on many other things such as export prices across all exporters and strength of the industry in the importing country which are exogenous from the point of view of the individual exporter.

[2] The export price used by the authorities p^x_{hfijt} does not necessarily equal the true export price p_{hfijt}.

duties would be even higher until the reassessment is completed, further reducing demand. Firms would need deep pockets to survive that.

Hence, firms set prices under uncertainty at stage one. A firm will never set a price below the monopoly price $p^m_{hfijt}(\varphi)$ and never one higher than $p^a_{hfijt} = p_{hkkt}$ which would completely avoid the duty in case the firm receives IT.[3] Hence, the firm chooses a price $p^*_{hfijt}(\varphi)$ for which $p^m_{hfijt}(\varphi) \leqslant p^*_{hfijt}(\varphi) \leqslant p^a_{hfijt}$ to maximise expected profits:[4]

$$
\begin{aligned}
&E\pi(p^*(\varphi), 1 + T_{hfijt}) = \\
&(1 - \rho_{hj})\pi(p^*(\varphi), 1) \\
&+ \rho_{hj}\left(\alpha_j \pi(p^*(\varphi), \frac{p_{hfiit}(\varphi)}{p^*(\varphi)\tau_{hijt}}) + \beta_j \pi(p^*(\varphi), \frac{p_{hkkt}}{p^*(\varphi)/\tau_{hijt}}) + \gamma_j \pi(p^*(\varphi), \frac{p_{hkkt}}{\bar{p}_{hijt}/\tau_{hijt}})\right).
\end{aligned} \tag{A.1}
$$

Let us first look at TYPE 2 dumping. Under this type of dumping, if the firm gets MET, it pays no AD duty as $\frac{p_{hfijt}(\varphi)}{\tau_{hijt}} = p_{hfiit}(\varphi)$ and dumping cannot be identified. If it gets IT, it can influence the duty by increasing its export price (net of transport cost) up to a maximum of the constructed price to reduce or eliminate the duty. If the firm receives NMET, there is nothing it can do to affect the size of the duty. It can be seen that charging the monopoly price is preferred to charging the high price in three out of four possible states (no investigation, MET and NMET). In the case of IT, the firm is better of if it had chosen the high price. Given uncertainty around the AD investigation and that the firm maximises expected profits, there are values for ρ_{hj}, α_j, β_j and γ_j for which charging a price p^* below p_{hkkt} is the optimal strategy.

Under TYPE 1, MET firms will pay a duty which is however lower than that paid by IT or NMES firms assuming its domestic price is below the constructed normal value. Here, charging $p^m_{hfijt}(\varphi)$ is the better strategy in case no AD investigation is launched and in case the firm receives NMES. With IT, setting a high price in stage one is preferable. With MET it is unclear as $\frac{p^a_{hfijt}}{\tau_{hijt}} = p_{hkkt}$ may be larger than $p^m_{hfijt}(\varphi)$ inclusive of the MET duty. Once again dumping is the profit maximising strategy for certain values of ρ_{hj}, α_j, β_j and γ_j. Given uncertainty, the firm will set a price p^*_{hfijt} which is somewhere between $p^m_{hfijt}(\varphi)$ and p^a_{hfijt} and hence constitutes dumping under at least one regime. To sum up, given uncertainty around the AD investigation - dumping is not only possible but also a firm's preferred pricing strategy in the model given certain perceived parameter values of ρ_{hj}, α_j, β_j and γ_j.

A.2 Anti-Dumping in Melitz-Ottaviano

In this section, we sketch a simple Melitz-Ottaviano type model which incorporates AD duties in order to get a better understanding of their effects on exporters. Following Melitz and Ottaviano (2008), consumers in country j consuming product h maximise the

[3] In reality, there is also uncertainty around p_{hkkt}.

[4] The indices for p^* are omitted in the equation for better legibility. They should read p^*_{hfijt}.

