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Estimating the repercussions from China's export VAT rebate policy

Julien Gourdon,^{*} Laura Hering,[†] Stéphanie Monjon[‡] and Sandra Poncet^{§¶}

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Abstract

Our study shows that China's export value-added tax (VAT) rebate system is a major industrial policy that affects its exports. We use export data at the HS6-product level for a panel of 329 Chinese cities over the 2003-12 period to assess how changes in the export VAT tax have affected China's export performance. We consider different trade margins in terms of volumes, prices and the number of countries served. To counter endogeneity, we exploit variations in the expected impact of the export VAT rebates by trade regime, which come from an eligibility rule disqualifying certain export flows from the rebates. Our results suggest that a 1% decline in the export VAT tax leads to a 7.2% relative increase in eligible export values at the city level. This effect is due to an adjustment of quantities and the number of foreign markets served while the average unit values of exports remain unchanged.

Keywords: VAT system, policy evaluation, export tax, export performance, trade elasticity, China.

JEL codes: F10, F14, H20, O25.

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1 Introduction

In recent decades, the Chinese government has intervened openly and forcefully to promote the country’s export performance while guiding the structural transformation of the economy. A privileged instrument of this intervention is the country’s unique system of export Value-Added Tax (VAT) rebates directly influences China’s competitiveness on the world market. In previous economic crises, export VAT rebates have been a key adjustment variable in supporting Chinese exporters. Notably, China’s export VAT rebate system has been identified as the most important state measure in terms of international trade covered during the financial crisis (Global Trade Alert, 2010). Also more recently in 2018 and 2019, China repeatedly raised export VAT rebates for a wide range of products in a “bid to boost prospects for shipments amid its trade war with the United States” (Reuters, 2018).¹

Contrary to other forms of public intervention such as currency manipulation, multiple subsidies and trade protection, the rather confusing system of tax rebates for exporters has however been largely overlooked. This is particularly surprising given that export VAT rebates can be modified easily and directly affect the country’s international competitiveness. Especially in the current context of calls to apply higher tariffs on Chinese products, it is crucial to be aware of the mechanisms available to the Chinese authorities to mitigate the effects of their trading partners’ more protectionist policies.

In this paper, we use a panel of exports of Chinese cities² disaggregated by product and trade regime for the period 2003-12, which allows us to directly link export flows with their respective export VAT rebate at the very detailed HS6-product level.³ We propose a

¹<https://fr.reuters.com/article/idUSKCN1LN12F>

²Mainland China is divided into 31 province level entities which are further divided into cities (prefectures) which are administrative units encompassing an urban area and adjacent rural counties under its jurisdiction.

³China exports under three main trade regimes: ordinary trade, processing with imported materials and processing with supplied materials. In our empirical analysis, we will exploit the differential treatment of the policy across these trade regimes.

new identification strategy based on a triple difference approach that exploits differences in the export VAT rebates across products, years and trade regimes. Our analysis shows that China’s export VAT rebate system is indeed an effective industrial policy and how it has affected the different trade margins in terms of volumes, prices and the number of countries served.

China’s VAT policy differs from the standard destination-based VAT system of the OECD countries by not fully refunding the VAT on exports.⁴ Instead, Chinese exporters may receive VAT rebates that vary across commodities, and range from zero to the full refund of the typical 17% VAT rate.⁵ The Chinese VAT system thus imposes a tax on exporters whose goods receive a VAT refund rate lower than the applicable VAT rate. These incomplete VAT rebates to exporters make it less advantageous to export a product than to sell it domestically. Section 2 will show that the very name of export VAT rebates is actually misleading as the repercussions of a certain change in the rebate on exporters are not proportional to their value-added but only on the export value. Incomplete export VAT rebates hence amount to export taxes and are expected to lead to lower exports (Feldstein and Krugman, 1990).⁶

Even though most Chinese exporters face an export VAT tax, the export VAT rebate system has been considered as providing Chinese exporters with an advantage with respect to foreign competitors (Evenett et al., 2012). Two features have been highlighted as evidence that this export VAT rebate system is indeed a systematic form of export management. First, there is tremendous variation across goods in the levels of and changes to the export

⁴The Value-Added Tax (VAT) is an indirect consumption tax: it is paid to the revenue authorities by the seller of the goods, who is the “taxable person”, but it is actually borne ultimately by the final consumer. Most countries, including also the EU countries, the US and Japan, leave no residual VAT contained in the export price to avoid double taxation on final consumption. They follow an approach called exempt-credit-refund: exports are exempt from VAT and exporters will be refunded the VAT paid on their purchases of inputs for the production of their exports.

⁵The standard VAT rate, which was 17% over the period studied, was reduced to 16% in May 2018 and then to 13% in April 2019.

⁶We hence use the terms of incomplete export VAT rebate and export VAT tax interchangeably.

VAT rebates. Second, over the last decade, export VAT rebate rates have been adjusted frequently, both upwards and downwards (WTO, 2010).⁷ In particular, since the beginning of the global financial crisis in 2008, China has increased export VAT rebate rates several times. In contrast to many other countries, China’s exports resisted rather well during the crisis and more than sextupled between 2002 and 2012, growing two times faster than the world exports over that period.

Our empirical approach exploits variations in the policy across products (within a given industry), over time and across different types of trade and by this builds on efforts to address the problem of omitted variables which has traditionally hindered the evaluation of the impact of trade policies on export performance. It is indeed likely that the timing and scope of changes in the refund rate are correlated with various broader economic variables, such as worldwide economic conditions and product characteristics, as well as other industrial policies which affect export performance.

We address the resulting endogeneity via two approaches. First, we exploit variations in the expected impact of the export VAT rebates by trade regime, which come from an eligibility rule disqualifying a specific kind of processing trade called “processing with supplied materials” from the rebates. The other kind of processing trade (referred to as “processing trade with imported materials”) is subject to the standard rules. Chinese trade occurs through either ordinary or processing forms. Processing trade refers to the operations of enterprises that procure raw materials or intermediate inputs from abroad and, after assembling them in China, re-export the products.⁸ The typical export VAT rebate policy is that of “pay-first-and-refund-later”, which applies to ordinary trade and processing trade with

⁷We compute that, over the 2002-12 period, 89% of the products underwent at least one change in their VAT-refund rate.

⁸China’s processing regime confers substantial benefits on export processors such as the right to import duty-free raw materials, components, and capital equipment used in processing activity (Naughton, 1996). These benefits are the same for both kinds of processing trade and therefore do not differ according to eligibility for export VAT rebates.

imported inputs. By contrast, the “no collection and no refund” policy applies to processing trade with supplied inputs. In this type of trade, the firm undertakes processing or assembly work on materials it does not own. Even if the exporter pays VAT on purchases of intermediates, there is no entitlement to any export refund. We therefore expect export VAT refunds to have an effect only on eligible export activities (ordinary and processing trade with imported materials), which is confirmed by our empirical results. We propose various exercises to ensure the validity of our difference-in-difference-in-differences estimation. We notably account via a strict set of fixed effects for differences between the eligible and non-eligible trade regime that could bias our coefficients of interest. We also rule out the possibility that the export VAT rebate policy may change the trade form chosen by firms.

Second, we rely on disaggregated city-level data instead of national exports. This allows to control for the heterogeneity in the dynamics of export flows across the Chinese territory. Being able to account for local comparative advantages and unevenly distributed shifts in exports between products or between trade regimes reduces the concern that our estimates suffer from an omitted variable bias. Further, the inclusion of fixed effects at the city level takes into account various political economy mechanisms that cause trade performance to have a feedback effect on the level of trade protection, including the export VAT rebate rate. Breaking down the export data to the city-product-trade regime level has also the important advantage that it allows to account for the granularity of exports and explore the different margins of adjustment to the policy even in absence of transaction-level data (Feenstra and Hanson, 2005).⁹ Our analysis will therefore focus on how city-level exports adjust to a change in the export VAT rebate in terms of quantities, prices and number of

⁹We are unfortunately not able to study in greater details the margins of adjustment since information on the type of processing trade, which is key to our identification strategy, is available at the firm level only until 2006 and covers therefore only a period in which export VAT tax mostly only increased. By using city data we can rely on a longer time period that includes the recent financial crisis and allows us to study the intensive and extensive margin of adjustment at the city-product level.

export destinations.

With our approach, we propose a more detailed analysis than the few existing studies on this policy, which focus on averages of rates calculated at the national level (Chen et al., 2006)¹⁰ or at the industry-province level (Chandra and Long, 2013).¹¹ The latter two studies cover periods ending in 2002 and 2006 respectively. Our sample extends to 2012, hence including the worldwide trade crisis of 2008-2010 during which the export VAT rebate rates rebounded after years of reduction. Our analysis is closer to that of Garred (2018) which also looks at export VAT rebates at the product level. His paper focuses mainly on the link between export VAT taxes and import tariffs and shows that decreases in export VAT rebates have partly restored China's pre-WTO trade policy. He also identifies a negative correlation between China's export VAT tax and the value of the country's exports at the product level. However, he does not attempt to establish a causal link.

Our main contribution is to rely on more disaggregated data and apply a triple difference identification strategy so as to overcome the endogeneity concerns of Garred (2018) and establish a causal link between the export VAT tax policy and the various export margins (volumes, prices and the number of countries served). We hence provide a detailed assessment of the different channels through which China's export VAT rebate policy affects the country's commercial performance while taking into account endogeneity issues that traditionally bias trade elasticities estimates (Goldberg and Pavcnik, 2016). Further, we develop a simple model of international trade with heterogeneous firms to highlight the expressions for the elasticity of the trade volume and price with respect to the export tax resulting from

¹⁰Chen et al. (2006) use aggregate data from 1985 to 2002 and find that export VAT rebates are positively correlated with China's exports, final domestic consumption, and foreign exchange reserves. The size of their sample is limited to 18 observations.

¹¹Chandra and Long (2013) use firm-level panel data for 2004-2006 and find a positive association between firm export volume and the average rebate rate (over exports) in the firm's industry-province pair. The explanatory variable in this study is the average ratio of the value of VAT rebates over exports, calculated over all exporting firms in the same province, 2-digit industry and year. This is instrumented by a proxy for local fiscal conditions.

the incomplete VAT rebates. We hence contribute to the recent trade literature that aims at estimating trade elasticities with respect to tariffs and other variable trade costs (Bas et al., 2017). With our identification strategy we can estimate the aggregate trade elasticity for China, a key parameter to evaluate the welfare impacts of trade liberalization.¹² Our last contribution consists in uncovering differences in the adjustments made by exporters following tax changes according the time period. We are particularly interested in identifying the effect of the export VAT tax reduction implemented during the financial crisis.¹³

Our results confirm that China’s export VAT rebate system is indeed an effective tool for export management. Whereas there is, as expected, no significant effect on non-eligible exports, we find a negative and significant effect of the export VAT tax on eligible exports. The estimation of our benchmark specification suggests that a one percent rise in the export VAT tax will lead to a 7.2% decline in eligible export values with respect to non-eligible trade.¹⁴ This effect on city-level export values goes uniquely via a change in the quantities so that prices, measured as unit values, are unaffected. Our point estimates of the effect of the export VAT tax on exports are actually fully in line with the estimates obtained in the recent trade literature of the parameters included in its theoretical expression. Our estimates on both quantities and prices are consistent with our model and are coherent with the trade elasticity estimates obtained on more disaggregated data in the recent trade literature (Head and Mayer, 2014; Fontagné et al., 2018).

Overall, our findings suggest that higher rebates granted by the Chinese authorities to exporters do not translate into lower prices for foreign consumers but benefit companies

¹²Our results on unit values help infer the impact of a rebate change on the pricing strategy of exporters and hence are complementary to existing studies on pricing-to-market and pass-through (Fitzgerald and Haller, 2018; Fontagné et al., 2018).

