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Technical barriers to trade and export performance: Comparing exiting and staying firms

Hao Wei [a,***], Yue Tu [a,**], Peng Zhou [b,*]

[a] Business School, Beijing Normal University, No.19, Xinjiekouwai Street, Beijing, China
[b] Cardiff Business School, Cardiff University, D47, Aberconway Building, Colum Drive, Cardiff, CF10 3EU, UK

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ABSTRACT

Technical Barriers to Trade (TBTs) present a major challenge to exporters and policymakers. Prior studies have shown that TBTs induce the exit of exporters, but little is known about the differences of subsequent export performance between exiting and staying firms. We investigate the case of Chinese firms suffering TBT shocks in the US market with the PSM-DID method. The results show that exiting firms gain higher export growth than staying firms by exploring new markets more extensively and exploiting other existing markets more intensively. Besides, we also find that staying firms gain higher prices and higher quality than exiting firms by conforming to the higher standards after TBT shocks. Our findings suggest that exporters can survive tough TBT shocks by optimizing within-firm reallocations of resources across markets and products.

1. Introduction

Technical barriers to trade (TBTs) involve technical regulations, standards, and conformity assessment procedures. Being a critical indicator of market accessibility in the last few decades, TBTs have become a key concern for academics and policymakers (Jafari and Britz, 2018). Different from tariffs and quotas, TBTs regulate trade of specific products via control over quality rather than price and quantity. Therefore, they are treated as preferable measures to protect the customers and promote sustainability (Disdier et al., 2016), but enforcement of product standards can also be protectionism in disguise (Grundke and Moser, 2019), adding an extra "compliance cost" to exporters (Fischer and Serra, 2000). According to the United Nations' calculation, international trade is extensively regulated through impositions of TBTs, with more than 30 percent of product lines and almost 70 percent of world trade being affected in 2020.1F[1] TBTs have gained popularity in non-tariff measures since the 21st century, making up more than half in 2021 (Fig. 1). To keep the fairness of international trade, the WTO allows members to raise specific trade concerns (STCs) to TBT notification countries when they feel the technical measures are unfair or unnecessary. Hence, TBT measures involved in STCs can be reflected as restrictive TBTs or stringent TBTs (Fontagné and Orefice, 2018; Singh and Chanda, 2021).

In China, according to annual exporter surveys conducted by the General Administration of Quality Supervision, Inspection and Quarantine of China (AQSIQ) since 2006, nearly 30 to 40 percent of Chinese exporters have suffered from foreign TBTs every year, especially the TBT measures imposed by the US. Based on our calculation, the exit rates of the firm-products affected by stringent US TBT measures increased either in the year when an STC was raised or the following year in our sample.

A well-known case is the US Consumer Product Safety Improvement Act (CPSIA) which was signed in August 2008. CPSIA set limits on total lead in products and set a criterion for accreditation of third-party certification bodies, causing great burdens for Chinese toy exporters. In response to this, China raised an STC against the US, stating that these

* Corresponding author.
** Corresponding author.
*** Corresponding author.
E-mail addresses: weihao9989@163.com (H. Wei), tuyue711@163.com (Y. Tu), zhoup1@cardiff.ac.uk (P. Zhou).

[1] Key Statistics and Trends in Trade Policy, UNCTAD, 2021. https://unctad.org/system/files/official-document/ditctab2022d2_en.pdf.

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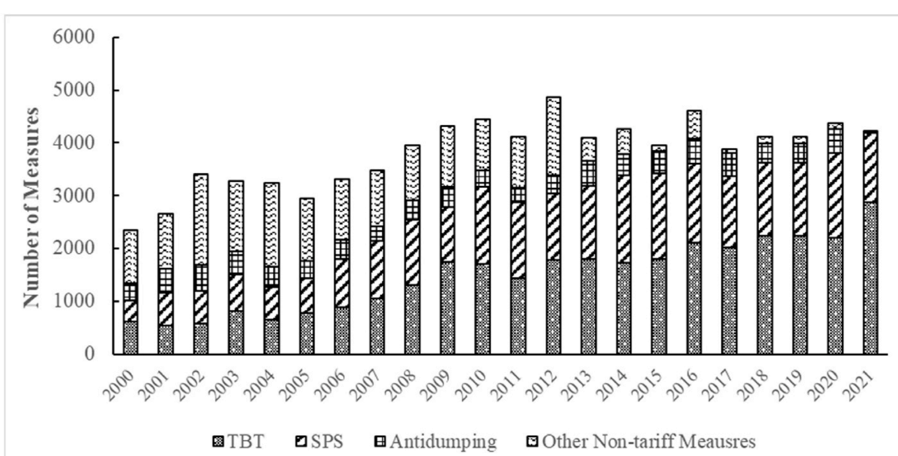
requirements violate the least trade-restrictive principle of the TBT Agreement and would lead to unnecessary and high costs for Chinese exporters.[2] However, the case was not well settled in time. A large number of Chinese toy exporters closed down in 2008. Some survivors withdrew from the US market and searched for new opportunities in other countries, while others opted to remain in the US market despite incurring heavy compliance costs.

We are concerned about whether and how the two different choices lead to different subsequent export performance, especially that of exporters exiting from the TBT-imposing market, which is largely ignored in the literature. To deal with this question, a better understanding of exporters' stay and exit behavior in response to TBT is necessary. Past empirical research shows that TBTs can lead to exits of exporters, since they make export procedures more cumbersome and costly (Fontagné and Orefice, 2018; Curzi et al., 2020). Mostly, it is found that under-performing or less-productive exporters are more likely to exit the TBT-imposing market, for they cannot afford the additional cost of adapting the product to a tougher standard in the TBT-imposing country (Hu et al., 2019; Fernandes et al., 2019; Curzi et al., 2020).

However, this view is challenged recently by a nascent literature which presents an opposite story. It posits that higher-performing exporters are more likely to withdraw or reduce their exports disproportionately from the market following a market-specific shock (Fontagné and Orefice, 2018; Héricourt and Nedoncelle, 2018; De Sousa et al., 2020; Crozet et al., 2021). This novel view is articulated under a multi-destination framework, or from a market portfolio view. Specifically, when confronted with an exogenous shock in a particular market, capacity-constrained firms will reallocate shares across different markets to maximize the profits of the market portfolio (Vannoorenberghe, 2012; Berman et al., 2015; De Sousa et al., 2020; Almunia et al., 2021). Since more productive exporters are typically endowed with more resources and export destinations (Lawless, 2009), they can divert their exports from the TBT-imposing country to other TBT-free countries more easily and with lower market switching costs (Fontagné and Orefice, 2018). When the market switching cost is lower than the compliance cost, exporters tend to exit the TBT-imposing market and reorient their exports towards other markets. In contrast, less productive exporters are less capable of exploiting other existing markets or tapping into new markets, so they may have no better choice but to stick to the TBT-imposing market to survive. Hence, from the market portfolio view, more productive exporters have a higher tendency to exit the TBT-imposing market due to their lower market switching cost. This argument can be seen as a contradiction to the conventional view that "winners never quit."[3]

An integration of these two contrasting views demonstrates that exiters can be under-performing exporters as well as high-performing exporters before TBT shocks. It implies that exit is not just a forced option of failed endeavor for exporters due to inferior capability but can also be a desirable decision for exporters to rearrange and optimize their export shares across destinations. In other words, exporters may be either unable or unwilling to continue exporting to a tough market, and they are not necessarily self-selecting into exiting due to low performance (Crozet et al., 2021). Based on these arguments, we seek to find out whether exiting and staying firms show different subsequent export performance following a TBT shock. To do so, we use Chinese Customs Data spanning from 2000 to 2016 and the data of stringent TBT imposed by the US. To deal with the possible self-selection bias in a rigorous way, notwithstanding the literature basis analyzed above, we adopt the Propensity Score Matching with Difference-in-Differences (PSM-DID) method in the empirical analysis. Our empirical findings show that the exiting group gains a higher subsequent export growth compared to those sticking to the market. The mechanism is that exiters switch destination markets more effectively both along the extensive margin (explore new markets) and the intensive margin (exploit other existing markets), which more than compensates for the loss in the US market. Nevertheless, the staying group outperforms the exiting group in terms of a higher price and higher quality. These findings provide new insights for exporters in dealing with TBTs and developing a niche development mode when encountering a restrictive TBT shock in a destination market.



Note: TBT = Technical Barriers to Trade; SPS = Sanitary and Phytosanitary Measures. Data Source: Authors' calculations based on WTO-I-TIP Database.

