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Government subsidization and corporate product strategies: evidence from Chinese exporters

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Abstract

Purpose – This study aims to take advantage of exporters' product codes and examine the effects of government subsidization on corporate product strategies by focusing on the dimension of product differentiation.

Design/methodology/approach – This study uses harmonized system (HS) product codes to construct a novel measure of product differentiation among a sample of Chinese exporters during 2000–2012. It uses propensity score matching to construct a comparable sample of control firms for exporters receiving government subsidies, and then a difference-in-differences (DID) analysis is conducted.

Findings – This study finds that product differentiation decreases immediately upon receiving a government subsidy. This finding suggests that in an emerging market, firms use their subsidy to imitate competitors rather than increase innovation. Further analyses show that this effect is concentrated among wholly foreign-owned enterprises and firms that focus on general trade rather than processing trade. In addition, the authors find some evidence that government subsidization leads to an increase in the number of product lines and decreases in domestic value added and export product quality.

Originality/value – This study constructs a novel measure of product differentiation for a large sample of Chinese exporters and provides insights that government subsidization can affect corporate product strategies.

Keywords Government subsidy, Product differentiation, Product strategy, Product market competition

Paper type Research paper

1. Introduction

China's rapid growth in international trade has spurred great interest in its supporting policies. China and other developing countries rely heavily on subsidies to promote exports (e.g. Haley & Haley, 2008; Defever & Riaño, 2017). After China joined the World Trade Organization in 2001, its subsidy policy became a sensitive and controversial issue (Hwang & Mai, 2007; Bown & Hillman, 2019). A large body of literature on this issue focuses on the quantitative aspect of international trade (i.e. export volume) (e.g. Hoffmaister, 1992; Chen, Mai, & Yu, 2006; Eckaus, 2006; Görg, Henry, & Strobl, 2008; Girma, Gong, Görg, & Yu, 2009). In particular, Girma *et al.* (2009) document that China's subsidies encourage existing exporters to export more (intensive margin) but do not effectively encourage nonexporters to start exporting (extensive margin). However, to the best of our knowledge, much less

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literature on government subsidies delves into the qualitative aspect of international trade, such as export product structure and product quality. Our study adds to the literature by investigating the effects of government subsidization on exporters' product strategies, specifically the dimension of product differentiation [1].

The effects of government subsidization on exporters' product strategies depend on how these subsidized exporters leverage governmental financial supports. On the one hand, firms may invest more in research and development (R&D) to promote product innovation, which in turn enables them to better differentiate their products from those of competitors. Product differentiation is an important strategy for firms to maintain sustainable competitive advantage (e.g. Smith, 1956; Murray, Kotabe, & Zhou, 2005; Cho & Tsang, 2020). On the other hand, with the help of government support, firms may invest more in mature product lines to imitate their competitors and follow the market trends, which decreases product differentiation. However, this strategy would inevitably increase product market competition unless the market demand exceeds the total supply. A large body of literature examines the effectiveness of government subsidies in promoting industrial innovation, but the empirical evidence is inconclusive (Dimos & Pugh, 2016). One major reason might be that firms are heterogeneous and thus they may have different preferences in investment and product strategies. In addition, firm managers need to allocate scarce resources efficiently and choose the most suitable strategy (Sorenson, 2000). For example, some may prioritize R&D investments, which are risky and uncertain but also can generate competitive advantages. Others may invest in mature product lines, which are less risky but result in higher level of competition. Therefore, it is *ex ante* unclear how government subsidies affect exporters' choice of competition mode and the degree of their product differentiation [2].

To empirically examine the impact of government subsidies on exporters' competition strategy, we must address two main challenges. First, a firm's choice of competition strategy is unobservable and difficult to measure though it can be inferred from the degree of product differentiation (e.g. Smith, 1956; Dickson & Ginter, 1987; Mukherjee, 2014; Hoberg & Phillips, 2016). Using transaction-level international trade data of China exporters, we construct a novel measure of product differentiation to capture the extent to which an exporter's product space differs from that of its competitors. Second, government subsidies are not randomly assigned; hence, it is challenging to make causal inferences. To address this concern, we use propensity score matching to identify a group of control firms with comparable firm-level characteristics. Based on this matched sample, we then conduct a difference-in-differences (DID) analysis to establish causality between government subsidization and exporters' product differentiation.

The DID analysis of a large sample of Chinese exporters during 2000–2012 shows that, compared with exporters that do not receive any subsidies, subsidized exporters experience significant decreases in product differentiation in the postsubsidy period. This finding suggests that government subsidization increases the use of imitation, rather than innovation, as a competitive strategy. As previously argued, firms still face fierce competition, but government subsidies and cheap labor costs allow exporters in China to compete via low prices (Haley & Haley, 2008). Our finding also aligns with prior studies demonstrating China's quantity-driven export growth (e.g. Shi, 2011). Further analyses reveal significant heterogeneous effects of government subsidies. Specifically, we find that the effect of government subsidies on exporters' product differentiation is concentrated in foreign-owned enterprises and firms focused on general, rather than processing, trade.

To provide more insights, we also examine other potential consequences of government subsidies. As our main finding suggests that exporters in China tend to invest in mature product lines instead of R&D, we expect recipients of a government subsidy to increase the number of products manufactured and to decrease product quality. Consistent with our expectation, we find some evidence that government subsidization leads to a larger number of export products and a lower level of domestic value added and export product quality.

Taken together, our study provides novel insights that government subsidization can affect exporters' choice of competition strategy. In particular, our findings suggest that government subsidies in China lead exporters to engage in price-based competition, which in turn decreases product differentiation and quality.

Our paper makes two key contributions to the literature. First, we introduce a novel measure of product differentiation that is available for a large sample of exporters in China. Prior literature measures product differentiation by classifying export products into homogeneous and heterogeneous categories (e.g. Rauch, 1999; Hu & Tan, 2016) or using survey data (e.g. Boehe & Barin Cruz, 2010). Recently, Hoberg and Phillips (2016) use textual analysis to collect product names disclosed in financial reports, but this approach offers limited accuracy. By using harmonized system (HS) codes, we can accurately identify the product space of each exporter. As such, our measures should be useful for future studies on China's role in international economics.