quadratic utility function

$$U^j = q_0^j + \alpha \int_{h\epsilon\Omega} q_h^j di - \frac{1}{2}\gamma \int_{h\epsilon\Omega} (q_h^j)^2 di - \frac{1}{2}\eta \left(\int_{h\epsilon\Omega} q_h^j dh \right)^2 , \tag{A.2}$$

with $q_0^j$and q_h^j representing consumption of the numeraire good and each variety h. α and η are positive demand parameters indexing the degree of substitutability between the numeraire and differentiated varieties. γ is a positive demand parameter representing the degree of product differentiation between varieties. Consumer maximisation yields the following demand function for individual varieties:

$$q_h^j = \frac{1}{\gamma}(p_{max}^j - p_h^j), \tag{A.3}$$

where p_{max}^j is the cut-off price. Given demand, an exporting firm f in country i sets (consumer) export prices p_{hfij} to maximise export profits π_{hfij} subject to AD duties T^{hfij} set by the importing country j:

$$\pi_{hfij} = \left(\frac{p_{hfij}}{1 + T_{hfij}} - \tau_{hij} c_{hfi} \right) \frac{L_j}{\gamma} \left(p_{max}^j - p_{hfij} \right) , \tag{A.4}$$

where τ_{hij} is the iceberg transport cost, c_{hfi} the firm's marginal cost and L_j the size of the destination country. The duty T^{hfij} depends on the export price p_{xhfij}:

$$1 + T_{fhij} = \frac{p_{fhij}^n}{p_{fhij}/\tau_{hij}} = p_{fhij}^{-1} p_{hfij}^n \tau_{hij}, \tag{A.5}$$

where p^n is "normal value". In the case of China, this is either the price charged domestically (in the case of Market Economy Treatment) or a reference price in a third country (Individual Treatment or Non-Market Economy Treatment).

Reference Case - Pricing in the absence of AD duties: In the absence of AD duties, firms set export prices to maximise the following profit function as in Melitz and Ottaviano (2008):

$$\pi_{hfij} = (p_{hfij} - \tau_{hij} c_{hfi}) \frac{L_j}{\gamma} \left(p_{max}^j - p_{hfij} \right) , \tag{A.6}$$

$$\Rightarrow p_{hfij}^{NAD} = \frac{1}{2}(p_{max}^j + c_{hfi}\tau_{hij}), \tag{A.7}$$

where p_{hfij}^{NAD} is the optimal price in the absence of AD. From Equation (A.7), it can be seen that the price charged depends on the degree of competition in the destination market modeled by p_{max}^j. In this model, dumping takes place if $p_{hfij}^{NAD} < p_{hfii}^{NAD}$ which is the case whenever $p_{max}^j < p_{max}^i$. Of course the model can also accommodate the legal definition of dumping, i.e. $p_{hfij} < p_{hfij}^n$, which is the "normal value". We now examine two possible states of AD.

State 1 - Pricing under AD uncertainty: In state 1, there is uncertainty surrounding the AD process. The firm does not know whether it will become subject to AD duties when setting prices. AD duties are realised with probability ρ_{hj}. The firm sets a price $p_{fhij}$to maximise expected profits:

$$E\pi_{fhij}(p_{fhij},T(p_{fhij}),\rho_{hj}) = (1-\rho_{hj})[(p_{fhij}-\tau_{hij}c_{fhi})\frac{L_j}{\gamma_{hj}}(p_{max_{hj}}-p_{fhij})] + \rho_{hj}[(p_{fhij}(p_{fhij}(p^n_{fhij})^{-1}\tau^{-1}_{hij}) - \tau_{hij}c_{fhi})\frac{L_j}{\gamma_{hj}}(p_{max_{hj}}-p_{fhij})]. \tag{A.8}$$

Differentiating yields:[5]

$$\frac{\partial \pi}{\partial p} = (1-\rho)\frac{L}{\gamma}[(p_{max}-p)-(p-\tau c)] + \rho\frac{L}{\gamma}[2pp_n^{-1}\tau^{-1}(p_{max}-p)-(p^2p_n^{-1}\tau^{-1}-\tau c)] = 0, \tag{A.9}$$

$$\begin{aligned}
&\Rightarrow (1-\rho)p_{max} - 2(1-\rho)p + (1-\rho)\tau c + 2\rho p p_n^{-1}\tau^{-1}p_{max} - 2\rho p^2 p_n^{-1}\tau^{-1} - \rho p^2 p_n^{-1}\tau^{-1} + \rho\tau c = 0,\\
&\Rightarrow (1-\rho)p_{max} + 2p[\rho p_n^{-1}\tau^{-1}p_{max} - (1-\rho)] + (1-\rho)\tau c + \rho\tau c - 3\rho p^2 p_n^{-1}\tau^{-1} = 0,\\
&\Rightarrow 3\rho p^2 p_n^{-1}\tau^{-1} - 2p[\rho p_n^{-1}\tau^{-1}p_{max} - (1-\rho)] = (1-\rho)p_{max} + \tau c,\\
&\Rightarrow (3\rho p_n^{-1}\tau^{-1})p^2 - 2[\rho p_n^{-1}\tau^{-1}p_{max} - (1-\rho)]p - [(1-\rho)p_{max} + \tau c] = 0,
\end{aligned}$$