¹³In our analysis, we also explicitly address possible tax avoidance strategies of exporters, as there is evidence that exporters under-report the value of their exports to avoid paying taxes based on the value of exports (Ferrantino et al., 2012).

¹⁴We use for this the linear approximation of $\ln(1+t)$ by t knowing that t , the average export VAT tax rate, is between 2% and 8% as displayed by Figure B-1.

exporting from China through increased margins. This allows exporters, particularly the least efficient among them, to maintain and even expand into international markets. Our estimates suggest that its policy of incomplete VAT rebates has allowed China to cope with negative external shocks like the global financial crisis in 2008-2009 and hence provides a room for maneuver that China can use to manage its exports to fit its development goals. Overall, however, China's unconventional approach on VAT rebates has actually depressed its export volumes: if China brought its system in line with that of Western countries and offered a full VAT refund to its exporters (who faced an average export VAT tax of 6.3% in 2012), this could lead potentially to a relative increase of 45% in eligible exports in the absence of any mitigating general equilibrium effects.

The remainder of the paper is structured as follows. The next section describes the Chinese export VAT rebate system. Section 3 overviews our empirical specification that directly derives from a simple model, derived in Appendix A, which incorporates export taxation from incomplete export VAT rebates into a standard trade model with firm heterogeneity. Section 3 also describes the data. Section 4 discusses the results. The last section concludes.

2 The export VAT rebate system

Implemented in 1994 to replace the old industrial and commercial standard tax, the Chinese VAT system differs from that applied in many Western countries, in particular because it is not neutral for exporters (Yan, 2010). In theory, neutral VAT implies a zero rate on exported goods and a full refund of the domestic VAT paid by exporters on their inputs. In practice, China's VAT applies at a standard rate of 17 percent on goods sold on the domestic and foreign market.¹⁵ Export goods are however subject to the export VAT rebate system, which

¹⁵A reduced rate of 13 percent applies to basic staples or household necessities such as food, fuel, electricity, books, newspapers and magazines, and agricultural products.

may lead to a reduced VAT rate. These rebates for exported goods vary by commodity and range from zero to the 17% VAT rate.¹⁶ This implies that whenever the VAT rate is higher than the VAT rebate for a given product, this results in a positive export VAT tax rate which is applied to the exported value of this product.

Even though the Chinese VAT rebate policy on exports is complex and has changed frequently over time¹⁷, the logic has remained fairly stable (Ferrantino et al., 2012). Ordinary trade and processing exports with purchased imported materials fall under the standard rule, which is known as the “pay-first-and-refund-later” method. The main point is that the export VAT rebate enters into the calculation of the tax burden of a producer through a term called the export VAT tax which corresponds to the product of the export VAT rate (VAT rate minus VAT rebate) and the total export value (and not the value added incorporated in exports). Equation 1 below reports the official formula used to calculate the total amount of VAT to be paid by businesses (Circular No. 7, 2002). This includes, next to a classical term where the VAT rate is applied to the value-added tax base, a specific term that corresponds to the export VAT tax and which is our focus of interest:

$$\begin{aligned} \text{VAT payable} = & \underbrace{\sum_k (\text{domestic sales}_k \times \text{VAT rate}_k)}_{\text{domestic sales VAT}} - \underbrace{\left(\sum_{k'} \text{inputs}_{k'} \times \text{VAT rate}_{k'}\right)}_{\text{input VAT}} \quad (1) \\ & + \underbrace{\sum_k (\text{Exports}_k - \sum_{k'} \text{BIM}_{k'}) \times (\text{VAT rate}_k - \text{export VAT rebate rate}_k)}_{\text{export VAT tax}} \end{aligned}$$

¹⁶China started off with a complete rebate in 1994, but the strong rise in exports during the nineties led to a heavy fiscal burden for the government, so the country quickly lowered the export VAT rebates and fixed different rates across sectors (Chandra and Long, 2013).

¹⁷VAT rebates are set by the State Administration of Taxation. Changes are typically announced in a circular jointly edited by the State Administration of Taxation, the Ministry of Finance, the National Development and Reform Commission, the Ministry of Commerce and the General Administration of Customs.

where k denotes products and k' the intermediate inputs used to produce k .

Domestic sales VAT is the VAT collected on domestic sales and input VAT is the VAT paid on inputs subject to VAT. The input VAT applies to all inputs, whether domestically-sourced or imported, except the bonded duty-free imported materials (BIM).¹⁸

The export VAT tax, captured by the last expression of Equation 1, indicates that all else equal, a higher export VAT rebate lowers the fiscal burden for exporters.¹⁹ For exporters that do not use bonded duty-free inputs, a one percentage-point lower VAT rebate increases their tax payment by one per cent of the value of their export. The change in the fiscal burden is thus not related to the value-added. The very name of the VAT rebate policy on exports is misleading as the bite of a certain shortfall in the rebate does not hurt firms in proportion to the importance of their domestic input purchases. Exporters may of course pay VAT on the inputs they use but this amount is not connected to the export VAT rebate they get for their exports. It is therefore not necessary to know the share of domestic value added in exports to assess the quantitative importance of the VAT rebate policy for exports. In our empirical strategy the key explanatory variable is the export VAT tax rate defined as the difference between the VAT rate and the export VAT rebate rate, in logs as derived from our model in Appendix A.

In contrast to ordinary trade and processing trade with imported materials, processing exports with supplied materials are not entitled to any VAT refund (China Tax & Investment Consultants Ltd, 2008). This type of trade falls under the rule of the “tax-exempt” (or “no collection and no refund”) method. In export processing with supplied materials, the Chinese firm undertakes processing or assembling work on materials it does not own. The property of these materials is retained by a foreign party. There is no sale and therefore no VAT

¹⁸Imports under the bonded status are free from import duties and VAT. This would typically be the case for processing trade activities.

¹⁹If the VAT payable is negative, the tax bureau will refund it. In fact, the amount of refundable VAT is capped by $\sum_k(\text{Exports}_k - \sum_{k'}\text{BIM}_{k'})$.

is levied on these inputs. The exporting company, even if it has paid VAT on other local supplies, is in no way entitled to VAT rebates on the products it exports.

Our empirical approach, detailed in Section 3, exploits this eligibility rule that disqualifies processing trade with supplied materials from the rebates. We measure the impact of the export VAT rebate policy on city-level exports as its differential effect between eligible and non-eligible regime for a given product-year pair, while taking into account structural differences between products, cities and the two trade regimes through various sets of fixed effects.

Stylized facts on export VAT rebates are presented in Appendix B.

3 Empirical specification and Data

3.1 Empirical specification

Our empirical specification is directly derived from the simple model presented in Appendix A. We expect that an increase in export taxes lowers the number of exporters and the value and volume of exports for surviving exporters. The overall effect on aggregate prices is predicted to be very small due to composition effects.

Our main dependent variable, $\ln \text{export}_{ck,t}^R$, is the log of the export values of HS6 product k in city c under regime R in year t , with R comprising the eligible and non-eligible regime. In our empirical analysis, we also study the policy repercussions on export quantities, unit values and the number of destinations to which a city exports a specific product.

Our benchmark specification is the following:

$$\begin{aligned} \ln \text{export}_{ck,t}^R = & \alpha \ln \text{export VAT tax}_{k,t-1} \times \text{Eligibility}^R \\ & + \lambda X_{ck,t-1}^R + FE_{k,t} + FE_{ck}^R + FE_{cs,t}^R + \epsilon_{ck,t}^R \end{aligned} \quad (2)$$

In line with our model, the export VAT tax variable is defined as $\ln(1+(\text{VAT rate-export VAT rebate}))$. The dummy $Eligibility^R$ takes the value one if the export flow is in the eligible trade regime and zero otherwise.

Our key coefficient of interest, α , captures the differential impact of the export VAT tax on eligible exports relative to non-eligible exports. The export VAT tax variable is lagged by one year to allow the firms to adjust their production to the generally unanticipated changes in the tax rates.²⁰ In this triple difference specification, we include fixed effects at the product-year level ($FE_{k,t}$), city-product-regime level (FE_{ck}^R) and at the city-sector-regime-year level ($FE_{cs,t}^R$).

Product-year fixed effects ($FE_{k,t}$) capture all factors that shape the export performance for a given product in a given year and that may correlate with the rebate policy. They include world demand and all product-specific policies which have the same expected impact on eligible and non-eligible exports, such as subsidies, tariffs imposed by China’s trading partners and R&D promotion policies (Girma et al., 2009). Moreover, adjustments to VAT rebates appear to be made to meet various objectives such as technological upgrading, mitigating the risk of trade disputes or food safety. Therefore, variations in export performance for a given product may lead to a change in the discount for that product. As these product-level factors do not vary much between trade regimes for a given product, such as export dynamics or sophistication (Eisenbarth, 2017; Garred, 2018), they are well captured by the product-year fixed effects.

The city-product fixed effects that vary by regime type (FE_{ck}^R) control for structural differences between eligible and non-eligible regimes and make both trade regimes more comparable.²¹ By varying at the city level these dummies take into account the comparative

²⁰In unreported results available upon request we add the contemporaneous export VAT tax variable in our specification to check whether firms anticipate or respond to policy changes faster than a one-year lag. This variable is not significant and its introduction does not affect the coefficient on the lagged rebate rate.

²¹Well-known differences between ordinary and processing trade flows are notably in terms of their domestic

advantage of each product in a given location. The evolution of China’s comparative advantages in the export of a given product and regime type depends a lot on the geographical location of the producer. For example, the decline of often inefficient state-owned automobile producers in the interior of China has been accelerated by the establishment of partly foreign-owned electric vehicle producers in the South of the country. These evolutions may be correlated with our regressor of interest (export VAT tax \times eligibility) because they occurred simultaneously with an increase in VAT export rebates²² and affect exports differently according to the type of ownership and productivity of firms, two important factors in the choice of trade regime. These factors are difficult to control for if the study is conducted with data aggregated at the national level. The use of city-level exports allows to account for unobserved changes in comparative advantages that lead to some unevenly distributed shifts in exports between products or between trade regimes for a given product.

Our last set of fixed effects are city-sector-regime-year dummies ($FE_{cs,t}^R$) which capture demand and supply shocks that are common to all products of regime type R in sector s in year t for city c .²³ Most importantly, they control for potential time varying differences across regime types for a specific sector in a given city, such as local shocks impacting the two trade types differently or average rebate rates for all the products in the same sector. In the same time, these fixed effects control for all time varying city and sector characteristics that may vary across trade regimes, such as labor and capital intensity.

Thanks to these very demanding fixed effects, our estimated effect is identified solely value added, sectoral distribution, production structure, productivity and factor intensity (Dai et al., 2016; Kee and Tang, 2016). In Section 4.4.1, we further show that our results hold when dropping ordinary trade and limiting the sample to processing trade only, where the structural differences between eligible and non-eligible trade are expected to be much smaller.

²²On average for the automotive sector (Chapter 87), the export VAT rebate increased by 2 percentage points between 2008 and 2012.

²³Sectors s are defined following the Chinese GB/T industry classification. Our main sample with 3,346 products at the HS6-level consists of 401 4-digit sectors. The match between Chinese GB/T industry codes and HS codes is taken from Upward et al. (2013). There are a few HS6 for which the GB/T code is not available. In this case we assign missing values with the most common GB/T over coarser HS codes.

by the variation of exports across products within the same sector, city, trade regime and year, while we control for everything that is specific to a product in a given year that is the same for both trade regimes and constant over time for each product-city-regime type combination.

We are not aware of any other national policy that is specific to non-eligible processing exports with supplied inputs. However, specific regulations apply to processing trade, so that they fully apply to non-eligible flows, while they only partially apply to eligible flows, which combine ordinary trade and processing with imported materials. We address these regulations explicitly to avoid bias in our estimates.