Second, our study adds to the literature by providing evidence on the effects of government subsidies on exporters' mode of competition, product differentiation and product quality. Prior literature on the intersection of government subsidization and international trade mainly focus on quantity (e.g. Hoffmaister, 1992; Eckaus, 2006; Görg *et al.*, 2008; Girma *et al.*, 2009). Our paper complements this literature by investigating the impact of subsidization on product differentiation and export quality. Our paper also enriches the literature on corporate product strategy (e.g. Smith, 1956; Cooper & Kleinschmidt, 1985) and firms' response to product market competition (e.g. Mayer, Melitz, & Ottaviano, 2014; Ryou, Tsang, & Wang, 2022). Our findings should be of interest to policymakers, especially those in developing countries.

The rest of this paper is organized as follows. Section 2 describes the empirical methodology, including data sources, sample selection, variables and DID model. Section 3 introduces the propensity score matching procedure and presents our main empirical results. In section 4, we explore the heterogeneous effects of government subsidization. We examine other potential outcomes of government subsidization in section 5 and conclude in section 6.

2. Empirical methodology

2.1 Data sources

Our study uses export and financial data from Chinese exporters. To measure exporters' product differentiation, we rely on detailed export data compiled by the General Administration of Customs of the People's Republic of China. The export data covers 2000 to 2012 and provides detailed information on each trade, including exporter name, nature (e.g. general trade and processing trade), eight-digit HS code of exported product, volume and value. To construct government subsidization and other control variables, we extract financial data from the Chinese industrial enterprises database maintained by the National Bureau of Statistics of China. The bureau conducts an annual survey of all state-owned enterprises, regardless of firm size, and of large non-state-owned enterprises with an output value of 5 million or more Chinese Yuan. These surveyed firms account for 98% of total exports from China (Brandt, Van Biesebroeck, & Zhang, 2012). Because the survey data cover a longer period than the export data, we limit our sample to the 13 years in which they overlap, yielding a final sample that covers 2000 to 2012. The export and survey databases use different firm identifiers, so we cannot directly merge the financial data with the export data. However, we can reliably match firms in both databases using information such as firm name, name of legal representative and executives, postal code and telephone number.

2.2 Product differentiation

As previously mentioned, we rely on export data to measure product differentiation. To construct the measure, we analyze the whole dataset at the firm-year-product level, where a product is identified by its unique eight-digit HS code [3]. To limit our focus to major products only, we exclude products that contribute to less than 1% of the company's annual export value [4]. This exclusion leaves over ten million firm-year-product observations across our sample period of 13 years, covering 489,183 unique exporters and 9,538 unique products.

Following Hoberg and Phillips (2016), we calculate the product cosine similarity for each pair of exporters year by year. As the first step, we use the following vector with N dimensions to represent the product space of a given firm i:

$$P_i = (p_{i1}, p_{i2}, p_{i3}, \ldots, p_{ik}, \ldots, p_{iN}) \tag{1}$$

In vector P_i, the element p_{ik} is defined as the ratio of export value of product k to the total export value of firm i's major products. That is, p_{ik} equals 0 if firm i does not export product k. In this way, we weight each product according to its contribution to firm i's annual export value. N refers to the total number of unique products exported by all Chinese firms in a given year. In our sample, N is 6,041 in 2000 and 7,168 in 2012. We then normalize the vector P_i to have unit length as follows:

$$V_i = \frac{P_i}{\sqrt{P_i \cdot P_i}} \tag{2}$$

We repeat this procedures for any other firm j in the same year to obtain its normalized vector V_j. The product cosine similarity between firm i and firm j in each year is calculated as follows:

$$Similarity_{ij} = (V_i \cdot V_j) \tag{3}$$

Because both vectors V_i and V_j are normalized to have unit length, the above similarity score can be any real number bounded by 0 and 1. Intuitively, the similarity score increases when both firms export more of the same products. The weight also matters, as we weight each product according to its export value. For example, the similarity score equals 1 for a pair of firms exporting the same set of products with the same weights. Suppose there are two firms, both export products A and B but one firm primarily exports product A and the other primarily exports product B. In this case, the similarity score is positive but close to 0 even though both firms share the same scope of products. Accordingly, the similarity score also would be 0 for a pair of firms that do not share any common products.

Next, we aggregate firms' pairwise similarity scores to the firm-year level as our measure of product differentiation. Following Hombert and Matray (2018), we calculate the pairwise product differentiation as 1 minus the pairwise similarity score:

$$Differentiation_{ij} = 1 - (V_i \cdot V_j) \tag{4}$$

Likewise, the pairwise product differentiation can take any value between 0 and 1. In each year, we take the average of pairwise product differentiation among the firm's competitors as our firm-year measure of product differentiation:

$$PDIFF_i = \frac{1}{C_i}\sum_{j=1}^{C_i}(1 - (V_i \cdot V_j)) = 1 - \frac{1}{C_i}\sum_{j=1}^{C_i}(V_i \cdot V_j) \tag{5}$$

In Equation (5), C_i is the number of competitors for firm i in a specific year. Instead of using the traditional approach based on industry classification, we take advantage of the export product network to identify firm i's competitors. Specifically, firm i and firm j are deemed competitors if $\left(V_i \cdot V_j\right) > 0$. The rationale for this identification is that firms sharing at least one common product compete to some extent.

During our sample period, direct sales from manufacturing firms contribute to about 80% of Chinese exports. Traders, which purchase products from domestic suppliers to resell overseas, contribute to about 20% of total exports [5]. We follow Ahn, Khandelwal and Wei's (2011)approach to identify trading companies as those whose translated Chinese names include the words "trading," "importer" or "exporter." Accordingly, we construct two measures of product differentiation: *PDIFF1* is based on exports of both manufacturing firms and trading companies and *PDIFF2* is based on exports made by manufacturers only.

2.3 Government subsidization

Government subsidy data are available from the Chinese industrial enterprises database. To ensure that the subsidy received by the exporter is substantial for its operation, we select treatment firms based on two conditions: 1) the firm's annual subsidy exceeds 500,000 RMB or 2) its subsidy ratio (*SUBRATIO*), calculated as subsidy amount divided by annual sales, exceeds 1% and the amount exceeds 100,000 RMB [6]. Throughout our sample period, some treatment firms may receive multiple subsidies. Our main DID analysis focuses on treatment firms receiving their first subsidy. To implement a DID analysis, we create an indicator of treatment firms (*TREAT*), which takes a value of 1 for treatment firms and 0 for control firms. Control firms are those that never receive a subsidy during our sample period. As detailed in section 3.1, we use propensity score matching to identify a control firm for each treatment firm. For each pair of matched firms, we include in our regression sample six-year observations from $t-3$ to $t+2$ (i.e. three years before and after receiving a government subsidy in year t). The dummy variable *POST* equals 1 in the postsubsidy period (from year t to $t+2$) and 0 otherwise.