Fig. 1. Decomposition of non-tariff trade measures from 2000 to 2021
Note: TBT = Technical Barriers to Trade; SPS = Sanitary and Phytosanitary Measures. Data Source: Authors' calculations based on WTO-I-TIP Database.

Our contributions to the existing literature are mainly twofold. First,

[2] More specific details can be found in document G/TBT/M/46, see https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=Q:/G/TBT/M46.pdf&Open=True.

[3] This quote comes from Vince Lombardi, "Winners never quit and quitters never win."

previous works examine the impact of a foreign TBT shock on exporters' stay-exit behaviors and the subsequent performance of exporters staying in the destination market. But how about exporters exiting the market? How do they perform following TBT shocks? Do the staying and exiting firms achieve different subsequent overall export performance? To answer these questions, we push the research further by exploring the subsequent overall export performance of both staying exporters and exiting exporters following TBT shocks. This can also be taken as a complement to a rich literature on the relationship between exporting and firm performance. Existing studies in this stand of literature mainly focus on exporters' pre-entry performance (self-selection into exporting effect), post-entry performance (learning-by-exporting effect), and pre-exit performance (self-selection into exiting effect) (Mallick and Yang, 2013), while we extend this literature to explore exporters' post-exit performance[4] (Girma et al., 2003).

Second, our paper reveals a bright side of the export market exit from the market portfolio perspective. Exiting from a particular export market is generally seen as a failure in the literature. Nevertheless, exporters make decisions from the market portfolio view rather than a single market perspective, so a loss in one market could be covered by a gain in another market. Export market exit does not necessarily mean total failure. By investigating the export performance in all destinations in entirety, our empirical findings show that exporters exiting the TBT-imposing market even gain higher subsequent overall export growth than exporters staying in the market, providing evidence against the other half of the conventional view that "quitters never win".[5] The reasoning is that, by circumventing high compliance costs and relaxing the capacity constraint, exit from a particular market motivates and enables exporters to explore new markets extensively and exploit other existing markets intensively. Accordingly, under the general equilibrium framework, exit from a particular market can be an important way to optimize the within-firm reallocation of resources across markets (Bernard et al., 2011). It provides a novel perspective for understanding exporters' exit-stay strategy. We plot an illustration (Fig. 2) to demonstrate the research design of our paper.

The remainder of the paper proceeds as follows. Section 2 provides a critical review of the related literature. Section 3 describes the empirical strategy and the data used. Section 4 reports and discusses the empirical results. Section 5 analyzes the detailed mechanisms underlying the observed patterns. Section 6 conducts several extended analyses to enrich our results. Section 7 summarizes the results and concludes the paper.

2. Literature review

Our paper is mainly related to three strands of literature. First, our paper relates to the literature addressing the impact of foreign TBTs on exports. The results are mixed. At the country level, most studies find that foreign TBTs would hamper overall exports (Essaji, 2008; Orefice, 2017; Grundke and Moser, 2019). However, Swann et al. (1996) find that standards in the UK would promote trade partners' exports to the UK. Bao and Qiu (2012) show that TBTs would decrease the number of exporting countries (reduce the extensive margin) but increase the exports of an exporting country (promote the intensive margin). Similarly, at the firm level, studies show that TBT would raise exporters' exit probability or lower their participation probability (reduce the extensive margin) but increase the export value of incumbent exporters (promote the intensive margin) (Fontagné and Orefice, 2018; Ali, 2019). While these studies help reveal different export impacts of TBTs, they mainly concern the impact of TBT on firms' stay-exit decisions, and staying firms' subsequent performance, leaving out the subsequent performance of exporters exiting the TBT-imposing market. Accordingly, we aim to fill this literature gap by considering the subsequent export performance of the staying cohort as well as the exiting cohort.

Second, our paper adds to a growing body of literature on within-firm reallocation in response to trade shocks. The product margin and the destination margin are two main internal dimensions that firms reallocate resources along[6] (Bernard et al., 2011; Meng et al., 2020). Previous works mainly focus on firms' product margin adjustment in response to different forms of trade shocks, such as trade liberalization (Iacovone and Javorcik, 2010; Bernard et al., 2011), exchange rate shocks (Chatterjee et al., 2013; Caselli et al., 2017), foreign demand shocks (Mayer et al., 2021), antidumping measures (Lu et al., 2018; Meng et al., 2020). In recent years, within-firm adjustment along the destination margin has begun to gain attention. Héricourt and Nedoncelle (2018) investigate how French firms reallocate their exports across destinations following an exchange rate volatility shock in a specific destination. They emphasize the benefit of firm-level destination adjustment to stabilize overall French total exports. In a closely related paper, Fontagné and Orefice (2018) examine whether and how French exporters adjust their destinations in response to TBT shocks. However, unlike their attempts to demonstrate the adjustment itself, our paper aims to indicate the importance of destination adjustment for a firm's overall export performance, taking destination adjustment as a key mechanism.

Third, our paper correlates with a burgeoning literature on the impact of US trade policy shocks on Chinese export. Lu et al. (2013, 2018) study the export effect of US antidumping duties against China, while Handley and Limão (2017), and Feng et al. (2017) explore the impact of US trade policy uncertainty on Chinese exporters' behavior. In recent years, this strand of literature has paid plenty of attention to the impact of the US-China trade war on Chinese export (Jiao et al., 2022; Audzei and Brůha, 2022; Ding et al., 2022; Jiang et al., 2023). By focusing on another arduous trade shock arising in the US market, namely the restrictive technical measures imposed by the US, our paper serves as a complement to this strand of literature.

3. Empirical strategy

3.1. Model

To estimate the heterogeneous export impact of TBT shocks on exiting and staying firms, a Difference-in-Differences (DID) regression model is set up as follows:

$$Export_{ipt} = \alpha_0 + \alpha_1 Stay_{ip} \times Post_{pt} + \gamma Control_{ipt} + \mu_{it} + \nu_{pt} + \eta_{ip} + \varepsilon_{ipt} \tag{1}$$

where the subscripts i, p, t index firm, product, and year, respectively. Following Fontagné and Orefice (2018), Singh and Chanda (2021), we define a product at the four-digit level of Harmonized System (HS4) in coherence with the TBT data. The dependent variable $Export_{ipt}$ is the export growth rate of firm i's product p in year t, calculated as mid-point growth: $Export_{ipt} = \frac{(V_{ipt}-V_{ipt-1})}{\frac{1}{2}(V_{ipt}+V_{ipt-1})}$, where V_{ipt} and V_{ipt-1} denote the export value of firm i's product p in year t and year $t-1$, respectively. We employ the mid-point growth rate method since it has the advantage of being bounded within the interval [-2,2], avoiding large variations or outliers in the conventional growth rate measure (Davis and Haltiwanger, 1992; Vannoorenberghe, 2012; Mayer et al., 2021).

[4] One key distinction is that this strand of literature mainly focuses on export status and overall firm performance, while our paper focuses on exporting dynamics in a destination and export performance. Another difference is that the existing literature explores exporting and performance in general cases, while our paper is set in the context of TBT shocks.

[5] Here, "quitters" refer to exporters exiting from the TBT-imposing market.

[6] Gervais (2018) emphasizes "region switching" as another internal adjustment margin. It refers to changes in firms' production locations, reflecting the spatial reallocation of resources that takes place within surviving firms as they open and close establishments in different regions.

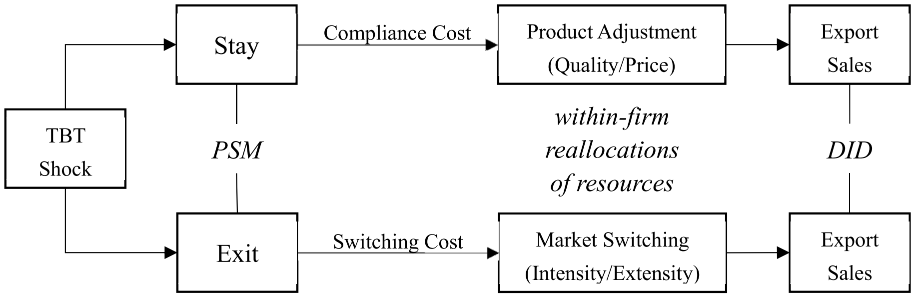


Fig. 2. Research design.

α_1 is the parameter of our main interest, which represents the average effect of the stay-exit behavior on the subsequent export growth of the firm-product. Specifically, if α_1 is significantly larger (smaller) than 0, it indicates the export growth of the stay group is higher (lower) than that of the exit group. If α_1 is insignificant, it means that the two groups do not have any discernible differences in export growth, even though they choose different market strategies.