So that the optimal export price under uncertain AD is

$$p_1^* = \frac{2[\rho p_n^{-1}\tau^{-1}p_{max} - (1-\rho)] \pm \sqrt{4[\rho p_n^{-1}\tau^{-1}p_{max} - (1-\rho)]^2 + 12\rho p_n^{-1}\tau^{-1}[(1-\rho)p_{max}+\tau c]}}{6\rho p_n^{-1}\tau^{-1}}. \tag{A.10}$$

Differentiating with respect to ρ yields

$$\begin{aligned}
\frac{\partial p_1^*}{\partial \rho} &= f(p_{max,}p_n,\tau,c,\rho), \qquad \text{(A.11)}\\
\Rightarrow \frac{\partial p_1^*}{\partial \rho} &= \frac{p_{max}}{3\rho} + \frac{p_n\tau}{3\rho}\\
&+ \frac{2\rho p_{max}^2 - 2p_n^2\tau^2 + 3cp_n\tau^2 + 2\rho {p_n}^2\tau^2 + p_np_{max}\tau - 2\rho p_np_{max}\tau}{3\rho(2(\rho^2p_n^2\tau^2 - \rho^2p_np_{max}\tau + \rho^2p_{max}^2 - 2\rho p_n^2\tau^2 + \rho p_np_{max}\tau + 3c\rho p_n\tau^2 + p_n^2\tau^2)^{(1/2)})}\\
&- \frac{(\rho^2p_n^2\tau^2 - \rho^2p_np_{max}\tau + \rho^2p_{max}^2 - 2\rho p_n^2\tau^2 + \rho p_np_{max}\tau + 3c\rho p_n\tau^2 + p_n^2\tau^2)^{(1/2)}}{3\rho^2}\\
&+ \frac{\rho p_{max} - p_n\tau + \rho p_n\tau}{\rho^2}.
\end{aligned}$$

[5] The indices are omitted from now on for better legibility.

It will be shown further down that there exist values for the parameters so that p_1^* is increasing in ρ. Hence, the firm increases prices if it expects AD duties to be implemented.

State 2 - Certain AD duties: In state 2, prices and AD duties are set simultaneously.[6] The firm knows that AD duties are calculated according to Equation (A.5) and sets prices accordingly. The two states can also be seen as a sequential game. The firm operates under state 1 until duties are realised. Once this is the case, the firm can either stick to its pricing decision or pay a fixed cost F to apply for a review and face the decision problem of state 2. The profit equation in state 2 is

$$\pi_2 = \left(\frac{p_2}{1+T_2} - \tau c\right) \frac{L}{\gamma} \left(p^j_{max} - p_2\right), \tag{A.12}$$
$$\Rightarrow \pi_2 = \left(p_2(p_2 p_n^{-1} \tau^{-1}) - \tau c\right) \frac{L}{\gamma} \left(p^j_{max} - p_2\right).$$

Differentiating yields

$$\frac{\partial \pi_2}{\partial p_2} = c\tau - \frac{p_2^2}{p_n \tau} - \frac{2p_2(p_2 - p_{max})}{p_n \tau} = 0,$$
$$p_2^* = \frac{p_{max}}{3} + \frac{(p_{max}^2 + 3cp_n\tau^2)^{1/2}}{3}. \tag{A.13}$$

Calibration: In order to make predications on firms dumping behaviour, we now calibrate the model by setting plausible values for parameters. The aim of this exercise is not to show that certain results must hold but instead that our empirical results regarding price setting by firms are consistent with the model. The parameter values must fulfil several conditions. First, a firm will never set a price p below the profit maximising price in the absence of dumping. Second, assuming $p^n > p^{NAD}$ which is required for dumping to take place, firms will never set a price above the normal value. Consequently, $p^{NAD} = \frac{1}{2}(p_{max} + \tau c) \leq p \leq p^n$. In addition, it is realistic to assume $p^n < p_{max}$. For simplicity, we take $\tau = 1$. Given the above conditions, we set $p_{max} = 4$, $p^n = 3.5$ and $c = 2$.