The main preferential treatment of processing trade consists in the exemption of import tariffs on inputs used in processing exports. Import tariffs thus only apply to ordinary trade. Since we do not know which inputs are used in the production of ordinary exports, we do not know the corresponding import tariffs at the product level. However, the city-sector-year-regime fixed effects account for the general level of import tariffs on inputs used by sector s in city c in year t in a way which is specific to each regime type R . To ensure that our results on the export VAT tax do not pick up the effect of import protection, we add import tariffs of product k interacted with the eligibility dummy.²⁴

Finally, since even with our various sets of fixed effects it is still possible that export dynamics for a given product within the same sector vary by trade regime or city and are correlated with the export VAT rebate rate, we add a vector of control variables $X_{ck,t-1}^R$. To account for export dynamics at the city and HS6 product level, we control for the change in city-product export values from t-2 to t-1 (Export growth $_{ck,t-1}$).²⁵ Further, we include

²⁴In Appendix D-3 we detail two additional policies that are specific to processing trade (export processing zones and product-specific restrictions to processing trade) and ensure that our results hold when accounting explicitly for these policies.

²⁵See Appendix C-3 for the construction of these variables. Following the suggestion of an anonymous referee we also ensured that our point estimates are not driven by “bad controls”. For example, in case foreign firms are less responsive to rebate rates, their share of exports may change in a particular city-product-year

the share of exports by foreign firms (Foreign share $_{ck,t-1}^R$) and the share of state-owned firms (State share $_{ck,t-1}^R$) defined at the city-product-regime level. These two controls are crucial to account for the time-varying ability of different localities to export different products (under different regimes) as export performance in China varies greatly by firm ownership (Amiti and Freund, 2010).²⁶ $\epsilon_{ck,t}^R$ is the error term.

All regressions cluster standard errors at the product level to account for serial correlation of the error term within products.²⁷

3.2 Data

Our variable of interest is the export VAT tax corresponding to the difference between the export VAT rebate and the VAT rate. Export VAT rebate rates and VAT rates at the tariff-line level (HS 8-digit or more disaggregated levels) are taken from the Etax yearbooks of Chinese Customs. While export VAT rebates change frequently, the VAT rates have remained constant between 2002 and 2012.²⁸ Appendix C-1 provides more detail.

We link the export VAT data to export data by city-product-year which come from the Chinese Customs. We observe values, quantities, and number of destination countries for a panel of 4,823 products over the 2003-2012 period.

We split export flows into two groups depending on whether they are eligible or not to VAT refund. Eligible trade includes ordinary trade and processing trade with imported materials (also known as import-and-assembly). The latter refers to “business activities in

cell as a consequence of policy change. In unreported results available upon request we find that our results are not significantly affected when the vector of control variables is not included.

²⁶The export VAT rebate policy does not depend on the ownership of the firm but only on the chosen trade regime.

²⁷One remaining concern of this triple-difference specification comparing export VAT tax repercussions on eligible and non-eligible exports is the possibility that the export VAT tax policy affects the trade form chosen by exporting firms, i.e. higher export VAT tax for a given product may lead firms to switch from eligible to non-eligible trade. Appendix D-1 provides some suggestive evidence that this is not a major threat to our identification strategy.

²⁸The standard rate of 17 percent applies to roughly 93% of our main sample.

which the operating enterprise imports materials/parts by paying foreign exchange for their processing, and exports finished processed products for sale abroad” (Manova and Yu, 2016).

Non-eligible trade corresponds to processing trade with supplied materials (also called processing & assembly).²⁹ It refers to “the type of inward processing in which foreign suppliers provide raw materials, parts or components under a contractual arrangement for the subsequent reexportation of the processed products. Under this type of transaction, the imported inputs and the finished outputs remain property of the foreign supplier” (General Administration of Customs of the People’s Republic of China, 2013).

Over our sample period (2003-2012), China’s export flows (excluding the category “other exports”) are composed of 46% ordinary trade, 45% processing trade with imported inputs (eligible processing) and 9% processing trade with supplied inputs (non-eligible processing). While the share of the non-eligible export flows decreases over time (for reasons we discuss in Appendix D-1), the share of ordinary trade shows a small upward trend (see Figure C-1). However, it remains comparable in size to processing with imported inputs whose share remains stable over the sample period.³⁰

Combining the trade data and the VAT data leaves us with 4,792 HS6 products and 436 cities.³¹ As our empirical strategy appeals to heterogeneous policy responses according to the trade regime, we drop products which are not exported under both the eligible and the non-eligible regime, as well as localities that do not export under both the eligible and the

²⁹The other transaction types in the data include specific flows such as international aid, contracting projects or customs warehousing trade. These other types together cover less than 7% of total exports over the 2003-2012 period. We do not include these flows in our analysis as we have only limited information on how the export VAT rebate policy is applied to them. Column 1 of Table D-2 provides robustness checks to ensure that our results remain when this trade category (“others”) are included and regarded as eligible.

³⁰In Section 4.4.1 the sample is reduced to processing trade only, so that the identification is based on the comparison of eligible to non-eligible processing exports at the city-product-year level. In this sample, the non-eligible processing exports represent close to 40% of the sample.

³¹Cities are administrative units below the provinces encompassing an urban area and adjacent rural counties under its jurisdiction. Our sample includes prefecture and county level cities. Our main results hold if we limit our sample to prefecture-level cities only.

non-eligible regime.³²

Our final sample includes observations for 329 cities on 3,346 HS6 products (representing 314,892 city-product pairs). The trade included in this sample represents over 80% of China’s total exports under these two regimes over the sample period. The construction of unit value and extensive margin is described in Appendix C-1.

4 Results

4.1 Policy repercussions on export values

In this section, we present our main results on the average effect of the export VAT tax on export values following the specification in Equation 2. The effect of the export VAT tax is identified by comparing its effect on eligible trade flows for a given city-product pair with that on the corresponding non-eligible flows.

Results are displayed in Table 1. Before we rely on our benchmark specification, columns 1 and 2 estimate the effect of the export VAT tax separately on the two trade regimes. Including only one regime type in the regression does not allow to control for product-year specific fixed effects that can account for confounding factors at the product level. Therefore we add a variety of product-year specific variables to compensate for the absence of $FE_{k,t}$. Following the gravity literature, we account for supply-side determinants of exports by adding China’s export growth in this product over the previous period and we control for demand-side determinants by including the world import value, again defined at the product level. Further, we add export taxes and import tariffs which are specific to product k .³³

³²We exclude exports coming from the so-called “bonded zones” and “export processing zones” (EPZs) in which the VAT regime is different. In Appendix D-3 we show that our results are virtually unchanged when exports from these zones are included in our sample and coded as non-eligible exports in their corresponding city.

³³Export tax is another fiscal measure affecting Chinese exports, although it applies to far fewer products than export VAT rebates. For a detailed description and the construction of the control variables, see

Table 1: The impact of the export VAT tax on export flows

Dependent variable	Ln export value $_{ck,t}^R$ (city/product/trade regime/year)			
	(1) Eligible	(2) Non-Eligible	(3) All	(4) All Benchmark
Ln VAT export tax $_{k,t-1}$	-7.262 ^a (0.523)	0.029 (1.076)	0.347 (1.074)	
Ln VAT export tax $_{k,t-1} \times \text{Elig.}^R$			-7.629 ^a (1.118)	-7.178 ^a (1.180)
Export growth $_{ck,t-1}$	0.161 ^a (0.002)	0.119 ^a (0.007)	0.159 ^a (0.002)	0.158 ^a (0.002)
Foreign export share $_{ck,t-1}^R$	0.430 ^a (0.010)	0.479 ^a (0.024)	0.434 ^a (0.010)	0.418 ^a (0.009)
State export share $_{ck,t-1}^R$	-0.013 ^c (0.007)	0.223 ^a (0.027)	0.003 (0.007)	-0.020 ^a (0.007)
Export growth $_{k,t-1}$	0.133 ^a (0.011)	0.094 ^a (0.028)	0.129 ^a (0.010)	
World demand $_{k,t-1}$	2.074 ^a (0.143)	1.738 ^a (0.292)	2.040 ^a (0.142)	
Export tax $_{k,t-1}$	-1.140 (0.891)	1.463 (2.050)	-1.098 (0.893)	
Import tariff $_{k,t-1}$	-0.032 (0.572)	0.094 (1.257)	-0.144 (1.250)	
Import tariff $_{k,t-1} \times \text{Elig.}^R$			0.114 (1.179)	1.890 (1.157)
Fixed effects				
City-product (FE $_{ck}$)	Yes	Yes		
City-sector-year (FE $_{cs,t}$)	Yes	Yes		
City-product-regime (FE $_{ck}^R$)			Yes	Yes
City-sector-regime-year (FE $_{cs,t}^R$)			Yes	Yes
Product-year (FE $_{k,t}$)				Yes
Observations	1,749,521	188,970	1,938,491	1,938,491
R^2	0.832	0.836	0.832	0.844

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

Columns 1 and 2 indicate that the effect of the export VAT tax is - as expected - limited to the eligible exports. We have a negative and highly significant coefficient of -7.3 for eligible trade in column 1, while the coefficient of the export VAT tax for non-eligible trade in column 2 is close to zero and not significant. This latter result suggests that non-eligible trade is indeed a valid control group for evaluating the export repercussions of the changes in the VAT refunds to exporters. Changes in the export VAT rebate rate hence do not seem to result in a simple nominal relabeling of the trade regime. We thus reject the possibility that the value of exports going up in the eligible regime after the rebate rise is being merely reallocated from the non-eligible regime with total exports remaining the same.

In column 3 we combine the two trade regimes but still exclude the product-year fixed effects $FE_{k,t}$ to get an estimate of the repercussions of the export VAT tax on exports for both trade regimes. However, we add the city-sector-year-regime dummies ($FE_{cs,t}^R$), so that our coefficient is capturing only variations in exports in response to the VAT export tax across products that are within the same sector, city, trade regime and year. To separate the effect of a change in the tax between eligible and non-eligible exports, we also include, next to the export VAT tax variable, its interaction with a dummy for Eligibility. As explained in Section 3, import tariffs only apply to ordinary trade. We thus also allow the coefficient of the import tariff to be different for eligible and non-eligible trade. The latter, which consists uniquely of processing trade, should not be affected by this tariff.

The negative and highly significant coefficient of the export VAT tax interacted with the Eligibility dummy in column 3 suggests that the export tax stemming from incomplete VAT rebates has negative repercussions for eligible exports. In contrast, the export VAT tax has no significant effect on values when exports consist of non-eligible processing with supplied inputs, as indicated by the relatively small and non-significant coefficient of the

Appendix C-3.

average export VAT tax that captures the effect for the non-eligible export flows.

Our proxies for world demand and supply side dynamics have all the expected positive and significant impact on our dependent variable. However, other trade policy measures (export tax and import tariffs) fail to be significant. In presence of sector-year dummies ($FE_{cs,t}^R$) this may reflect that there is limited heterogeneity in these rates between products in the same sector.