Following Héricourt and Nedoncelle (2018), we include Des_{ipt} as part of the control variables ($Control_{ipt}$) which represents the log number of destinations the firm-product serves. Besides, we include firm-year fixed effects μ_{it}, product-year fixed effects ν_{pt}, and firm-product fixed effects η_{ip} to control for time-varying firm attributes, time-varying product attributes, and specific time-invariant firm-product characteristics, respectively.[7] In addition, considering that the growth of products sharing the same HS4 code in the same year may be correlated, we cluster standard errors at the HS4 product-year level.

3.2. Data

Our empirical analysis draws on two main datasets. First, the export data are collected by China's General Administration of Customs (2000–2016). This dataset contains comprehensive information on each export transaction at the firm-product-country level, including the code of the exporting firm, six-digit Harmonized System (HS6) product category, export destination country, and the value and quantity of products exported. Second, the data on TBTs and STCs are collected from the WTO's TBT-IMS (TBT-Information Management System) database.

Our paper concentrates on the restrictive TBTs imposed by the US, namely TBTs which involve specific trade concerns raised by China against the US. Considering that the sample data spans from 2000 to 2016, we restrict the years when STCs were raised within the period 2004–2012. By this restriction, we can gain more sufficient information about firm-products' export growth rate both before and after TBT shocks. A summary of the STCs involved in our paper is reported in Table A1. Descriptive statistics of key variables are reported in Table 1.

3.3. Methodology

Our research topic is subject to self-selection bias because the stay group and the exit group are not assigned at random but rather firms' endogenous decisions. If better-performing or under-performing firm-products are more likely to exit, there can be biases in the estimation (Li et al., 2016). Though we have drawn the argument from the existing literature that both better-performing exporters and under-performing exporters may exit, we proceed to alleviate the self-selection bias in a more rigorous way. Following Mallick and Yang (2013), we first resort to the PSM technique to get a sample within which the stay group and the exit group are matched like for like before TBT enactment, and then apply DID based on equation (1).

Table 1
Descriptive statistics.

Variables	Obs	Mean	SD	Min	Max
STAY (=1 if a firm-product belongs to the stay group)	202899	0.60	0.49	0	1
POST (=1 if the year is later than the year when an STC is raised)	202899	0.44	0.50	0	1
EXPORT1 (mid-growth rate of export values)	180320	0.04	0.90	−2	2
EXPORT2 (logarithmic growth rate of export values)	180320	0.06	1.40	−11.48	12.69
EXPORT3 (mid-growth rate of export quantities)	180320	−0.02	0.90	−2	2
DES1 (=1 if a firm-product has more than one country)	202899	0.75	0.44	0	1
DES2 (the number of a firm-product's destination markets)	202899	7.29	9.87	1	174
FIRM SIZE (firm's total export values, million dollars)	202899	53.74	374.21	0.0001	20625.06

Notes: "Obs" is the number of observations. "Mean" is the mean value of the variables. "SD" is the standard deviation of the variables. "Min" and "Max" are the minimal value and the maximum value of the variables, respectively.

Our implementation of the PSM-DID approach is as follows. First, we pick out all the restrictive TBT-affected firm-products and classify them into different subsamples based on the TBT event and the industry type, ensuring that the stay group and the exit group are faced with the same TBT shock and belong to the same HS2 category.[8]

Second, to classify the stay group and the exit group, we follow the classification of Girma et al. (2003), Iacovone et al. (2013), and Argente et al. (2018): if a firm-product keeps exporting to the US market after the TBT imposition, it belongs to the stay group. If a firm-product stops exporting to the US market but still exports to other markets in the years after the TBT imposition, it is classified as the exit group[9]F.2 And to

[7] *Stay* and *Post* in the primary specification are absorbed by the firm-product fixed effects and product-year fixed effects.

[8] As shown in Table A1, most STC events only involve one product (HS4 level) except for IMS-ID140 which involves HS84 and HS85, and IMS-ID172 which involves HS61, HS62 and HS63. Hence, most products are matched not only within one industry, but also within one type of product at the HS4 level.

[9] Form the definition above, we can see that "exit" does not mean exiting from the whole export market, but only exiting from the US market and still surviving in other markets. That is to say, our sample is restricted to the survivors in the export market after the TBT imposition. To put it more accurately, the two groups should be defined as "stay-in-US group" and "exit-from-US group", which we call "stay group" and "exit group" for short.

avoid the mixed effect of the intermittent export behavior in the US market, following the method of Girma et al. (2003) and Lu et al. (2010), we exclude firm-products which initially stay and then exit or which initially exit and then return to the US market.

Third, for each subsample, we implement the one-to-one nearest-neighbor matching method with replacement and with a caliper size of 0.05 to get a matched sample by the characteristics of the firm-products prior to the year of TBT enactment. As for the covariates, we follow Girma et al. (2003), Görg et al. (2012), and Fontagné and Orefice (2018) to include firm size (log export value of the whole exporter), the multi-destination status of the firm-product, and export growth rate. To ensure the matching quality, we conduct balancing tests for each matched subsample to ensure the quality of matching.[10]

Finally, we merge the matched observations in the subsample with their information on other years to construct a panel dataset and append the panel data of different matched sub-samples to obtain a total matched sample for the estimation.

4. TBT effect on export sales

4.1. Baseline results

Table 2 reports the baseline results based on the matched sample. From column (1) to column (7), we gradually include various fixed effects, with *Stay* and *Post* absorbed correspondingly. In particular, column (7) which controls for all the three fixed effects, with *Stay* and *Post* absorbed simultaneously, may create the most accurate estimate. The key parameter of interest, α_1, is negative and significant throughout the columns. As previously analyzed, the significant and negative coefficient indicates that exporters who choose to stay in the US market have a comparatively lower growth rate than exiters at the firm-product level.

This result seems counterintuitive and contradictory to the conventional wisdom that quitters are usually losers. However, there are two caveats to this finding. First, we applied the PSM method to get two comparable cohorts of exporters prior to TBT shocks, so the cohort of exporters who choose to exit the US market in our sample shares similar characteristics with the cohort of exporters who choose to stick to the US market. Exporters which exit not only the US market but also the whole export market are *not* included in the comparison, for they do not have subsequent export performance. Second, we restricted our attention to the most stringent TBT, namely TBTs associated with STCs. If we extend to include the normal TBT which might only require minor adaptation of the product, the result might be different. We are to conduct a battery of tests to ensure the robustness of the result under the two caveats in Table 2.

4.2. Parallel Trend Test

Application of DID method requires that the stay group and the exit group share a parallel trend, i.e., the two groups do not have significant differences in export growth before they decide to stay or exit. Following Beck et al. (2010), we build the following model to conduct a parallel trend:

$$Export_{ipt} = \beta_0 + \beta_\tau \sum_{\tau=t-6}^{t+6} Stay_{ip} \times Post_{p\tau} + \gamma Control_{ipt} + \mu_{it} + \nu_{pt} + \eta_{ip} + \varepsilon_{ipt} \tag{2}$$

where τ stands for the year dummy, and other variables are the same as above. We set the year after TBT imposition as the period t, for this is the year showing divergence between stay and exit. We test the change six years before t and six years after t.[11] That means τ belongs to the integral number within the interval $[t-6, t+6]$. Following the common practice (Fan et al., 2020; Crescenzi et al., 2021), we select period $t-1$, namely the year before the stay-exit decision as the base period. Fig. 3 presents the parallel test result. It shows that the two groups do not have significant distinctions before period t, so the parallel trend is satisfied.

4.3. Placebo specification

There is a potential concern that there may exist some unobservable factors affecting firm-products' export growth, which can be mixed up with the estimated effect. To address this concern, we employ the placebo test by constructing several fictitious year dummies for the TBT shock. Specifically, we put the TBT shock time ahead of one year, two years, and three years, respectively. Reassuringly, our placebo specifications in Table 3 reveal that there are no significant distinctions among the two groups if we set the TBT notification year to the fictitious pre-period, for all the coefficients of the interaction terms are insignificant. The placebo test proves the robustness of our baseline results.[12]

4.4. Long-differenced estimations

Additionally, one may worry that there exists a potential serial correlation problem in the baseline estimate. To deal with this concern, we follow the method used in Acemoglu et al. (2016) and Ghani et al. (2016) to construct a long-differenced estimation by comparing the average export growth rate change between the two periods, i.e., the period before and the period after the stay-exit decisions. The control variables are also averaged across the period. Table 4 displays the long-differenced estimation results. In all the four columns, the signs and significance of the main variable are remarkably robust to the baseline result in Table 2.