2.4 Model specification

To examine the effects of government subsidization on product differentiation, we estimate the following DID model:

$$PDIFF_{i,t} = \alpha_i + \mu_t + \beta_1 TREAT_{i,t} \times POST_{i,t} + \beta_2 POST_{i,t} + \gamma X_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

In this model, the dependent variable is one of our product differentiation measures, as constructed in section 2.2. The subscripts i and t represent firm and year, respectively. The regression includes firm fixed effects, α_i, which captures the time-invariant characteristics of each sample firm [7]. We also include year fixed effects (μ_t) to account for time-variant macroeconomic factors. Our focus is the coefficient on the interaction term between the treatment dummy ($TREAT_{i,t}$) and postsubsidy dummy ($POST_{i,t}$) defined in section 2.3. A significantly positive (negative) β_1 would suggest that exporters increase (decrease) their product differentiation after receiving a government subsidy.

In Equation (6), we also control for a series of firm-level control variables ($X_{i,t-1}$). Specifically, we control for the firm's total factor productivity (*TFP*), estimated using Olley and Pakes' (1996) methodology; firm size (*SIZE*), defined as the natural logarithm of total assets; return on assets (*ROA*), calculated as net income scaled by lagged total assets; financial leverage (*LEV*), calculated as total liability divided by total assets; and firm age (*AGE*), the log of 1 plus the number of years since establishment. We also control for product diversity, captured by the number of export products (*NP*) because as firms increase their product diversity, it becomes more difficult to differentiate their products from those of their competitors. All control variables are lagged by one year. Continuous variables in our regression model are winsorized at the 1st and 99th percentiles, and standard errors are clustered at firm level [8].

3. Propensity score matching and DID results

3.1 Propensity score matching

In our DID specification, we compare subsidized exporters' actual level of product differentiation with the counterfactual level if they did not receive a government subsidy. The main challenge is that the counterfactual level of product differentiation is unobservable. Following prior literature (e.g. Rosenbaum & Rubin, 1985; Heckman, Ichimura, & Todd, 1998; Dehejia & Wahba, 2002; Shipman, Swanquist, & Whited, 2017; Yang, He, Zhu, & Li, 2018; Brucal, Javorcik, & Love, 2019), we use propensity score matching to identify a reasonable counterfactual for each subsidized exporter [9]. Specifically, we use the following probit model to estimate the propensity score:

$$TREAT_{i,t} = \beta_0 + \beta_1 \Delta PDIFF2_{i,t-123} + \gamma X_{i,t-123} + Ownership\ F.E. + Province\ F.E. + Industry\ F.E. + Year F.E. + \varepsilon \quad (7)$$

In Equation (7), we use the average value of each independent variable in the past three years (i.e. from year $t-3$ to $t-1$) to predict whether a firm will receive a government subsidy in year t. The dependent variable is the treatment dummy, which equals 1 for firms receiving subsidy and 0 otherwise. In the prediction model, we include all firm-level control variables, as defined in Equation (6), as well as ownership fixed effects, province fixed effects, industry fixed effects and year fixed effects. In addition, we also control for the average change of product differentiation in the past three years to enhance the parallel trend of our outcome variable in the pre-subsidy period [10].

We run this prediction model on a sample consisting of both treatment firms and potential control firms. Treatment firms receive substantial government subsidization, and control firms never receive any subsidy during our sample period. To calculate the average value of each variable, we drop observations with missing variables in the previous three years. We keep all available observations of each potential control firm to increase the chance of successful matching, but we keep only the year t observation of each treatment firm (i.e. the year in which the firm receives subsidy). As we already take the average of each variable from year $t-3$ to $t-1$, this treatment observation captures characteristics of the treatment firm before receiving subsidization. In short, we intend to find a control firm for each treatment firm based on firm characteristics in the presubsidy period. For the prediction model, the final sample comprises 68,132 firm-year observations, including 54,738 observations of control firms ($TREAT = 0$) and 13,394 observations of treatment firms ($TREAT = 1$).

Table 1 presents the implementation of propensity score matching. In Column (1) of Panel A, we present the results of predicting government subsidization. Consistent with our intuition, the Chinese government is more likely to subsidize larger firms and firms with poor performance. Based on the estimation in Column (1), we can derive each observation's propensity score (i.e. the likelihood of receiving a subsidy). We then do a one-by-one match without replacement. Specifically, for each treatment firm, we try to find a control firm with a close propensity score within the same ownership type, location province, industry and year. To ensure similarity between matched firm pairs, we further require the difference between their propensity scores to be less than 10%. We successfully match 2,615 pairs of firms, which we use for our main analyses [11].

To check the matching performance, we rerun the prediction model on the matched sample. As shown in Column (2) of Panel A, the pseudo R^2 is nearly 0, and the p-value of the Wald χ^2 test is 1, suggesting that our matching procedure significantly reduces the prediction power of firm-level characteristics. In Panel B, we compare the sample means of the variables used in our matching procedure between the treatment group and the control

Dep. var. =	(1) before matching *TREAT*	(2) after matching *TREAT*
Panel A: estimation of propensity scores		
TFP	0.0052 (0.51)	−0.0037 (−0.13)
SIZE	0.5404*** (54.17)	−0.0026 (−0.14)
ROA	−0.1021** (−2.43)	0.1457* (1.78)
LEV	0.1852*** (11.79)	−0.0770*** (−2.64)
AGE	−0.0768*** (−4.24)	0.1518*** (4.34)
NP	0.0912*** (6.46)	0.0020 (0.07)
Δ*PDIFF2*	−0.1586* (−1.67)	0.0450 (0.20)
Ownership fixed effects	Yes	Yes
Province fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
N	68,132	5,230
Pseudo R^2	0.3590	0.0045
p-value of Wald χ^2 test	0.0000	1.0000

