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## Abstract

This paper explores an under-researched margin of firms' export adjustments in response to negative trade policy shocks: export reallocation across markets. Using detailed Chinese customs data spanning from 2000 to 2015 and a difference-in-differences approach, we compare export dynamics between multi-destination exporters that were subject to antidumping (AD) duties and those that were not affected. Our empirical results show that, on average, AD duties reduced firms' entry into new markets and increased their exit from existing markets. These effects were less pronounced for exports to high-income destinations and high-quality products. Continuing exporters, however, raised their exports to non-AD markets after being affected by AD duties and this effect was stronger for high-income destination exports. Further analysis underscores the role of quality upgrading in explaining the trade-promoting effect of AD duties in third countries. Our findings reconcile the seemingly contradictory trade diversion and tariff echoing effects of AD duties documented in earlier studies.

JEL-Codes: F130, F140, F510, F610.

Keywords: antidumping, multi-destination firms, within-firm adjustment, quality.

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# 1 Introduction

With more countries joining the WTO and regional free trade agreements that do not allow member countries to impose discretionary tariffs, non-tariff barriers such as antidumping (AD) actions are more widely used as a means to protect the domestic market. This is especially the case when countries show evidence of trade partners dumping into their markets. As the world's largest economies, the USA and EU imposed AD duties on 9.0% and 6.6% of their imported HS-6 products respectively between 1995 and 2013 (Felbermayr and Sandkamp, 2020). While AD measures can protect import-competing domestic producers, domestic firms that import targeted products can be harmed (Jabbour et al., 2019). On the other hand, foreign firms that export targeted products are often affected even more substantially. Existing studies find that AD investigations can significantly reduce exports, mainly due to a higher number of exits from the exporting markets (Vandenbussche and Zanardi, 2010; Lu et al., 2013; Crowley et al., 2018). Surviving exporters, however, reduce their product scope, raise their product sophistication, and upgrade their product quality, suggesting a reallocation across products within firms (Lu et al., 2018; Meng et al., 2020). Building on existing studies, this paper studies a substantially under-researched margin of firms' adjustment following negative trade shocks, i.e. reallocation across exporting markets, and focuses on the spillover effects on the export behaviour of multinational exporters in non-AD markets.

Specifically, this paper aims to answer the question of whether multi-destination exporters increase their exports of a product to other countries and/or enter new markets if the product in question receives AD duties in one country. If so, do firms export to similar or substantially different markets? The former could be due to the fact that firms can continue to make profits thanks to the similar business environment whereas the latter could be related to the "tariff echoing" effect, which suggests that similar countries may impose the same trade barriers following the imposition of AD duties in one country(Tabakis and Zanardi, 2017; Crowley et al., 2018). We also investigate whether firms upgrade the quality of their products after receiving AD duties and whether this quality upgrading varies based on the income level of export markets to understand the mechanisms behind firms' adjustments across exporting markets.

To answer these questions, we rely on China's transaction-level customs data spanning the years between 2000 and 2015, which are further matched to the data of AD duties imposed by all countries. China presents an appealing case to study these questions for two reasons. First, following its accession to the WTO in 2001, China witnessed a remarkable increase in exports

and became the world's largest merchandise exporter in 2010.[1] Accompanied by its rapid export growth, China has also faced the highest number of AD investigations, accounting for a quarter of the global total number (Felbermayr and Sandkamp, 2020). Consequently, Chinese exporters are among the most affected and have had to make significant adjustments in response to AD duties (e.g. Lu et al., 2013; Crowley et al., 2018; Lu et al., 2018; Meng et al., 2020). Second, China features a high number of multi-destination exporters. Over our sample period, 85% exporters shipped their products to more than one market and on average to 11 destinations.[2] This makes China especially suitable for analysing firms' across-market adjustments.

Taking advantage of the full coverage of products and export destinations of China's customs data, our empirical approach explores firms' heterogeneous exposure to AD duties across products and countries. Specifically, we generate a measure of exposure to AD actions at the firm-Harmonised System (HS) 6-digit product level and distinguish between firm-product duplets that received AD duties in at least one country and those that were never affected. We then employ a difference-in-differences (DiD) approach and compare firm-product duplets that were subject to AD duties and non-affected firm-products that belong to the same HS 4-digit product category. The granularity of the customs data allows us to control for a set of strict fixed effects that account for both demand and supply factors. This way, we are able to identify the causal effects of AD duties on firms' export behaviour. Relying on this approach, we first examine firms' adjustment along the extensive margin by focusing on their entry and exit dynamics into and from third countries after receiving AD duties. We also explore heterogeneity by the income level of export markets and the quality of products. The latter allows us to understand whether firms strategically adjust the entry and exit dynamics in other markets depending on the quality of products in response to adverse trade shocks.

Our second step focuses on the intensive margin. We specifically examine changes in export values, quantities, and prices of continuing exporters, again, in third countries, in response to trade policy shocks in one market and possible heterogeneity by market type. Existing studies find that AD duties induce firms to upgrade the quality and raise the sophistication of their products exported to AD-imposing countries (Lu et al., 2018; Meng et al., 2020). We propose that these effects could also extend to products exported to other countries. As a third step, we investigate this possibility as an additional dimension of firms' adjustment and also as a mechanism to understand the impacts on export volumes. Considering that some firms may change their export destination type from high- to low-income countries or vice versa, we allow

[1] See https://unctad.org/news/china-rise-trade-titan.

[2] French firms export their products on average also to 11 destinations (Mayer et al., 2014) whereas Argentine firms export to an average of five destinations (Brambilla et al., 2012).

for such heterogeneity and investigate whether they upgrade or downgrade the quality of their products following a change in export destination types.

Our empirical results reveal several interesting findings. First, we find that firms were less likely to export their investigated products to new markets and more likely to exit existing non-AD markets in response to AD duties. This is consistent with earlier findings that AD duties induce more firm exits (Crowley et al., 2018; Felbermayr and Sandkamp, 2020) but in contrast to the trade deflection effects that are widely documented in the literature (Bown and Crowley, 2006, 2007; Felbermayr and Sandkamp, 2020). One possible explanation for the latter is the "tariff echoing" effect such that other countries are likely to impose the same AD duties following the imposition of AD duties in one country (Tabakis and Zanardi, 2017; Crowley et al., 2018). We also find that AD duties have a market selection effect such that firms that previously exported high-quality products tended to stay whereas low-quality exporters were more likely to exit.

Second, focusing on the intensive margin of the adjustments, we find that continuing firms increased their exports to third countries when their products were targeted by AD duties, suggesting that multi-destination exporters reallocated across their existing markets when they experienced adverse trade policy shocks in one market. These results support the trade deflection effects of AD actions documented in earlier studies (Bown and Crowley, 2006, 2007; Felbermayr and Sandkamp, 2020) but are present only among continuing exporters. Distinguishing between high- and low-income destinations, the trade deflection effects of AD duties are significantly stronger for products exported to high-income countries.

Our results also indicate that the positive effects of AD duties on exports are mainly driven by growth in quantities but the price effects are limited, a finding consistent with a prior study by Felbermayr and Sandkamp (2020) using Chinese customs data. However, we find significant heterogeneity when distinguishing between products with a high versus low-quality scope; exporters raised the price of products with a high-quality scope while reduced the price of those with a low scope. This implies that exporters do not simply divert exports from AD to non-AD markets, but update the quality of their products that have a high potential for quality upgrading. Using a refined measure of product quality that controls for the price component in unit values (Khandelwal, 2010; Khandelwal et al., 2013; Manova and Yu, 2017), we find that firms upgraded the quality of their AD-affected products to third countries on average and this impact is especially stronger for high-income destinations but less so for low-income destinations if AD duties were imposed by high-income countries. These results highlight the role of quality upgrading as a channel to explain the trade-promoting effects of AD duties in third countries. Our further results show that firms' quality upgrading is closely related to the

toughness of market competition in third countries.

This paper builds upon the extensive literature that studies the consequences of AD actions. While it is less controversial that AD actions have strong trade dampening effects in the imposing countries (Messerlin, 1989; Prusa, 1996, 2001; Vandenbussche and Zanardi, 2010; Lu et al., 2013; Sandkamp, 2020), the impact on the affected exporters is far more multi-dimensional. It is documented that AD actions induce firms more likely to exit the imposing market (Lu et al., 2013; Crowley et al., 2018; Felbermayr and Sandkamp, 2020), reduce the product scope but increase the sophistication and upgrade the quality of exporting products (Lu et al., 2018; Meng et al., 2020). The effect on firms' productivity, however, is still inconclusive. Chandra and Long (2013) find that US AD duties reduce the labour productivity of targeted Chinese firms. By contrast, AD duties could also improve the productivity of continuing exporters and hence the overall competitiveness of Chinese exporters (Jabbour et al., 2019) with less efficient exporters exiting the market (Lu et al., 2013; Felbermayr and Sandkamp, 2020).

Another body of literature focuses on the spillover effects of exports to third countries when exporters are subject to AD investigations in one country. Analysing US AD actions on Japanese exports, Bown and Crowley (2006) and Bown and Crowley (2007) find that AD duties increased Japanese exports of the same product to third countries. Similar findings are found for Vietnamese footwear exporters (Hoai et al., 2017) and Chinese exporters (Felbermayr and Sandkamp, 2020). However, firms may also reduce their exports of AD-targeted products as well as closely related products to foreign countries due to the scare of similar countries imposing the same non-tariff barriers (Crowley et al., 2018).

This paper distinguishes it from and complements these existing studies in various aspects. First, a large majority of existing studies primarily focus on the AD duties imposed by the US and/or the EU (e.g. Prusa, 1996; Bown and Crowley, 2007; Lu et al., 2013; Jabbour et al., 2019; Felbermayr and Sandkamp, 2020; Sandkamp, 2020). In this paper, we extend the coverage to all countries that imposed AD duties during our sample period. An early study by Felbermayr and Sandkamp (2020) finds that Chinese exporters react differently to AD duties imposed by the EU as compared to the US. The extension to full coverage thereby allows us to provide a full picture of the consequences of AD duties.

Second, existing studies mainly concentrate on how AD affects exports to AD-imposing countries. Only a few papers touch upon the spillover effects to the exports to non-AD countries (e.g. Hoai et al., 2017; Felbermayr and Sandkamp, 2020). This paper, instead, focuses on firms' exports to third countries when they are affected by AD duties in one country and presents

comprehensive empirical evidence on firms' adjustments in their export behaviours in those markets. Our paper is closely related to Bown and Crowley (2006) and Bown and Crowley (2007) that document the trade deflection effects of the US AD duties on Japanese exports to other markets. Different from those two papers that use aggregated product-level data and concentrate solely on the US AD duties, this paper employs firm-product level data that allow us to analyse cross-market reallocation within firms, thereby providing a nuanced picture at the firm level and contributing to a better understanding of the trade deflection effects. Moreover, rather than focusing on AD measures imposed by one specific country or region, we consider all AD-imposing countries. This enables us to uncover rich heterogeneous effects across AD imposing country types and destination types.

Our paper is most related to Crowley et al. (2018) and Bao et al. (2021), both of which analyse firm-level export adjustments in third markets when facing trade policy uncertainties. While we find consistent evidence with Crowley et al. (2018) that firms were less likely to enter new foreign markets and more likely to exit foreign markets when their products were targeted by AD actions, our results also reveal that surviving exporters indeed increased their exports to foreign markets.[3] The differential adjustments along the extensive and the intensive margins provide explanations for the co-existence of seemingly contradictory trade deflection effects and the tariff echoing effects. These results also explain why the aggregate effects of AD on global trade are only modest (Egger and Nelson, 2011). Additionally, we provide evidence showing that heterogeneity in product quality and quality upgrading among incumbent exporters are important channels explaining the AD-induced export adjustments in non-AD markets. To the best of our knowledge, this paper documents the first extensive evidence of third-country effects of AD duties at the firm level.