4.5. Robustness checks

In this subsection, we perform further robustness checks, including alternative measures and alternative specifications.

Alternative measure of the export growth rate. Firstly, we alternatively use the first log difference measure to calculate export growth, the equation of which is as: $Export_{ipt} = \Delta lnV_{ipt} = lnV_{ipt} - lnV_{ipt-1}$. Secondly, we use the export quantity growth rate to eliminate the price effect as in

[10] The balancing testing results are not included in the text due to space limitations. They are available upon request.

[11] Since the sample spans the period 2000–2016, which is 17 years in total. It contains 16 periods' export growth at most. Therefore, we can choose at most 8 periods before and after the separation year. Notwithstanding, those who continues to export in all the 17 sampling years only make up a very small proportion. Most exporters only appear in no longer than 12 years. Considering this, we set the range of as [t-6, t+6], where the year larger than t+6 or smaller than t-6 are unified to t+6 or t-6, respectively.

[12] We also conduct another placebo test by random sampling of the interactive term. The result of the placebo test shows that the coefficients of the interaction term are distributed around 0, mostly within the range of [-0.02, 0.02], which is far away from the true estimated coefficient of the interaction term (−0.153) in our baseline result. Moreover, most p values are above 0.1, indicating the coefficients from random sampling is not significant. This result also alleviates the concern of unobserved factors. To save space, we do not report the result here, but it is available upon request. We are grateful to an anonymous referee for this suggestion.

Table 2
Baseline results of TBT effect on export sales growth.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stay × Post	−0.116***	−0.057***	−0.131***	−0.144***	−0.096***	−0.144***	−0.153***
	(0.020)	(0.021)	(0.024)	(0.024)	(0.018)	(0.026)	(0.026)
Stay		0.063***	0.016	0.021			
		(0.013)	(0.016)	(0.016)			
Post	−0.390***						
	(0.020)						
Des	0.321***	0.120***	0.165***	0.177***	0.335***	0.391***	0.389***
	(0.009)	(0.003)	(0.005)	(0.005)	(0.009)	(0.010)	(0.010)
Constant	−0.186***	−0.154***	−0.160***	−0.175***	−0.408***	−0.442***	−0.437***
	(0.025)	(0.007)	(0.009)	(0.008)	(0.015)	(0.015)	(0.015)
Firm-year FE	NO	NO	YES	YES	NO	YES	YES
Product-year FE	NO	YES	NO	YES	YES	NO	YES
Firm-product FE	YES	NO	NO	NO	YES	YES	YES
N	180320	180316	113583	113577	180316	113583	113577
adj. R^2	0.047	0.092	0.230	0.237	0.080	0.201	0.206

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively. Column (7) with all fixed effects included is the baseline result, while columns (1)–(6) with partial fixed effects included are provided for robustness. *Stay* is absorbed by firm-product fixed effects in columns (1), and (5)–(7). *Post* is absorbed by product-year fixed effects or firm-year fixed effects in columns (2)–(7). It should be noted that, theoretically, as a variable at the product-year level, *Post* can only be absorbed by product-year fixed effects rather than firm-year fixed effects. But in our sample, a firm is either a single-product firm, or a multi-product firm with products suffering from TBT in the same year, which implies that a firm corresponds to one value of *Post* in a certain year, and thus *Post* can also be absorbed by firm-year fixed effects.

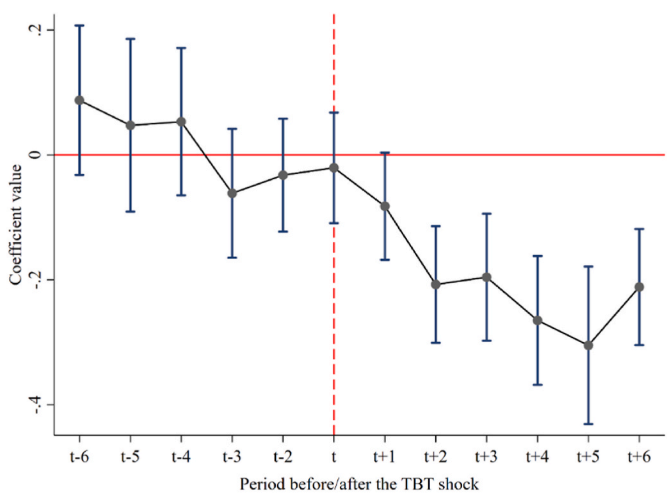


Fig. 3. Parallel trend test.

Table 3
Result for placebo tests.

Variables	1 year ahead	2 years ahead	3 years ahead
	(1)	(2)	(3)
Stay × Post	−0.043	0.001	−0.011
	(0.038)	(0.042)	(0.049)
Des	0.735***	0.734***	0.734***
	(0.021)	(0.021)	(0.021)
Constant	−0.495***	−0.509***	−0.504***
	(0.021)	(0.023)	(0.027)
Firm-Year FE	YES	YES	YES
Product-Year FE	YES	YES	YES
Firm-Product FE	YES	YES	YES
N	113513	113513	113513
adj. R^2	0.202	0.202	0.202

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

Fajgelbaum et al. (2020), including the mid-point measure and the first log difference measure. The corresponding results are reported in Table 5 columns (1)–(3), all of which are quite robust.

Table 4
Result for long-differenced estimation.

Variables	(1)	(2)	(3)	(4)
Stay × Post	−0.075**	−0.088***	−0.161***	−0.171***
	(0.029)	(0.031)	(0.026)	(0.029)
Stay	0.515***	0.568***	0.544***	0.586***
	(0.052)	(0.067)	(0.059)	(0.069)
Post	0.363***	0.356***	0.615***	0.270***
	(0.024)	(0.023)	(0.060)	(0.050)
Des	0.092***	0.116***	0.095***	0.108***
	(0.027)	(0.020)	(0.020)	(0.017)
Constant	−0.657***	−0.571***	−0.775***	−0.682***
	(0.031)	(0.016)	(0.072)	(0.066)
Product FE	NO	YES	NO	YES
Year FE	NO	NO	YES	YES
N	20596	20596	20596	20596
adj. R^2	0.107	0.125	0.118	0.137

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively. Column (4) with all fixed effects included is the baseline result, while columns (1)–(3) with partial fixed effects included are provided for robustness.

Alternative measure of control variables. We alternatively use a dummy variable to account for a firm-product's destination status. The multi-destination status variable takes the value of 1 when the firm-product exports to more than one destination at period t, and 0 otherwise. As reported in Table 5 column (4), the result is still consistent with the baseline result.

Controlling for the financial crisis. Our sample includes the period 2008–2009 when the global financial crisis broke out in the US and spread to the whole world. One may worry that this shock may give rise to unusual impacts on export growth. We use two methods to knock out this effect. First, we exclude all the observations in year 2008 and year 2009. Second, we add a control variable reflecting the country's shock level. Following Mayer et al. (2021), the measurement of the shock level is $Shock_{ipt} = \sum_j w_{ipjt} \times lnGDP_{jt}$, where the subscripts j indicates the destination. GDP_{jt} is the real GDP of destination j in year t, and w_{ipjt} is the weight calculated by the export share of firm i's product p to destination j in year t. The GDP data is drawn from the WDI database provided by the World Bank. The results under the two methods are presented in Table 5 columns (5) and (6) respectively. We find robust results when controlling for the financial crisis or every year's exogeneous shock.

Table 5
Results for robustness checks.

Variables	First log difference	Export quantity growth		Alternative of Des	Exclude financial crisis impact		Control other TBT	Control the tariff level
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Stay × Post	−0.168***	−0.120***	−0.129***	−0.100***	−0.214***	−0.165***	−0.153***	−0.153***
	(0.041)	(0.026)	(0.041)	(0.026)	(0.037)	(0.026)	(0.026)	(0.026)
Des	0.615***	0.388***	0.624***	0.462***	0.391***	0.395***	0.390***	0.389***
	(0.017)	(0.010)	(0.017)	(0.014)	(0.011)	(0.010)	(0.010)	(0.010)
Shock						0.017***		
						(0.002)		
TBTother							−0.390	
							(0.127)	
Tariff								0.000
								(0.001)
Constant	−0.711***	−0.501***	−0.806***	−0.293***	−0.395***	−0.920***	−0.437***	−0.439***
	(0.025)	(0.014)	(0.024)	(0.013)	(0.017)	(0.065)	(0.015)	(0.017)
Firm-Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Product-Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm-Product FE	YES	YES	YES	YES	YES	YES	YES	YES
N	113577	113561	113541	113577	91204	112100	113577	113577
adj. R^2	0.208	0.193	0.197	0.194	0.206	0.207	0.206	0.192

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

Controlling for other simultaneous TBT. Up till now, we have restricted all our attention to the restrictive TBT measures in the US. Nevertheless, since the export growth rate is measured at the firm-product level, it is reasonable to take into account the restrictive TBT measures a firm-product faces in all destinations. Accordingly, in this part, we add a dummy variable *TBTother* which takes the value of 1 if a firm-product has gone through a restrictive TBT in another country, and 0 otherwise. As shown in Table 5 column (7), the baseline result still holds when controlling for other simultaneous TBT.

