How effective are VAT export taxes? Evidence from China

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Abstract

Compared to most countries, China's value-added tax (VAT) system is not neutral and makes it less advantageous to export a product than to sell it domestically. However, the large and frequent changes to the VAT refunds which are offered to exporters have led China to be accused of providing its firms with an unfair advantage in global trade. We use city-specific export-quantity data at the HS6-product level over the 2003-12 period to assess how changes in the VAT export tax have affected China's export performance. Our identification strategy exploits an eligibility rule disqualifying a specific trade regime from the rebates. We find that the VAT rebate system is indeed an effective industrial policy and can improve China's international competitiveness. Eligible export quantity for a given city-HS6 pair declines by 7% following a one percent rise in the VAT export tax. We show that the efficiency of this export tax policy is magnified when it applies to products with denser links with the local productive structure. Hence export benefits from VAT rebates are greater for activities for which the necessary capabilities and resources are available.

Keywords: VAT system, export tax, export performance, trade elasticity, product relatedness, China.

JEL codes: F10, F14, O25.

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1 Introduction

Over the last decades, China's government has heavy-handedly and openly intervened to promote the country's export performance while in the same time guiding the structural transformation of the economy. In this paper, we study the effectiveness of China's system of Value Added Tax (VAT) export rebates which has been identified as the most important state measure in terms of international trade covered during the recent crisis (Global Trade Alert, 2010). 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 largely been overlooked. This is particularly surprising given that VAT rebates can be modified easily and directly affect the country's international competitiveness in the short run.

China's VAT policy differs from the standard destination-based VAT system of the OECD countries by not fully refunding the VAT on exports. Instead, exporters may receive VAT rebates that vary across commodities, and range from zero to the full refund of the typical 17% VAT rate. The Chinese VAT system thus imposes a tax on exporters whose goods receive a VAT refund rate lower than the applicable VAT rate.[1] Such incomplete export VAT rebates hence amount to export taxes and are expected to lead to lower exports (Feldstein and Krugman, 1990).[2]

[1]The 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: exports are not subject to VAT and VAT exporters have paid on inputs is refundable. In China, 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 VAT rebates is misleading as the repercussions of a certain change in the rebate on exporters are not proportional to their value-added.

[2]We hence use the terms of incomplete VAT rebate and VAT export tax interchangeably.

Even though most Chinese exporters face a VAT export tax, the 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 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 VAT rebates. Second, no other country amends its VAT rebates so often. Over the last decade, export VAT rebate rates have been adjusted frequently, both upwards and downwards (WTO, 2010).[3] In particular, since the beginning of the global financial crisis in 2008, China has increased 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.

This paper proposes a careful evaluation of the effects of the frequent movements in the Chinese VAT rebate system on the quantity exported. It further highlights a heterogeneous effect of this policy depending on the local productive structure. Our paper hence investigates the effectiveness of what appears to be a major instrument of Chinese industrial policy influencing its international competitiveness.

Two other studies have considered the impact of VAT rebates in China. Chen et al. (2006) use aggregate data from 1985 to 2002 and find that export VAT rebates are positively correlated with the country's exports, final domestic consumption, and foreign exchange reserves.[4] Chandra 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)

[3] In total, over the 2002-12 period, 89% of the products at the HS6-product level underwent at least one change in their VAT-refund rate.

[4] However, the size of their sample is limited to 18 observations.

in the firm's industry-province pair.[5]

We here depart from this analysis as we use more disaggregated data on quantities and prices. We directly link the rebate at a very detailed product level (HS6) to corresponding Chinese exports and study an extended period of ten years, which covers the worldwide trade crisis of 2008-2010 during which the rebate rates rebounded after years of reduction. In our empirical analysis we rely on product-level export data for a panel of 329 Chinese cities over the 2002-2012 period.

One additional contribution is that we show that the gains of VAT export rebates are magnified for products with denser connections to the local productive structure, suggesting that industry-policy efficiency is stronger when there is pre-existing productive knowledge.