Column 4 reports our benchmark results (corresponding to Equation 2). The added product-year fixed effects account for all time-varying product-level factors which are common to both regimes so these variables are dropped.³⁴ The results confirm that our key variable of interest, the interaction term between the export VAT tax and the Eligibility dummy, is highly significant. The coefficient of -7.17 suggests that a one percent increase in the export VAT tax leads to a 7.17% decrease in eligible export values relative to non-eligible exports. This effect is economically significant even in the context of China's average export growth of about 20% per year over the last decades. A quick back of the envelope calculation thus suggests that the adoption of a full VAT rebate system, as in many Western countries, would potentially induce a relative increase of 45% in the Chinese exports of eligible activities.³⁵

While our estimate is half that of Chandra and Long (2013), it is about the same size as Garred's (2018). By using more disaggregated data at the city and product level than Chandra and Long (2013), we hence obtain a more reasonable impact which is consistent with our simple model presented in Appendix A. As we show in Section A-2, when we follow Chaney (2008) and assume that the marginal cost has a Pareto distribution, the export tax elasticity for the export value is equal to $\frac{\sigma(1-\gamma)-1}{\sigma-1}$ (Equation 14). Using the parameters

³⁴The export VAT tax (without the interaction term) is also dropped as it is accounted for by the product-year fixed effects.

³⁵This number is obtained by multiplying the export VAT tax rate in 2012 (6.3%) with our average elasticity of 7.17 (column 4 of Table 1).

proposed by the literature for γ and $\gamma/(\sigma - 1)$ we obtain a range for the elasticity between -5 and -11, which is remarkably consistent with our estimate of -7.17.

Table D-2 shows that our results hold and that the magnitude of the export VAT tax coefficients remains highly similar when we modify the sample and add more controls. Tables D-3, D-4 and D-5 ensure that the main results from column 4 of Table 1 are robust across various subsamples.

4.2 The impact of the export VAT tax on different export margins

In this section, we investigate whether the strong reaction of export values to changes in export VAT tax is mainly due to changes in prices or changes in quantities. In line with our model, we expect that an increase in the export VAT tax will reduce the quantities shipped as the taxes are an additional cost to the producer. However, the increase in costs is expected to affect not only the intensive margin but also the extensive margin of exporters by driving the least productive firms out of the export market, leading to less destination countries served. We therefore study the impact of the policy on the different margins of adjustment: quantities, prices and the number of export destinations.

While our theoretical model can provide a clear prediction of a negative impact of the tax on aggregate quantities, the net effect on aggregate prices is ambiguous: the direct negative repercussion of the tax on firm-level export prices may be more than compensated by the composition effect related to the exit of the least productive firms that charge high prices, leading actually to a decline in aggregate prices. Furthermore, the repercussions of a change in rebates on export prices depend also on the extent to which exporters pass rebates through to prices. Exporters could well keep prices constant and absorb the changes in rebates in their margins. Also, considering that unit values are a common proxy for product quality, we could expect a positive effect on unit values when a decrease in the export VAT tax leads

to quality improvements. The expected sign of the overall effect on the average price for product-city pairs is thus not clear.

Even though we cannot estimate the effect of the export VAT tax on the extensive margin at the firm level,³⁶ we can look at its impact on the number of destinations served by each city-product pair. If firms exit from the export market after a tax increase, we expect that, overall, fewer destinations will be served.

Table 2 reproduces the main results of Table 1 (corresponding to columns 1, 2, and 4) for each of the three adjustment margins, respectively the quantity exported, the average price and the number of destinations.

Panel A of Table 2 presents the results for export quantities. The coefficient measured on the export VAT tax for export quantities is very similar to that obtained on export values. These results strongly suggest that the policy impact observed on export values is driven by a decrease in the eligible exported quantities.³⁷

Panel B of Table 2 reports the estimation results for unit values and confirms this conclusion. Conditional on our strict controls, we find no significant differential effect of export VAT rebates on unit values for the two trade regimes. Our findings thus suggest that there is no change in average (tax inclusive) prices or in average quality of the exported goods after a change in the export VAT tax. This finding is in line with Garred (2018). If anything, the marginally significant negative estimate we measure in Column 1 may suggest that the least productive firms are driven out of the export market, so that overall prices fall as a result of an increase in taxes.

³⁶As mentioned above, firm-level exports that provide information on export value by product for the different trade regimes are only available for a few years up to 2006.

³⁷Looking at quantities rather than values has an interest that goes beyond simply decomposing the adjustment margin. Under-reporting of the value of exports by firms to avoid paying taxes based on the value of exports can pose measurement problems. If these practices affect values and not quantities as suggested by Fisman and Wei (2004), export prices should be underreported. An increase in the export VAT rebate should encourage exporters to cheat less and thus report a higher price to customs. We also address this issue in Section 4.4.

Table 2: The impact of the export VAT tax on different export margins

	(1)	(2)	(3)
Panel A			
	Ln Quantities $_{ck,t}^R$		
Subsample	Elig	Non-elig	All
Ln export VAT tax $_{k,t-1}$	-7.356 ^a (0.530)	0.114 (1.096)	
Ln export VAT tax $_{k,t-1} \times \text{Elig.}^R$			-7.172 ^a (1.249)
R^2	0.877	0.868	0.885
Panel B			
	Ln Unit values $_{ck,t}^R$		
Subsample	Elig	Non-elig	All
Ln export VAT tax $_{k,t-1}$	-0.400 ^c (0.234)	-0.122 (0.508)	
Ln export VAT tax $_{k,t-1} \times \text{Elig.}^R$			-0.129 (0.482)
R^2	0.921	0.927	0.924
Panel C			
	Ln Nb of countries $_{ck,t}^R$		
Subsample	Elig	Non-elig	All
Ln export VAT tax $_{k,t-1}$	-2.609 ^a (0.228)	0.446 (0.359)	
Ln export VAT tax $_{k,t-1} \times \text{Elig.}^R$			-2.906 ^a (0.394)
R^2	0.883	0.851	0.896
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes
Additional controls $_{k,t-1}^R$	Yes	Yes	
Fixed effects			
City-product (FE $_{ck}$)	Yes	Yes	
City-sector-year (FE $_{cs,t}$)	Yes	Yes	
City-product-regime (FE $_{ck}^R$)			Yes
City-sector-regime-year (FE $_{cs,t}^R$)			Yes
Product-year (FE $_{k,t}$)			Yes
Observations	1,938,491	1,938,491	1,938,491

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

In the light of our simple model with heterogeneous firms, finding that the elasticities are the same for export values as for export quantities suggests that while exporters pass on VAT rebate changes in prices, a substantial entry/exit by inferior firms leads to a compositional change such that there is no change in average prices. As shown at the end of the model in Section A-2, under Pareto the export tax elasticity for the unit value is $\frac{-1}{\sigma-1}$, which equals -0.2 in the case where $\sigma = 6$. The predicted coefficient for export prices is hence much smaller than that for export values or quantities. Our results are rather in line: our estimates on unit values are very small and are not significantly different from zero.

Finally, panel C presents the results on the number of destinations that city c serves with product k under regime R . If firms start or stop exporting a given product as a result of a change in the export VAT rebate, we expect the number of destinations to change as well. Indeed, we confirm that higher export VAT taxes discourage exporters from serving a specific market entirely: the point estimates suggest that the number of destinations to which a Chinese city exports is decreasing by nearly 3% as a result of a one percent rise in export VAT tax. Again, this only applies to eligible exports. As with the other margins, ineligible processing trade shows no reaction to a change in export VAT tax.

4.3 The role of the export VAT tax during the financial crisis

Claims that China is using its export VAT tax rebate system to give its exporters an unfair advantage on the world market have been raised in particular during the recent financial crisis, which started in the last quarter of 2008. In 2009, global trade dropped by about 11%. In response to the global recession the average export VAT tax declined from 7.94% in 2008 to 6.72% in 2009. In 2010, the government increased the VAT rebates even further for many of the products concerned by the initial tax cut in 2008 or 2009. In total, between 2008 and 2010, export VAT taxes declined for 2870 HS6-products, while over the same time

period it rose for only 382 products. This steep decline in tax rates came after several years of a steady increase in the average tax rates, as we show in Figure B-1.

Given our previous findings, we would expect that these tax decreases have indeed helped Chinese exporters to perform better during the crisis. However, in the first years after the crisis hit, the government doubled down on its initial tax rebates in 2008 and 2009. Also, world demand for many products was very low at that time. Therefore, it is not clear that exporters could benefit from the tax cut to the same extent as in better times. To test whether the sensitivity of China's exports with respect to changes in the export VAT tax remain the same throughout the crisis years, we add interaction terms of the tax with year dummies for the last four years of our sample, which capture the year of the crisis and its immediate aftermath.

Table 3 shows the results of this specification for export values and the three margins of adjustments (quantities, unit prices and the number of destinations). Column 1 shows results for export values, indicating that the effect of the tax seems indeed less strong in 2010 and 2011, after the largest number of tax decreases. Using the average coefficient of the export tax and its interaction term with 2010 ($4.184 - 9.196 = -5.012$) in column 1 of Table 2 we compute that the decline of 1.1% in our independent variable would be responsible for 5.5% higher eligible exports over that crisis year than in the counterfactual of no policy change. Even though this is lower than our benchmark estimate of 7.17 it is still important.

We thus conclude that even though there seems to be a somewhat lower sensitivity of exports to changes in the export VAT tax in the years after the crisis, there seems to be no disruption in the repercussions of the VAT policy.

When we look at the decomposition of this effect into price and quantity, we see that this effect is again driven mostly by the changes in quantities. Firms did not seem to use the decrease in taxes to increase their margins, as prices are unaffected. Interestingly, we see

Table 3: The impact of the export VAT tax during the crisis

	(1)	(2)	(3)	(4)
	Ln Value $_{ck,t}^R$	Ln Quantity $_{ck,t}^R$	Ln Unit value $_{ck,t}^R$	Ln Nb Countries $_{ck,t}^R$
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R$	-9.196 ^a (1.239)	-8.938 ^a (1.258)	-0.021 (0.564)	-3.045 ^a (0.471)
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R \times 2009$	1.954 (1.642)	2.944 ^c (1.775)	-1.569 ^c (0.801)	0.168 (0.594)
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R \times 2010$	4.184 ^b (1.820)	4.114 ^b (1.900)	-0.203 (0.821)	0.176 (0.674)
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R \times 2011$	3.908 ^b (1.799)	2.957 (1.887)	0.424 (0.700)	0.914 (0.716)
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R \times 2012$	2.385 (1.740)	1.295 (1.829)	0.354 (0.826)	-0.422 (0.700)
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes	Yes
Fixed effects				
City-product-regime (FE $_{ck}^R$)	Yes	Yes	Yes	Yes
City-sector-regime-year (FE $_{cs,t}^R$)	Yes	Yes	Yes	Yes
Product-year (FE $_{k,t}$)	Yes	Yes	Yes	Yes
Observations	1,938,491	1,938,491	1,938,491	1,938,491
R^2	0.844	0.885	0.924	0.896

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. ^c stands for city, k for the HS6 product level, t for year and R refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

a negative and significant effect on unit values in 2009. This could be potentially explained by the many firms who experienced an export VAT tax increase in 2008 (1,626 products observed an overall increase in their tax rate in 2008 compared to 2007) and hence who got particularly hit by the crisis as they were still adapting to the higher costs from the recent raise in export VAT tax. This could have led these firms to either exit or substantially decrease their margins in order to be still able to compete on the international markets.

From our findings we can thus conclude that even though the sensitivity of exports to changes in the VAT export tax was slightly lower during the global recession than in previous years, the massive rise in Chinese export VAT rebates in response to the crisis helped to

maintain the profitability of domestic exporters amid declining world prices, and resulted in relatively higher Chinese exports for the products that benefited from this policy.

4.4 Are our results immune to exporters' misreporting practices?

This section asks whether our estimates of the decline in the value of exports as a result of the decrease in the export VAT rebate could simply reflect misreporting by businesses of their exports for tax evasion purposes. There is evidence that Chinese exporters under-report the value of their exports to avoid paying taxes based on the value of exports (Ferrantino et al., 2012). Misreporting can happen either through the underreporting of export values or through the misclassification or mislabeling of goods from a higher-taxed to a lower-taxed product. If this is a common practice, this could lead to an upward bias of the estimate of the policy impact.