We can now derive the following results: From Equations A.7 and A.13 we see that the consumer price in the absence of AD $p^{NAD} = 3$ is smaller than under certain AD $p_2^* = 3.36$ which is in turn smaller than the price necessary to eliminate the duty ($p^n = 3.5$). Hence, in a Melitz-Ottaviano world, firms will absorb part of the duty in order to avoid losing too much demand. If $(1+T)$ was exogenous (as is the case for NMES) and set such that $1 + T = \frac{p^n \tau}{p^{NAD}} = 1.167$, this would imply a consumer price of $p^T = \frac{1}{2}(p_{max} + c\tau(1+T)) = 3.167$ which is smaller than under the endogenous AD duty. This is not surprising since the endogenous duty provides the firm with an incentive to raise prices, as the duty will fall in response.

Under uncertainty and assuming $\rho = 0.5$, firms would set $p_1^* = 3.2263$, which is between p^{NAD} and p_2^*. In addition, for the parameters set above, $\frac{\partial p_1^*}{\partial \rho} > 0$ so that p_1^* is

[6] This is a simplification. As discussed in Section 2 of the paper, AD duties in period t are a function of prices in period $t-1$. This dynamic relationship is ignored for simplicity.

strictly increasing in ρ for all $0 < \rho < 1$. Firms hence set higher prices when they think AD is more likely.

Finally, as in the Melitz world, firms will only adjust prices if $\pi_2(p_2^*) - F > \pi_2(p_1^*)$. If the costs of applying for a review are sufficiently high, the costs from doing so might outweigh the benefits of raising prices and lowering the duty.

CONCLUSION: The model implies that there exist plausible parameter values such that:

1. Prices under AD will be higher than prices in the absence of AD. However, it will never be optimal for firms to raise prices to fully eliminate the duty.

2. Under uncertainty, prices will be larger than in the absence of AD but lower than under certain AD. Hence, the firm raises prices even before becoming subject to AD.

3. If fixed costs of applying for a review following the imposition of AD are prohibitively high, the firm may not raise prices at all.

Taken together, these three mechanisms provide an explanation for the empirical observation that on average firms do not change prices following the imposition of AD duties. The model also provides additional motivation for our empirical strategy as export prices depend on p_{max} and c_{hfi}. These reflect demand and supply side variables and should be taken into account by using product-destination-time and firm-product-time fixed effects respectively.

B Detailed Robustness Checks

Table B.1: Firm-level: Elasticities - including Product-specific Duties

Dependent Variable	(1) ln value	(2) ln price	(3) ln quantity
AD Duty EU	-2.3292***	0.2052	-2.5344***
	(0.6617)	(0.1474)	(0.6486)
AD Duty US	-0.4212**	-0.0040	-0.4172***
	(0.1692)	(0.0312)	(0.1619)
EU = US (p value)	0.0052	0.1647	0.0015
R^2	0.8410	0.9584	0.8783

Note: AD Variable: ln(1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms and firms exporting before treatment only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 18,187,189 observations, 5,419,324 clusters.

Table B.2: Firm-level: Excluding Products receiving Product Treatment only

Dependent Variable	(1) ln value	(2) ln price	(3) ln quantity
AD Duty EU	-2.3829***	0.2000	-2.5830***
	(0.6644)	(0.1497)	(0.6499)
AD Duty US	-0.4124**	-0.0047	-0.4077**
	(0.1691)	(0.0312)	(0.1617)
EU = US (p value)	0.0040	0.1805	0.0012
R^2	0.8406	0.9585	0.8781

Note: AD Variable: ln(1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms and firms exporting before treatment only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 18,156,972 observations, 5,415,5574 clusters.

Table B.3: Firm-level: Including Firms entering and exiting post Treatment

Dependent Variable	(1) ln value	(2) ln price	(3) ln quantity
AD Duty EU	-7.5175***	-0.3994	-7.1181***
	(1.5916)	(0.3244)	(1.6472)
AD Duty US	-4.8946***	-0.0526	-4.8419***
	(1.5668)	(0.2740)	(1.5305)
EU = US (p value)	0.2387	0.4095	0.3092
R^2	0.8413	0.9586	0.8787

Note: AD Variable: ln(1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 17,995,219 observations, approx. 5,381,000 clusters.

Table B.4: Firm-level: Excluding Intermediaries

Dependent Variable	(1) ln value	(2) ln price	(3) ln quantity
AD Duty EU	-7.0956***	-0.4530	-6.6426***
	(1.7704)	(0.3621)	(1.8373)
AD Duty US	-5.1766***	0.1731	-5.3497***
	(1.9601)	(0.2577)	(1.9165)
EU = US (p value)	0.4677	0.1591	0.6264
R^2	0.8514	0.9623	0.8868

Note: AD Variable: ln(1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 13,118,639 observations, 4,077,722 clusters.