A growing body of literature examines the effects of trade protectionism in the context of the 2018 trade war (Amiti et al., 2019; Fajgelbaum et al., 2020; Cavallo et al., 2021; Jiao et al., 2022; Jiang et al., 2023), sanctions (Crozet et al., 2021; Larch et al., 2022; Miromanova, 2023), and technical barriers (Fontagné et al., 2015; Fontagné and Orefice, 2018). These studies predominantly focus on the impact on either exports to or imports by countries imposing these measures. The understanding of how firms redistribute their exports across markets and the third-market effects still remains limited. Our findings complement this literature and offer insights into the third-market effects of trade protectionism.

Our finding of firms upgrading their export quality speaks to the literature that documents

[3] Bao et al. (2021) document "a within-firm chilling effect" which indicates that firms reduced the export quantities of products to other markets subsequent to receiving AD actions in one market. Discrepancies between their finding and ours may potentially stem from differences in sample periods and estimation strategies.

the importance of the income level of destination markets in affecting export quality. Due to the non-homothetic preferences of consumers such that rich consumers have a higher demand for better-quality products, firms tend to produce and export high-quality products shipped to high-income destinations (Hallak, 2006; Verhoogen, 2008; Brambilla and Porto, 2016; Wang et al., 2022). Controlling for both demand and supply factors by including strict fixed effects, we find that AD duties induced firms to upgrade the quality of their exports and such effect was stronger for high-income destination exports. This finding emphasises the role of quality that is insofar understudied in the literature that examines the trade effects of adverse policy shocks.

The remainder of the paper proceeds as follows. Section 2 presents our empirical strategy, followed by descriptions of the data used in this paper in Section 3. Section 4 and Section 5 report empirical results and robustness checks. Section 6 concludes.

## 2 Empirical strategy

This section presents the empirical model and identification strategy that we use to estimate the export dynamics of multi-destination firms in response to AD duties.

To this end, we are specifically interested in how firms adjust their exports of the same product to third, non-AD markets if a product is subject to AD duties in one market. Along the extensive margin, firms may exit existing markets or enter new markets. Along the intensive margin, continuing exporters may increase or reduce their exports to existing markets. To identify the causal effects of AD duties, we would ideally compare changes in firms' exports of product $i$ before and after receiving AD duties with a counterfactual of the same product receiving no AD duties. However, such a counterfactual is not observable. To construct a comparable counterfactual, we choose products exported to the same market that are within the same HS 4-digit category by other firms but are never investigated by AD (Crowley et al., 2018; Meng et al., 2020; Felbermayr and Sandkamp, 2020). The assumption here is that those products are similar to the investigated one before receiving AD duties. In a DiD framework, we investigate the disparity in firms' exporting performances in third markets between treated and control products following AD induced policy shocks. The empirical specification is as follows:

$$y_{fhct} = \alpha + \beta ln(ADduty_{fht} + 1) + \theta_{fhc} + \theta_{hct} + \theta_{ft} + \varepsilon_{fhct} \tag{1}$$

where $y_{fhct}$ measures firm $f$'s exports of HS 6-digit product $h$ to non-AD country $c$ in year $t$. In the empirical analysis, we consider various measures of firms' export adjustments, including

market entry and exit that capture adjustments along the extensive margin, and export value, quantity, and price (all transformed by natural logarithm) that measure the intensive margin adjustments.

Our key variable of interest is $ADduty_{fht}$, which indicates the ad valorem duties or value-added duties[4] imposed on product $h$ exported by firm $f$ in year $t$, transformed by natural logarithm. It equals zero for all pre-AD years and all non-AD products. To account for these zero values, we add one before taking logs. This variable is equivalent to a continuous DiD measure but allows for heterogeneity in the extent of treatment across firms, captured by the level of AD duties. Its coefficient, $\beta$, measures the average within-firm shift in exports of the same product to third markets following its treatment by AD duties in one country relative to similar, non-treated firm-products, and hence measures the effects of AD duties on the outcome variables.

The granularity of our transaction-level data allows us to include a set of stringent fixed effects in Equation (1).[5] $\alpha_{fhc}$ indicates firm-product-country fixed effects. They control for all time-invariant characteristics specific to the firm, product, and country triplet. Conditional on these fixed effects, our identification of the effects of AD duties derives from over-time variations in a firms' exports of a specific product to a specific destination market. Additionally, we control for product-country-year fixed effects ($\alpha_{hct}$) to account for the overall time-variant demand for product $h$ by country $c$, and firm-year fixed effects ($\alpha_{ft}$) to capture firm-level export supply shocks in year $t$.[6] Notice that product-country-year fixed effects also control for gravity determinants of exports such as distance to the destination country, contiguity, common language, and regional trade agreements which vary at the country or country-year level. Firm-year fixed effects could absorb the effects of supply shocks at the firm level over time, such as changes in productivity or financial situations, which subsequently impact firms' export performances. $\varepsilon_{fhct}$ is the error term. We cluster the standard errors at the firm-product level to allow for possible correlations across firms' exports of the same product to different markets.[7]

Equation (1) estimates the average effects on exports to all non-AD markets. To understand whether firms adjust their exports to high-income versus low-income countries differently, we

[4]Between 2000 and 2015, 43 percent and 33 percent of 707 AD measures against Chinese firms are in the form of ad valorem duties and specific duties. We drop firms affected by other AD measures, such as price undertakings and quota restrictions. For specific duties, we calculate the value-added duty rate as specific duty×export quantity/export value.

[5]As emphasised by Felbermayr and Sandkamp (2020), including fixed effects is important for eliminating sources of omitted variable bias.

[6]Controlling for firm-year level fixed effects is the most restricted possible way as our key independent variable, the AD duty measure, is at the firm-product-year level. In a robustness check, we include firm-HS4 product-year fixed effects where HS4 product indicates product categories defined at the HS 4-digit level.

[7]Our results are robust to two-way clustered standard errors at the firm-product and country-product levels that additionally allow for serial correlations across firms that export the same product to the same market.

extend Equation (1) by introducing an interaction term between the antidumping duty measure and a high-income destination indicator in Equation (2), shown as follows:

$$y_{fhct} = \alpha + \beta_0 ln(ADduty_{fht} + 1) + \beta_1 ln(ADduty_{fht} + 1) \times HI_{ct} + \theta_{fhc} + \theta_{hct} + \theta_{ft} + \varepsilon_{fhct} \quad (2)$$

where $HI_{ct} = 1$ if a destination market belongs to the high-income category in year $t$ according to the World Bank classification.[8] In Equation (3), we further distinguish between products that are exported to different types of market relative to the AD-imposing country. Specifically, $UP_{fhct}$ indicates the case that firm $f$ receives AD duties on its product $h$ in a low-income country but exports to a high-income country. Similarly, $DN_{fhct}$ equals 1 if a firm receives AD duties on its product $h$ in a high-income destination but exports to a low-income country. The reference group consists of firm-products for which the AD-imposing and destination markets are the same type.

$$\begin{aligned} y_{fhct} =& \alpha + \beta_0 ln(ADduty_{fht} + 1) + \beta_1 ln(ADduty_{fht} + 1) \times UP_{fhct} \\ &+ \beta_2 ln(ADduty_{fht} + 1) \times DN_{fhct} + \beta_3 UP_{fhct} + \beta_4 DN_{fhct} + \theta_{fhc} + \theta_{hct} + \theta_{ft} + \varepsilon_{fhct} \end{aligned} \quad (3)$$

Existing literature documents that firms may adjust the quality of their exported products when receiving AD investigations (Jabbour et al., 2019) or according to the market demand for quality (Verhoogen, 2008; Brambilla and Porto, 2016). We thereby consider the quality of exports as an additional margin of firms' adjustments on their exports. Along the extensive margin, we specifically investigate whether the quality of the exported product determines firms' exit from existing markets or entry into new markets. Along the intensive margin, we are interested in whether continuing firms upgrade the quality of their products exported to non-AD markets following AD investigations. We also allow for heterogeneous changes in export quality across market types.

Precisely measuring the quality of products is challenging as the quality of products is not observed. We follow the literature (see e.g. Khandelwal, 2010; Khandelwal et al., 2013) and estimate unobserved product quality from export prices $p_{fhct}$ and quantities $q_{fhct}$. The intuition of this approach is that conditional on prices, the demand for high-quality products is higher, thereby higher export quantities. This measure is supreme to using unit values in that unit

[8] We identify high-income countries according to the per capita income level from the World Development Indicators database maintained by the World Bank (World Bank, 2021b).

values also include differences in production costs and transportation costs. As we show later, AD duties do not significantly change the average prices of exports to third markets while firms actually upgrade the quality of their products. Specifically, we proxy product quality as the residual from the following OLS regression conditioning on prices and fixed effects:

$$lnqua_{fhct} = \sigma lnp_{fhct} + \theta_h + \theta_{ct} + \varepsilon_{fhct} \tag{4}$$

where $lnqua_{fhct}$ and $lnp_{fhct}$ denote the logarithm of export quantity and price of product $h$ exported by firm $f$ to destination country $c$ in year $t$. $\sigma$ indicates the elasticity of substitution, data of which are obtained from Broda and Weinstein (2006). $\theta_h$ is product fixed effects accounting for average differences between HS 6-digit products and $\theta_{ct}$ denotes country-year fixed effects controlling for changes in demand for quality in the destination country over time.

# 3 Data, analytical sample, and descriptive evidence

## 3.1 Data sources

The main data used in our empirical analysis are from two sources: the Chinese Customs Database (CCD) maintained by China's General Administration of Customs, and the Global Antidumping Database (GAD) constructed by Bown (2011) and maintained by the World Bank (World Bank, 2021a). The CCD records the universe of all trade transactions for the period spanning 2000 to 2015. It reports detailed information on the trading firm, product at the HS 8-digit level, values and quantities, as well as the destination of each export transaction.

Compared to the aggregated country-level trade data that are commonly used in the earlier literature, firm-level trade data have several advantages. First, the detailed information on firms and their exported products enables us to match with antidumping data from the GAD, allowing us to precisely identify the exact firms and products that were subject to antidumping duties in each country. Based on the matched data set, we explore how firms adjust their exports of affected products in other markets. Further, we are able to explore firms' adjustments along both the intensive and the extensive margins. As we show later, such dimension is the key to understanding the seemingly contradictory trade deflection effects and tariff echoing effects documented in earlier studies (e.g. Bown and Crowley, 2006, 2007; Tabakis and Zanardi, 2017; Crowley et al., 2018).

Second, the universal coverage of firms and products of the CCD provides us with large

flexibility to choose comparison firm-products that are similar enough to the affected ones by AD duties. We are also able to include a rich set of fixed effects in our estimation models, which are deemed crucial for the identification of casual effects.

Third, with firm-level information on export values and quantities, hence also prices, we are able to measure the quality of each exported product at the firm level. This makes it possible to compare quality differences between narrowly defined firm-product duplets and helps understand the reasons behind the differential exporting dynamics across heterogeneous firms following AD shocks. We demonstrate that differences in product quality play a crucial role in determining firms' decisions to enter or exit third markets along the extensive margin, as well as in firms' heterogeneous adjustments in exports to high- versus low-income destinations along the intensive margin.