Variable	Before matching Control group N = 54,738	Before matching Treatment group N = 13,394	Before matching Difference in mean	After matching Control group N = 2,615	After matching Treatment group N = 2,615	After matching Difference in mean
Panel B: checking matching performance						
TFP	2.7139	1.7683	0.9456***	1.8667	1.8510	0.0157
SIZE	9.8873	11.3560	−1.4686***	10.4743	10.4958	−0.0215
ROA	0.1481	0.1238	0.0243***	0.1324	0.1362	−0.0038
LEV	0.5899	0.7387	−0.1488***	0.7690	0.7125	0.0565**
AGE	2.0234	2.1011	−0.0777***	1.9949	2.0621	−0.0672***
NP	0.9818	1.0026	−0.0208**	1.0364	1.0377	−0.0013
Δ*PDIFF2*	−0.0012	−0.0034	0.0022**	−0.0035	−0.0030	−0.0005
Propensity Score	0.1215	0.5046	−0.3831***	0.2958	0.2937	0.0021

Note(s): This table presents our propensity score matching. Panel A uses a probit model to estimate propensity scores, and Panel B checks the performance of our matching procedure. We do a one-by-one match without replacement. Specifically, for each treatment firm, we try to find the control firm with the closest propensity score within the same ownership type, location province, industry and year. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively

Table 1. Propensity score matching

group. Though we observe significant differences between treatment and control groups before matching, most of these differences disappear after matching. We also find that the overall propensity scores of matched control firms are essentially the same as that of matched treatment firms, although these control firms are slightly younger and have significantly higher financial leverage. Taken together, our propensity score matching performs reasonably well in identifying control firms. Treatment and control firms in our matched sample are comparable in terms of firm characteristics in the presubsidy period.

Based on these matched pairs of firms, we construct a panel sample to conduct our main DID test. For these matched firms, we include in our regression sample six-year observations from $t-3$ to $t+2$ (i.e. three years before and three years after receiving a government subsidy in year t). After dropping observations with missing regression variables, we drop matched firm pairs in which a treatment or control firm does not have any available observations in either the pre- or post-subsidy period. Our matched final sample comprises 17,218 firm-year observations. Table 2 presents the descriptive statistics for this matched sample. Our two

Table 2.
Descriptive statistics of matched sample (N = 17,218)

	Mean	SD	P25	Median	P75
PDIFF1	0.5183	0.1470	0.4310	0.5359	0.6264
PDIFF2	0.4469	0.1596	0.3468	0.4632	0.5645
TREAT	0.4971	0.5000	0.0000	0.0000	1.0000
POST	0.5378	0.4986	0.0000	1.0000	1.0000
TFP	2.4781	1.8302	0.0000	3.1787	3.9972
SIZE	10.5680	1.1268	9.7848	10.5101	11.2583
ROA	0.1230	0.1785	0.0212	0.0611	0.1467
LEV	0.5486	0.2563	0.3600	0.5564	0.7434
AGE	2.1195	0.5651	1.7918	2.1972	2.4849
NP	1.0587	0.7571	0.6931	1.0986	1.6094

Note(s): This table presents the descriptive statistics of the regression variables in our matched sample. We present the mean, standard deviation (SD), 25th percentile (P25), median and 75th percentile (P75) of each regression variable. All continuous variables are winsorized at the 1st and 99th percentiles

measures of product differentiation, *PDIFF1* and *PDIFF2*, have mean values of 0.5183 and 0.4469, respectively. Because this is a matched sample, the treatment dummy (*TREAT*) and postsubsidy dummy (*POST*) both have means close to 50%.

3.2 DID results

To examine the effect of government subsidy on exporters' product differentiation, we estimate the DID model specified in Equation (6) on the matched final sample of 17,218 firm-year observations. Table 3 presents the DID results. In Columns (1) and (3), we focus on *PDIFF1*, a measure of product differentiation based on the combined product space of two types of exporters (i.e. manufacturing firms and trading companies). In Columns (2) and (4), we focus on *PDIFF2*, an alternative measure of product differentiation constructed solely on the product space of manufacturing exporters. We start our analyses with a simplified DID model in which we do not control for firm-level control variables. As shown in the first two columns, we find significantly negative coefficients on the interaction terms of $TREAT \times POST$. After controlling for a series of firm-level characteristics, we continue to find similar results in the last two columns. For instance, in Column (4), the coefficient on $TREAT \times POST$ is -0.0091 and significant at the 5% level (t-value = -2.57) [12]. These results show that, compared with that of control firms, treatment firms' product differentiation decreases after receiving government subsidies. This finding suggests that Chinese exporters tend to leverage governmental financial supports to invest in mature product lines to imitate their competitors and follow the market trends, instead of investing in innovation projects. This finding is consistent with prior literature documenting that Chinese exporters tend to compete via low prices (Haley & Haley, 2008) and government subsidies induce firms' overinvestment behavior (Zhang, An, & Zhong, 2019).

In terms of control variables, most are insignificant, which is expected because our analyses are based on matched samples. In the last two columns, we find that larger firm size (*SIZE*) is associated with lower product differentiation, perhaps because larger firms face more competition and hence may find it harder to differentiate their products from competitors. We also find that product diversity (*NP*) is negatively associated with product differentiation, which is consistent with our expectation that increased product diversity makes it harder for firms to differentiate their products from those of their competitors.

An effective DID model requires treatment and control groups to maintain similar trends in the preevent period. We check this parallel trend assumption and examine the dynamic effects of government subsidization in Table 4. We replace the dummy of *POST* in

Table 3. Main results

Dep. var. =	(1) PDIFF1	(2) PDIFF2	(3) PDIFF1	(4) PDIFF2
TREAT × *POST*	−0.0090*** (−2.76)	−0.0100*** (−2.74)	−0.0082*** (−2.58)	−0.0091** (−2.57)
POST	0.0006 (0.23)	0.0007 (0.24)	0.0018 (0.67)	0.0020 (0.65)
TFP			0.0003 (0.21)	0.0006 (0.37)
SIZE			−0.0063*** (−3.09)	−0.0061*** (−2.66)
ROA			−0.0063 (−1.07)	−0.0050 (−0.77)
LEV			0.0041 (0.80)	0.0033 (0.57)
AGE			−0.0038 (−0.89)	−0.0036 (−0.77)
NP			−0.0239*** (−10.06)	−0.0269*** (−10.12)
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	17,218	17,218	17,218	17,218
Adjusted R^2	0.709	0.689	0.713	0.693

Note(s): This table presents our main results by estimating the baseline DID model on the matched sample. The dependent variables are one of our measures of product differentiation. The dummy variable *TREAT* takes a value of 1 for treatment firms and 0 for control firms. The dummy variable *POST* equals 1 in the postsubsidy period (from year t to $t+2$) and 0 otherwise. All continuous variables are winsorized at the 1st and 99th percentiles. The model includes firm and year fixed effects. Presented in the parentheses below each coefficient is the t-value based on standard errors clustered by firm. Constant terms are estimated but omitted for presentation. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively

Dep. var. =	(1) PDIFF1	(2) PDIFF2	(3) PDIFF1	(4) PDIFF2
TREAT × *Period(−2)*	−0.0019 (−0.43)	−0.0011 (−0.21)	−0.0034 (−0.74)	−0.0026 (−0.52)
TREAT × *Period(−1)*	−0.0067 (−1.31)	−0.0057 (−1.00)	−0.0073 (−1.43)	−0.0064 (−1.13)
TREAT × *Period(0)*	−0.0095* (−1.84)	−0.0091 (−1.59)	−0.0100** (−1.99)	−0.0098* (−1.73)
TREAT × *Period(1)*	−0.0131** (−2.16)	−0.0124* (−1.84)	−0.0128** (−2.15)	−0.0122* (−1.84)
TREAT × *Period(2)*	−0.0172*** (−2.59)	−0.0190** (−2.57)	−0.0161** (−2.49)	−0.0178** (−2.48)
Firm-level controls	No	No	Yes	Yes
Period indicators	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	17,218	17,218	17,218	17,218
Adjusted R^2	0.709	0.689	0.713	0.694

Note(s): This table tests the parallel trend assumption and dynamic effects of government subsidy. The dependent variables represent one of our measures of product differentiation. The dummy variable *TREAT* equals 1 for treatment firms and 0 for control firms. The period indicator *Period(x)* equals 1 in year $t + x$ and 0 otherwise, where year t is the year of receiving a government subsidy. The model includes firm and year fixed effects and firm-level control variables. All continuous variables are winsorized at the 1st and 99th percentiles. Presented in the parentheses below each coefficient is the t-value based on standard errors clustered by firm. Constant terms are estimated but omitted for presentation. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively

Table 4.
Parallel trend and dynamic effects

Equation (6) with a series of relative period dummies. In our matched sample, we focus on an event window covering three years before and after the treatment firms receive a subsidy. We use year $t-3$ as the benchmark period and include five period indicators from $t-2$ to $t+2$ and their interaction terms with the treatment dummy (*TREAT*). Insignificant coefficients on *TREAT* × *Period(−2)* and *TREAT* × *Period(−1)* suggest that treatment and control firms maintain similar trends in product differentiation in the pre-subsidy period. Indeed, we find that these coefficients are statistically insignificant across four columns: whereas the first two columns do not control for firm-level characteristics, the last two columns do. These results validate the parallel trend assumption of our main DID model, and validation tests hold for both measures of product differentiation. Therefore, our main DID results are less likely to be driven by the violation of the parallel trend assumption.

As for the dynamic effects of government subsidization, we find that product differentiation of treatment firms starts to decline in the same year they receive a subsidy, as evidenced by significantly negative coefficients on *TREAT* × *Period(0)*. More importantly, we also find that the coefficients on *TREAT* × *Period(1)* and *TREAT* × *Period(2)* are significantly negative, suggesting that the negative effect of government subsidization on product differentiation lasts for three years or longer. In addition, we observe an increasing trend in coefficient magnitudes from year t to $t+2$ (e.g. in Column (4), the coefficients of *TREAT* × *Period(0)*, *TREAT* × *Period(1),* and *TREAT* × *Period(2)* are −0.0098, −0.0122 and −0.0178, respectively. Taken together, these results highlight the importance of considering the long-term effects of government subsidization.

3.3 Robustness checks

In Table 5, we conduct a series of robustness checks for our main results. In our main DID analyses, we focus on treatment firms receiving a substantial government subsidy (i.e. the subsidy exceeds 500,000 RMB, or the subsidy exceeds 100,000 RMB and exceeds 1% of the firm's annual sales). One might argue that this selection criterion is somewhat arbitrary. To address this issue, we first use various alternative cut-offs to identify a treatment sample of

Table 5. Robustness checks

Threshold	$T = 0.50$		$T = 1.00$		$T = 2.00$	
Dep. var. =	PDIFF1 (1)	PDIFF2 (2)	PDIFF1 (3)	PDIFF2 (4)	PDIFF1 (5)	PDIFF2 (6)
Panel A: requiring the government subsidy amount to exceed T% of annual sales and exceed 100,000 RMB						
TREAT × *POST*	−0.0097*** (−2.68)	−0.0108*** (−2.68)	−0.0133*** (−3.09)	−0.0155*** (−3.23)	−0.0169*** (−2.76)	−0.0193*** (−2.81)
POST	0.0027 (0.87)	0.0022 (0.64)	0.0008 (0.21)	0.0011 (0.26)	0.0009 (0.17)	0.0024 (0.40)
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	13,036	13,036	8,456	8,456	4,345	4,345
Adjusted R^2	0.710	0.691	0.728	0.711	0.734	0.717

Threshold	$T = 300$		$T = 500$		$T = 1,000$	
Dep. var. =	PDIFF1 (1)	PDIFF2 (2)	PDIFF1 (3)	PDIFF2 (4)	PDIFF1 (5)	PDIFF2 (6)
Panel B: requiring the amount of government subsidy to exceed T thousand RMB						
TREAT × *POST*	−0.0084** (−2.55)	−0.0092** (−2.49)	−0.0077* (−1.80)	−0.0084* (−1.76)	−0.0122** (−2.11)	−0.0126* (−1.93)
POST	0.0017 (0.61)	0.0018 (0.57)	0.0001 (0.02)	0.0006 (0.14)	0.0005 (0.10)	0.0002 (0.03)
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	15,953	15,953	9,921	9,921	5,144	5,144
Adjusted R^2	0.712	0.691	0.714	0.692	0.724	0.702

Dep. var. =	PDIFF1 (1)	PDIFF2 (2)	PDIFF1 (3)	PDIFF2 (4)
Panel C: matching all government subsidies regardless of the amount				
SUBRATIO × *POST*	−0.1779** (−2.45)	−0.1970** (−2.40)	−0.1773** (−2.49)	−0.1961** (−2.43)
POST	0.0003 (0.23)	−0.0000 (−0.02)	0.0013 (0.95)	0.0011 (0.67)
Firm-level controls	No	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	42,221	42,221	42,221	42,221
Adjusted R^2	0.712	0.694	0.717	0.699