Table B.5: Firm-level: Excluding Producers

Dependent Variable	(1) ln value	(2) ln price	(3) ln quantity
AD Duty EU	-6.1620***	-0.3942	-5.7677***
	(1.6294)	(0.3096)	(1.6749)
AD Duty US	-5.4369***	-0.1148	-5.3221***
	(1.8265)	(0.3321)	(1.7989)
EU = US (p value)	0.7664	0.5374	0.8557
R^2	0.8464	0.9589	0.8822

Note: AD Variable: ln(1 + AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6)-Firm in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Surviving firms only. Country-Product-Firm, Country-Product-Time and Product-Firm-Time FEs. 15,790,108 observations, 4,931,772 clusters.

Table B.6: Product-level: Decomposition - MFN Tariffs - Weighted Duties

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-1.1602***	-0.7590***	0.1032	-0.5044
	(0.3753)	(0.1335)	(0.1620)	(0.3204)
Duty US	-1.0431***	-0.3815***	0.0231	-0.6848***
	(0.1815)	(0.0540)	(0.0677)	(0.1676)
Duty other	-0.3308***	-0.1558***	0.0254	-0.2005**
	(0.0946)	(0.0476)	(0.0443)	(0.0828)
MFN Tariff	0.0135	-0.0468	0.0251	0.0352
	(0.0856)	(0.0346)	(0.0443)	(0.0788)
EU = US (p value)	0.7790	0.0086	0.6479	0.6169
R^2	0.8938	0.9507	0.9513	0.9098

Note: AD Variable: ln(1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-hs4-Time and Product-Time FEs. 1,297,588 observations; 208,595 clusters.

Table B.7: Product-level: Trade Deflection - Decomposition - Dummies

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.4981***	-0.2885***	0.1191***	-0.3287***
	(0.1223)	(0.0565)	(0.0448)	(0.1139)
Duty US	-0.8245***	-0.1998***	-0.0423	-0.5825***
	(0.1775)	(0.0669)	(0.0549)	(0.1547)
Duty other	-0.7024***	-0.3370***	0.0702***	-0.4355***
	(0.0730)	(0.0387)	(0.0265)	(0.0569)
Duty EU 3rd	-0.0034	-0.0090	0.0599***	-0.0543***
	(0.0165)	(0.0082)	(0.0072)	(0.0140)
Duty US 3rd	0.2354***	0.1778***	-0.1241***	0.1818***
	(0.0154)	(0.0072)	(0.0082)	(0.0145)
EU 3rd = US 3rd (p)	0.0000	0.0000	0.0000	0.0000
R^2	0.8013	0.8815	0.9151	0.8439

Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product and Country-Sector-Time FEs. 2,101,917 observations; 351,684 clusters.

Table B.8: Product-level: Decomposition - Weighted Duty - simple FEs

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-1.6787***	-0.9768***	0.2076*	-0.9095***
	(0.3247)	(0.1135)	(0.1221)	(0.3012)
Duty US	-1.1103***	-0.4602***	0.0995**	-0.7497***
	(0.1591)	(0.0515)	(0.0436)	(0.1424)
Duty other	-0.5965***	-0.2746***	0.0752**	-0.3972***
	(0.0983)	(0.0471)	(0.0325)	(0.0742)
EU = US (p value)	0.1158	0.0000	0.4043	0.6311
R^2	0.8222	0.9089	0.9241	0.8569

Note: AD Variable: ln(1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-Time and Product-Time FEs. 2,102,174 observations; 351,745 clusters.

Table B.9: Product-level: Trade Deflection - Decomposition - Weighted Duty - simple FEs

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-1.3274***	-0.7342***	0.3077**	-0.9009***
	(0.3515)	(0.1844)	(0.1518)	(0.3208)
Duty US	-0.8739***	-0.2605***	-0.0030	-0.6103***
	(0.1912)	(0.0700)	(0.0515)	(0.1629)
Duty other	-0.6016***	-0.2666***	0.0409	-0.3760***
	(0.0944)	(0.0579)	(0.0402)	(0.0704)
Duty EU 3rd	0.1259***	0.1060***	0.1200***	-0.1001***
	(0.0452)	(0.0223)	(0.0218)	(0.0385)
Duty US 3rd	0.2218***	0.1750***	-0.0937***	0.1405***
	(0.0167)	(0.0078)	(0.0089)	(0.0156)
EU 3rd = US 3rd (p value)	0.0510	0.0040	0.0000	0.0000
R^2	0.7965	0.8775	0.9138	0.8410

Note: AD Variable: ln(1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product Country-Time and Sector-Time FEs. 2,102,083 observations; 352,152 clusters.