Controlling for tariffs. Tariffs vary across destinations and products, which might also affect the export growth rate. To address this concern, we include a variable reflecting the tariff at the firm-product level, which is constructed à la Lileeva and Trefler (2010) as: $Tariff_{ipt} = \sum_j w_{ipjt} \times \tau_{pjt}$. $Tariff_{ipt}$ is the weighted average tariff firm i's product p in year t are faced with. τ_{pjt} is the average tariff imposed by the importer country j on product p from China in year t. Other variables are the same as before. We use the effectively Applied Tariff Rates (AHS) compiled by WITS. As reported in Table 5 column (8), controlling for the tariff level does not affect the baseline result.

4.6. Modified PSM methods

In the baseline regression, we use Chinese Customs Data to get a sample as large as possible. However, the selectable covariates to conduct PSM are greatly limited since many firm-level variables are not available in the Customs Data. There might be concerns that the two matched groups are not comparable enough and omitted variable bias might exist. To further alleviate these concerns, we attempt to modify PSM with more covariates by utilizing the data of Chinese Annual Surveys of Industrial Firms (ASIF), which cover all state-owned enterprises and above-scale non-state firms in China. The ASIF provide detailed firm-level characteristics, including total assets, total liabilities, employment, etc. We merge the baseline sample with ASIF data through unique firm names, telephone numbers, and postcodes. Due to data availability, the merged data span from 2000 to 2013. Hence, to get sufficient information about observations' export growth rate before and after STCs were raised, we restrict the TBT events in our research to those whose corresponding STCs were raised during the period 2004–2009. Then we divide the merged data into subsamples in terms of the relevant TBT events and industries. We conduct PSM for each subsample. Due to the limited size of the newly merged subsamples, we follow Alguacil et al. (2022) and adopt the one-to-three nearest neighbor matching method with replacement and with a caliper size of 0.05.

As for the covariates, apart from the variables adopted in the baseline PSM, we also add variables that may affect firms' stay/exit choices and their subsequent export performance, including firm productivity (labor productivity measured by the ratio of value added over the number of workers), total assets (in log), capital intensity (the ratio of net fixed asset over the number of workers), firm age (in log), export intensity (the ratio of export sales over total sales), and export value of the product (in log), and firm ownership (a dummy variable which takes the value of 1 if a firm is foreign-owned, otherwise 0). The balancing test results show that most of the p-values exceed 0.05 after matching, ensuring the quality of matching.[13]

Table 6 reports the results based on the newly matched sample. The main coefficient is also significant and negative throughout the columns, which further ensures the robustness of our baseline result.[14]

5. Market switching mechanism analysis

Since the baseline result suggests that the exit group gains higher growth at the firm-product level, we infer that they must have diverted towards other export destination markets to a stronger extent, which can more than compensate for the export loss from the US market. In other words, switching export markets more actively might be the reason why the exit group outperforms the stay group. Therefore, in this section, we investigate the research question deeper by comprehensively examining the export market switching mechanism behind the empirical results. Essentially, firm-level export market switching belongs to the within-firm adjustment along the destination margin, serving as an important way for firms to reallocate exports away from tough markets. It can also be interpreted as a micro version of the trade deflection effect or the third-country effect (Bown and Crowley, 2007; Héricourt and Nedoncelle, 2018). In fact, a few works have explored the market switching effect (or trade deflection effect) of non-TBT shocks in the US on Chinese exporters in recent years. For example, Fajgelbaum et al. (2021) find that the US tariff surges on China led to China's export market switching from the US to the rest of the world. Jiang et al. (2023) confirm this result and demonstrate that China's export market switching stabilized total Chinese exports despite a significant reduction of exports to the US

[13] The balancing testing results are not included in the text due to space limitations. They are available upon request.

[14] Considering the number of observations is reduced by almost 80 percent in this method, the merged sample is much less representative than the baseline sample. Hence, we just use this result as a complement to the baseline result.

Table 6
Results for modified PSM.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stay × Post	−0.171***	−0.108***	−0.152***	−0.148***	−0.179***	−0.141**	−0.187***
	(0.028)	(0.024)	(0.056)	(0.028)	(0.065)	(0.059)	(0.068)
Stay		0.077***	0.021			0.017	
		(0.016)	(0.044)			(0.045)	
Post	−0.429***						
	(0.027)						
Des	0.266***	0.137***	0.175***	0.293***	0.360***	0.189***	0.367***
	(0.013)	(0.006)	(0.013)	(0.012)	(0.020)	(0.013)	(0.021)
Constant	0.008	−0.132***	−0.125***	−0.260***	−0.313***	−0.142***	−0.317***
	(0.024)	(0.009)	(0.018)	(0.018)	(0.031)	(0.017)	(0.031)
Firm-year FE	NO	NO	YES	NO	YES	YES	YES
Product-year FE	NO	YES	NO	YES	NO	YES	YES
Firm-product FE	YES	NO	NO	YES	YES	NO	YES
N	30856	30835	22928	30835	22928	22846	22846
adj. R^2	0.042	0.094	0.219	0.068	0.185	0.224	0.186

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively. Column (7) with all fixed effects included is the baseline result, while columns (1)–(6) with partial fixed effects included are provided for robustness.

during the US-China trade war. Jiao et al. (2022) find that, in response to the US tariff shocks, Chinese exporters reduced their exports to the US significantly, and increased their exports to the European Union countries. Besides, Lu et al. (2013) find that the US anti-dumping measures against China did not cause a significant market switching effect. In a similar vein, we want to find out whether the market switching mechanism holds in the TBT case at the firm-product level. To this end, before conducting empirical analysis in the sub-sections, we first identify four theoretical channels through which the two groups' market switching behaviors can be affected.

The first channel is the *motive* of market switching. The exit group is expected to have stronger market switching motives because they have lost their sales in the US market, so they are under greater pressure to search for other markets to survive and thrive. Put differently, they rely more on other countries to boost their overall sales growth. In contrast, the stay group has weaker market switching motives (Chen et al., 2008).

The second channel is the *capability* of market switching. Since the stay group devotes most of their resources to the US market, they tend to be more capacity constrained in market switching (Berman et al., 2015; Almunia et al., 2021). Moreover, since to continue serving the US market bears a high compliance cost, it might give rise to tighter financial constraints, which may further restrict exporters from switching to other markets. In contrast, the exit group does not have to bear the compliance cost, but their revenue is facing a loss because of the withdrawal from the US market, which might also tighten the financial constraint for market switching. Therefore, it is ambiguous as to which group is more competent in the market switching capability.

The third channel is export learning behavior. To meet the demanding requirement of a strict TBT in a specific market, the stay group may be forced to improve product quality for that market (the US in our case), which is identified as "learning-by-exporting" (Clerides et al., 1998; Yang and Mallick, 2014). Through the spillover effects of learning, the products exported to other markets may also get improved and upgraded, which enhances market switching for the stay group. Whereas, the exit group, by circumventing the standard, may not experience quality improvement and thus cannot rival the stay group in quality competence in other markets, which may impede its market switching.

The final channel is known as the chilling effect (Vandenbussche and Zanardi, 2010). If the exit group fears that other countries will follow the US and implement similar technical measures in the future, they may give up market switching as a solution to the shock but try other solutions, such as product switching. As a result, the exit group may not tend to switch markets actively because of this so-called chilling effect. However, the stay group might have less concerns in this regard, since the experience of coping with restrictive TBTs in the US market might enable them to overcome similar trade barriers in other markets. Moreover, other countries' similar technical standards may enable them to reap economies of scale in upgrading products. Hence, the chilling effect does not constitute a big impediment for the stay group in switching to other markets.