Note(s): This table presents various robustness checks for our main results. In Panels A and B, we use different threshold to select the government subsidy amount and redo the propensity score matching and DID analysis. In Panel C, we match all government subsidies regardless of the amount and replace the treatment dummy (*TREAT*) with the subsidy ratio (*SUBRATIO*), calculated as subsidy amount divided by annual sales. The model includes firm and year fixed effects and firm-level control variables. All continuous variables are winsorized at the 1st and 99th percentiles. Presented in the parentheses below each coefficient is the *t*-value based on standard errors clustered by firm. Constant terms are estimated but omitted for presentation. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively subsidized exporters. In Panel A, we use the subsidy ratio (i.e. subsidy amount divided by annual sales). Specifically, we require the subsidy amount to exceed 100,000 RMB and the subsidy ratio to be larger than 0.5, 1 or 2%. For each cut-off ratio, we identify a sample of government-subsidized firms and implement propensity score matching, as introduced in subsection 3.1, to construct a matched sample. For example, in the first two columns in Panel A, we start with a sample of firms receiving a government subsidy exceeding 0.5% of their annual sales. We then match these companies with exporters receiving no subsidy to get a matched sample of 13,036 firm-year observations during the event window of [$t-3$, $t+2$]. The choice of different cut-offs can dramatically affect our final sample size, yet we continue to find significantly negative coefficients on the interaction terms of $TREAT \times POST$.

In Panel B, we use the subsidy amount to construct alternative testing samples. Specifically, we require the subsidy amount to exceed 300,000, 500,000 or 1,000,000 RMB. The lower amounts result in larger sample sizes, but we get qualitatively similar results across all three alternative samples: compared with control firms, treatment firms' product differentiation decreases after receiving government subsidies. Taken together, the results in Panels A and B show that changing the selection criteria of government subsidization does not change our inferences.

In Panel C, we use an alternative approach to further address the concern of sample selection. Instead of imposing restrictions on the economic magnitude of government subsidization, we include all exporters' with a first-time subsidy events during our sample period. Again, we implement propensity score matching to find matching control firms, yielding 42,221 firm-year observations during the event window [$t-3$, $t+2$]. Because we include all subsidy events regardless of the amount, we use the subsidy ratio (*SUBRATIO*) to capture the economic magnitude of government subsidization and modify Equation (6) as follows:

$$PDIFF_{i,t} = \alpha_i + \mu_t + \beta_1 SUBRATIO_{i,t} \times POST_{i,t} + \beta_2 POST_{i,t} + \gamma X_{i,t-1} + \varepsilon_{i,t} \qquad (8)$$

In Equation (8), *SUBRATIO* is calculated as the subsidy amount divided by the exporter's annual sales. We assign the positive subsidy ratio to all observations in the event window for each treatment exporter that receives any government subsidy. By contrast, observations of control exporters always have a subsidy ratio equal to 0. In this way, the defined variable of *SUBRATIO* not only captures the intensity of government subsidization but also differentiates between treatment and control exporters. A more intensive subsidy should have a stronger impact on exporters' product differentiation. We run Equation (8) on the newly constructed testing sample. Consistent with our expectation, we find significantly negative coefficients on $SUBRATIO \times POST$, suggesting that treatment firms experience larger decreases in product differentiation after receiving a higher subsidy. The results from the alternative model continue to support our main findings. Given that this alternative model specification complements our baseline DID model, we set forth to report both results for our later analyses.

4. Heterogeneous effects of government subsidization

In this section, we investigate the heterogeneous effects of government subsidization. We first focus on the role of equity ownership by exploring if the relation between government subsidization and product differentiation varies across different types of ownership. Then, we compare the effects of government subsidization between general trade exporters and processing trade exporters.

4.1 The role of ownership type

China government provides a lot of financial support to firms in private sector and plays a pivotal role in shaping firm behavior (e.g. Fang, Lerner, Wu, & Zhang, 2018; Gong, Shan, &

Yu, 2022; Pan, Zhang, & Zhang, 2022). Given that government policies (e.g. subsidy and taxation) often vary for firms with different ownership types, firm ownership is an important dimension of firm-level characteristics in China studies (e.g. Hu, 2001; Qian, Gao, & Tsang, 2015; Fang *et al.*, 2018; Han, He, Pan, & Shi, 2018). We therefore explore if the effect of government subsidization is heterogeneous for firms with different ownership.

In terms of ownership, our sample covers four types of exporters: joint ventures of local firms and foreign companies, wholly foreign-owned enterprises, state-owned enterprises and others. These different types of exporters may have different incentives that affect the relation between government subsidization and product differentiation. To explore this conjecture, we divide our sample into four subsamples and rerun the regressions on each subsample. Table 6 presents the results [13]. In Panel A, we divide our baseline sample into four subsamples according to exporters' equity ownership type. Results show that the regression coefficient on *TREAT* × *POST* is significantly negative only for wholly foreign-owned enterprises (Coeff. = −0.0149, *t*-value = −2.70) subsamples. In Panel B, the results from matching all government subsidies, regardless of the amount, show the same pattern. The concentration of depressive effects among wholly foreign-owned exporters suggests that using government subsidies to attract foreign investments may reduce product differentiation.

China has made great efforts to attract foreign capital since its economic reform. During our sample period, which covers China's admittance to the World Trade Organization, several government policies at the central and local levels intend to offer incentives and preferential treatment to foreign investors. While these supporting polices may facilitate long-term innovation and thus promote product differentiation, it is also plausible that firms

Dep. var. = *PDIFF2*	JVs (1)	WFOEs (2)	SOEs (3)	Non-SOEs (4)
Panel A: results based on our baseline sample				
TREAT × *POST*	0.0007 (0.09)	−0.0149*** (−2.70)	−0.0103 (−0.57)	−0.0083 (−1.40)
POST	−0.0039 (−0.62)	0.0067 (1.44)	0.0093 (0.51)	0.0012 (0.22)
Firm-level controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	4,098	6,331	603	6,186
Adjusted R^2	0.695	0.732	0.682	0.644
Panel B: matching all government subsidies regardless of the amount				
SUBRATIO × *POST*	−0.2645 (−1.27)	−0.2054* (−1.87)	0.1015 (0.27)	−0.1399 (−1.00)
POST	0.0070** (2.24)	0.0006 (0.26)	−0.0052 (−0.47)	−0.0021 (−0.70)
Firm-level controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	10,823	17,203	1,185	13,010
Adjusted R^2	0.706	0.730	0.678	0.647