Table B.10: Product-level: Decomposition - Dummies - simple FEs

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.6235***	-0.3571***	0.0638*	-0.3303***
	(0.1139)	(0.0392)	(0.0339)	(0.1051)
Duty US	-1.1379***	-0.4549***	0.1043***	-0.7874***
	(0.1477)	(0.0497)	(0.0375)	(0.1271)
Duty other	-0.7410***	-0.3369***	0.1110***	-0.5152***
	(0.0684)	(0.0316)	(0.0219)	(0.0530)
EU = US (p value)	0.0058	0.1221	0.4229	0.0055
R^2	0.8222	0.9089	0.9241	0.8569

Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-Time and Product-Time FEs. 2,102,174 observations; 351,745 clusters.

Table B.11: Product-level: Trade Deflection - Decomposition - Dummies - simple FEs

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.5343***	-0.3232***	0.1248***	-0.3359***
	(0.1197)	(0.0590)	(0.0445)	(0.1107)
Duty US	-0.8733***	-0.2508***	-0.0164	-0.6060***
	(0.1784)	(0.0670)	(0.0537)	(0.1545)
Duty other	-0.7043***	-0.3393***	0.0793***	-0.4443***
	(0.0737)	(0.0390)	(0.0258)	(0.0564)
Duty EU 3rd	-0.0121	-0.0141*	0.0593***	-0.0573***
	(0.0167)	(0.0084)	(0.0072)	(0.0141)
Duty US 3rd	0.2425***	0.1810***	-0.1230***	0.1845***
	(0.0156)	(0.0073)	(0.0083)	(0.0146)
EU 3rd = US 3rd (p)	0.0000	0.0000	0.0000	0.0000
R^2	0.7965	0.8776	0.9138	0.8410

Note: AD Variable: AD Dummy. Other countries' own duties controlled for but not reported. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-Time and Sector-Time FEs. 2,104,083 observations; 352,152 clusters.

Table B.12: Product-level: Decomposition - Product-specific Duties

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-1.3606***	-0.8282***	0.0642	-0.5967**
	(0.3537)	(0.1260)	(0.1449)	(0.3040)
Duty US	-0.9266***	-0.3692***	0.0195	-0.5769***
	(0.1577)	(0.0489)	(0.0577)	(0.1481)
Duty other	-0.3764***	-0.1771***	0.0311	-0.2303***
	(0.0964)	(0.0485)	(0.0445)	(0.0851)
EU = US (p value)	0.2625	0.0007	0.7741	0.9533
R^2	0.8860	0.9454	0.9500	0.9074

Note: AD Variable: ln(1 + Product-specific AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-hs4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Table B.13: Product-level: Decomposition - Chemicals - Weighted AD Duty

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.3592	-0.7928**	-0.0055	0.4391
	(0.5656)	(0.3152)	(0.1696)	(0.6061)
Duty US	-1.3511***	-0.5289***	0.0210	-0.8432**
	(0.4632)	(0.1021)	(0.1439)	(0.3739)
Duty other	-0.5008	-0.3837**	0.0298	-0.1469
	(0.3928)	(0.1514)	(0.1299)	(0.3669)
EU = US (p value)	0.1736	0.4223	0.9053	0.0694
R^2	0.8860	0.9454	0.9500	0.9074

Note: AD Variable: ln(1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Table B.14: Product-level: Decomposition - Chemicals - Dummies

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.1517	-0.2921***	-0.0346	0.1750
	(0.2386)	(0.1007)	(0.0671)	(0.2349)
Duty US	-1.4835***	-0.5426***	0.0007	-0.9416***
	(0.4500)	(0.0984)	(0.1478)	(0.3641)
Duty other	-0.2974*	-0.1665**	0.0758	-0.2066
	(0.1551)	(0.0703)	(0.0699)	(0.1709)
EU = US (p value)	0.0088	0.0720	0.8274	0.0095
R^2	0.8860	0.9454	0.9500	0.9074

Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Table B.15: Product-level: Decomposition - Metals