Moreover, we build on recent 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 likely affect export performance. Chinese authorities may have simultaneously increased VAT rebates and implemented other trade-promotion measures. We then risk over-estimating the positive export effects of VAT refunds. Another problem comes from reverse causality: export VAT rebate rates may increase to boost the exports of poorer-performing products or, on the contrary, of those commodities with greater export-growth potential. In both cases we have endogeneity.

Our main strategy to counter endogeneity exploits variations in the expected impact of

[5]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 VAT rebates by trade regime, which comes from an eligibility rule disqualifying processing trade with supplied materials from the rebates. Chinese trade occurs through either ordinary or processing forms. Processing trade refers to operations of firms, most often foreign, which obtain raw materials or intermediate inputs from abroad and, after assembling them in China, re-export the products.[6] The typical export VAT policy is that of "exempt, credit, and refund" (or "refund after collection"), which applies to ordinary trade and processing trade with 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 thus expect VAT rebates to only have an effect on eligible export activities (ordinary and processing trade with imported materials).[7]

Using HS6-product level export data for a panel of Chinese cities, we isolate the causal effect of the VAT export tax stemming from incomplete VAT rebates using a difference-in-difference estimate. We compare the difference in export quantity growth between eligible and non-eligible transactions of products for which the rebate grew sharply to that of products where it grew more slowly. We ensure that this approach is valid and show that firms do not respond to VAT export tax adjustments by switching between the eligible and non-eligible trade regime. This identification strategy thus allows us to provide a sound estimate of an aggregate trade elasticity of China's trade. We hence contribute to the recent trade literature that aims at estimating trade elasticities with respect to tariffs and other variable

[6]China'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).

[7]This expectation builds on the assumption of exogeneity of the choice of the trade regime with respect to the VAT rebates. We show that non-eligible exports are indeed unrelated to the VAT rebate.

trade costs.[8]

The key explanatory variable of our baseline specification is an interaction between the VAT export tax at the product level and a dummy for eligible trade. We include product-year specific fixed effects so as to capture all factors that affect all exports (both eligible and non-eligible flows) for a given product in a year. In particular, these fixed effects control for other nationwide industrial policies that target specific products and are potentially correlated with the VAT rebate. The main advantage of our specification at the city level is that we can account for the fact that comparative advantage varies greatly across China. Notably we add fixed effects to account for factors that are common to exports of each regime type for a specific product in a given city and time varying city-level sector characteristics by regime type.[9]

We further use the spatial structure of our data to refine our identification by exploiting variations in the expected impact of the export VAT taxes by product across cities. A growing literature suggests gains from matching between an activity and the local comparative advantage and warns against the inconsistency of an industrial policy with the local productive structure (Crozet and Trionfetti, 2013; Lin, 2012, Cai et al., 2011). The production of goods requires capabilities and products that vary considerably in their knowledge requirements (Hausmann and Hidalgo, 2011). We hence expect the export VAT policy to have a greater effect on activities when there is more pre-existing productive knowledge.

We construct a density indicator for each city-product pair which reflects the density

[8]See for example Bas et al. (2015) for an overview on the most recent studies estimating aggregate trade elasticities.

[9]Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. This is the standard industrial classification used in China and is likely to be of relevance for most national or local industrial policies.

of the links between the targeted product and the local product space. It is calculated using bilateral proximities that are determined at the worldwide level and hence cannot be suspected of endogeneity.[10] This particularity allows us to determine the causal effect of the VAT export tax on exports, even if the export tax and the regime choice were not exogenous to economic activity. As products vary in terms of their intrinsic density of links to the local productive structure, in our benchmark specification we thus filter out the impact of the export tax policy using the density index, which captures the intrinsic predisposition to benefit from export-promoting policies.

This strategy allows us to shed light on the conditions of industrial policy effectiveness and thus helps to identify its main beneficiaries.

Our results confirm that China's VAT system is indeed an effective tool for export management. We find a negative and significant effect of the VAT export tax only when exports are eligible. Our estimates suggests that a one percent rise in the VAT export tax will lead to a 7% decline in eligible export quantities with respect to non-eligible trade. We observe that increasing VAT rebates is also efficient in boosting exports (even though to a lesser extent) during economic downturns, which makes this policy an interesting instrument for fiscal devaluations. The estimated trade elasticities are confirmed in various robustness checks and are the same for export values as for export quantities. Our point estimates are fully consistent with a model with heterogeneous firms building on Chaney (2008) where exporters pass VAT rebate changes through to prices but where substantial entry/exit by inferior firms leads to a compositional change such that there is no change in average prices.[11]

[10] Proximity between two products is determined based on world co-exporting probabilities which are hence not related to the particularities of Chinese locations. See Section 4.3 for details.