To summarize the four theoretical channels, we can see that a mixture of effects is likely to be at play, so it is meaningful to empirically test how the two groups switch their markets to achieve export sales growth. To do so, we need a quantitative measure of the degree of market switching.

There are two methods in the literature for this measure. The first is to estimate the sales of other markets—if other markets' sales have increased, it means there is market switching (Berman et al., 2015; Héricourt and Nedoncelle, 2018; Jiao et al., 2022). The second is to estimate the number of markets—a greater number of new markets means a stronger degree of market switching (Fontagné and Orefice, 2018). To paint a complete picture, we combine these two methods and develop four extended measures of the degree of market switching: the overall market switching, market switching along the intensive margin (exploit other old markets), market switching along the extensive margin (explore new markets), and geographical heterogeneity of the aimed switching markets.

5.1. The overall measure of market switching

We take $Export_{ipt}^{non-US}$, i.e., the export sales growth for all the markets except the US market, as the dependent variable and rerun the baseline regression model to estimate the degree of overall market switching. The result is reported in Table 7 column (1). The coefficient of the main explanatory variable remains significantly negative, which reveals that the exit group has a stronger degree of market switching. This implies that the exit group devotes more resources and time to market switching, while the stay group concentrates more on complying with market standards in the US. Further, we proceed to investigate whether the market switching gap is achieved through exploiting old markets (along the intensive margin) or exploring new markets (along the extensive margin), or both, and how geographic areas differ in market switching.

5.2. Market switching along the intensive margin

Market switching along the intensive margin refers to switching to other old markets, which is denoted by $Export_{ipt}^{non-US-old}$, i.e., the export sales growth in the non-US old markets. We take it as the dependent variable and rerun the baseline estimation.

Fundamentally, it is worth clarifying how we classify new markets and old markets. There are two popular definitions in the related liter-

Table 7
Mechanism analysis (1): Export market switching.

Variables	Export $^{non-US}$	Export$^{non-US-old}$		Export ^{new}		Number^{new}		Add^{new}	
		Def. 1	Def. 2	Def. 1	Def. 2	Def. 1	Def. 2	Def. 1	Def. 2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Stay × Post	−0.204***	−0.189***	−0.178***	−0.238***	−0.240***	−0.198***	−0.105***	−0.063***	−0.204***
	(0.024)	(0.025)	(0.027)	(0.035)	(0.036)	(0.011)	(0.011)	(0.009)	(0.024)
Des	0.539***	0.433***	0.395***	0.589***	0.644***	0.749***	0.421***	0.392***	0.539***
	(0.010)	(0.011)	(0.010)	(0.016)	(0.016)	(0.004)	(0.004)	(0.005)	(0.010)
Constant	−0.639***	−0.520***	−0.494***	−0.842***	−0.859***	−0.071***	0.019***	0.160***	−0.639***
	(0.015)	(0.015)	(0.015)	(0.022)	(0.022)	(0.006)	(0.007)	(0.007)	(0.015)
Firm-Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Product-Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-Product FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	113577	113577	113577	113577	113577	113577	113577	113577	113577
adj. R^2	0.215	0.151	0.136	0.056	0.085	0.800	0.528	0.575	0.215

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively. Export$^{non-US-old}$ is a firm-product's export growth rate in all of its destinations except the US. Export$^{non-US-old}$ is a firm-product's export growth in its old destinations except the US. Export ^{new} is a firm-product's export growth in its new destinations. Number^{new} is the log number of a firm-product's new destination markets plus one. Add^{new} is a dummy variable equal to 1 if a firm-product adds a new destination. In Def.1, if the destination has not emerged in all the previous periods before t, it is defined as new, otherwise as old. In Def.2, if the destination in period t does not emerge in period t-1, it is defined as new, otherwise as old.

ature. The first definition takes all the previous periods as the reference. Specifically, if a destination has not emerged in the market portfolio in all the previous periods before t, it is defined as a "new" market; otherwise as an "old" market. This definition is adopted by Berman et al. (2012), and Li et al. (2015). Alternatively, the reference is the period $t-1$ only. If a destination in period t does not emerge in the market portfolio in period $t-1$, it is defined as a "new" market, otherwise as an "old" market. Fontagné and Orefice (2018) adopt this definition method. To ensure the robustness of our estimates, we rerun the estimation by both definitions. As indicated in Table 7 columns (2) and (3), the coefficient of the interaction term is significantly negative in both columns. This demonstrates that the exit group can achieve higher export growth by exploiting the old market(s).

5.3. Market switching along the extensive margin

Market switching along the extensive margin refers to switching to new markets in our study. We rerun the baseline model by constructing three measures as dependent variables, i.e., $Export^{new}$, $Number^{new}$, Add^{new}. Specifically, $Export^{new}$ represents the export growth of new markets; $Number^{new}$ represents the number of new markets, calculated in the form of $log(1 + number\ of\ new\ markets)$[15]; Add^{new} is a dummy variable equal to 1 if the firm-product exports to a new destination, and 0 otherwise. A larger value of any of these three measures corresponds to a stronger extent of market switching along the extensive margin. For robustness, we also adopt both definitions of new markets depicted in section 5.2.

The estimates are reported in columns (4)–(9) of Table 7. It shows that the key parameter remains significantly negative throughout the six columns, regardless of how we define the new market and which dependent variable measure we use. We can conclude with confidence that the exit group gains a higher growth rate by exploring new markets or along the extensive margin.

5.4. Geographic heterogeneity of market switching

Now we assess whether there is geographic heterogeneity for the aimed markets between the two groups. Jiao et al. (2022) find that in response to US tariff shocks, Chinese exporters' exports to the European Union countries increased at a significant level, while their exports to other countries did not change significantly. Zhou et al. (2021) find a similar interdependence pattern in service trade (international tourism) among China, Japan, and South Korea. Enlightened by their insights, we try to find out whether there is a significant difference between the stay and exit groups in the following geographic areas: Asia, Europe, Africa, Oceania, North America, and South America.

The results are reported in Table 8. It can be seen that the interaction term stays negative throughout the columns, indicating that market switching in all the six macro regions is stronger among the exit group than the stay group. For convenience of comparison, we arranged the order of the columns according to the magnitude of the coefficient of the interaction term. The results imply that the exit group's most conspicuous comparative advantage in market switching lies in the European market. North America (without the US) comes second, followed by South America, Oceania, and Asia, whereas Africa comes last.

The region ladder of destination market switching might be formed due to a combination of factors. First, market switching cost determines whether exporters would like to or are able to switch markets. If the switching cost is too high, exporters would not switch markets but may choose to stay. The switching cost is associated with market similarity, firms' export experience, and trade distance. With similar income levels, close geographic distance, similar culture, and common language in most countries, the European market and North American market are most proximate to the US market regarding consumer preference and product standards, leading to a lower market switching cost from the US to these markets. Moreover, according to our calculation, the share of exporters with prior experience in the European market before they encounter TBTs in the US market is the largest in our sample. This implies that most Chinese exporters are familiar with the European market and the information barrier to explore or exploit the European market is relatively low, which also contributes to a low switching cost. Besides, a closer trade distance to the destination country may also conduce to a lower switching cost.

Second, market size determines how many products can be switched to a market. Larger markets are able to absorb a larger fraction of exports that would have been shipped to the US. In contrast, small markets can only absorb limited foreign goods, which would restrain the potential of exporters' market switching, even if they involve a low market switching cost. The relatively large market size (measured in GDP) of the European market may drive exporters to head for it actively.

Third, market uncertainty is another crucial factor of market

[15] Considering that some firm-products have not developed any new markets, indicating that the number of new markets may have some zeros. This may lead to some missing observations if we introduce the dependent variable in log form. Hence, we follow the general practice in the literature when dealing with this kind of case (e.g., Foster and Gutierrez, 2013; Bas et al., 2017) by adding one to the variable first and then taking logs.