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-1.3002**	-0.5388**	0.1537	-0.9151
	(0.6025)	(0.2353)	(0.1795)	(0.5987)
Duty US	-1.7958***	-0.5932***	0.1807*	-1.3834***
	(0.4811)	(0.1660)	(0.1038)	(0.4355)
Duty other	-0.6097**	-0.2424***	0.0531	-0.4203*
	(0.2587)	(0.0876)	(0.0804)	(0.2381)
EU = US (p value)	0.5195	0.8500	0.8959	0.5258
R^2	0.8860	0.9454	0.9500	0.9074

Note: AD Variable: ln(1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Table B.16: Product-level: Decomposition - Metals - Dummies

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.5297**	-0.2367***	0.0291	-0.3220*
	(0.2187)	(0.0863)	(0.0600)	(0.1936)
Duty US	-1.2103***	-0.4012***	0.1368*	-0.9458***
	(0.3677)	(0.1304)	(0.0774)	(0.3208)
Duty other	-0.8861***	-0.3760***	0.0611	-0.5712***
	(0.1736)	(0.0640)	(0.0581)	(0.1593)
EU = US (p value)	0.1114	0.2922	0.2707	0.0951
R^2	0.8860	0.9454	0.9500	0.9074

Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Table B.17: Product-level: Decomposition - Machinery

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.5811	-0.7756***	0.2012	-0.0067
	(0.9222)	(0.2519)	(0.7513)	(0.4562)
Duty US	-0.7839***	-0.1726**	0.2041	-0.8153**
	(0.2282)	(0.0761)	(0.2130)	(0.3637)
Duty other	-0.4185**	-0.1105	0.1871**	-0.4951***
	(0.1983)	(0.0909)	(0.0878)	(0.1839)
EU = US (p value)	0.8309	0.0220	0.9970	0.1655
R^2	0.8860	0.9454	0.9500	0.9074

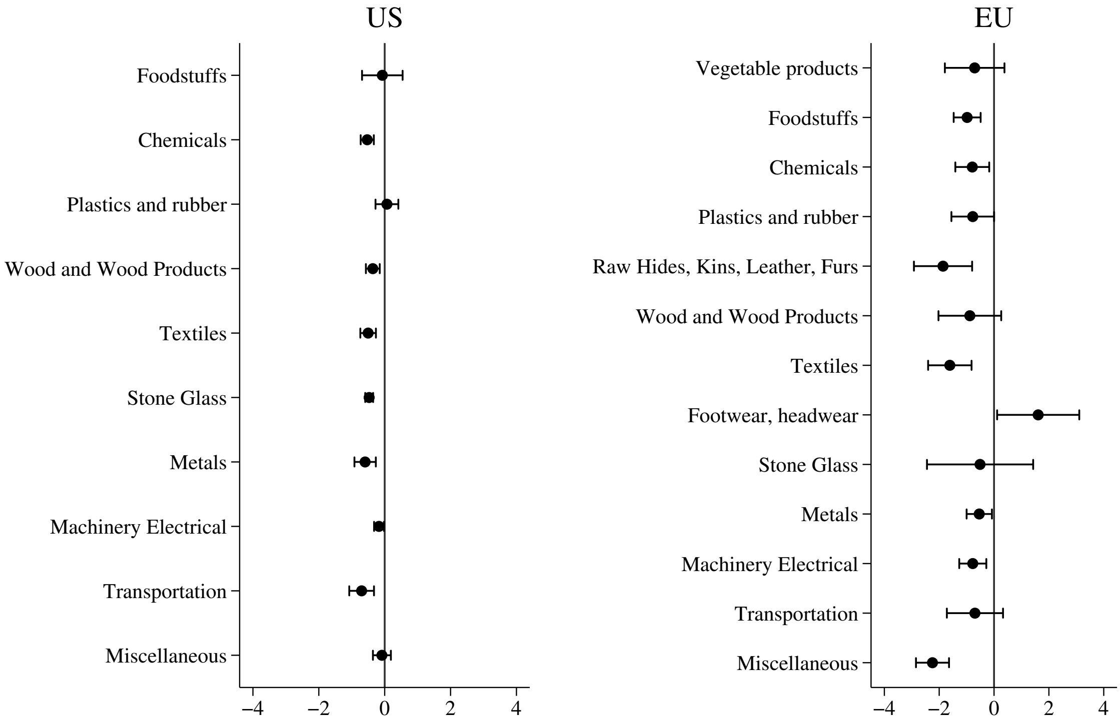
Note: AD Variable: ln(1 + Trade weighted AD Duty Rate/100). Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Table B.18: Product-level: Decomposition - Machinery - Dummies