[11] The model is presented in Appendix C-1.

We further measure greater export repercussions of VAT export taxes for products that are close to those in the local export basket. Our results hence suggest that industrial-policy effectiveness is magnified by pre-existing productive knowledge. This adds to the recent literature cautioning against one-size-fits-all policy that disregards local circumstances (Kali et al., 2013; Lin, 2012). This is in particular in line with existing results that tariff interventions and export promotion policies in China were most successful when targeted at sectors where there was already a latent comparative advantage (Cai et al, 2011; Chen et al. 2016).

The remainder of the paper is structured as follows. The next section describes the Chinese VAT rebate system. Section 3 overviews our empirical specification which derives from the model presented in Appendix C-1 that incorporates export taxation from incomplete VAT rebates into a standard trade model with firm heterogeneity. Section 4 describes the data and construction of variables. Section 5 discusses the results. The last section concludes.

2 The VAT rebate system

2.1 The export tax formula

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 (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 China, VAT

applies at a standard rate of 17 percent on goods sold on the domestic and foreign market.[12] Export goods are however subject to the VAT rebate system, which may lead to a reduced VAT rate. The rebates for exported goods vary by commodity and range from zero to the 17% VAT rate.

The Chinese VAT rebate policy on exports is complex and has changed frequently over time. However, 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 "exempt-credit-refund" (or "refund after collection") method. According to Circular No.7 (2002), the official formula used to calculate VAT payable is as follows:

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

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

Output 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).[13] The tax on exporters whose goods receive a VAT rebate rate lower than the applicable VAT rate is captured by

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

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

the last interaction term. A higher VAT rebate lowers the fiscal burden for exporters.[14] For exporters that do not use bonded duty-free inputs, a one percentage-point cut in the VAT rebate rises their tax payment by one percent of their export value. 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.[15]

In contrast to ordinary trade and processing trade with imported material, 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 this case, even if the exporting company paid VAT on purchases on inputs, it is not entitled to any refund. 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. The Chinese authorities then consider that there are no imports and no export sales: as such, no VAT on imported inputs is collected and hence no VAT is refunded.

Our empirical approach exploits the eligibility rule that disqualifies processing trade with supplied materials from the rebates. We measure the impact of the VAT rebate policy on city-level exports as its differential effect across regime types for a given product-year pair, while accounting for time invariant city-product-regime type and time varying city-level sector characteristics via the relevant fixed effects.

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

[15] There is hence no need to know the share of the 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 tax defined as the difference between the VAT rate and the VAT rebate rate, in logs as derived from our model in Appendix C-1.

2.2 Stylized facts on the eligibility status and VAT rebate

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. There are a variety of rationales for these export restrictions including the manipulation of the terms-of-trade, stabilization of the domestic demand, food security or value-chain climbing (Bouët and Laborde, 2011).

In China, export VAT rebate changes have been carried out frequently to address various economic issues: managing the trade surplus, increasing government revenue or guiding the growth of certain industries. Figure A-1 depicts the evolution of the average ratio between the VAT rebate and VAT rates over the 2002-2012 period. The average VAT rebate share declined continuously from 2002, before rebounding in 2009 in reaction to the international crisis. The downward trend reflects the growing financial burden of refunding the rebates for the government as China's trade surplus exploded as well as the strategic reduction of rebates on products associated with environmental problems or looming trade disputes (Gourdon et al., 2016). In 2008, eligible exporters could get back roughly 51% of their VAT cost, down from 84% in 2002. This proportion rose back to 58% in 2009 as the global economic crisis induced the authorities to raise the export VAT refund rates on thousands of commodities.[16]