The fact that our estimate of the tax elasticity of trade is similar for quantities and values is, however, rather reassuring. Quantities are more easily observable by customs authorities and hence may be less subject to misreporting. Fisman and Wei (2004) find prevalent underreporting of the total value imported to China from Hong-Kong to avoid paying taxes based on export value. Quantities seem much less affected by these practices. This would imply that export prices are underreported. An increase in the export VAT rebate should encourage exporters to cheat less and thus declare a higher price at customs. However, as we have shown in our results so far, the estimates for quantities and values are highly similar and do not suggest that there is much underreporting of values that is systematically correlated with changes in the export VAT tax. Nevertheless, there might be still the problem of misclassification of products.

We follow two main strategies to alleviate the concerns. In our first approach, we exclude ordinary trade and focus only on processing trade, as stricter controls and enforcement of

processing trade at the Chinese border makes exporters of processing products less likely to under-report than normal exporters (Ferrantino et al., 2012). Our second approach consists in comparing trade elasticities of exports to high-income and low-income countries.

4.4.1 Processing trade

Table 4 reproduces our baseline results when zooming in on the differential effect of the VAT policy between eligible and non-eligible processing trade. In addition to reducing the risk of under-reporting, limiting the sample to processing trade also allows to ensure a greater comparability between the two trade regimes by making our sample more homogenous. All eligible and ineligible trade flows are conducted under the processing regime and are therefore subject to the same regulations with the exception of the export VAT rebate policy. The rules specific to the processing trade, such as the exemption from import duties and restrictions under processing trade, now apply to the full sample and therefore cannot bias our coefficient of interest.

Ordinary and processing regimes differ in a variety of dimensions (notably the use of domestic inputs)³⁸ that could be perceived as potentially calling into question the identification strategy based on the comparison of ineligible processing flows with eligible flows combining eligible processing flows and ordinary flows. However, as we explain in Section 2, the increase in the export VAT tax does not hurt firms in proportion to the importance of their domestic input purchase. We thus do not expect a differential impact of the export VAT tax between ordinary and eligible processing trade due to their differential use of domestic inputs. Nevertheless, one could still worry that processing exporters who are more likely compared to ordinary exports to rely on bonded duty-free imported inputs (BIM in Equation 1) respond less to a given change in the export rebate as the total value rebated is

³⁸Ordinary exports embody more than twice as much domestic value added per US dollar as do processing exports (Kee and Tang, 2016; Koopman et al., 2012).

Table 4: The impact of the export VAT tax: Only processing trade

	(1)	(2)	(3)	(4)
	Ln Value $_{ck,t}^R$	Ln Quantities $_{ck,t}^R$	Ln Unit value $_{ck,t}^R$	Ln Nb Countries $_{ck,t}^R$
Ln VAT tax $_{k,t-1} \times \text{Elig.}^R$	-3.810 ^a (1.248)	-4.663 ^a (1.354)	0.551 (0.641)	-1.538 ^a (0.468)
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes	Yes
Fixed effects				
City-product-regime (FE $_{ck}^R$)	Yes	Yes	Yes	Yes
City-sector-regime-year (FE $_{cs,t}^R$)	Yes	Yes	Yes	Yes
Product-year (FE $_{k,t}$)	Yes	Yes	Yes	Yes
Observations	489,773	489,773	489,773	489,773
R^2	0.866	0.949	0.893	0.879

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers here to the different eligibility regimes in the VAT-rebate system among processing trade only: the non-eligible processing trade with supplied inputs and the eligible processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

calculated using a lower tax base (exports minus BIM). Moreover, we could expect a stronger impact of changes in the export VAT tax for firms that also have good access to the domestic market. Because ordinary exporters are more likely to sell in the domestic market as well, they may be more responsive to a change in export VAT tax, as they can more easily shift sales between domestic and foreign buyers.

Results displayed in Table 4 confirm a negative effect of the export VAT tax on values, quantities and the number of countries served, even though the coefficients are slightly lower compared to our full sample (Table 1 and Table 2). This reduction is expected in view of the three arguments listed above: less under-reporting, smaller tax base for the rebate and less capacity to redirect exports to the domestic market.

However, the decrease in the coefficients actually appears to be mainly the result of the reduction in sample size. Our demanding set of fixed effects restricts the identification to variations of exports across products within the same sector, city, trade regime and year.

When ordinary trade is excluded, this restriction requires a city to export under both the non-eligible processing regime and the eligible processing regime for a given sector. This constraint is much more restrictive than the initial requirement that a city must export in both the non-eligible processing regime and the eligible regime for a given sector, regardless of whether the latter is in the ordinary or processing regime. Table D-6 in the appendix reproduces our baseline results of Table 1 and Table 2 with eligible exports including ordinary exports but on the restricted sample of Table 4. The point estimates are similar to those in Table 4 suggesting that the lower magnitude of the coefficients is mainly explained by the lower number of observations and thus a smaller range of cities and products used for the identification of the policy impact.

Overall, we believe that the main point is that the coefficients we obtained in those various tables are negative and significant for both ordinary and eligible processing trade and that the effects on all margins are consistent with our theoretical expectations. This reassures us that the overall negative repercussions of the export VAT tax we identified in the previous sections are not mainly driven by misreporting or structural differences between processing and ordinary trade. Since our intent is to assess how the changes in the export VAT tax have affected China's export performance, we feel it is appropriate to use the whole sample of observations and include ordinary trade in the eligible trade as ordinary transactions account for at least 45% of China's exports and hence constitute the main basis on which the export VAT rebate policy is applied.

4.4.2 High-income versus low-income countries

Our second approach to ensure that misreporting of export flows is not driving our results consists in comparing trade elasticities of exports to high-income and low-income countries. If misclassification or underreporting in order to avoid paying taxes is common, it might be

more likely to happen with shipments to less developed countries, where there is less capacity to detect and sanction irregularities at border controls at arrival (Fisman and Wei, 2009; Jean and Mitaritonna, 2010). If that is the case, we would expect to see a stronger impact of the tax on shipments towards poorer countries.

To test for this hypothesis we split the exports of each city-product-regime triplet into two groups of countries according to their income level. We construct for each year two different export flows for each triplet: one for high income and one for lower income countries.³⁹ In principle this should double our sample size, but not all city-product-regime triplets export to both groups of countries every year. We add to our empirical specification a new interaction variable between the export VAT tax and a dummy for High income countries. We also modify our set of fixed effects in order to better capture any potential differential evolution of exports between the two groups of destination countries. Notably, we let the product-year dummies and the city-product-regime dummies vary by the two different destination groups noted d ($FE_{kd,t}$ and FE_{kd}^R). We keep the already very demanding time-varying city-sector-regime dummies, $FE_{cs,t}^R$, as splitting them further up by destination would lead to too many small groups without any variation to exploit. Instead, we add two different subsets that vary by type of destination: $FE_{sd,t}^R$ vary by sector, regime type, destination and year and $FE_{cd,t}^R$ are city-regime type fixed effects that vary by year and destination and control for the fact that cities may evolve differently in their orientation towards specific destinations.

Results for this strict specification for export values and the three margins of adjustment are displayed in Table 5. For all columns the average effect of the export VAT tax remains similar to our main results in Tables 1 and 2. The interaction with the high income dummy is never significant and the negative sign of the coefficient indicates that, if anything, the

³⁹We follow here the classification of the World Bank given by the World Development Indicators. High income countries are those countries that are defined as *High income* in 2002. All other countries are classified as lower income countries.

Table 5: The impact of the export VAT tax by group of country

	(1)	(2)	(3)	(4)
	Ln Value $_{ckd,t}^R$	Ln Unit Value $_{ckd,t}^R$	Ln Quantity $_{ckd,t}^R$	Ln N countries $_{ckd,t}^R$
Ln VAT tax $_{k,t-1} \times \text{Elig.}^R$	-5.120 ^a (1.560)	0.867 (0.689)	-5.600 ^a (1.726)	-2.258 ^a (0.565)
Ln VAT tax $_{k,t-1} \times \text{Elig.}^R \times \text{High Income}_d$	-1.652 (1.768)	-1.047 (0.685)	-1.272 (1.883)	-0.209 (0.504)
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes	Yes
Fixed effects				
City-product-regime-group (FE $_{ckd}^R$)	Yes	Yes	Yes	Yes
City-sector-regime-year (FE $_{cs,t}^R$)	Yes	Yes	Yes	Yes
Product-year-group (FE $_{kd,t}^R$)	Yes	Yes	Yes	Yes
Sector-regime-year-group (FE $_{ds,t}^R$)	Yes	Yes	Yes	Yes
City-regime-year-group (FE $_{cd,t}^R$)	Yes	Yes	Yes	Yes
Observations	3,009,119	3,009,119	3,009,119	3,009,119
R^2	0.823	0.914	0.869	0.874

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors (*s*) are defined following the Chinese 4-digit GB/T industry classification and regroup several products. *d* distinguishes between high-income and low-income countries.

effect of the tax seems to be stronger in the high income countries. These results therefore suggest that our estimates are not driven by misreporting to avoid export VAT taxes.

5 Conclusion

Our study shows that China's export value-added tax (VAT) rebate system is a major industrial policy that affects its exports. We propose a new identification strategy using export data at the city-product level over the 2003-12 period to show how changes in the export VAT tax affect the different trade margins in terms of volumes, prices and the number of countries served. We address endogeneity by exploiting variations in the expected impact of the export VAT rebates by trade regime, which come from an eligibility rule disqualify-

ing certain export flows from the rebates. Our difference-in-difference-in-differences results suggest that a 1% rise in the export VAT tax leads to a 7.2% relative decrease in eligible export values at the city level. This effect is due to an adjustment of quantities while the average unit values of exports remain unchanged. These results, combined with the finding of a decrease in the number of countries served, are in line with our theoretical predictions that changes in export VAT tax pass through to prices, but that substantial entry/exit by inferior firms leads to a compositional change such that there is no change in average prices.

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A Theoretical Framework

We present a simple model of international trade with heterogeneous firms to highlight the expressions for the elasticity of the trade volume and price with respect to the export tax resulting from the incomplete VAT rebates. As explained in the main text, the non-rebated VAT amounts to an export tax. While it is expected that an export tax lowers the number of exporters and the volume of exports for infra-marginal exports, we need to derive our estimating equation from a formal model of trade to interpret the elasticity we get on the tax for the export quantity and export price at the product level.

A-1 Production and consumption

Our model builds on Melitz (2003) and Chaney (2008). We focus on the behavior of exporters using a partial equilibrium. We consider a given industry, characterized by the standard Dixit-Stiglitz assumption of monopolistic competition. There are N firms in this industry, each producing a single differentiated variety.

To produce and sell good k on a foreign market, each firm i incurs a firm-specific marginal cost c_i , a product-specific ad-valorem export tax t_k ⁴⁰ and a destination-country export fixed cost C_j that is considered to be identical for all firms exporting to country j .

As is usual in the Dixit-Stiglitz monopolistic competition framework, the profit-maximizing price is a constant mark-up over marginal cost:

$$p_k(c_i) = \frac{\sigma}{\sigma - 1} c_i \quad (3)$$

where $\sigma > 1$ is the elasticity of substitution between two varieties of good k .

The price firm i charges for product k with marginal cost c_i to consumers on market j

⁴⁰It corresponds to the un-rebated VAT. As indicated in Equation 1 in the main text, the export tax rate implied by the incomplete VAT rebate applies to the export value.

includes also the export VAT tax:⁴¹

$$p_{kj}(c_i) = \frac{\sigma}{\sigma - 1} c_i (1 + t_k) \quad (4)$$

Let E_j denote the total expenditure in country j on the relevant industry, and P_j the price index in country j . The final demand for goods in location j is derived from the maximization of the representative consumer's CES utility function. Country j 's demand for a given variety i of good k is:

$$m_{kj}(c_i) = p_{kj}(c_i) q_{kj}(c_i) = [p_{kj}(c_i)]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} \quad (5)$$

From these exports, firm i will receive the value net of taxes $\frac{m_{kj}(c_i)}{(1+t_k)}$.