The GAD collects information on all AD cases in over 30 countries until 2019 and has been the most widely used database for AD analysis. For each AD case, it reports the HS codes of investigated products at 6 to 10-digit level depending on the initiated country and a name list of firms that are involved in each case. This feature of the database allows us to define treatment at the firm product level in contrast to most existing studies that define AD treatment at the product level. For the purpose of this paper, we extract information on AD cases against China between 2000 and 2015 by 26 trading partners under the WTO's Agreement on Antidumping.[9] This database also reports the timeline of each case, including the initiation date, the date of implementing preliminary AD measures, and the date of imposing final AD measures. In this paper, we use the determined final AD duties as our main treatment measure. The availability of additional dates makes it possible to examine potential anticipation effects following the initiation of AD investigations.

Table 1 reports the summary statistics of AD cases against Chinese firms between 2000 and 2015. 74% of AD cases were ended with antidumping measures, including ad valorem duties, a fixed or specific amount of duties, and price undertaking, among which 87% were AD duties. AD imposing countries do not only include developed countries such as the USA and the EU, who initiated 12% and 10% AD cases during our sample period, but also include large developing countries such as India (17%), Brazil (9%), and Turkey (8%). In our empirical analysis, we distinguish between AD duties implemented by high- versus low-income countries and examine whether firms responded differently. 16% of HS 6-digit products (820 out of 5113) exported by Chinese firms were subject to AD duties imposed by different trading partners during the sample period.

[9] We treat the 28 countries of the European Union as a single trading partner.

Table 1: Number of AD cases on Chinese products by trade partner: 2000-2015

| Trade partners | No. of AD cases | Share(%) | No. of AD measures | No. of AD duties | Affected products |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| India | 154 | 16.56 | 127 | 107 | 234 |
| USA | 116 | 12.47 | 88 | 88 | 275 |
| European Union | 93 | 10.00 | 70 | 62 | 154 |
| Brazil | 83 | 8.93 | 51 | 51 | 94 |
| Turkey | 75 | 8.06 | 67 | 67 | 163 |
| Argentina | 70 | 7.53 | 56 | 32 | 57 |
| Mexico | 47 | 5.05 | 28 | 25 | 40 |
| Colombia | 41 | 4.41 | 21 | 0 | 0 |
| Australia | 39 | 4.19 | 20 | 8 | 24 |
| Canada | 36 | 3.87 | 27 | 27 | 79 |
| South Africa | 27 | 2.90 | 11 | 9 | 10 |
| South Korea | 20 | 2.15 | 17 | 14 | 27 |
| Thailand | 19 | 2.04 | 14 | 11 | 50 |
| Indonesia | 19 | 2.04 | 11 | 11 | 32 |
| Pakistan | 17 | 1.83 | 8 | 8 | 12 |
| Peru | 15 | 1.61 | 15 | 11 | 44 |
| Russia | 12 | 1.29 | 11 | 10 | 34 |
| Malaysia | 11 | 1.18 | 7 | 7 | 18 |
| Taiwan | 10 | 1.08 | 6 | 4 | 10 |
| Ukraine | 8 | 0.86 | 8 | 7 | 15 |
| Israel | 6 | 0.65 | 4 | 3 | 9 |
| New Zealand | 5 | 0.54 | 4 | 3 | 3 |
| Japan | 3 | 0.32 | 2 | 2 | 2 |
| Trinidad and Tobago | 2 | 0.22 | 2 | 7 | 7 |
| Jamaica | 1 | 0.11 | 1 | 1 | 2 |
| Uruguay | 1 | 0.11 | 1 | 1 | 1 |
| Total | 930 | 100 | 677 | 571 | 820 |

*Notes:* Table shows statistics of AD cases on Chinese products by trade partner between 2000 and 2015. Columns (1) to (4) report the number of AD cases, AD measures, AD duties as well as the number of affected products measured at the HS 6-digit level. Data are from World Bank (2021a).

### 3.2 Analytical sample and identification of AD treated firm-products

To analyse the causal effects of AD duties on firms' export adjustments across markets, we constrain our sample to firms that export a product to multiple destinations and focus on firm-products subject to AD duties in at least one market and similar firm-products that are never affected. Our analytical sample is constructed as follows.

First, given that countries report their investigated products at different HS levels varying from

6 to 10 digits while the first 6 digits are according to the harmonised international standards, we aggregate Chinese export data to the HS 6-digit level for each firm by destination country for each year over 2000-2015. Second, we identify trade intermediaries following the literature (e.g. Ahn et al., 2011; Fan et al., 2015) and exclude them from our sample so that we focus on manufacturing firms.Third, we restrict our sample to surviving firms following antidumping actions for the analysis of the intensive-margin analysis. Those are the firms that export in at least two consecutive years over 2000-2015. Lastly, we consider only products that belong to the same HS 4-digit categories as those subject to AD duties. That said, HS 4-digit product categories where no HS 6-digit product is ever subject to AD duties are excluded. This way we compare similar products within the same HS 4-digit categories but exposed differently to AD duties. Our final sample includes 196,043 manufacturing exporters, 2300 HS 6-digit products, and 231 destinations from 2000-2015.

To identify firm-products that are affected by AD duties, we match products at the HS 6-digit level and firms based on firm names. While matching products based on the standard HS codes is relatively straightforward, identifying the same firms in the two data sets is challenging. This is because firm names in the customs data are in Chinese whereas in the GAD are in English. Moreover, some firms on the GAD firm list are indeed the producers, not the exporters. To increase matching rates, we first translate firms' English name to Chinese using the online translator DeepL and then match firms' Chinese names in the two data sets using the *matchit* command in Stata that allows for fuzzy similarity matching between text variables (Raffo, 2015). For firm names that are not perfectly matched (with a similarity score below 1), we manually check the accuracy of matching and further identify firms that are indeed the same but with slightly different names due to translation inaccuracies. Using this approach, we successfully matched 90% (2,290) of the firms that were subject to AD duties from all countries in the GAD, 87% (1,095) for the US cases and 90% (391) for the EU cases. Felbermayr and Sandkamp (2020) use a similar approach and achieve comparable matching rates.

In some cases, AD duties do not target specific firms but specific products, which account for 37% of all the AD cases during 2000-2015. For those cases, we treat all firms that exported those specific products to AD-imposing countries as being treated.

As we focus on firms' export dynamics in third markets following AD duties, we drop firm-product observations that were directly affected by AD duties in AD-imposing countries. Also, we drop firms that exported both AD and non-AD products to exclude possible spillover effects on non-AD products within firms.

Table 2 reports the summary statistics for the key dependent and explanatory variables based on the analytical sample, with columns (1) and (2) corresponding to the full sample, and columns (3)-(4) and (5)-(6) corresponding to the treatment and control groups, respectively. On average, treated products are exported slightly more to non-AD markets measured in both values and quantities with higher qualities but at lower prices relative to control products.

Overall, firms export an average of 65.5 percent of each product to high-income countries, and this share is 69.7 percent measured at the firm level including all exported products, as shown in Panel C. When we split the full sample into treatment and control groups, we observe that a higher percentage of treated products (73.9 percent) are exported to high-income countries compared to the control products, where the percentage is 63.2 percent. A similar pattern is present when we measure at the firm level. Also, treated products tend to be exported to a higher number of destinations. As shown in Panel D, firms export each of their products to 6.6 destinations on average and to an average of 13.1 destinations if we count all products. However, treated products are exported to an average of 8.1 destinations in contrast to an average of 6.2 destinations for the control group. Measured at the firm level, firms export to an average of 14.0 destinations for the treatment group as compared to an average of 13.6 destinations for the control group.

### 3.3 Descriptive evidence

Before presenting estimation results, in this section, we plot the time trend of our key variables of interest for the treatment and control groups. In Figure A.1 in the appendix, we first plot the average entry rate into and exit rate from non-AD markets four years around the year of receiving AD duties, aiming to show descriptive trends of export adjustments along the extensive margin. Figure A.1a shows that the average entry rates are virtually the same for both treatment and control groups before AD duties. While the control group remains a relatively stable entry rate over time, firm-products that received AD duties observed an immediate drop following the duties, indicating a negative impact of AD duties on market entries. Figure A.1b shows the average exit rates. Without AD duties, control products show a systematically higher exit rate of around seven percent than the treated products and the trends between the two groups are very stable. However, those receiving AD duties experience a surge in exit rate thereafter, resulting in a similar level to the control group. Such a change suggests a positive effect of AD duties on market exits in third markets.

Figure A.2 in the appendix displays the time trend of average export values, quantities, prices,

Table 2: Summary statistics of key variables

| | All firms | | Treatment group | | Control group | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Panel A. Dependent variables | | | | | | |
| $\text{Entr}_{fhct}$ | 0.256 | 0.437 | 0.266 | 0.442 | 0.253 | 0.435 |
| $\text{Exit}_{fhct}$ | 0.143 | 0.350 | 0.165 | 0.371 | 0.135 | 0.342 |
| $\text{Value}_{fhct}$ (in log) | 10.335 | 2.559 | 10.467 | 2.560 | 10.290 | 2.557 |
| $\text{Quantity}_{fhct}$ (in log) | 8.153 | 3.397 | 8.582 | 3.265 | 8.007 | 3.428 |
| $\text{Unit value}_{fhct}$ (in log) | 2.182 | 2.383 | 1.885 | 2.140 | 2.283 | 2.452 |
| $\text{Quality}_{fhct}$ (in log) | 0.165 | 0.874 | 0.198 | 0.798 | 0.153 | 0.898 |
| Panel B. Explanatory variables | | | | | | |
| $\text{AD duty}_{fht}$ | 0.005 | 0.033 | 0.021 | 0.066 | 0 | 0 |
| $\text{HI}_{ct}$ | 0.483 | 0.500 | 0.441 | 0.496 | 0.497 | 0.500 |
| $\text{Quality scope}_{hs4}$ | 0.268 | 0.443 | 0.316 | 0.465 | 0.251 | 0.434 |
| $\text{UP}_{fhct}$ | 0.206 | 0.404 | 0.240 | 0.427 | 0.194 | 0.396 |
| $\text{DN}_{fhct}$ | 0.354 | 0.478 | 0.343 | 0.475 | 0.357 | 0.479 |
| $\text{Quality}_{fhct-1}$ | 0.138 | 0.570 | 0.186 | 0.501 | 0.120 | 0.592 |
| $\text{GDP}_{ct-1}$ (in log) | 27.149 | 1.691 | 27.164 | 1.772 | 27.142 | 1.651 |
| $\text{No. of exporters}_{hct-1}$ (in log) | 3.863 | 1.432 | 4.165 | 1.449 | 3.718 | 1.401 |
| $\text{HHI}_{hct-1}$ (in log) | 0.284 | 0.206 | 0.282 | 0.194 | 0.285 | 0.211 |
| Panel C. Export share to high-income countries | | | | | | |
| Firm-product-level | 0.655 | 0.379 | 0.739 | 0.329 | 0.632 | 0.388 |
| Firm-level | 0.697 | 0.330 | 0.733 | 0.310 | 0.678 | 0.335 |
| Panel D. Number of export destinations | | | | | | |
| Firm-product-level | 6.590 | 6.810 | 8.136 | 8.260 | 6.181 | 6.309 |
| Firm-level | 13.104 | 11.040 | 13.996 | 12.053 | 13.607 | 11.367 |
| No. of firms | 37,696 | | 10,915 | | 26,781 | |
| Observations | 1,989,392 | | 506,041 | | 1,483,351 | |

*Notes:* Table shows summary statistics of key variables based on our analytical sample. The treatment group includes products that received AD duties in at least one market, and the control group includes products within the same HS 4-digit product categories as the treated products but never received AD duties. Trade data are from China customs and AD data are from the GAD. Sample spans from 2000 to 2015. Dependent variables in Panel A measure firms' exports in non-AD markets. Panel B shows summary statistics for key explanatory variables. $\text{AD duty}_{fht}$ indicates firm $f$ product $h$ being treated by AD duties in at least one country in year $t$. $\text{HI}_{ct}$ indicates high-income countries according to the World Bank list. $\text{Quality scope}_{hs4c}$ measures the scope for quality upgrading at the HS 4-digit level. $\text{UP}_{fhct}$ indicates firm $f$ exporting product $h$ to low-income destinations in year $t-1$ and to a high-income market $c$ in year $t$. $\text{DN}_{fhct}$ indicates firm $f$ exporting product $h$ to high-income destinations in year $t-1$ and to a low-income market $c$ in year $t$. $\text{Quality}_{fhct-1}$ denotes the quality of firm $f$'s exports of product $h$ to destination market $c$in year $t-1$. $\text{GDP}_{ct-1}$ is the GDP level of country $c$ in year $t-1$. $\text{No. of exporters}_{hct-1}$ is the total number of Chinese exporters of product $h$ to country $c$ in year $t-1$. $\text{HHI}_{hct-1}$ is the Herfindahl index of product $h$ over all exporters in country $c$ in year $t-1$. Panel C shows the share of exports to high-income destinations. Panel D shows the number of export destinations.

and qualities of exports for continuing exporters in non-AD markets, which essentially show export adjustments along the intensive margin. In all four sub-figures, products receiving AD duties show a parallel trend to the comparison products before treatment while the disparity between the two groups appears following AD duties. Specifically, treated products experienced an increase in export values, prices, and qualities relative to non-treated products whereas changes in export quantities are much milder.