Our empirical strategy comparing eligible and non-eligible exports will be a good one only if i) the trade under the two regime types is comparable and ii) the VAT rebate policy does not affect the trade form chosen by firms, i.e. if a cut in the VAT rebate for a given product does not lead firms to switch from eligible to non-eligible trade. Whereas non-

[16]The 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.

eligible trade represents only about 10% of our observations, Figure A-2 shows that the sectoral composition of both trade regimes is very similar. Hence, results are not driven by eligible trade being specialised in specific sectors which may be more sensitive to changes in VAT rebates.[17] Also the two export regimes are highly comparable in terms of their spatial distribution. For both, the four main provinces of origin are Guangdong, Jiangsu, Shandong and Zhejiang. These similarities make us confident that non-eligible trade is indeed a valid control group for our purpose.

Concerning the switching of regime types, both recent studies on regime choice and evidence from our data suggest that there is no systematic response to changes in VAT rebates.

A growing literature has underlined the specific motives behind the ineligible regime of processing trade with supplied materials in China, which are 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

[17]Note that our sample is restricted to products that are exported under both trade regimes.

buyers.[18] Finally, Brandt and Morrow (2013) 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, diversity, quality or cost advantage of Chinese manufacturers of intermediate inputs and not reflect the ups and downs in the VAT export tax.

Consistent with these arguments, we find no evidence that products with high rebates also have a relatively low share of non-eligible exports. Figure A-3 plots the ratio of the VAT rebate to the VAT rate in 2007 against the share of non-eligible exports at the city-level in 2008.[19] It indicates the absence of association between the VAT rebate policy and forms of trade. Figure A-4 plots for every product the change in the VAT rebate between 2002 and 2012 against the change in the share of non-eligible exports. It suggests that there is little correlation between the evolution of rebates and the trade form chosen by exporters.

Figure A-5 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) and the growing diversity and quality of China's intermediates (as suggested by Brandt and Morrow, 2013).[20]

[18] It could also depend on the degree of relationship specificity of the physical capital used in production (Nunn and Trefler, 2013).

[19] A similar pattern of no correlation is obtained using different years.

[20] One could worry that the decline in trade volumes for the ineligible group makes it unlikely that this is

Finally, Table A-1 addresses more directly the possibility of firms switching from eligible to non-eligible trade after an increase in the VAT export 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 VAT export tax should result in a shift towards the eligible regime. We thus expect a negative coefficient of the VAT export tax. Conversely, in Column 2, where we look at the share of destinations which see a switch to non-eligible trade, we expect a positive coefficient, since a higher tax makes it less advantageous to export for eligible compared to non-eligible trade.[21] For both types of trade, coefficients are close to zero and we do not find any significant impact of the VAT export tax. We are thus confident that firms modifying their regime type is not driving our results in Section 5.

3 Empirical specification

Our empirical specification is directly derived from the simple model presented in Appendix C-1. The dependent variable is the log of the export quantity of HS6 product k in city c under regime R in year t, with R comprising the eligible and non-eligible regime. Our focus on export quantities is motivated by growing evidence on the underreporting of export values by exporters to avoid paying taxes (VAT or processing taxes) based on export

a good benchmark relative to which the performance of eligible exports is measured. We will show that our results hold when we run regressions separately for the eligible and ineligible regime and when we limit our sample to the city-product pairs that export simultaneously under both regimes.

[21] As controls, we include city-product and city-sector-year fixed effects as well as all variables that we use in our regressions on export quantity. For details on the specification and data, see Section 3 and Section 4.

value (Ferrantino et al., 2012). Quantities are more easily observable by customs authorities and hence may be less subject to misreporting.[22]

We regress the exported quantities on the interaction between the VAT export tax (i.e. non-rebated VAT) and a dummy for eligible exports. In line with our model, the VAT export tax variable is defined as ln (1 + (VAT rate - VAT rebate)). All right-hand side variables are lagged by one year. Our baseline specification is then given by:

$$\ln \text{Export quantity}^R_{ck,t} = \alpha \ \ln \text{VAT export tax}_{k,t-1} \times \text{Eligibility}^R + \lambda X^R_{ck,t-1} + \gamma_{k,t} + \mu^R_{ck} + \nu^R_{cs,t} + \epsilon^R_{ck,t} \quad (2)$$

where the dummy *Eligibility*^{R} takes the value one if the export flow is in the eligible trade regime and zero otherwise.