A-2 Export tax, trade volume and price

Using profit-maximizing prices (Equation 3), we can write the profit for firm i from exporting good k to country j as:

$$\pi_{kj}(c_i) = \frac{m_{kj}(c_i)}{(1 + t_k)} - c_i q_{kj}(c_i) - C_j = \frac{m_{kj}(c_i)}{\sigma(1 + t_k)} - C_j \quad (6)$$

Firms decide to export based on their individual profit. Let \bar{c}_j denote the marginal-cost level that ensures that the revenue from exporting to country j just equals the total exporting cost. Substituting Equations 5 and 4 in Equation 6 gives:

$$m_{kj} = \left[\frac{\sigma}{\sigma - 1} \bar{c}_i (1 + t_k) \right]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} = C_j \sigma (1 + t_k) \quad (7)$$

Hence the marginal-cost threshold value is:

⁴¹For simplicity we abstract from transportation costs.

$$\bar{c}_j = \lambda_j \frac{1}{C_j} \frac{1}{(1+t_k)^{\frac{\sigma}{\sigma-1}}}, \quad (8)$$

with $\lambda_j = \frac{\sigma-1}{\sigma} E_j^{1/(\sigma-1)} P_j$.

All firms with marginal cost lower or equal to \bar{c}_j ⁴² will export to j a quantity equal to:

$$q_{kj}(c_i) = \left[\frac{\sigma}{\sigma-1} c_i (1+t_k) \right]^{-\sigma} \frac{E_j}{P_j^{1-\sigma}} \quad (9)$$

Assuming that marginal cost is distributed as $P(\tilde{c} < c) = F(c)$ and $dF(c) = f(c)$, the total number of exporting firms is:

$$N_j = \int_0^{\bar{c}_j} N f(c) dc \quad (10)$$

with the marginal-cost threshold \bar{c}_j falling with the export tax (Equation 8). A drop in \bar{c}_j corresponds to a higher productivity threshold for exporting and hence fewer exporters.

The exported quantity is:

$$Q_j = \int_0^{\bar{c}_j} N q_{kj}(c_i) f(c) dc \quad (11)$$

It is straightforward to see that the intensive margin (average quantity per exporting firm in Equation 9) and the extensive margin (total number of firms in Equation 10) of the bilateral exported quantity to j , Q_j , are negative functions of the export tax t_k .

Total export value also declines as the export tax rises since it brings a reduction in the number of exporters N and a rise in price p_{kj} :

$$V_j = \int_0^{\bar{c}_j} N m_{kj}(c_i) f(c) dc = \int_0^{\bar{c}_j} N [p_{kj}(c_i)]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} f(c) dc \quad (12)$$

Our expectation is hence a reduction in the export quantity and value following a rise in the export tax stemming from incomplete VAT rebates.

⁴²Note that \bar{c}_j compares to \bar{c}_j^* the classical threshold in Melitz (2003) in the following way: $\bar{c}_j = \bar{c}_j^* \frac{1}{(1+t_k)^{\frac{\sigma}{\sigma-1}}}$.

The theoretical prediction regarding average (tax-inclusive) export prices ($\frac{V_j}{Q_j}$) is less clear cut since it concretely depends on the assumptions regarding the distribution of marginal cost $F(c)$. On the one hand, a rise in trade costs results in higher prices (Equation 4). On the other hand, a rise in the export tax induces a fall in the cut-off \bar{c} , which drives some of the less productive firms, those charging high prices, out of export markets. This composition effect induces a reduction in the average unit value of exports that could well more than fully compensate the initial rise in individual prices.

We can obtain a direct expression of the export tax elasticity for the export value if we specify the marginal cost distribution function $F(c)$. Let us follow Chaney (2008) and assume that the marginal cost c has a Pareto distribution, bounded between 0 and 1, with a shape parameter $\gamma > \sigma - 1$. In that case, marginal cost is distributed as $P(\bar{c} < c) = F(c) = c^\gamma$ and $dF(c) = f(c) = \gamma c^{\gamma-1}$.

Using the expressions of p_{kj} (Equation 4) and of \bar{c}_j (Equation 8), Equation 12 then becomes

$$V_j = \int_0^{\bar{c}_j} N\left[\frac{\sigma}{\sigma-1}c_i (1+t_k)\right]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} f(c) dc = A(1+t_k)^{1-\sigma} [(1+t_k)^{\frac{-\sigma}{\sigma-1}}]^{(1-\sigma+\gamma)} \quad (13)$$

where A includes parameters that do not vary as a function of c or t .

Once simplified and log-linearized we obtain :

$$\ln V_j = \ln A + \frac{\sigma(1-\gamma)-1}{\sigma-1} \ln(1+t_k) \quad (14)$$

This yields an export tax elasticity for the export value which is equal to $\frac{\sigma(1-\gamma)-1}{\sigma-1}$. The literature proposes average estimates of σ for China of about 6 (Broda and Weinstein, 2006). Following di Giovanni and Levchenko (2013) and considering that $\gamma/(\sigma-1)$ can range between 1 and 2, we obtain a range for the export tax elasticity for the export value between

-5 and -11.

We can obtain a direct expression of the export tax elasticity for the export quantity by following the same approach for Equation 11.

We get :

$$\ln Q_j = \ln B + (1 - \gamma) \frac{\sigma}{\sigma - 1} \ln(1 + t_k) \quad (15)$$

Using the average estimates of σ and γ as above, we obtain a range for the elasticity for the export quantity between -4.8 and -10.8.

Following the same logic we find that export tax elasticity for the average export price ($\frac{V_j}{Q_j}$) is $\frac{-1}{\sigma-1}$. Assuming that $\sigma = 6$ yields a value of -0.17.

B Stylized facts on VAT rebates

Over the 2002-2012 period, only 13% of the products received rebates compensating for the full VAT rate. Incomplete rebates, which are equivalent to export taxation, are hence the rule in China. Export taxes are implemented in different countries for a variety of reasons, such as manipulation of the terms of trade, stabilization of domestic demand, food security or value-chain climbing (Bouët and Laborde, 2011). The temporal evolution of the average export VAT tax applied in China suggests that different motivations have prevailed over time. As can be seen in Figure B-1, the average tax rate has increased continuously from 2002, before falling sharply in 2009 in reaction to the international crisis. The upward trend reflects mostly the attempt to reduce the growing financial burden of refunding the rebates for the government as China's trade surplus exploded (Chandra and Long, 2013). It may also reflect China's attempt to offset the effect of the import tax cuts implemented in the context of WTO accession (Garred, 2018). In addition it corresponds to strategic reductions of rebates on products associated with environmental problems or looming trade disputes

(Gourdon et al., 2016). Whereas in 2002 the average export VAT tax rate was only 2%, it increased to around 8% in 2008. This rate decreased to around 6% in 2009 as the global economic crisis induced the authorities to raise the export VAT refund rates on thousands of commodities.⁴³

The primary logic of export VAT rebate changes relates to the support for sophisticated high-technology products and the limitation of exports of energy intensive and polluting products (Gourdon et al., 2016; Eisenbarth, 2017). Variations in export VAT rebates also appear consistent with mitigation of trade dispute risks and the pursuit of food security. The financial crisis in 2008 has however led authorities to increase export rebates across the board. Reinforced support to export activities applied to a variety of industries including low technology products such as textiles and ceramics (Gourdon et al., 2016). There is hence no reason to believe that rebates are disproportionately targeted towards products whose export response is very elastic with respect to rebates so that it drives our findings.

Figure B-2 displays, for each of the 97 HS2 categories, the average and standard deviation of export VAT taxes for 2002, the first year of our sample.⁴⁴ This shows that export VAT taxes vary substantially across products, even within a sector.

Figure B-3 reports for each HS2 category the average annual change between 2002 and 2011 in the export VAT tax at the HS6 level, illustrating the magnitude of changes in the VAT rebates over the period. During our sample period, the export VAT tax increased overall, with only a few sectors experiencing a decline. However, the standard deviations highlight the wide variety of variations in export VAT rebates between products in the same sector, which is consistent with the use of export VAT rebates as a fine industrial policy tool.

⁴³The average probability that an adjustment takes place in a given year for a given HS6 product was 34% over this period. This figure was over 60% in both 2004 and between 2007 and 2009.

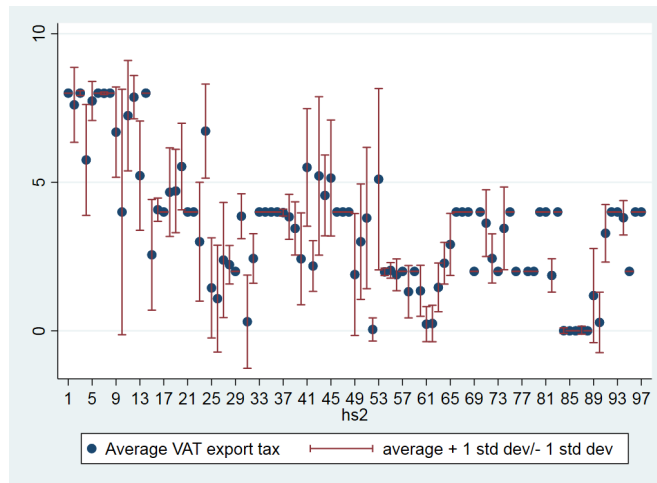
⁴⁴In our regressions, we define sectors according to the Chinese 4-digit GB/T industry classification. However, since there are more than 400 GB/T sectors, Figures B-2 and B-3 use the broader HS2 classification which has only 97 subgroups. A HS2 category regroups up to 509 HS6 products.

Figure B-1: Evolution of yearly average export VAT tax 2002-2012



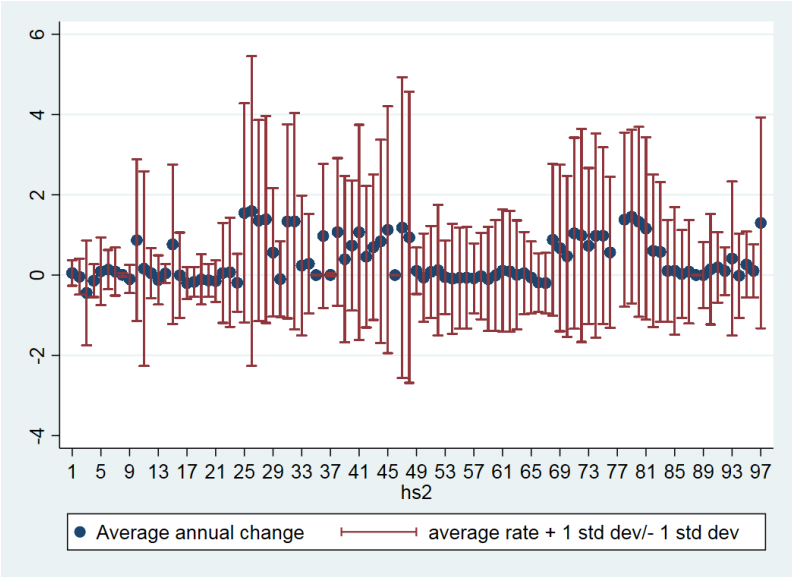
Note: The VAT tax is calculated in % as the simple average over all products. During our sample period the export VAT tax rates range between 0 and 17%.