Dependent Variable	(1) ln value	(2) ln no. firms	(3) ln mean price	(4) ln mean quantity
Duty EU	-0.2908	-0.3098***	0.0039	0.0151
	(0.3202)	(0.1131)	(0.2593)	(0.1962)
Duty US	-0.7930***	-0.2231***	0.1474	-0.7173**
	(0.2198)	(0.0817)	(0.1886)	(0.3243)
Duty other	-0.6139***	-0.2426***	0.1170	-0.4883***
	(0.1819)	(0.0649)	(0.0879)	(0.1630)
EU = US (p value)	0.1955	0.5348	0.6541	0.0531
R^2	0.8860	0.9454	0.9500	0.9074

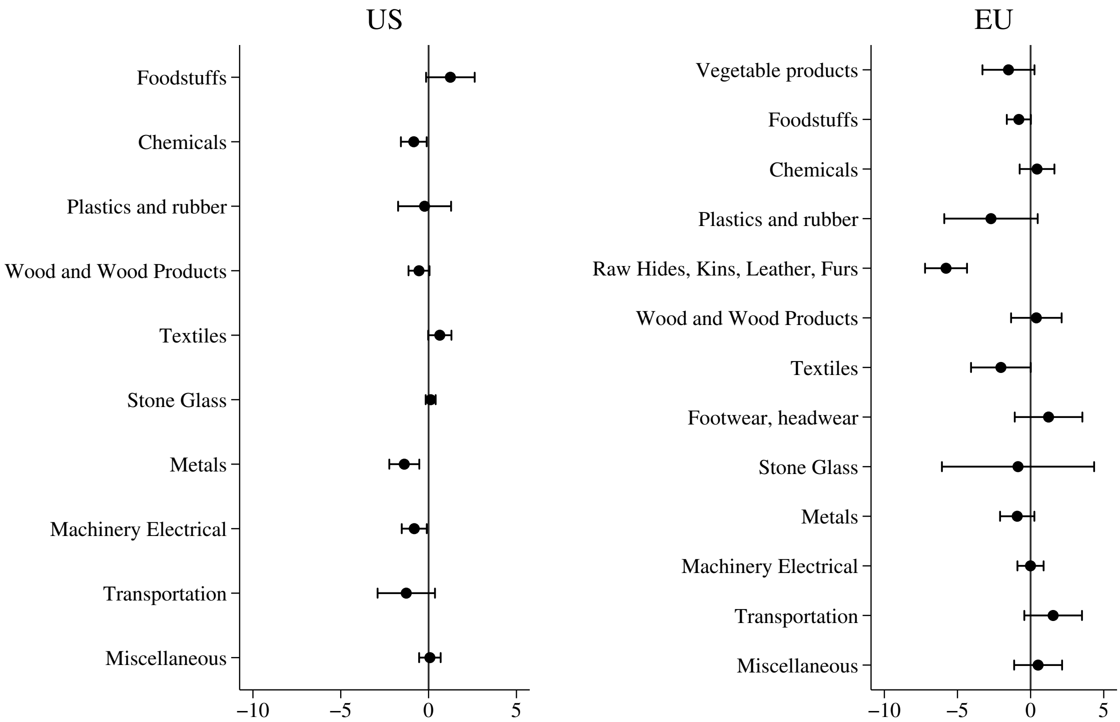
Note: AD Variable: AD Dummy. Robust standard errors clustered by Country-Product(HS6) in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. Country-Product, Country-HS4-Time and Product-Time FEs. 1,765,887 observations; 293,660 clusters.

Figure B.1: The Effect of AD Duties on the Number of Exporters, nested by Sector



Note: Regression of ln exports on ln(1 + Trade weighted AD Duty Rate/100), Country-Product, Country-HS4-Time and Product-Time FEs. Robust standard errors clustered by Country-Product. 293,660 clusters. 1,765,887 observations. Vertical line corresponds to zero. Sorted by sector classification.

Figure B.2: The Effect of AD Duties on average Export Quantity, nested by Sector



Note: Regression of ln exports on ln(1 + Trade weighted AD Duty Rate/100), Country-Product, Country-HS4-Time and Product-Time FEs. Robust standard errors clustered by Country-Product. 293,660 clusters. 1,765,887 observations. Vertical line corresponds to zero. Sorted by sector classification.