We account for potential confounding factors via various fixed effects. Our preferred specification includes product-year fixed effects ($\gamma_{k,t}$). This way, we appeal to a differential effect of rebates across regime types for a given product-year pair. Product-year dummies account for all factors that affect product-level exports irrespective of the trade regime in a given year. These include world demand and all product-specific policies which have the same expected impact on eligible and non-eligible trade, such as sector-level subsidies, R&D promotion policies etc., and which are potentially correlated with the VAT rebate (Girma et al. 2009).[23]

[22] Fisman and Wei (2004) find prevalent underreporting of the total value imported to China from Hong-Kong but not significant misreporting of total quantities. In Section 5.5, we complement the quantity estimates with results on values and unit values to infer the impact of a rebate change on the pricing strategy of the exporter.

[23] We are not aware of any other national policy that treats eligible and non-eligible trade differently, except for import tariffs which we include explicitly in our regressions.

Our key coefficient of interest, α, captures the total impact of the VAT export tax on eligible exports, including both the effect on the number of firms and on the quantity sold by each firm.[24]

Using disaggregated data at the city-level allows to control for the spatial heterogeneity in China's economy. We account for a city's comparative advantage and export intensity with city-product-regime fixed effects (μ^R_{ck}). Further, city-sector-regime-year dummies ($\nu^R_{cs,t}$) capture demand and supply shocks that are common to all products k of regime type R in sector s at year t for city c.[25] These fixed effects control for city and time varying sector characteristics such as labor and capital intensity. Moreover, they account 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 a potentially differential evolution of exporter characteristics across trade regimes.

$X^R_{ck,t-1}$ is a vector of control variables, with coefficient vector λ. We account for year (and regime type) specific supply-side determinants of export dynamics at the city-product level: First, we add the change in city-level export quantity for products from t-2 to t-1 at the HS6 product-level (Export growth$_{ck,t-1}$). Further, we include the share of exports by foreign firms (Foreign share$^R_{ck,t-1}$) and the share of state-owned firms (State share$^R_{ck,t-1}$) defined at the city-product-regime level. These last two controls are crucial to account for the time-varying ability of different cities to export different products as export performance

[24]We 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. Our study focuses on the intensive margin of adjustment at the city-product level.

[25]Sectors 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).

in China varies importantly by firm ownership (Amiti and Freund, 2010).[26]

Finally, $\epsilon^R_{ck,t}$ is the usual error term. All regressions cluster standard errors at the product level to account for serial correlation of the error term within products.[27]

In Section 5.3, we estimate our benchmark specification in which we further refine our identification strategy by filtering the impact of the VAT export tax by product density. For this we adapt Eq. 2 to include the triple interaction term between the VAT export tax, Eligibility dummy and the density of the links between the targeted product and the local product space:

$$\begin{aligned}\ln \text{Export quantity}^R_{ck,t} = \beta \ \ln \text{VAT export tax}_{k,t-1} \times \text{Eligibility}^R \times \text{Density}_{ck} \\ + \lambda X^R_{ck,t-1} + \gamma^R_{k,t} + \mu^R_{ck} + \nu^R_{cs,t} + \epsilon^R_{ck,t} \end{aligned} \tag{3}$$

where our main variable of interest is the triple interaction term that identifies the intrinsic predisposition of a product in a given city to benefit from the VAT export tax policy. This triple interaction term does not only vary by product, year and trade regime, but also by location. This allows us to introduce product-regime-year fixed effects ($\gamma^R_{k,t}$), which account for all time varying differences across products that vary by regime type and could not be controlled for in our baseline specification. By construction, these fixed effects capture also the double interaction between the VAT export tax and the Eligibility dummy. To correctly identify our coefficient of interest, β, the vector of controls, $X^R_{ck,t-1}$, also includes the interaction between the VAT export tax and product density. The interaction between

[26] All firms (whatever their ownership type) receive similar VAT rebates or pay identical export and import duties.

[27] All results hold with clustering at the sector level accounting for potential correlation in the error term for products in the same sector.

the Eligibility dummy and local product density is constant over time and thus captured by the city-product-regime fixed effects (μ_{ck}^{R}).