Note(s): This table presents subsample analyses for each type of firm ownership. We divide our matched sample into four subsamples: joint ventures of local firms and foreign companies (JVs), wholly foreign-owned enterprises (WFOEs), state-owned enterprises (SOEs) and others (labeled as Non-SOEs). In Panel A, we present the results based on our baseline sample. In Panel B, we match all government subsidies regardless of the amount and replace the treatment dummy (*TREAT*) with the subsidy ratio (*SUBRATIO*), calculated as the subsidy amount divided by annual sales. The model includes firm and year fixed effects and firm-level control variables. All continuous variables are winsorized at the 1st and 99th percentiles. Presented in the parentheses below each coefficient is the *t*-value based on standard errors clustered by firm. Constant terms are estimated but omitted for presentation. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively

Table 6. Heterogeneous effects: type of firm ownership

benefiting from these policies may expand product lines to exploit short-term profitability, resulting in lower product differentiation. Our main finding supports the latter argument that government subsidization induces homogenous competition among exporters in China because exporters tend to use subsidy funding to expand product lines rather than invest in innovation. Our subsample analyses suggest that this is especially true for wholly foreign-owned enterprises.

Several features of wholly foreign-owned exporters might help explain why the depressive effects of government subsidization on product differentiation concentrate in these exporters. First, parent companies' intention of establishing facilities in China might be building a profit center as appose to an innovation center. These exporters are typically subsidiaries of foreign companies from developed countries where can better nurture innovation. As an emerging country, China's relative advantage is the cheap labor costs, not technology or innovation. Second, because of their foreign background, these exporters gain better understanding of the international market. Better knowing the market enables them to identify and follow the trends. Third, these exporters probably perceive higher uncertainty in operational environment that may discourage long-term investments such as innovation projects. For instance, the perceived uncertainty may result from the lack of political connection and a poor understanding of Chinese culture. Taken together, compared with other exporters in our sample, it is more likely to be true for these wholly foreign-owned exporters that making use of government subsidies in expanding mature product lines instead of developing new products is an optimal product strategy.

4.2 General trade versus processing trade

To promote exportation, the Chinese government has focused on processing trade since the 1980s. In our sample period (2000–2012), the percentage of processing trade gradually decreased and general trade began to dominate exports. Given the noticeable differences in these two types of trades (e.g. Dai, Maitra, & Yu, 2016), one might expect government subsidization to affect each firm type differently. To explore this conjecture, we split our sample into two subsamples: firms focusing solely on general trade and firms engaging in some degree of processing trade. Table 7 presents the results. In Panel A, results show that the regression coefficients on $TREAT \times POST$ are negative for both subsamples but significant only for general trade exporters (Coeff. = −0.0100, *t*-value = −2.08). In Panel B, the results from matching all government subsidies regardless of the amount also show that the coefficient on $SUBRATIO \times POST$ is significantly negative only for the general trade subsample. Our results suggest that the depressive effects of government subsidization on product differentiation is concentrated among general-trade exporters, which is consistent with the notion that processing-trade exporters are mainly responsible for product manufacture, whereas general-trade exporters can choose what to design, produce and sell.

5. Additional analyses on the effects of government subsidization

In prior sections, we document a significantly negative effect of government subsidization on product differentiation among exporters in China. This finding is consistent with our argument that subsidization induces homogenous competition. That is, companies tend to use subsidy funding to expand existing product lines that are similar to those of competitors. Accordingly, subsidized exporters should have more diversified product lines, compared to unsubsidized ones. In addition, because our results suggest that subsidy funding is not invested in innovation, it seems unlikely that it can positively affect exporters' product value and quality. In this section, we shift our focus from studying product differentiation to

Dep. var. = *PDIFF2*	General trade (1)	Processing trade (2)
Panel A: results based on our baseline sample		
TREAT × *POST*	−0.0100** (−2.08)	−0.0069 (−1.32)
POST	0.0018 (0.44)	−0.0001 (−0.03)
Firm-level controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	9,921	7,297
Adjusted R^2	0.668	0.723
Panel B: matching all government subsidies regardless of the amount		
SUBRATIO × *POST*	−0.3042** (−2.57)	−0.0607 (−0.58)
POST	−0.0008 (−0.37)	0.0027 (1.11)
Firm-level controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	25,231	16,990
Adjusted R^2	0.676	0.728

Note(s): This table presents subsample analyses by dividing our matched sample into firms focusing on general trade and those focusing on processing trade. In Panel A, we present results based on our baseline sample. In Panel B, we match all government subsidies regardless of the amount and replace the treatment dummy (*TREAT*) with the subsidy ratio (*SUBRATIO*), calculated as the subsidy amount divided by annual sales. The model includes firm and year fixed effects and firm-level control variables. All continuous variables are winsorized at the 1st and 99th percentiles. Presented in the parentheses below each coefficient is the *t*-value based on standard errors clustered by firm. Constant terms are estimated but omitted for presentation. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively

Table 7. Heterogeneous effects: General versus processing trade

examining potential outcomes of government subsidization on product diversity, value added and quality.

To empirically test these potential outcomes, we use the number of products (*NP*) to capture exporters' product diversity based on eight-digit HS codes. To capture domestic value added, we follow Kee and Tang (2016) to calculate the ratio of domestic value added for exports to gross exports (*DVAR*). Finally, we follow prior literature to construct two measures of product quality: Khandelwal's (2010) product quality measure (*QK*) and Fan, Li, and Yeaple's (2015) estimated export product quality (*QF*).

Table 8 presents the results. Panel A shows the results based on our baseline sample, and Panel B shows the results from matching all government subsidies regardless of amount. In Column (1), *NP* is the dependent variable. Consistent with our expectation, we find that subsidized exporters have more export products than unsubsidized ones. In Column (2), we focus on domestic value added [14]. We find that the value added in products of subsidized exporters is significantly lower in the post-subsidy period, compared with that of unsubsidized exporters. In Columns (3)–(4), we use two measures of export product quality as independent variables, and we find negative coefficients on *TREAT* × *POST*. Although the coefficients in Panel A are insignificant, they are statistically significant in Panel B. Taken together, we find some evidence that government subsidization results in exporters' expanding their product lines but decreasing their domestic value added and export product quality. These findings corroborate our main finding, suggesting that government subsidization induces homogenous competition among exporters in China.