Taken together, the differential patterns between the treated and control products suggest strong evidence that AD policies significantly influence firms' export adjustments in third markets. In the next section, we estimate the causal effect in a DiD framework by distinguishing between export market types and explore possible mechanisms.

# 4 Empirical Results

## 4.1 AD duties and firms' export market entry and exit dynamics

### 4.1.1 Baseline results

We begin by examining firms' adjustment along the extensive margin in response to AD duties. Specifically, we are interested in firms' entry and exit dynamics of specific products in third markets following AD duties imposed by one market. To this end, we estimate a linear probability model according to Equation (1) where the outcome variable is a binary variable indicating whether firm $f$ did not export product $h$ to country $c$ in year $t-1$ but started to export to that market in year $t$ or whether a firm exported product $h$ to country $c$ in year $t-1$ but stopped exporting to the same market in year $t$, measuring market entry and exit respectively. In a DiD framework, we compare firm-products subject to AD duties in at least one market with similar non-affected ones within the same HS 4-digit sectors. We control for fixed effects at the firm-product-country, firm-year, and product-country-year levels.

Table 3 presents the estimation results where columns (1) and (2) correspond to the results for market entries and columns (3) and (4) correspond to market exits. Columns (1) and (3) present the baseline estimation results and columns (2) and (4) allow for heterogeneity between low- and high-income markets.

The estimation result in column (1) shows a negative and highly significant coefficient on AD duties, suggesting that products that were subject to a higher AD duty in one market were less likely to enter other markets relative to similar, unaffected firm-products. The size of the

Table 3: Antidumping duties and firms' entry and exit dynamics

| | Market entry | | Market exit | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\text{ADduty}_{fht}$ | -0.390*** | -0.569*** | 0.267*** | 0.340*** |
| | (0.075) | (0.092) | (0.058) | (0.087) |
| $\text{ADduty}_{fht} \times \text{HI}_{ct}$ | | 0.356*** | | -0.146* |
| | | (0.085) | | (0.085) |
| Firm-product-country FE | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes |
| Observations | 1,989,392 | 1,989,392 | 1,989,392 | 1,989,392 |
| R-squared | 0.518 | 0.518 | 0.573 | 0.573 |

*Notes:* This table reports the estimation results of the impacts of AD duties on firms' export market entry and exit. The outcome variable in columns (1) and (2) is a binary variable indicating whether firm $f$ exported product $h$ to a new market in year $t$. The outcome variable in columns (3) and (4) is a binary variable indicating whether firm $f$ stopped exports of product $h$ to market $c$ in year $t$ and onward. $\text{HI}_{ct}$ is a high-income country indicator. Robust standard errors clustered at the firm-product level in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

coefficient implies that a 10 percent increase in AD duties reduced the probability of entering a new market by 3.9 percentage points. Benchmarking to the sample average, firm-products that received an average AD duty (2.1 percent) would have a reduction of 0.78 percentage points in the probability of entering a new market compared to firm-products receiving no AD duties. This is equivalent to 2.93 percent of the average prevalence (see Table 2).

Distinguishing between low- and high-income markets, the negative effect on market entry is less salient for high-income markets, reflected by a positive and highly significant coefficient on the interaction term, as shown in column (2). Specifically, a 10 percent rise in AD duties reduced the probability of entering a low-income market by 5.7 percentage points, in contrast to a 2.1 percentage point reduction for high-income market entry.

Turning to market exit, the results in columns (3) and (4) show that AD duties increased the probability of exiting existing markets and such impact is less strong for high-income markets. A 10 percent rise in AD duties would raise the probability of exiting an existing market by 2.7 percentage points. The effect for low-income markets was 3.4 percentage points and around half the size for high-income markets.

#### 4.1.2 The role of product quality and the market selection mechanism

The results in Table 3 indicate an overall negative effect of AD duties on firm's exports of affected products to third countries along the extensive margin. Distinguishing between export market types reveals that the negative effect is less salient for products exported to high-income countries. These patterns are very much inline with the descriptive evidence in Figure A.1 and consistent with earlier findings in Crowley et al. (2018). One possible explanation for these patterns is related to firms' productivity change following AD treatment. The imposition of AD duties essentially increases firms' export costs and acts as a negative policy shock to firms' production. If firms contract their production overall following AD treatment, their exports to third markets could be adversely affected such that the probability of entering new markets and staying in existing markets falls. However, existing studies, such as Jabbour et al. (2019), show that heterogeneous firms with various productivity levels respond differently to AD duties. While low-productivity firms are more likely to exit the AD market, highly productive firms tend to increase their investment in research and development (R&D), which subsequently raises their productivity and international competitiveness, amounting to a positive average productivity effect. This suggests possible positive spillover effects on firms' exports to third countries, which is not what we find in Table 3. Importantly, we control for firm-year fixed effects in all regressions, which capture the productivity effects of AD treatment at the firm level. Conditional on the productivity effects, we find negative impacts on firms' market entry and exit dynamics in third markets.

An alternative explanation is the "tariff scares" effect documented in Crowley et al. (2018) as a result of the "tariff echoing" phenomenon (Tabakis and Zanardi, 2017). Following the imposition of AD duties in one country, similar countries may also impose AD duties on the same product. This increases policy uncertainties in the exporting markets, eventually reducing firms' entry to new markets and inducing firms to exit existing markets. While this channel could well explain the average entry and exit patterns shown in columns (1) and (3) of Table 3, the differential adjustments in low- versus high-income countries remain unexplained.

In this paper, we provide an additional explanation from the perspective of export quality, which accommodates both the overall entry and exit patterns and the heterogeneity across market types. Similar to the heterogeneous adjustments at the firm level in response to AD treatment in Jabbour et al. (2019), we hypothesise that firms exporting heterogeneous products with various quality levels may respond differently to AD duties. As AD duties often target products with lower prices, firms exporting high-quality products are relatively less concerned

about third countries imposing AD duties on the same product given their higher quality and hence prices. Alternatively, firms could upgrade the quality of their export products following AD treatment, but this is only possible for products with a high-quality scope. Subsequently, high-quality products and/or products with a high-quality scope are less affected by AD duties. Considering that products exported to high-income destinations are often of high quality (Hallak, 2006; Brambilla and Porto, 2016), the negative effects of AD duties on exported products to high-income destinations could be milder.

To investigate the role of product quality, we first estimate the quality of product $h$ for firm $f$ following Khandelwal (2010) and Khandelwal et al. (2013) based on export values and quantities, and then interact the quality of each product one year before receiving AD duties with the AD duty measure. Table 4 reports the estimation results for market entries in columns (1) and (2) and market exits in columns (3) and (4). In columns (1) and (2), we continue to find that AD duties were associated with a lower probability of market entry. Such impact seemed not to vary across the levels of product quality, indicated by the insignificant coefficient of AD duties and product quality in $t-1$. However, product quality mattered for entering high-income markets. While the negative effect of AD treatment tended to be smaller for high-income market entries for low-quality products, high-quality products had a relatively higher probability of entering high-income market entry after receiving AD duties, reflected by the positive and significant coefficient of the triple difference estimate. Similar to the baseline results in Table 3, columns (3) and (4) show that third market exits increased with AD duties. Such a positive impact, however, diminished with product quality, as evident by the negative coefficient of the interaction term. The positive effect of AD duties on firms' exit was even smaller for high-quality products exported to high-income markets, albeit it is statistically insignificant.

The results in Table 4 imply that firms responded differently to AD duties for high- versus low-quality products. Firms tended to exit third markets and were less likely to enter new markets for low-quality products, whereas this effect was smaller for high-quality products, especially those targeting high-income markets. This suggests that high-quality products tended to remain in existing markets and were more likely to enter new markets relative to low-quality products, indicating a potential market selection mechanism for high-quality products in export markets. As we formally demonstrate in the next section, exports of surviving, high-quality products even expanded following AD treatment.

Table 4: Antidumping and firms' entry and exit dynamics: The role of export quality

| | Market entry | | Market exit | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\text{ADduty}_{fht}$ | -0.169** | -0.274*** | 0.287*** | 0.360*** |
| | (0.067) | (0.081) | (0.067) | (0.097) |
| $\text{ADduty}_{fht} \times \text{HI}_{ct} \times \text{quality}_{fhct-1}$ | | 0.183** | | -0.145 |
| | | (0.086) | | (0.092) |
| $\text{ADduty}_{fht} \times \text{quality}_{fhct-1}$ | 0.002 | -0.021 | -0.139* | -0.136 |
| | (0.101) | (0.122) | (0.074) | (0.094) |
| $\text{ADduty}_{fht} \times \text{HI}_{ct}$ | | 0.108 | | 0.001 |
| | | (0.123) | | (0.099) |
| $\text{quality}_{fhct-1} \times \text{HI}_{ct}$ | | 0.046*** | | 0.005* |
| | | (0.004) | | (0.003) |
| $\text{quality}_{fhct-1}$ | -0.012*** | -0.040*** | -0.006*** | -0.009*** |
| | (0.002) | (0.004) | (0.002) | (0.003) |
| Firm-product-country FE | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes |
| Observations | 1,534,551 | 1,534,551 | 1,534,551 | 1,534,551 |
| R-squared | 0.540 | 0.540 | 0.583 | 0.583 |

*Notes:* This table reports the estimation results of the heterogeneous impacts of AD duties on firms' export market entry and exit by product quality. The outcome variable in columns (1) and (2) is a binary variable indicating whether firm $f$ exported product $h$ to a new market in year $t$. The outcome variable in columns (3) and (4) is a binary variable indicating whether firm $f$ stopped exports of product $h$ to market $c$ in year $t$ and onward. Product quality is estimated following Khandelwal (2010). $\text{HI}_{ct}$ is a high-income country indicator. Robust standard errors clustered at the firm-product level in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

## 4.2 Antidumping duties and export adjustments of continuing exporters

### 4.2.1 Baseline results

In this section, we focus on firm-products that remained in the third exporting market after receiving AD duties and investigate how AD duties affected the exporting performances of continuing exporters, which measures export adjustments along the intensive margin. To this end, we constrain our sample to firm-products that are observed at least two years both before and after the imposition of AD duties and estimate Equation (1) using the log of exports as the outcome variable. Table 5 presents the estimation results conditional on a full set of fixed effects. Column (1) reports the baseline results and column (2) allows for differential effects on the