Table 8
Mechanism analysis (2): Geographic heterogeneity.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Europe	North America	South America	Oceania	Asia	Africa
Stay × Post	−0.321***	−0.225***	−0.166***	−0.163***	−0.162***	−0.102***
	(0.029)	(0.029)	(0.023)	(0.026)	(0.030)	(0.020)
Des	0.602***	0.298***	0.287***	0.250***	0.460***	0.184***
	(0.012)	(0.010)	(0.008)	(0.009)	(0.011)	(0.007)
Constant	−0.640***	−0.291***	−0.305***	−0.265***	−0.589***	−0.204***
	(0.017)	(0.014)	(0.012)	(0.012)	(0.016)	(0.010)
Firm-Year FE	YES	YES	YES	YES	YES	YES
Product-Year FE	YES	YES	YES	YES	YES	YES
Firm-Product FE	YES	YES	YES	YES	YES	YES
N	113577	113577	113577	113577	113577	113577
adj. R^2	0.182	0.064	0.059	0.056	0.133	0.053

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively. It should be noted that, since we seek to evaluate the aimed export destination markets of Chinese exporters apart from the US, "North America" here does not include the US, and "Asia" does not include China. "Europe", "North America", "South America", "Oceania", "Asia", and "Africa" denote a firm-product's export growth in European markets, North American markets, South American markets, Oceanian markets, Asian markets, and African markets, respectively.

switching when exporters take export stability into consideration. A low level of market uncertainty enhances exports by offering a stable environment for international trade. Based on the data of the World Uncertainty Index (WUI), we find that during our sampling years, Africa witnesses comparatively high uncertainty in most years, while North America (US not included) and Oceania usually experience low-level uncertainty. This may also partly explain why Africa ranks below other areas in aimed markets.

One unexpected result is that Asia ranks below South America and Oceania, though with slightly weak inferiority. This is perhaps because South America and Oceania bear higher market similarities to the US market due to closer distance or closer income level, which induces a lower switching cost. Besides, Asia may have already been intensively exploited by Chinese exporters and the potential for further market penetration is somewhat limited. And perhaps more importantly, the TBT-affected Chinese products in our sample are mostly labor-intensive products, such as clothing textiles and toys, which are also the exporting products with comparative advantage in many other Asian countries. Therefore, the market demand for these products from China is relatively small in Asia than in South America and Oceania.

6. Extensions

From the baseline estimates, we have shown that the exit group gains a superior export sales growth rate, but export sales growth is only one aspect of export performance. There are other export performance indicators such as price and quality to be investigated to paint a more complete picture of the effects.

6.1. The effect on price

There are three possible price effects for the stay group. First, the cost channel—the stay group must bear an additional compliance cost which is then passed through to prices, partially or completely. Second, the quality channel—the quality of the stay group's product may be upgraded, enabling exporters to demand a higher price. Third, the competition channel—some firms may exit the US market after TBT shocks (Fontagné and Orefice, 2018; Hu et al., 2019; Curzi et al., 2020), which reduces the competition in an industry. This is known as the anti-competitive effect of TBT (Fontagné and Orefice, 2018). A lower extent of competition strengthens the market power and the pricing power of the incumbents, which may contribute to a higher price markup. All three effects lead to the same direction—a higher price.

For the exit group, there are two price effects. First, the cost channel—as depicted in the mechanism analysis, the exit group seeks overall export growth by exploiting old markets or exploring new markets. Since there are substantially higher marginal costs for approaching new customers in old markets (Arkolakis, 2010), and there are also fixed costs to be paid for exploring new markets (Helpman et al., 2008), all these higher costs might translate into higher prices. Second, the competition channel—the exit group is inferior in product quality to the stay group since they do not meet the standard required by restrictive TBTs. To retain the market share, they might have to lower their price markups because of the competitive pressure. The three effects have ambiguous outcomes, and the final result waits to be empirically tested.

To estimate the price effect, we use firm-products' prices as the dependent variable and other variables in the baseline model as independent variables. Calculation of product prices follows the common practice in the related literature (Manova and Zhang, 2012): $P_{ipt} = \frac{\sum_j V_{ipjt}}{\sum_j Q_{ipjt}}$, where P, V and Q denote the export price, export value and export quantity, respectively. Column (1) of Table 9 presents the estimation result. The key coefficient of *Stay* × *Post* is significantly positive, which verifies the fact that the price is higher for the stay group than the exit group following TBT shocks.

Table 9
The effect of stay-exit decisions on price and quality.

Variables	Price	Quality (Method 1: demand residual measure)	Quality (Method 2: relative price measure)
	(1)	(2)	(3)
Stay × Post	0.037***	0.017**	0.047**
	(0.016)	(0.007)	(0.015)
Des	−0.008	−0.045***	0.010**
	(0.005)	(0.002)	(0.004)
Constant	1.553***	−0.858***	0.245***
	(0.007)	(0.004)	(0.006)
Firm-Year FE	YES	YES	YES
Product-Year FE	YES	YES	YES
Firm-Product FE	YES	YES	YES
N	128872	57836	128872
adj. R^2	0.858	0.789	0.745

Notes: Standard errors in parentheses are two-way clustered at the product and year level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

6.2. The effect on quality

Now we proceed to explore the effect on quality, which also helps verify whether the effect on price is partly contributed by the quality channel (Mallick and Marques, 2016). Specifically, when a country imposes a strict technical standard, exporters who continue to serve the market are prompted to upgrade their products, so the product quality is likely to get improved. The exit group, however, without the pressure to conform to the TBT, might not get quality enhancement. To verify this hypothesis, we use the firm-product's quality as the dependent variable and rerun the baseline model. Product quality is measured in two ways. The first follows Khandelwal et al. (2013) based on the demand residual, which is widely used in the trade literature, while the second follows Argente et al. (2018) based on the relative price.

In the first method, quality is defined as any attribute that raises consumer demand other than price (Khandelwal et al., 2013). The intuition of this method is that, if two varieties within the same product type have the same price, consumers would prefer the one with higher quality. To put it differently, conditional on price, a product with a higher quantity is assigned higher quality. According to this logic, we estimate quality from the demand side with both the quantity and price information. Specifically, we incorporate quality into consumers' preferences, and estimate quality via the demand function in log form as:

$$\log Q_{ipjt} + \sigma \bullet \log P_{ipjt} = \theta_{jt} + \varepsilon_{ipjt} \tag{3}$$

where Q_{ipjt} and P_{ipjt} denote export quantity and export price of firm i's product p selling to destination j in year t, respectively. θ_{jt} is the importer-year fixed effect that collects the importing country's income and price index. ε_{ipjt} is the residual which includes the quality factor. Considering the endogeneity problem, we adopt the average price of firm i product p to other destinations as the instrument variable of P_{ipjt}. The value of σ is assigned in reference to Broda and Weinstein (2006). And since the regression is conducted for each product type respectively, it naturally controls the product attributes. Then the quality for each firm-product-destination-year observation can be estimated as the residual from the above regression with the value of σ as: $quality_{ipjt} = \frac{\widehat{\varepsilon_{ipjt}}}{(\sigma-1)} = \frac{Q_{ipjt}-\widehat{Q_{ipjt}}}{(\sigma-1)}$.

To make it comparable across different product types, we make a standardization of the measure as $\overline{quality_{ipjt}} = \frac{quality_{ipjt} - \min quality_{ipjt}}{\max quality_{ipjt} - \min quality_{ipjt}}$. The quality measure is initially calculated at HS6-destination level, and then aggregated to HS4 level with the export share as the weight.

For robustness, we also employ the second method, i.e. the relative price measure. We develop a benchmark measure as the log difference between the price of a specific product of a firm and the median price of this product type, $quality_{ipt}^{benchmark} = \log \frac{P_{ipt}}{\overline{P_{pt}}}$, where $quality_{ipt}^{benchmark}$ is the relative price of product p produced by firm i in year t, and $\overline{P_{pt}}$ is the median price of product p in year t. Therefore, the benchmark measure captures how far the prices of the products produced by firm i are from the median price level within their product type in year t. To be more specific, if the price of a product is highly above the median price of its type, then $quality_{ipt}^{benchmark}$ is positive and large. On the contrary, if the price of a product is far below the median price of the product type, then $quality_{ipt}^{benchmark}$ is negative and small. The benchmark quality measure is initially calculated at the HS6 level, and then aggregated to the HS4 level weighted by the export share.

The empirical results using the two quality measures are reported in columns (2)–(3) of Table 9, respectively. The key coefficient of *Stay*$\times$ *Post* is significantly positive in both columns, which confirms our prediction that the stay group has improved their quality compared to the exit group.

6.3. The effect of competing strategies

As discussed in the former section, the quality and price of the stay group are higher, but the export sales of the exit group grow faster. In the regressions, the decision between stay and exit is an independent variable ("X"), but it is also an endogenous variable to be determined ("Y") from the firm's perspective. It entails extending the causality chain further to discuss how the stay-exit decision is made in relation to the competing strategy of the firm. We borrow the definition of competing strategies from Eckel et al. (2015) and adapt their definition to our setting.