6. Conclusion

In this paper, we investigate the effect of government subsidization on exporters' product strategy. Exploiting comprehensive product-level export data on exporters in China during

Dep. var. =	*NP* (1)	*DVAR* (2)	*QK* (3)	*QF* (4)
Panel A: results based on our baseline sample				
TREAT × *POST*	0.0420*** (3.10)	−0.0389*** (−2.62)	−0.0760 (−0.60)	−0.0321 (−0.49)
POST	−0.0231* (−1.90)	0.0088 (0.56)	0.1564 (1.50)	0.0807 (1.45)
Firm-level controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	17,218	6,807	13,873	13,873
Adjusted R^2	0.776	0.659	0.710	0.740
Panel B: matching all government subsidies regardless of the amount				
SUBRATIO × *POST*	0.6299* (1.86)	−1.0159*** (−3.62)	−9.0183** (−2.45)	−4.8141*** (−2.71)
POST	0.0022 (0.34)	0.0068 (0.90)	0.0099 (0.18)	0.0014 (0.05)
Firm-level controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	42,221	17,347	32,642	32,642
Adjusted R^2	0.782	0.703	0.688	0.722

Note(s): This table presents the effects of government subsidization on firms' other outcomes. Specifically, we focus on the total number of export products (*NP*), Kee and Tang's (2016) ratio of domestic value added in exports to gross exports (*DVAR*), Khandelwal's (2010) product quality measure (*QK*) and Fan *et al.*'s (2015) estimated export product quality (*QF*). In Panel A, we present results based on our baseline sample. In Panel B, we match all government subsidies regardless of the amount and replace the treatment dummy (*TREAT*) with the subsidy ratio (*SUBRATIO*), calculated as the subsidy amount divided by annual sales. The model includes firm and year fixed effects and firm-level control variables. All continuous variables are winsorized at the 1st and 99th percentiles. Presented in the parentheses below each coefficient is the *t*-value based on standard errors clustered by firm. Constant terms are estimated but omitted for presentation. ***, ** and * represent statistical significance at the 1, 5 and 10% levels, respectively

Table 8. Other outcomes of government subsidization

2000–2012, we introduce a novel measure of product differentiation that captures the extent to which an exporter can differentiate its product space from that of competitors. We use a propensity score matching procedure to construct a sample of comparable treatment and control firms, and our DID analyses provide evidence that the product differentiation of treatment exporters decreases in the postsubsidy period. We further explore potential heterogeneous effects of government subsidization and find that the depressive effects of subsidization on product differentiation are concentrated mostly among wholly foreign-owned exporters and general-trade exporters. In addition, we find some evidence that subsidization leads to increases in product lines and decreases in domestic value added and overall product quality. Overall, our results suggest that government subsidization induces homogenous competition among exporters in China.

Relying on a new measure of product differentiation for a large sample of these exporters, our study provides insights that government subsidization can affect exporters' mode of competition. Nevertheless, a few caveats need to be considered. First, due to the data limitation, we use firm-level data of general production-related subsidies rather than export-specific subsidies. The central and local governments have different incentives to grant subsidies, and granted subsidies may have different purposes (Girma *et al.*, 2009; Lee, Walker, & Zeng, 2014). Therefore, our paper only speaks to the average effect of general subsidies, and without knowing the specific policy objective, it is difficult to tell if it is an intended or unintended consequence. Second, we acknowledge that the association between government subsidization and product differentiation may not be causal because government do not randomly select firms for subsidization and the selection process is largely unobservable. For instance, government may tend to provide financial support to firms facing higher level of product market competition for some unknown reasons. We try to establish causality by using a DID design combined with propensity score matching, but the propensity score matching can only deal with differences in observed characteristics between treatment and control group. To enhance causal inferences, future study may consider better settings, if available, e.g. natural experiments.

Notes

1. Note that government subsidies in our study refer to general production-related subsidies to exporters. Due to the same data limitation as in Girma *et al.* (2009), we have firm-level data of general production-related subsidies but not export-specific subsidies. According to our own calculation, the total subsidies received by exporters in China from 1998 to 2013 grew annually by around 15%, from 6.8 bn to 56 bn Chinese yuan.
2. It is also possible that government subsidies could have no effects on exporters' product strategies because changing long-term strategies can be costly and the subsidies may not be sufficient to cover the costs.
3. The harmonized system (HS) is a global product classification system, and the HS codes are commonly used in international trade. More details about HS codes can be found at https://www.trade.gov/harmonized-system-hs-codes
4. Given that we conduct matrix operations with a large dataset, this exclusion also considerably reduces the computational burden.
5. These trading companies serve as an intermediary in international trade. As documented in Ahn *et al.* (2011), 22% of Chinese exports were handled by trading companies in 2005.
6. In the robustness checks (see Table 5), changing the requirements for treatment firms does not change our inferences.
7. Because firm fixed effects absorb the dummy of treatment firms (*TREAT*), we do not include *TREAT* in the regression model.
8. In all regression analyses, we report the *t*-value, which is calculated based on standard errors clustered by firm and shown in parentheses below each coefficient. Constant terms are estimated but omitted for presentation.
9. We acknowledge that the propensity score matching has its own limitations (e.g. Cram, Karan, & Stuart, 2009; Shipman *et al.*, 2017). Propensity score matching cannot deal with unobservable differences between treatment and control groups and we can only match between treatment and control firms based on observable characteristics (Shipman *et al.*, 2017). In addition, there could be some characteristics that cannot be perfectly matched and accordingly, we follow Cram *et al.*'s (2009) suggestion and control for these factors in the analyses of matched sample.
10. The parallel trend assumption is pivotal to DID estimation. However, the parallel trend requires only the relative change, rather than the absolute level, to be similar in the preevent period. Therefore, we control for the average value of annual changes in *PDIFF2* in the previous three years. Our results are similar if we control for the average change in *PDIFF1* or control for neither of them.
11. We find suitable control firm matches for about 20% (=2615/13,394) of our treatment firms. The rest lack a suitable match based on type of ownership, location province, industry and year.
12. This magnitude is moderate but can be economically meaningful: compared with the mean value of the dependent variable (*PDIFF2*) in Column (4), the coefficient on $TREAT \times POST$ represents a 2% (=0.0091/0.4469) decrease in product differentiation.
13. Results are essentially the same when we alternatively use the *PDIFF1* as dependent variable. For brevity, we only report results of using *PDIFF2* in these tests of heterogeneous effects of government subsidization.
14. In Columns (2)–(4), the sample size decreases due to missing dependent variables. Estimating these dependent variables *DVAR*, *QK* and *QF* requires additional data.

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