Table 5: Antidumping and firms' exports to third markets: Adjustments along the intensive margin

| Dep. variable: | Value | | Quantity | | Price | |
|---|---|---|---|---|---|---|
| Export (in log) | (1) | (2) | (3) | (4) | (5) | (6) |
| $\text{ADduty}_{fht}$ | 4.113*** | 3.850*** | 4.311*** | 4.102*** | -0.289 | -0.329* |
| | (0.807) | (0.802) | (0.827) | (0.822) | (0.199) | (0.193) |
| $\text{ADduty}_{fht} \times \text{HI}_{ct}$ | | 0.998*** | | 0.804** | | 0.154 |
| | | (0.353) | | (0.375) | | (0.142) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,758,596 | 1,758,596 | 1,758,596 | 1,758,596 | 1,758,596 | 1,758,596 |
| R-squared | 0.838 | 0.838 | 0.901 | 0.901 | 0.884 | 0.884 |

*Notes:* This table reports the estimation results of the effects of AD duties on exports along the intensive margin. The dependent variables are export values, quantities, and prices, all in logs, as shown by column titles. $\text{HI}_{ct}$ is a high-income country indicator. Robust standard errors clustered at the firm-product level in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

exports to high-income markets. The results show that firms increased their exports of products that received AD duties to non-AD markets relative to unaffected similar firm-products. This effect was stronger for exports to high-income destinations. The size of the coefficients implies that a one percent increase in AD duties increased firms' exports to third countries by 4.11 percent on average. The impact was 3.85 percent for low-income countries and one percent higher for high-income destinations. These results imply within-firm trade diversion effects of AD duties that are documented in earlier studies only based on aggregated product-level data (e.g. Bown and Crowley, 2007; Hoai et al., 2017).

To understand whether the positive effects of AD duties on third market exports were driven by changes in exporting quantities or prices or both, in columns (3) to (6), we decompose total export values into quantities and unit prices, distinguishing between low- and high-income destinations. The results in columns (3) and (4) show very similar patterns to those in columns (1) and (2). AD duties significantly increased firms' export quantities of affected products to non-AD markets in comparison to unaffected firms and products. Such impact was more pronounced for high-income destinations. Comparing the magnitudes of the estimated coefficients reveals that they are virtually the same as those in columns (1) and (2), suggesting that the positive effects on total export values were by and large driven by changes in quantities.

This finding is further confirmed by the lack of significance in the price effect in column (5). When distinguishing between low- and high-income markets, we find that the price effect was negative and only marginally significant for products exported to low-income countries, as shown in column (6). The impact on high-income destination exports tended to be smaller, indicated by the positive coefficient of the interaction term, yet it was indistinguishable from the impact on products exported to low-income countries.

#### 4.2.2 Explaining the differential adjustments by destination market type: The role of quality upgrading

The results in Table 5 and in Section 4.1 suggest that AD duties imposed in one market led firms to select initially high-quality products for export to non-AD markets, resulting in sales growth. One can interpret the positive effect as export diversion from AD to non-AD markets. However, reallocation across markets, unlike adjusting exports in the same market, is associated with significant costs due to factors such as differences in the variable exporting costs related to distance, tariffs, non-tariff barriers, etc. In addition, consumers from countries with various income levels may have different preferences towards quality, with high-income countries typically having a stronger preference for quality (Hallak, 2006; Verhoogen, 2008; Brambilla and Porto, 2016). Consequently, firms may adjust the prices and quality of their exported products to align with the characteristics of destination markets (Flach, 2016). In response to a negative AD shock in one market, firms may not simply divert the same products to other markets. Rather, they must make necessary adjustments. Table 5 reveal that firms increased exports of affected products to third markets, with a disproportionately larger increase in high-income countries.

In this section, we move one step further and explore whether firms adjusted the quality of AD-affected products when exporting to non-AD markets, especially to high-income countries, aiming to obtain a more nuanced picture of how multi-destination exporters reallocate across markets when facing with negative trade shocks. In addition to the reasons linked to the demand of destination markets, changes in the quality of exported products could be due to the supply side, for instance, technology upgrading at the firm level. Existing studies find that surviving exporters following AD duties raise their investments in R&D to improve international competitiveness (Jabbour et al., 2019). This would allow firms to upgrade the quality of products exported to all markets unless firms strategically update the quality of products designated to certain markets. Notice that the firm-year fixed effects in our main regressions could absorb supply factors common to all destination markets at the firm level,

such as R&D investments. Analogously, product-country-year fixed effects can absorb changes in country-specific demand shocks for each product over time. Conditional on firm-year fixed effects and product-country-year fixed effects, the remaining variations stem from firms' heterogeneous adjustments across markets.

Before delving into the effects of AD duties on export quality, we first investigate possible heterogeneity in the baseline results in Table 5 between products of high quality scope and those of low quality scope. This consideration arises from the notion that differentiated products with a high variation in quality might enable firms to upgrade quality. In contrast, homogeneous products with little quality variation leave firms limited room for quality improvement. To this end, we follow Brambilla et al. (2012) and classify products into two categories. We first calculate the average unit value of each HS 6-digit product for each firm-country pair based on the customs data of 2000, the first year of our sample. Then we compute the variance in export quality for each HS 4-digit sector and define sectors with variance higher than the 75th percentile as "high-quality scope sectors" and others as "low-quality scope sectors". We replicate the estimations in Table 5 by interacting a dummy variable indicating "high-quality scope sectors" with the AD duty variable in the baseline specification and with the interaction term between AD duty and high-income country indicator in the extended specification.

The results are set out in Table 6, where columns use the log of export values, quantities and unit prices as the dependent variables respectively. Conditional on a full set of fixed effects, AD duties in one market led firms to export more in both values and quantities to other markets and the effects doubled for differentiated products. Interestingly, exporting prices declined with AD duties for homogeneous products whereas heterogeneous products experienced a significant price increase. This set of results reveals that firms might have applied different exporting strategies for homogeneous products as compared to heterogeneous products in response to negative trade shocks. For homogeneous products with limited potential for quality improvements, firms lowered their prices in non-AD markets to enhance international competitiveness. On the other hand, for differentiated products, firms tended to raise their prices, most likely in concert with quality upgrades.

In even columns where we allow for differences between high- and low-income destinations, the results show consistent patterns that AD duties reduced exporting prices but increased quantities for homogeneous products, resulting in net growth in values. For differentiated products, firms increased both prices and quantities, amounting to significantly higher growth in exporting values. The latter effects were even more pronounced for products exported to high-income destinations, indicated by the significant and positive coefficients of the triple

Table 6: Antidumping duties and firms' export adjustments along the intensive margin: The role of quality scope

| Dep. variable: | Value | | Quantity | | Price | |
|---|---|---|---|---|---|---|
| Export (in log) | (1) | (2) | (3) | (4) | (5) | (6) |
| $\text{ADduty}_{fht}$ | 2.641*** | 2.563*** | 3.279*** | 3.173*** | -0.639*** | -0.611*** |
| | (0.742) | (0.745) | (0.776) | (0.780) | (0.205) | (0.204) |
| $\text{ADduty}_{fht} \times \text{Scope}_{hs4} \times \text{HI}_{ct}$ | | 1.703** | | 1.279* | | 0.424* |
| | | (0.723) | | (0.735) | | (0.243) |
| $\text{ADduty}_{fht} \times \text{HI}_{ct}$ | | 0.343 | | 0.441 | | -0.0985 |
| | | (0.406) | | (0.414) | | (0.137) |
| $\text{ADduty}_{fht} \times \text{Scope}_{hs4}$ | 3.776*** | 3.291*** | 2.791*** | 2.426*** | 0.985*** | 0.864*** |
| | (0.810) | (0.817) | (0.861) | (0.846) | (0.304) | (0.274) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,726,286 | 1,726,286 | 1,726,286 | 1,726,286 | 1,726,286 | 1,726,286 |
| R-squared | 0.840 | 0.840 | 0.904 | 0.904 | 0.888 | 0.888 |

*Notes:* This table shows the heterogeneous results of the impacts of AD duties on exports by quality scope. Quality scope is measured as the variance of product qualities within each HS 4-digit category. $\text{HI}_{ct}$ is a high-income country indicator. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

interaction terms. This can be attributed to the strong preference for quality among consumers in rich countries, which incentivised firms to upgrade the quality and thus increase prices for differentiated products shipped to those markets (Flach, 2016; Manova and Yu, 2017).

Table 7 presents the results estimating the direct effects of AD duties on export quality, where we use the estimated quality measure from Equation (4) as the dependent variable. Column (1) shows that AD duties had a positive impact on the quality of products exported to third markets. A one percent rise in AD duties induced an average increase in product quality by 1.5 percent. This effect was stronger for products with high-quality scope, as shown in column (2). Distinguishing between low- and high-income markets, the results in column (3) reveal that AD duties had a positive effect on the quality of products shipped to both types of markets but the magnitude of the effect was significantly larger for high-income destinations. A one percent increase in AD duties was associated with a 1.2 percent rise in quality for products exported to low-income destinations and 0.2 percent more for those exported to high-income destinations. This is inline with our finding in Table 6 that firms tended to set a higher price for products exported to rich markets, especially for products of high-quality diversification.

Table 7: Antidumping duties and firms' export quality to third markets

| Dep. variable: Quality (in log) | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $\text{ADduty}_{fht}$ | 1.267*** | 1.110*** | 1.183*** | 0.887* | 1.226*** |
| | (0.130) | (0.134) | (0.136) | (0.482) | (0.135) |
| $\text{ADduty}_{fht} \times \text{Scope}_{hs4}$ | | 0.941*** | | | |
| | | (0.202) | | | |
| $\text{ADduty}_{fht} \times \text{HI}_{ct}$ | | | 0.237*** | 0.246*** | |
| | | | (0.091) | (0.091) | |
| $\text{ADduty}_{fht} \times \text{Distance}_{c}$ | | | | 0.0337 | |
| | | | | (0.054) | |
| $\text{ADduty}_{fht} \times \text{UP}_{fhct}$ | | | | | 0.242*** |
| | | | | | (0.093) |
| $\text{ADduty}_{fht} \times \text{DN}_{fhct}$ | | | | | -0.341*** |
| | | | | | (0.097) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,724,283 | 1,724,283 | 1,724,283 | 1,714,416 | 1,724,283 |
| R-squared | 0.849 | 0.849 | 0.849 | 0.849 | 0.849 |

*Notes:* This table reports estimation results of the effects of AD duties on export quality. The outcome variable is the log of export quality in all three columns. $\text{HI}_{ct}$ indicates high-income countries. $UP_{fhct}$ is a dummy variable indicating that firm $f$ received AD duties from a low-income country and exported to a high-income country. $DN_{fhct}$ denotes firm $f$ receiving AD duties from a high-income country and exporting to a low-income country. The omitted group includes firms whose country of AD imposition and exporting country are within the same income group. Robust standard errors clustered at the firm-product level in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

One concern with the interpretation of the differential impact on products exported to high-income countries is related to the "shipping the good apples out" effect (Hummels and Skiba, 2004). It states that exporters tend to ship better-quality products to remote markets due to higher transportation costs. For many developing countries including China, high-income markets are usually remote, involving high transportation costs. The result in column (3) could potentially reflect this effect rather than the effect of income levels of export markets. To alleviate this concern, we add distance to the exporting market in the estimation, which is interacted with the AD duty measure. Note that country fixed effects in our models could absorb the direct effects of bilateral distance on product quality. Its interaction with AD duties captures any varying effects of AD duties with distance, hence accounting for possible "shipping the good apples out" effect. The results in column (4) show that AD duties induced firms to upgrade export quality for remote markets, yet such differential effect is statistically insignificant. The

coefficient on the high-income country indicator interacted with AD duties remains unaffected, suggesting a limited role of distance.