According to Eckel et al. (2015), there are two possibilities. If a firm's profile of prices across products is inversely correlated with its profile of sales, it is classified as a price-competing strategy, or as a quantity-competing strategy. If the profile of prices across a firm's products is positively correlated with its profile of sales, it is classified as a quality-competing strategy. More specifically, when products of lower prices get higher sales, it means that products of lower prices are more competent, and this case is referred to as price-based competence. By contrast, when products of higher prices gain higher sales, it means that products of higher prices are more competent. Since products of higher prices usually correspond to higher quality, this case is referred to as quality-based competence.

We assess the competing strategy of each firm-product at the HS4 level by the following procedure. First, we drill down to the information of a higher level of disaggregation (HS6), and then we estimate equation (4) for every firm-product:

$$Rank_{ht}^{quantity} = \rho_0 + \rho_1 Rank_{ht}^{price} + \varepsilon_{ht} \tag{4}$$

where h indexes the HS6 code, $Rank^{price}$ denotes the rank of each HS6 code under the same HS4 code in descending order of price, $Rank^{quantity}$ denotes the rank of quantity of each HS6 code under the same HS4 code in descending order of quantity. If the coefficient ρ_1 is significantly bigger than 0, it means the quantity and the price change in the same direction, thus we define the firm-product as a quality-competing one, since a higher price gets a higher quantity. On the contrary, if it is significantly smaller than 0, it belongs to the pricing/quantity competing strategy, as a lower price gets a higher quantity. Since we can only get one rank if there is only one HS6 product under the HS4 level, we exclude these observations.

Then we explore how the competing strategies affect the choice between staying and exiting. We only include observations in the TBT imposition year, namely the year before staying and exiting choice to make up a cross-sectional sample. The empirical regression is as equation (5) shows:

$$Stay_{ipt} = \delta_0 + \delta_1 QualityStrategy_{ipt} + \delta_2 Controls_{ipt-1} + \omega_t + \sigma_p + \varepsilon_{ipt} \tag{5}$$

where $Stay_{ipt}$ is equal to 1 if the firm-product chooses to stay in the market, and 0 if the firm-product chooses to exit the market in $t+1$. *QualityStrategy* stands for the firm-product competing strategy, if the firm-product is classified as quality-competing, then $QualityStrategy = 1$; if the firm-product is classified as price-competing, then $QualityStrategy = 0$. We add the number of the firm-product's destinations in log form and the size of the firm proxied by the export sales in log form as control variables. Since the stay and exit choices are made in the next year after TBTs, using the control variable in the TBT imposition year is equal to lagging the control variable for one year, which helps mitigate the endogeneity concerns. Meanwhile, we include the year fixed effects ω_t and product fixed effects σ_p.

Table 10 presents the results. Our core variable *QualityStrategy* is significantly positive in each column, which confirms our intuition that the quality competing firm-product are more likely to stick to the US market and the price competing firm-product are more likely to exit the US market. The results are also in line with the theoretical reasoning that

Table 10
The effect of competing strategies on the stay/exit decisions.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Strategy	0.157***	0.124***	0.111***	0.111***	0.102***	0.068***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Des					0.119***	0.031***
					(0.003)	(0.004)
Size						0.069***
						(0.002)
Constant	0.510***	0.673***	0.370***	0.675***	0.398***	−0.411***
	(0.004)	(0.133)	(0.072)	(0.131)	(0.127)	(0.124)
Year FE	NO	YES	NO	YES	YES	YES
Product FE	NO	NO	YES	YES	YES	YES
N	18550	18550	18550	18550	18550	18550
adj. R^2	0.014	0.072	0.108	0.108	0.162	0.224

Notes: Standard errors in parentheses are two-way clustered at the product level. ***, **, * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

a firm's exit may be associated with the subjective strategies of a firm rather than productivity solely.

7. Conclusions

TBTs have been a major disruptive factor for many exporters in recent years. When a stringent TBT measure is imposed, an exporter is faced with the dilemma of "to be or not to be". Theoretically, we make an integration of two strands of literature with contrasting views on exporters' exit behavior in response to trade shocks and summarize that firms may either be unable or unwilling to exit an export market. Further, based on Chinese Customs Data and WTO's TBT-IMS database, we utilize the PSM-DID method to empirically investigate the difference of subsequent export performance between exiting and staying Chinese firms following the imposition of stringent TBT in the US. Our empirical result mainly reveals that at the firm-product level, the exit group achieves a comparatively higher growth rate than the stay group, which runs counter to the conventional view that "quitters never win". The mechanism why even quitters can win is that exiters effectively switch export markets and reorient their exports towards other destinations, which can compensate for the loss in the US market. Nevertheless, the stay group enjoys a higher price and quality than the exit group. To sum up, our findings showcase two effective development modes for exporters when confronting a tough TBT shock in an export destination. One is to stay in the TBT-imposing market and focus on upgrading product quality, while the other is to exit the market and explore new markets or exploit old markets, competing on the export scale.

Our findings have important practical implications. First, by revealing the importance of firms' flexible destination adjustment in response to tough trade shocks, our findings provide a practical insight for exporters to survive restrictive TBT shocks. When exporters find it unbearable or unworthy to pay a high compliance cost, quitting the TBT-imposing country and searching for other markets can be a strategic and wise decision. Just as Alexander Graham Bell says, "when one door closes, another door opens". As long as an exporter does not easily despair, and tries hard enough to exploit or explore other markets, there is still a silver lining. This also reveals the importance of export geographic diversification strategy, for a wider scope of export destinations enables exporters to undertake destination adjustment more easily and at a lower cost.

Nevertheless, there might be a concern that other countries may model their product standards on the high criterion of the US in the future, and a strict product standard is to become a worldwide trend, in which case, switching export markets cannot be a practical strategy in the long run. Admittedly, improving product quality is a long-term goal for exporters. But in the short term, if exporters are not well prepared to undertake the quality upgrading, flexibly switching markets, especially to markets with similar product preferences, can serve as a buffer against the TBT shock and allow exporters a breathing spell.

Second, our findings also have significant policy insights for the government. It reveals to policymakers that when designing export promotion policies, a one-size-fits-all policy might not be effective, but rather, the government should provide niche support to exporters with different development modes. For exporters who choose to stick to the TBT-imposing country, the government should offer more financial, technical, and informational support to help them adapt products; while for exporters who choose to exit the TBT-imposing country, the government should offer more support in market information, sales network or e-commerce platform to help them open up more markets and exploit the market potential of other markets. Besides, the government should cultivate exporters' internal potential and endogenous impetus to upgrade product quality and diversify markets, so that exporters are able to take a possible future TBT shock in stride.

There are mainly two limitations of our paper. On the one hand, due to data limitation, we cannot explore how Chinese firms switch their exports of the TBT-affected products from the US market to the domestic market. If the data is available, we can reveal how exporters switch markets not only within the export market portfolio but also between export markets and the domestic market. On the other hand, our paper concentrates on market switching mechanisms, but firms may also switch products. Finding out how firms switch products will also present a more complete picture of exporters' behavior in responding to TBT shocks. We will leave these topics for future research.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix

Table A1
STCs Involved in the Matched Sample

No.	IMS-ID	Raising Year	HS code (s)	Product(s)	Objective(s)
1	128	2005	8528	DTV Tuner	Prevention of deceptive practices and consumer protection
2	140	2006	8415, 8418, 8422, 8450, 8514, 8516, 8539	Certain Consumer Products, Commercial and industrial equipment	Protection of human health or safety; protection of the environment.
3	172	2007	61, 62, 63	Clothing textiles	Protection of human health or safety
4	208	2008	9503	Tricycles, scooters, pedal cars and similar wheeled toys; dolls' carriages; dolls; other toys; reduced-size "scale" recreational models, working or not; puzzles of all kinds	Protection of human health or safety
5	262	2010	8506	Primary cells and primary batteries, electrical; parts thereof	Protection of human health or safety; protection of the environment
6	341	2012	9405	Fluorescent lamps, incandescent lamps	Protection of the environment
7	354	2012	9403	Furniture and parts thereof	Protection of human health or safety

Notes: 'IMS-ID' is the ID number of the STC in the WTO's TBT-IMS Database. 'Raising Year' is the year when the STC is raised. 'HS code' is the product code of the Harmonized System. 'Product' is the targeted product affected by TBT. 'Objective' is the goal a TBT notification aims to achieve. As shown in Table A1, one STC event usually involves one product at the HS4 level except for IMS-ID 140 and IMS-ID 172. IMS-ID 140 involves seven types of products across two industries, while IMS-ID 172 involves three industries. Hence, most products are matched not only within one industry but also within one type of product at the HS4 level.
Source: The WTO's TBT-IMS Database.

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