Figure B-2: Average export VAT tax and dispersion within each HS2 (2002)



Note: There are in total 97 HS2 categories. Each HS2 category contains between 4 and 509 HS6 products (the median is 29). The export VAT tax rates range between 0 and 17%.

Figure B-3: Average annual change in export VAT tax and dispersion within each HS2 (2002-2012)



Note: There are in total 97 HS2 categories. Each HS2 category contains between 4 and 509 HS6 products (the median is 29). The export VAT tax rates range between 0 and 17%.

C Data sources and classifications

C-1 Export VAT rebate data

Export VAT rebate rates and VAT rates at the tariff-line level (HS 8-digit or more disaggregated levels) are taken from the Etax yearbooks of Chinese Customs. While export VAT rebates change frequently, the VAT rates have remained constant between 2002 and 2012.⁴⁵

The Chinese 8-digit classification is not consistent over time. To account for these changes which follow the different revisions of the international HS classification in 2002, 2007 and 2012, we aggregate the data to the HS 6-digit level (1996 revision)⁴⁶ using the yearly average of these rates.⁴⁷ This gives us the VAT rate and export VAT rebate for 5,006 exported HS6 products. Table C-1 presents some descriptive statistics.

C-2 Trade data

The data collected by Chinese Customs include annual export values and quantities by city at the 8-digit product level and separate trade flows according to transaction type and firm ownership. Aggregating the trade flows to the HS6 (1996 revision) level yields a panel of 4,823 products over the 2003-2012 period.

We construct the average unit value of exports by city c of product k for regime type R in year t as the weighted average of the ratio of values over quantities for each destination country. The weight of each observation is the share of this country-product pair in the exports under that regime type of the city in that year.

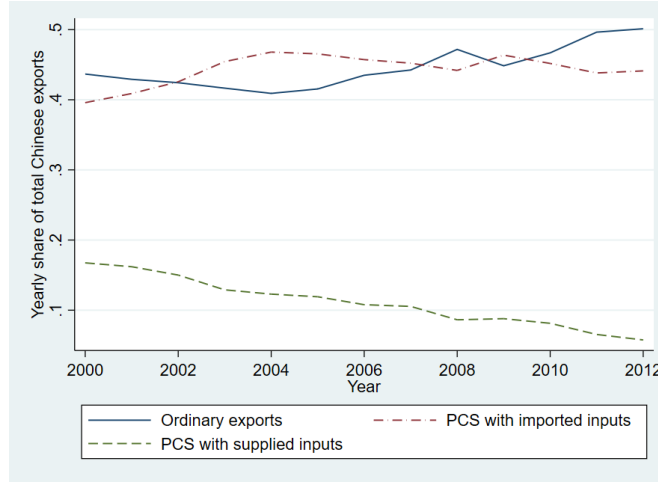
The extensive margin is defined as the number of countries d to which a city c exports a given product k in regime type R .

⁴⁵The standard rate of 17 percent applies to roughly 93% of our main sample.

⁴⁶The correspondence tables from UNCTAD can be found at http://unstats.un.org/unsd/trade/conversions/HS_Correlation_and_Conversion_tables.htm.

⁴⁷We use the simple average of all tariff lines within a HS6 product and all sub-periods within the year.

Figure C-1: Decomposition of China’s export flows by trade regime



Source: own calculations.

C-3 Construction and data sources of control variables

The Customs trade data is used to obtain several of our control variables: Export growth $_{k,t-1}$, Export growth $_{ck,t-1}$, Foreign export share $_{ck,t-1}^R$ and State export share $_{ck,t-1}^R$.

Export growth $_{k,t-1}$ and Export growth $_{ck,t-1}$ are yearly export growth at the product-level and at the city-product level respectively. These proxies of export dynamics are computed using the mid-point growth rate formula using export values from $t-2$ and $t-1$. Foreign export share $_{ck,t-1}^R$ and State export share $_{ck,t-1}^R$ measure respectively the share of export quantities by foreign and state-owned firms for each product-city-regime combination.

World demand $_{k,t-1}$ is defined as the share of China’s exports in world exports for a given product in a given year. This variable is obtained from the BACI world trade dataset.⁴⁸

Export tax information comes from the General Administration of Customs of the People’s Republic of China (www.customs.gov.cn) and the Ministry of Finance of the People’s Republic of China (www.gss.mof.gov.cn). We calculate annual export taxes at the HS 6-digit

⁴⁸This dataset is based on COMTRADE data using an original procedure that reconciles the declarations of exporters and importers (Gaulier and Zignago, 2010). BACI uses the 1996 HS 6-digit product nomenclature. It is downloadable from <http://www.cepii.fr/anglaisgraph/bdd/baci.htm>.

Table C-1: Summary statistics of variables

	Mean	Std. Dev.	Min	Max
Ln exported quantity $_{ck,t}^R$	9.895	3.665	0	24.117
Ln export value $_{ck,t}^R$	11.658	2.892	0	23.956
Ln unit value $_{ck,t}^R$	1.762	2.401	-10.127	19.969
Ln export VAT tax $_{k,t-1}$	0.042	0.035	0	0.157
VAT rebate $_{k,t-1}$ (%)	12.435	3.920	0	17
VAT rate $_{k,t-1}$ (%)	16.835	0.716	13	17
World demand $_{k,t-1}$	0.209	0.180	0	0.944
Export tax $_{k,t-1}$	0.084	1.391	0	106
Import tariffs $_{k,t-1}$	10.808	6.209	0	68
Export growth $_{k,t-1}$	0.195	0.326	-2	2
Export growth $_{ck,t-1}$	0.261	1.189	-2	2
Foreign export share $_{ck,t-1}^R$	0.240	0.380	0	1
State export share $_{ck,t-1}^R$	0.246	0.375	0	1

Refer to Section 3.2 and Appendix C-3 for a detailed description of these variables. The statistics are based on the sample in our triple-difference benchmark specification (1938416) (column 4 of Table 1).

level as the simple average over the various lines. This rate includes the special tax (from 2009) when applicable. The number of HS6 products covered by export taxes rose from 20 in 2002 to 252 in 2012.

Data on import tariffs at the HS6 level come from the World Integrated Trade Solution (WITS). We calculate simple averages of MFN tariffs, which measure the average level of nominal tariff protection applied to imports into China.

C-4 Different classifications of products

In Table D-3, we check that our results hold after excluding a number of product categories which have specifically been targeted by the Chinese authorities. Rare-earth products are those listed in the WTO reports (WTO, 2008 and 2010), and products under conflict are a small group of 21 HS6 products of raw materials.⁴⁹

⁴⁹Recently the “China Raw Materials dispute” at the WTO highlighted Chinese efforts to restrict its exports of rare-earth products which are key in the production process of many high-value products. China is by far the world’s largest producer of the 17 metals known collectively as “rare earths”. In the 2000s, Chinese authorities gradually tightened restrictions on these products in an effort to encourage the domestic

Energy- and emission-intensive products are identified from the European Commission classification which singles out 78 HS6 products as energy- and carbon-emission intensive (Bergmann et al., 2007). High-tech products are defined based on the list established by the OECD of 319 high-tech products (Hatzichronoglou, 1997). The list of high-skilled products comes from the UNCTAD.

D Robustness Checks

D-1 Evidence on switching of regime types

A main challenge of our empirical analysis concerns the switching of regime types as a consequence of a change in the export VAT rebate rate. Here, we provide several arguments that the regime choice seems to be independent from changes in the export VAT tax.

First, as shown in Column 2 of Table 1, we find no significant association between the export VAT tax and non-eligible exports which suggests that changes in the VAT rebate do not appear to determine the regime in which firms run their operations. By contrast, this suggests that non-eligible exports are indeed an appropriate control group.

Table D-1 addresses more directly the possibility of firms switching from eligible to non-eligible trade after an increase in the export VAT tax. We construct for each city-product-regime triad a time-varying indicator that measures the share of destinations for which a flow appears in regime type R while it disappears for the other regime type. In column 1 we look at the share of destinations that switch from non-eligible to eligible trade. If switching between regimes is common a decrease in the export VAT tax should result in a shift towards the eligible regime. We thus expect a negative coefficient of the export VAT tax. Conversely, in column 2, where we look at the share of destinations which see a switch to non-eligible processing of these metals and secure a better position in the global value chain.

trade, we expect a positive coefficient since a higher tax makes it less advantageous to export for eligible compared to non-eligible trade.⁵⁰ For both types of trade, coefficients are close to zero and we do not find any significant impact of the export VAT tax. We are thus confident that firms modifying their regime type is not driving our results in Section 4.

Our results are also consistent with the literature on the specific motives behind the ineligible regime of processing trade with supplied materials in China. Findings are largely unrelated to the VAT rebate system. Manova and Yu (2016) show that the regime type of trade chosen by companies is driven by the importance of financial constraints. Since the ownership of imported intermediates entails high up-front costs, financial constraints restrict firms to processing trade with supplied materials. Fernandes and Tang (2012) show that the choice of form of trade is related to factors that have been suggested by theories of the boundaries of the firm, such as control and hold-up. Their results suggest that control over imported components by international firms is an alternative to asset ownership in alleviating hold-up by export-processing plants. We hence expect the extent of processing trade with supplied materials to depend mostly on the observability of input use or the dominance and power of foreign buyers.⁵¹

Finally, Brandt and Morrow (2017) investigate another particularity of firms engaged in processing with supplied inputs: their inability to source domestically. As opposed to manufacturers engaged in ordinary trade and processing with imported materials, those in processing trade with supplied inputs are not allowed to buy inputs from China. Their role in China's exports should thus be related to the attraction of Chinese suppliers. The extent of processing trade with supplied inputs should then fall with improvements in the number,

⁵⁰We rely here on our double-difference specification, detailed in Section 3, which we run separately for the two regime types (and hence do not include the interaction with the Eligibility dummy and product-year fixed effects).

⁵¹It could also depend on the degree of relationship specificity of the physical capital used in production (Nunn and Treffer, 2013).

Table D-1: Regime switching

Dependent variable	Share of destinations ^R _{ck,t} that switched regime	
	(1) from eligible to non-eligible	(2) from non-eligible to eligible
Ln export VAT export _{k,t-1}	0.001 (0.003)	0.065 (0.045)
Export growth _{ck,t-1}	0.001 (0.001)	-0.001 (0.001)
Foreign export share ^R _{ck,t-1}	0.001 ^b (0.001)	0.019 ^a (0.002)
State export share ^R _{ck,t-1}	0.001 ^a (0.001)	0.016 ^a (0.002)
Export growth _{k,t-1}	-0.001 (0.001)	-0.001 (0.002)
World demand _{k,t-1}	0.001 (0.001)	-0.002 (0.010)
Export tax _{k,t-1}	0.012 ^c (0.007)	0.023 (0.050)
Import tax _{k,t-1}	0.003 (0.008)	-0.003 (0.039)
Fixed effects	city-product & city-sector-year	
Observations	1749521	188970
R ²	0.265	0.301

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. ^c stands for city, ^k for the HS6 product level, ^t for year and ^R refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors, indicated by ^s, are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

diversity, quality or cost advantage of Chinese manufacturers of intermediate inputs and not reflect the ups and downs in the export VAT tax.

To conclude, Figure C-1 shows the share of non-eligible exports between 2000 and 2012. This exhibits a continuous decline over the period, further suggesting the lack of any direct link between the choice of trade regime and the ups and downs in the VAT rebate policy. The downward trend is however consistent with the relaxation of financial constraints over time (in the spirit of Manova and Yu, 2016), the growing diversity and quality of China's intermediates (as suggested by Brandt and Morrow, 2017), and the progressive orientation of China's processing trade toward handling commodities with higher technological content and greater value-added potential.⁵²

D-2 Robustness to sample size and additional controls

Table D-2 shows that our benchmark results from Column 4 of Table 1 hold and that the magnitude of the export VAT tax coefficients remains highly similar when we modify the sample and add more controls. Column 1 of Table D-2 uses a sample which is no longer limited to ordinary trade and processing trade transactions but adds other types such as international aid, contracting projects or customs warehousing trade to the eligible export flows. These other regimes together cover less than 7% of total exports over the 2003-2012 period.