In column (5), we consider differences between the AD-imposing country and firms' exporting countries. Firms may adjust export quality when shifting market types, especially from a low- to high-income market. We categorise firms into three groups based on the income level of AD-imposing countries and export destination countries: 1) firms receiving AD duties in a low-income country and exporting to a high-income country ("market upgrade"); 2) firms receiving AD duties in a high-income country and exporting to a low-income country ("market downgrade"); and 3) firms exporting to the same type of market as the AD imposing country ("parallel change"). We then interact an indicator variable of the three firm types with AD duties, treating firms exporting to the same type of markets as the reference group, as shown by Equation (3). The results show that relative to firms staying in the same type of markets, who on average upgraded their product quality in response to AD duties, the quality-improving effect was stronger for those upgrading their market type, while the effect was weaker for those downgrading their export market type.

One may be concerned about the results in Table 7 in that the outcome variable is estimated. Imprecise estimations of the outcome variable could introduce measurement errors and influence the accuracy of our estimates. To address this, we follow the literature (Goldberg and Pavcnik, 2005; Dix-Carneiro and Kovak, 2017) and replicate Table 7 using a weighted least squares (WLS) estimation approach, where we employ the reciprocal of the standard errors of the estimated quality as weight. This approach assigns a smaller weight to observations with less precise quality estimates. The results in Table A.1 in the appendix show that the coefficients turn out smaller, yet the aforementioned findings remain consistent.

The results in Table 6 and Table 7 combined show that firms upgraded the quality of their products exported to third markets after receiving AD duties, and the income level of destination market mattered for quality upgrading. In addition to the trade diversion effect, these results provide an import channel explaining the trade-promoting effect of AD duties in third markets. As discussed earlier, quality upgrading could be related to the non-homothetic preferences of consumers from different countries. While this channel explains the quality upgrade of products exported to high-income countries as consumers from those countries have a stronger preference for quality, our results indicate that firms also upgraded the quality for products exported to low-income destinations (column (3) in Table 7). One possible explanation is the increased competition in non-AD markets if more firms diverted their exports to those markets with negative trade shocks; tougher market competition may have forced firms to upgrade the

quality of their exported products to improve competitiveness. Recall that continuing exporters are the ones exporting high-quality products as a result of the market selection mechanism of AD duties along the extensive margin. These firms are potentially also more profitable ones who are able to invest in quality upgrading (Bustos, 2011).

We examine this possibility by introducing three alternative measures of market competition. The first two measures, the GDP of the destination market and the number of Chinese firms exporting the same HS 6-digit product, are constructed following Mayer et al. (2014) who focus on French exporters. GDP measures the size of destination markets; competition is higher in larger markets. The number of Chinese firms exporting a specific HS 6-digit product measures competition among Chinese exporters of the same product in a specific exporting market. The third measure is the Herfindahl index (HHI) of each product $h$ exported by all countries to each non-AD country $c$ in the year of receiving AD duties using bilateral trade data from the UN Comtrade database. Different from the exporter number measure, which measures competition among Chinese exporters, this measure captures the competition associated with the exports of other countries. We allow these three measures to vary over time to reflect endogenous changes in the toughness of market competition as a result of more Chinese exports. We interact AD duties with these three measures and explore whether firms upgraded more the quality of their products exported to countries with tougher competition.

The results are presented in Table 8. In all columns, we continue to find a positive impact of AD duties on product quality for markets with an average extent of competition. This impact is significantly higher for markets with tougher competition, either measured by market size, the number of exporters, or the HHI. In even columns, we further interact AD duties and market competition measures with the high-income country indicator. The results show that the differential effects of market competition on export quality were even higher for high-income markets and this differential impact is sizable. These results provide supportive evidence for the market competition channel that affects firms' quality upgrading in response to negative shocks and their differential adjustments across market types.

## 5 Robustness checks

In this section, we perform several additional checks to examine whether our results are affected by anticipation effects, pre-trends, alternative measures of AD investigations, more stringent fixed effects, and the way of clustering standard errors.

One identification concern is related to the possible expectation effects before the final imposition

Table 8: Antidumping and firms' export quality: The role of export market competition

| Competition measures: | $GDP_{ct}$ | | No. of $exporters_{hct}$ | | $HHI_{hct}$ | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $ADduty_{fht}$ | 2.070** | 1.747* | 0.542*** | 0.543** | 1.475*** | 1.146*** |
| | (0.898) | (1.062) | (0.197) | (0.237) | (0.144) | (0.163) |
| $ADduty_{fht} \times Comp. \times HI_{ct}$ | | 1.122*** | | 0.724** | | -1.024*** |
| | | (0.323) | | (0.323) | | (0.370) |
| $ADduty_{fht} \times HI_{ct}$ | | 0.571*** | | 0.463*** | | 0.691*** |
| | | (0.124) | | (0.136) | | (0.144) |
| $ADduty_{fht} \times Comp.$ | 0.127*** | 0.112*** | 0.207*** | 0.182*** | -0.418** | 0.137 |
| | (0.034) | (0.041) | (0.046) | (0.061) | (0.211) | (0.256) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,472,798 | 1,472,798 | 1,472,798 | 1,472,798 | 1,472,798 | 1,472,798 |
| R-squared | 0.849 | 0.849 | 0.849 | 0.849 | 0.849 | 0.849 |

*Notes:* This table reports estimation results concerning the role of export market competition. Columns correspond to three alternative measures of market competition as shown by the column title. $GDP_{ct}$ is the GDP of the exporting market $c$ in year $t$. No. of $exporters_{hct}$ denotes the number of Chinese exporters exporting product $h$ to country $c$ in year $t$. $HHI_{hct}$ is the Herfindahl index calculated based on the exports of product $h$ by all countries to country $c$. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

of AD duties. This is relevant because AD investigations often take time before the final imposition and firms are usually exposed to the AD-induced policy uncertainties since the initiation of AD investigations. In some cases, preliminary measures are applied during the process of investigations. Policy uncertainties due to AD initiation and preliminary measures could have induced firms to make adjustments before the final imposition. This would invalidate our identification as the identified impacts on firms' exports would be partly driven by the anticipation effects. To check possible anticipation effects, we generate two dummy variables indicating the initiation of AD investigations ($ADint_{fhct}$) and the application of preliminary barriers ($ADpm_{fhct}$). We estimate Equation (1) by using these two dummy variables separately as the main AD measure and then include both as control variables in our main specification in which the log of AD duties is the main measure.

The results are reported in Table 9. We find in panels A and B that none of our third-country export measures responded significantly to AD initiation or preliminary measures, suggesting no expectation effects. Conditional on AD initiation and any preliminary measures, the effects

Table 9: Antidumping duties and firms' exports in third countries: The role of expectation effects

| Dep. variable: | Market entry | Market exit | Value | Quantity | Price | Quality |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A: AD initiation | | | | | | |
| $ADint_{fht}$ | -0.000 | -0.004 | 0.046 | 0.019 | 0.022 | 0.006 |
| | (0.008) | (0.003) | (0.032) | (0.033) | (0.013) | (0.012) |
| Observations | 1,965,430 | 1,965,430 | 1,738,298 | 1,726,056 | 1,726,056 | 1,724,283 |
| R-squared | 0.633 | 0.721 | 0.877 | 0.927 | 0.924 | 0.849 |
| Panel B: Preliminary measures | | | | | | |
| $ADpm_{fht}$ | 0.007 | -0.001 | -0.009 | -0.018 | 0.005 | -0.008 |
| | (0.008) | (0.004) | (0.035) | (0.036) | (0.015) | (0.012) |
| Observations | 1,965,430 | 1,965,430 | 1,738,298 | 1,726,056 | 1,726,056 | 1,724,283 |
| R-squared | 0.633 | 0.721 | 0.877 | 0.927 | 0.924 | 0.849 |
| Panel C: Controlling for expectation effects | | | | | | |
| $ADint_{fht}$ | -0.004 | -0.005 | 0.031 | 0.004 | 0.022 | 0.001 |
| | (0.009) | (0.004) | (0.036) | (0.038) | (0.016) | (0.014) |
| $ADpm_{fht}$ | 0.017 | 0.001 | -0.056 | -0.045 | -0.016 | -0.021 |
| | (0.010) | (0.005) | (0.040) | (0.042) | (0.017) | (0.014) |
| $ADduty_{fht}$ | -0.116*** | 0.023*** | 0.121*** | 0.146*** | -0.023 | 0.038*** |
| | (0.010) | (0.004) | (0.041) | (0.042) | (0.015) | (0.014) |
| Observations | 1,898,821 | 1,898,821 | 1,815,609 | 1,802,276 | 1,802,276 | 1,800,331 |
| R-squared | 0.635 | 0.724 | 0.877 | 0.925 | 0.922 | 0.848 |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* This table shows estimation results addressing possible expectation effects due to AD initiation and/or preliminary measures. $ADint_{fht}$ is a dummy variable indicating an AD investigation was initiated on firm $f$'s product $h$ in year $t$ and onward. Similarly, $ADpm_{fht}$ is a dummy variable indicating preliminary measures were imposed on firm $f$'s product $h$ in year $t$ and onward. $ADduty_{fht}$ is the log of AD duties as specified in Equation (1). All specifications include firm-product-country fixed effects, firm-year fixed effects, and product-country-year fixed effects. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

of the finalised AD duties, our primary measure, on exports are consistent with our baseline results, as shown in panel C.

While the results in Table 9 show no expectation effects on average, one may be still concerned about possible differences between treated and untreated firms in specific years prior to the

introduction of AD measures, which would violate the parallel trend assumption of the DiD approach. In Figure A.1, we depict the evolution of the export measures for treated and untreated firms and show a generally parallel trend for the two groups before firms received AD duties. To further validate this assumption, we perform an event study by estimating Equation (1) and replacing the AD duty variable with a full set of dummy variables spanning four years before and after AD treatment. As our main estimation uses a continuous measure of AD duties, which does not support event studies, we change it to a dummy variable that indicates firm-products that received AD duties. We report the results using this updated measure in appendix Table A.2. The results show very consistent patterns with our baseline results that use the continuous measure. AD duties tended to raise market exits of firm-products from existing non-AD markets and reduced entries into new markets relative to similar unaffected firm-products. Along the intensive margin, AD duties increased firms' exports of AD-targeted products to non-AD markets, measured in both values and quantities. Also, firms upgraded export quality in response to AD treatment.

Using the dummy variable of AD duties, we estimate the following equation:

$$y_{fhct} = \alpha + \sum_{t=-4}^{4} \beta_t T_{fh} \times D_t + \theta_{fhc} + \theta_{hct} + \theta_{ft} + \varepsilon_{fhct} \tag{5}$$

where $y_{fhct}$ denotes various outcome variables of interest, including firms' entry into and exit from third markets, export values, quantities, prices, and quality, all in logs. $T_{fh}$ indicates firm-product duplets that received AD duties in at least one country. As discussed earlier, the control group includes firms exporting similar products within the same HS 4-digit sectors that were not affected by AD duties. $D_t$ is a set of dummy variables indicating $t$ years before or after AD actions, with $t$ going from 4 years before to 4 years after the treatment. Specifically, the boundary years include all years until 4 years before the treatment and all years from 4 years after the treatment. We consider one year before treatment as the reference group.

Figure 1 and Figure 2 show the coefficient plots of $\beta_t$ in Equation (5) with firms' entry to and exit from non-AD markets as the measures of firms' extensive-margin adjustments and export value, quantity, price, and quality as the measures of intensive-margin adjustments. Overall, we do not see systematic differences between treatment and control firms prior to the treatment in all outcome variables, suggesting that the parallel trend assumption of the DiD approach is validated. Further, the event study figures show dynamics of firms' exports to third countries that are consistent with our earlier results (see Table 3 and Table 5). Firms receiving AD measures on average are less likely to enter new markets while more likely to exit existing

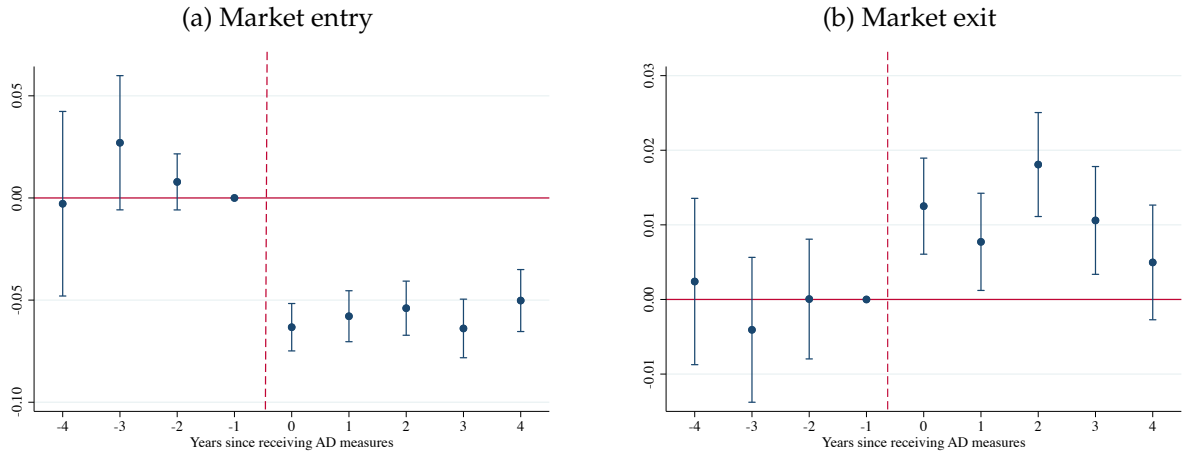


Figure 1: Event studies: Market entry rate to and exit rate from non-AD markets before and after AD shocks

*Notes:* Figures show the estimated coefficients in Equation (5) and the corresponding 95% confidence intervals.

markets. For continuing exporters, those affected by AD measured tend to have an increase in exports (in both total values and quantities) to non-AD markets while the effect declines after three years. The price effect appears relatively milder with a decreasing trend in the first two years following the shock and rebounding afterwards. We also see a clear increase in export quality shortly after the shock. Again, such an effect started to diminish two years later.

Although we choose products within the same HS 4-digit sectors as the AD-targeted products for the control group, assuming that products within the same HS 4-digit sectors are comparable, firms exporting non-AD-targeted products could be different from those exporting AD-targeted products. In all our estimations, we include a set of stringent fixed effects to account for average differences at different levels. Our event study results further validate our empirical strategy by showing no systematic differences between the treatment and control groups pre treatment. As an additional robustness check, we implement the propensity score matching (PSM) approach and select firm-product-country triplets that were similar to those that were affected by AD duties to further ensure that the two groups are comparable before treatment.

Specifically, we use a Logit model and estimate the probability of a firm-product-country triplet being subject to AD duties conditional on the average export quantities and prices before the imposition of AD duties, country-year fixed effects, and HS 4-digit sector fixed effects. The Logit model estimation results are reported in Table A.3 in the appendix. They show that both exporting quantities and prices are positively correlated to the propensity of receiving AD duties. Then we select firm-product-country triplets that have a similar probability of receiving AD duties for the control group and replicate our main analysis based on the matched sample.

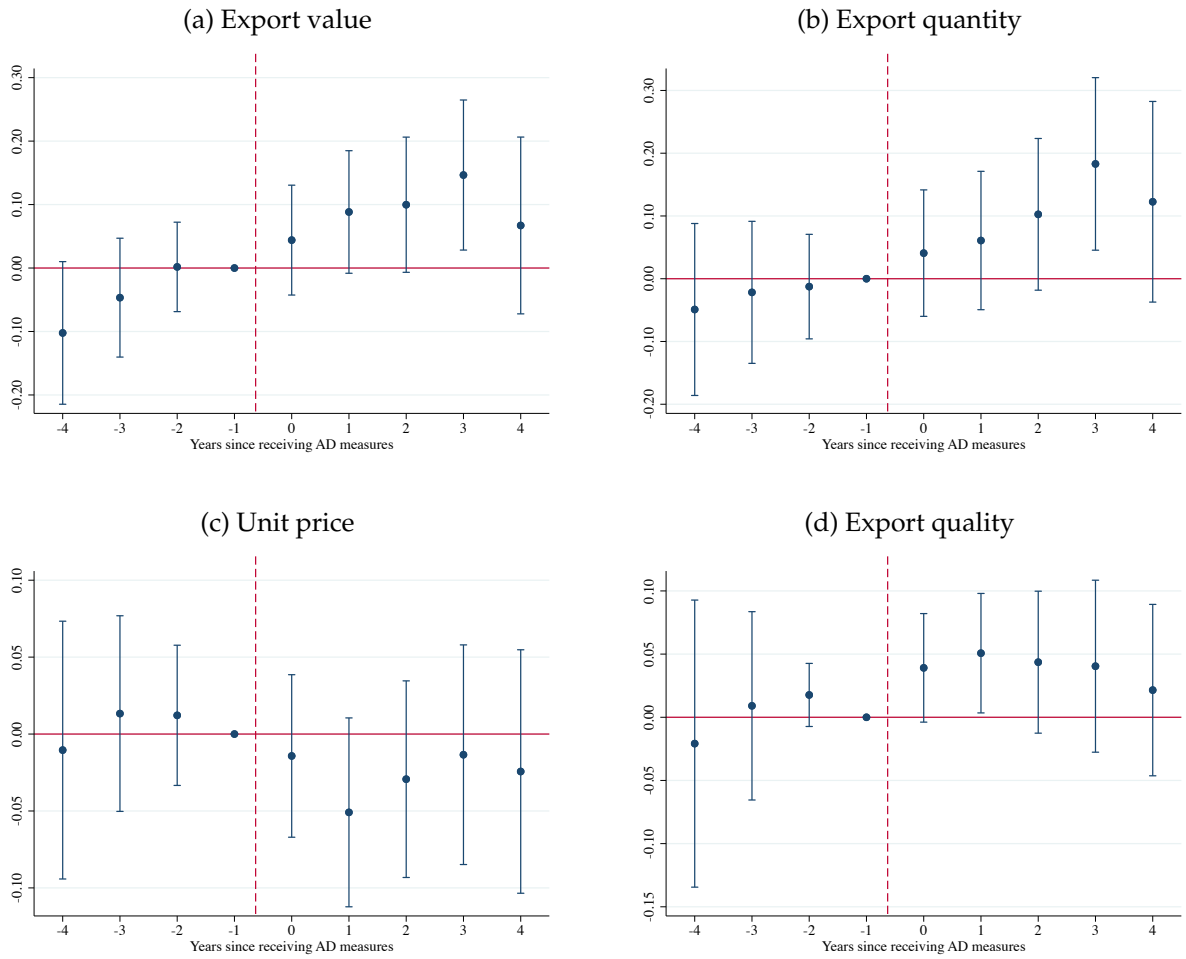


Figure 2: Event studies: Export value, quantity, price, and quality before and after AD shocks

*Notes:* Figures show the estimated coefficients in Equation (5) and the corresponding 95% confidence intervals.

The results based on the PSM-matched sample are set out in Table 10. PSM reduces the sample size considerably. However, the estimated effects of AD duties on firms' export performances along both the extensive and intensive margins are comparable to our baseline results. This further confirms the credibility of our main findings.

An additional concern about comparing treated and untreated products within the same HS 4-digit sector is the potential for spillover effects of AD duties within HS 4-digit groups. If firms expect unaffected, similar products to have a risk of being investigated, they may also make adjustments in their exports of those products. This would generate downward biases to our estimates. Descriptive trends for affected and unaffected products in figures A.1 and A.2 do not show evidence of discontinuous changes in any of export measures for the control group, which precludes the possibility of spillover effects within HS 4-digit groups. To empirically examine this concern, we include HS 4-digit group times year fixed effects on top of the baseline fixed effects. The newly added fixed effects could account for common changes in exports for

Table 10: Antidumping duties and firms' exports in third countries: Estimation results based on the PSM matched sample

| Dep. variable: | Market entry | Market exit | Value | Quantity | Price | Quality |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $ADduty_{fht}$ | -0.533*** | 0.303*** | 3.783*** | 2.740*** | 1.036 | 0.689*** |
| | (0.110) | (0.096) | (0.800) | (0.650) | (0.794) | (0.171) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 556,011 | 556,011 | 473,716 | 473,716 | 473,716 | 449,660 |
| R-squared | 0.528 | 0.581 | 0.879 | 0.926 | 0.940 | 0.863 |

*Notes:* This table reports the estimation results of Equation (1) using the PSM matched sample. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

all products within the same HS 4-digit group. The remaining disparities between affected and unaffected products would then be interpreted as the causal effects of AD duties. We present the results with HS 4-digit group times year fixed effects in Table A.4 in the appendix. All coefficient estimates are similar to the baseline estimates except for the impact on prices, which is now positive and highly significant.

Last but not least, we test whether our results are sensitive to the way of clustering standard errors. We cluster standard errors at the firm-product level, which allows for correlations across a specific firm's exports of the same product to different destinations but assumes independence across firms and products. This assumption may not be valid for firms that exported the same HS 6-digit product to the same market. We take this possibility into consideration by calculating two-way clustered standard errors at both the firm-product and country-product levels. The latter allows for correlations of the same product exported to the same market by different firms. The results in Table A.5 in the appendix show that all coefficient estimates remain highly significant except for the one for prices, consistent with our baseline results.

## 6 Conclusion

AD duties have been widely used as a means to protect domestic competing producers by many countries in the last decades. Existing studies have documented plentiful evidence on the

consequences of AD measures. Yet, relatively little is known about the spillover effects on firms' exports to third countries. This paper focuses on multi-destination exporters and analyses how firms adjust their exports to non-AD countries when the same product is subject to AD actions in one country.

Relying on the transaction-level Chinese customs data, we employ a DiD approach where we compare firm-product duplets that were affected by AD duties in at least one market and similar firm-product duplets that were not affected. The rich customs data allow us to include a set of stringent fixed effects to account for unobserved confounding demand and supply factors, thereby providing a clean identification for the causal effects of AD duties on firms' exports.

Along the extensive margin, we find that AD duties had a negative impact on firms' exports to non-AD markets. Firms tended to reduce the probability of entering new markets and increased the probability of exiting established non-AD markets for affected products by AD duties. This finding is consistent with the "tariff echoing effect" documented in earlier studies (Tabakis and Zanardi, 2017; Crowley et al., 2018). When we distinguish between high- and low-income destinations, the effects on both firm entry and exit were less pronounced for exports to high-income destinations. Further results indicate that the quality of products played a crucial role in determining firms' export market entry and exit dynamics. High-quality products were more likely to enter new markets and less likely to exit existing markets, suggesting a market selection mechanism for high-quality products remaining in the market.