In columns 2 and 3 we use stricter fixed effects. Column 2 uses time and city varying fixed effects at the HS4 product-level instead of the sector-level ($FE_{cs,t}^R$). Column 3 replaces the product-year fixed effects with the highly demanding city-product-year fixed effects. The

⁵²One could worry that the decline in trade volumes for the ineligible group makes it unlikely that this is a good benchmark relative to which the performance of eligible exports is measured. In total, non-eligible trade represents only about 10% of the observations in our final sample. However Table D-2 shows that our results hold when we limit our sample to the city-product pairs that export simultaneously under both regimes. Furthermore, our results hold when the sample is limited to processing trade only, where close to 40% of the observations represent non-eligible exports (Table 4).

Table D-2: Additional results

Dependent variable	Ln exported value (city/product/regime/year)				
	(1) including “others”	(2) HS4 FE	(3) city-product year FE	(4) reduced sample I	(5) reduced sample II
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R$	-7.231 ^a (1.171)	-5.444 ^b (2.116)	-5.548 ^a (1.330)	-5.896 ^a (1.216)	-5.554 ^a (1.331)
Additional controls $\text{R}_{ck,t-1}^R$	Yes	Yes	Yes	Yes	Yes
Fixed effects					
City-sector-regime-year ($\text{FE}_{cs,t}^R$)	Yes		Yes	Yes	Yes
Product-year (FE_{kt})	Yes	Yes		Yes	Yes
City-HS4 product-regime-year		Yes			
City-product-year (FE_{ckt})			Yes		
Observations	1,946,369	1,938,491	1,938,491	528,278	348,578
R^2	0.841	0.870	0.948	0.885	0.903

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors, indicated by *s*, are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Reduced sample I only contains the 40,332 city-product pairs that report exports under both types of trade during our sample period. Reduced sample II only includes the 38,678 city-product pairs that report both types of trade in the same year. Additional controls $\text{R}_{ck,t-1}^R$ include Export growth $_{ck,t-1}$, Foreign export share $_{ck,t-1}^R$, State export share $_{ck,t-1}^R$ and Import tariffs $_{k,t-1} \times \text{Elig.}$

last two columns account for the fact that not all cities export in every year their products in both trade regimes. To make sure that these variations are not driving our results, we check that our estimates remain unchanged when we rely on samples of city-product pairs that export simultaneously under both regimes. Column 4 limits the sample to only city-product combinations (“reduced sample I”) that report exports under both types of trade during our sample period. Column 5 uses a very strict sample including only city-product observations (“reduced sample II”) that report both types of trade in the same year. Results remain similar.⁵³

⁵³In unreported results, we also ensure that results hold for the reduced sample I when observations with zero exports are included by adding 1 to the exports inside the log. Due to the high dimensional fixed effects, we cannot provide standard poisson estimates including zero-value trade flows.

Table D-3: Exports and export VAT taxes: excluding sensitive sectors

Dependent variable	Ln Exported value (city/product/regime/year)				
	(1)	(2)	(3)	(4)	(5)
Sample restriction	only manuf	w/o rare earths	w/o energy-int.	w/o high-tech	w/o high-skilled int.
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R$	-7.150 ^a (1.202)	-7.177 ^a (1.181)	-6.969 ^a (1.177)	-7.746 ^a (1.260)	-7.273 ^a (1.203)
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes	Yes	Yes
Fixed effects					
City-product-regime (FE_{ck}^R)	Yes	Yes	Yes	Yes	Yes
City-sector-regime-year (FE_{cst}^R)	Yes	Yes	Yes	Yes	Yes
Product-year (FE_{kt}^R)	Yes	Yes	Yes	Yes	Yes
R^2	0.844	0.844	0.844	0.841	0.842
Observations	1,897,488	1,936,070	1,920,788	1,819,227	1,899,280

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors, indicated by *s*, are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Additional controls $_{ck,t-1}^R$ include Export growth $_{ck,t-1}$, Foreign export share $_{ck,t-1}^R$, State export share $_{ck,t-1}^R$.

The remainder of this section checks that the main results from column 4 of Table 1 are robust across various subsamples.

First, Table D-3 verifies that our estimates do not reflect the specific features of some products which have been targeted by Chinese authorities as either strategic or undesirable. This allows us to address concerns regarding omitted unobserved policies that may be correlated with both VAT rebates and export performance. Our findings of a negative and significant effect of the tax on exports remain throughout.

Column 1 confirms that our estimates do not reflect some particular features of agriculture by limiting the sample to manufacturing products, as agricultural products have indeed been particularly targeted by Chinese authorities concerned by food security in a context of rising prices, notably in 2006-8. In column 2, the few but very strategic rare-earth products are excluded to make sure that they do not drive our results. The same logic is behind the

Table D-4: Exports and export VAT taxes: alternative samples

Dependent variable	Ln Exported value (city/product/regime/year)		
	(1)	(2)	(3)
Sample restriction	only VAT rate = 17%	no full VAT rebate	no zero VAT rebate
	(1)	(2)	(3)
Ln export VAT $\text{tax}_{k,t-1} \times \text{Elig.}^R$	-7.127 ^a (1.258)	-6.189 ^a (1.379)	-6.275 ^a (1.451)
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes
Fixed effects			
City-product-regime (FE_{ck}^R)	Yes	Yes	Yes
City-sector-regime-year (FE_{cst}^R)	Yes	Yes	Yes
Product-year (FE_{kt}^R)	Yes	Yes	Yes
R^2	0.844	0.840	0.847
Observations	1,782,680	1,115,967	1,790,909

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

exclusion of energy and carbon-intensive products in column 3 which might be specifically targeted in the attempt to reduce pollution. Column 4 excludes high-tech products as defined by the OECD to ensure that we do not pick up the many unobserved subsidies granted in this sector.⁵⁴ Finally, our results also hold when dropping high-skill intensive products (column 5).⁵⁵

In Table D-4, we make sure that our results are not driven by a specific type of VAT rate or rebate. In column 1 we check that our estimates are not driven by the different VAT rates across products and drop the 165 HS6 products in our sample with the reduced rate of 13% (instead of the basic 17%). In column 2 we exclude products which have enjoyed a full rebate

⁵⁴High-tech exporters have likely benefited from a variety of policies such as FDI promotion, production and R&D subsidies and access to preferential-tax high-tech zones as part of the Chinese effort to upgrade exports. Findings are robust to alternative classifications by high-tech products, as e.g. defined by Eurostat.

⁵⁵For details on how we identify the products to drop, see Appendix C-4.

at any time over our sample period, since they may have benefited from other unobserved policies. Column 3 restricts our sample to products that have throughout the whole sample period a positive rebate. Despite the sharp reduction in the number of observations (we drop one third of the products in the second case) the point estimates do not change significantly.

Our main findings remain unchanged in all specifications. Hence, we conclude that our estimated VAT-export tax impact is not simply picking up other aspects of industrial policy or product specific features. Overall, this confirms our claim that changing VAT rebates is an effective policy tool to manage exports in China.

D-3 Robustness to specificities of processing trade

This appendix provides robustness checks to take into account the fact that processing trade is subject to certain specific regulations and preferential treatment compared to ordinary trade. These policies thus apply fully to non-eligible exports but only partly to eligible flows, which combine ordinary and processing with imported materials. These specific policies could potentially bias our estimates if they are not accounted for.

As detailed in Section 3, our benchmark specification accounts for the main preferential treatment of processing trade which consists in the exemption of import tariffs on inputs used in processing exports. However, this preferential treatment can be denied to certain products at certain times, so that these products can then only be traded under the ordinary regime.

Column 1 in Table D-5 excludes all products which are at one moment during our sample period restricted from trade under the processing regime. From our benchmark sample 556 products are concerned by these restrictions.⁵⁶ When excluding these products, our sample

⁵⁶The list of products concerned (HS8/HS10 tariff lines) is provided in what is called the “Catalogue of Commodities Prohibited under Processing Trade”. It is revised regularly, almost every year, by the Ministry of Commerce and the General Administration of Customs. Announcements indicate that the changes are designed to shift the direction of China’s processing trade toward handling commodities with

Table D-5: Exports and export VAT taxes: restrictions to processing exports

Dependent variable	Ln Exported value (city/product/regime/year)	
	(1)	(2)
Sample	excluding restricted products under processing	re-including EPZs and BZs
	(1)	(2)
Ln VAT export $\text{tax}_{k,t-1} \times \text{Elig.}$	-8.302 ^a (1.538)	-6.787 ^a (1.152)
Additional controls $R_{ck,t-1}^R$	Yes	Yes
Fixed effects		
City-product-regime (FE_{ck}^R)	Yes	Yes
City-sector-regime-year (FE_{cst}^R)	Yes	Yes
Product-year (FE_{kt}^R)	Yes	Yes
R^2	0.843	0.844
Observations	1,693,348	1,956,080

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

is reduced but the coefficient of our variable of interest is slightly larger, suggesting that not explicitly accounting for these restrictions is not driving our main findings.

The second policy we are aware of that is specific to processing exports only are the so-called “bonded zones” and “export processing zones” (EPZs) in which the VAT regime is different. In our main sample, we address this issue by excluding exports coming from these zones. To ensure that our results are not driven by firms moving in and out of these zones following changes in the export VAT rebate rate, we include the exports from these zones in our sample and code them as non-eligible exports in their corresponding city. Again, our results reported in column 2 of Table D-5 suggest that our main findings hold.

Finally, Table D-6 replicates the main results of Tables 1 and 2 for the observations of the restricted sample of Table 4, which looks at processing trade only. However, it keeps also higher technological content and greater value-added potential.

Table D-6: Robustness check: reproduction of baseline results with the restricted sample of Table 4.

	(1) Ln Value $_{ck,t}^R$	(2) Ln Quantities $_{ck,t}^R$	(3) Ln Unit value $_{ck,t}^R$	(4) Ln Nb Countries $_{ck,t}^R$
Ln VAT export tax $_{k,t-1} \times$ Elig.	-5.166 ^a (1.190)	-5.465 ^a (1.283)	0.366 (0.567)	-2.095 ^a (0.420)
Additional controls $_{ck,t-1}^R$	Yes	Yes	Yes	Yes
Fixed effects				
City-product-regime (FE $_{ck}^R$)	Yes	Yes	Yes	Yes
City-sector-regime-year (FE $_{cs,t}^R$)	Yes	Yes	Yes	Yes
Product-year (FE $_{k,t}$)	Yes	Yes	Yes	Yes
R^2	0.918	0.935	0.958	0.952
Observations	489,773	489,773	489,773	489,773

This table uses the same 489,773 observations as in Table 4 which compares eligible and non-eligible processing trade. However, here eligible flows also include ordinary trade. Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. ^a, ^b and ^c indicate significance at the 1%, 5% and 10% confidence level respectively. *c* stands for city, *k* for the HS6 product level, *t* for year and *R* refers to the two eligibility regimes in the VAT-rebate system: the non-eligible processing trade with supplied inputs and the eligible ordinary and processing trade with imported materials. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

the ordinary exports of these observations in the eligible flows. The coefficients in Table D-6 are lower than in Tables 1 and 2 and closer to the ones reported in Table 4. This shows that our finding of a lower coefficient in Table 4 is mainly driven by a reduction of the sample size and not by a lower sensitivity of eligible processing trade compared to eligible ordinary trade with respect to changes in the export VAT tax.