While AD duties reduced firms' exports to third markets along the extensive margin, continuing exporters, whose products were in high quality due to the market selection mechanism of AD duties, increased their exports in response to these duties. This finding aligns with the trade diversion effect of AD duties in earlier studies based on aggregated data (e.g. Bown and Crowley, 2007; Hoai et al., 2017) and provides the first micro-level evidence supporting this phenomenon. Decomposing export values into quantities and prices, we find that the growth in export values was primarily driven by increases in quantities, while prices experienced negligible changes on average. However, when distinguishing between high- and low-income destinations, we find substantive heterogeneity. The trade diversion effect was significantly stronger for the exports to high-income destinations in both values and quantities. Firms adopted different pricing strategies for their exports to high-income and low-income destinations. They tended to increase their prices for products exported to high-income markets whereas reduced prices for products exported to low-income markets.

Our further analysis shows that the trade-promoting effects on third countries and the

heterogeneous adjustments between high- and low-income countries were closely related to products' quality scope and quality upgrading. Continuing exporters on average upgraded their export quality to other countries after receiving AD duties in one country and such an effect is significantly stronger for the products shipped to rich markets. Additionally, firms upgraded their quality more for the products that received AD duties from a low-income country but were exported to high-income countries relative to those exported to the same type of markets. In contrast, products receiving AD duties from high-income countries but being shipped to low-income countries experienced less quality upgrading. We also find that firms' quality upgrading is associated with increased competition in non-AD markets.

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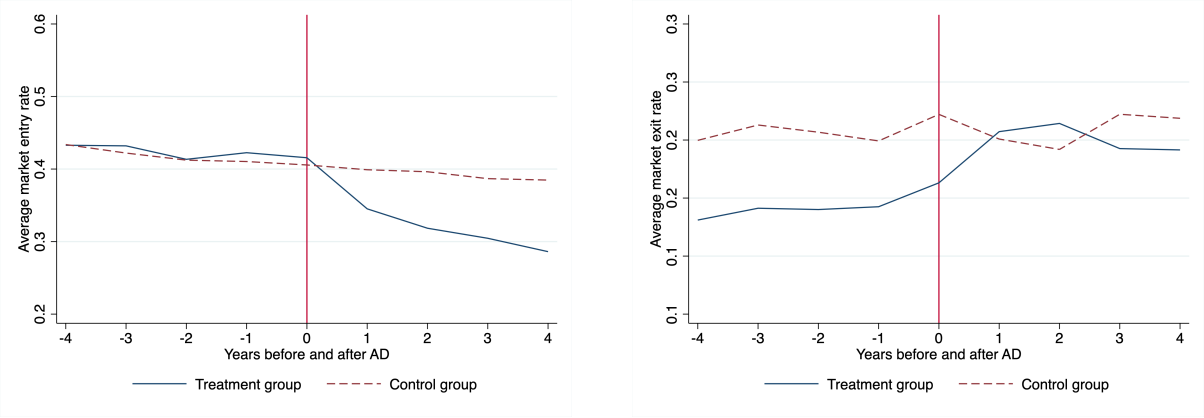
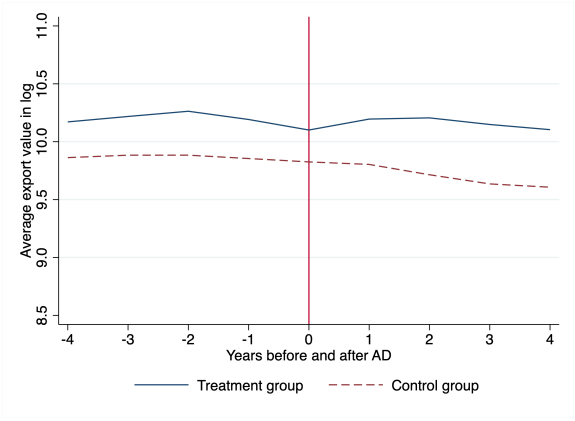
# Appendix: Additional figures and tables



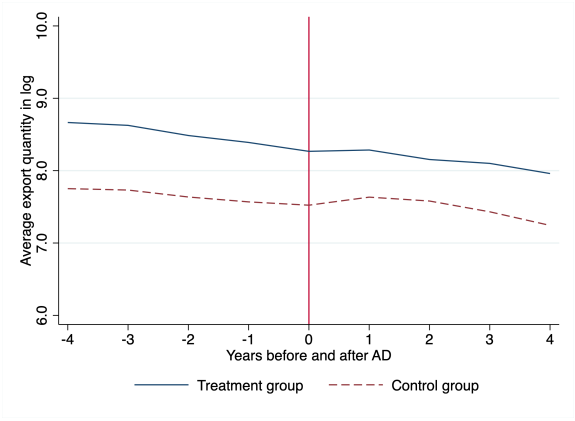

(a) Market entry (b) Market exit

Figure A.1: Average market entry rate to and exit rate from non-AD markets before and after AD by treatment status

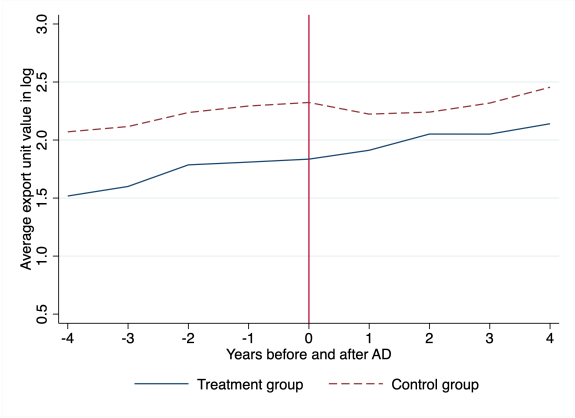
*Notes:* Figures show the average market entry rate to (left) and exit rate from (right) non-AD markets for each HS 6-digit product at the firm level before and after AF. The treatment group includes firm-product duplets that received AD duties in at least one market; the control group includes products that are within the same HS 4-digit sections but never receive AD duties.



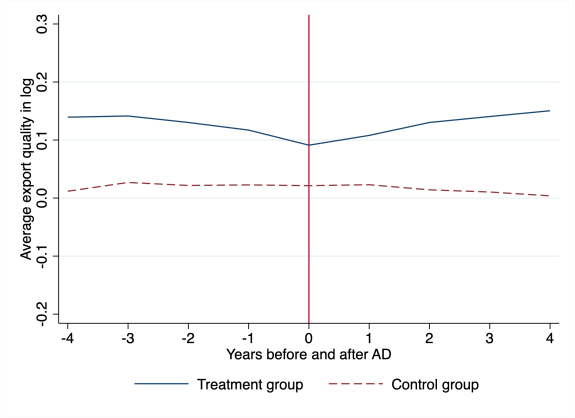

(a) Export value




(b) Export quantity




(c) Unit price




(d) Export quality

Figure A.2: Average export value, quantity, price, and quality before and after AD by treatment status

*Notes:* Figures show average export performances in non-AD markets following AD duties for the treated and control groups. Export values, quantities, prices and qualities are measured at the firm-product level. Products are identified at the HS 6-digit level. The treatment group includes firm-product duplets that received AD duties in at least one market; the control group includes products that are within the same HS 4-digit sections but never received AD duties.

Table A.1: Antidumping duties and firms' export quality to third markets: WLS estimation results

| Dep. variable: Quality (in log) | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $ADduty_{fht}$ | 0.666*** | 0.582*** | 0.624*** | 0.378 | 0.640*** |
| | (0.085) | (0.081) | (0.090) | (0.328) | (0.091) |
| $ADduty_{fht} \times Scope_{hs4}$ | | 0.440*** | | | |
| | | (0.115) | | | |
| $ADduty_{fht} \times HI_{ct}$ | | | 0.124** | 0.131** | |
| | | | (0.058) | (0.059) | |
| $ADduty_{fht} \times Distance_{c}$ | | | | 0.0279 | |
| | | | | (0.037) | |
| $ADduty_{fht} \times UP_{fhct}$ | | | | | 0.134** |
| | | | | | (0.061) |
| $ADduty_{fht} \times DN_{fhct}$ | | | | | -0.143** |
| | | | | | (0.070) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,724,283 | 1,724,283 | 1,724,283 | 1,714,416 | 1,724,283 |
| R-squared | 0.750 | 0.750 | 0.750 | 0.750 | 0.750 |

*Notes:* This table replicates the estimations in Table 7 using a weighted least squares estimation approach. The weight is constructed as the reciprocal of the standard errors of the estimated quality. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

Table A.2: Antidumping and firms' exports to third markets: Estimation results using an AD dummy

| Dep. variable: | Market entry | Market exit | Value | Quantity | Price | Quality |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $ADduty_{fht}$ | -0.145*** | 0.0414*** | 0.0762* | 0.0736* | 0.00214 | 0.0279* |
| | (0.00615) | (0.00539) | (0.0410) | (0.0426) | (0.0169) | (0.0166) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,989,392 | 1,989,392 | 1,726,056 | 1,726,056 | 1,726,056 | 1,724,283 |
| R-squared | 0.518 | 0.573 | 0.877 | 0.927 | 0.924 | 0.849 |

*Notes:* This table reports the estimation results using an AD dummy as the main measure. The AD dummy variable equals one for affected firms and products with the presence of AD duties and zero otherwise. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.

Table A.3: PSM: Selection into treatment – The probability of being treated by AD duties

| Dep. variable: | AD duty (=1) |
|---|---|
| $\log(\text{quantity})_{fhct-1}$ | 0.124*** |
| | (0.00229) |
| $\log(\text{price})_{fhct-1}$ | 0.0860*** |
| | (0.00362) |
| Country-year FE | Yes |
| Industry FE | Yes |
| Observations | 2,406,559 |
| Pseudo R-squared | 0.11 |

*Notes:* This table reports the Logit model estimation results about selection into treatment. The outcome variable is a binary variable indicating whether a firm-product duplet received AD duties in year $t$. The determinants are the quantities and unit prices exporting to market $c$ in year $t-1$, both measured in logs. We include country-year fixed effects and HS 4-digit sector fixed effects in the estimation. Robust standard errors clustered at the firm-product level in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table A.4: Antidumping duties and firms' exports to third markets: Controlling for HS 4-digit group times year fixed effects

| Dep. variable: | Market entry | Market exit | Value | Quantity | Price | Quality |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\text{ADduty}_{fht}$ | -0.390*** | 0.267*** | 5.433*** | 3.367*** | 2.075*** | 1.267*** |
| | (0.074) | (0.056) | (0.521) | (0.714) | (0.647) | (0.130) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| HS4-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,989,394 | 1,989,394 | 1,738,298 | 1,727,574 | 1,727,574 | 1,725,809 |
| R-squared | 0.518 | 0.573 | 0.570 | 0.732 | 0.715 | 0.472 |

*Notes:* This table reports the estimation results controlling for HS 4-digit product group times year fixed effects. Robust standard errors clustered at the firm-product level are reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table A.5: Antidumping duties and firms' exports to third markets: Two-way clustered standard errors

| Dep. variable: | Market entry | Market exit | Value | Quantity | Price | Quality |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $ADduty_{fht}$ | -0.390*** | 0.267*** | 4.113*** | 4.311*** | -0.289 | 1.267*** |
| | (0.0736) | (0.0565) | (0.496) | (0.671) | (0.219) | (0.125) |
| Firm-product-country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Product-country-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,989,392 | 1,989,392 | 1,758,596 | 1,758,596 | 1,758,596 | 1,724,283 |
| R-squared | 0.518 | 0.573 | 0.838 | 0.901 | 0.884 | 0.849 |

*Notes:* This table reports the estimation results using two-way clustered standard errors at both the firm-product level and the product-country level, which are reported in parentheses. * $p$ <0.1, ** $p$ <0.05, *** $p$ <0.01.