4 Data and Indicators

4.1 Data on VAT rates and rebates

Our variable of interest is the VAT export tax corresponding to the difference between the VAT rebate and the VAT rate. 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 VAT rebates change frequently, the VAT rates have remained constant between 2002 and 2012.[28] To account for the changes in the HS classification in 2002, 2007 and 2012, we aggregate the data to the HS 6-digit level (1996 revision)[29] using the yearly average of these rates.[30] This gives us the VAT rate and rebate for 5,006 exported HS6 products. Table A-2 presents some descriptive statistics.

4.2 Trade data

The data collected by Chinese Customs include annual export values and quantities by city at the HS 8-digit product level, and separate trade flows according to transaction type. Aggregating the trade flows to the HS6 (1996 revision) level yields a panel of 4,822 products over the 2003-12 period.[31]

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

[29] The correspondence tables from UNCTAD can be found at http://unstats.un.org/unsd/trade/conversions/HS Correlation and Conversion tables.htm.

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

[31] Quantities may be reported in different units over years. For example in tons in one year and in pairs or units another. Therefore, HS6 products for which the quantity unit is not consistent over time are dropped.

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 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).[32] 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).

Combining the trade data and the VAT data leaves us with 4,794 HS6 products and 436 cities.[33] As our empirical strategy appeals to heterogenous 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 cities that do not export under both trade regimes.[34] Our final sample includes observations for 329 cities on 3,346 HS6 products (representing 355,234 city-product pairs). The trade included in this sample represents more than 80% of China's total exports under these two regimes over the sample period. Table A-3 provides robustness

[32]The other transaction types in the data include international aid, border trade, contracting projects, customs warehousing trade and logistics goods by customs special control area. These other regimes together cover less than 7% of exports over the 2003-2012 period. We do not include these flows in our analysis, as we have only limited information on how the VAT rebate policy is applied to them. Column 2 of Table A-3 provides robustness checks to ensure that our results remain when these other flows are included and regarded as eligible.

[33]China is divided into 4 municipalities (Beijing, Tianjin, Shanghai and Chongqing) and 27 provinces which are further divided into prefectures. Our sample includes prefecture and county level cities. All our results hold if we limit our sample to prefecture-level cities only.

[34]We exclude exports coming from the so-called "bonded zones" and "export processing zones", in which all processing trade is treated as non-eligible for VAT refund.

checks where we limit our sample to the 40,336 city-product pairs that export under both regimes (restricted sample I) or to the 38,682 city-product pairs that export in the same year in both regimes (restricted sample II).

4.3 Product density

One of our contributions here is to evaluate whether the export repercussions from the VAT export taxes depend on pre-existing productive capabilities and resources, as proxied by the density of the linkages between product-level export activities and local specialization (which is a locality-product specific feature).

Our identification strategy allows the measured VAT export tax effect to depend on the consistency of the targeted product with the local productive structure. Our proxy of product relatedness at the location level is the density of links between the product on which the tax applies and the other products which the locality exports with comparative advantage. This is measured in 2000, prior to our sample period, so that it captures pre-existing productive knowledge, abstracting from the reverse causality coming from subsequent export performance. In Section 5.3 we estimate our benchmark specification (Equation 3) which includes the interaction of the $\ln$ VAT export $\text{tax}_{k,t-1} \times \text{Eligibility}^R$ term with the density for location-product pair ck.

We use the density indicator developed by Hidalgo et al. (2007) and Kali et al. (2013). Density for good k and locality c (Density_{ck}) is calculated as the average of good k's bilateral proximities with the other goods that city c exports with comparative advantage (RCA_c=1). The indicator is calculated as:

$$Density_{ck} = \frac{\sum_{k' \in RCA_c=1, k' \neq k} \phi_{k,k'}}{\sum_{k' \neq k} \phi_{k,k'}} \quad (4)$$

High density values indicate that city c has a comparative advantage in many goods that are closely related to product k. The local productive structure is likely to offer the necessary capabilities and resources to allow industrial policies targeting product k to effectively promote exports of this good.

The degree of proximity $\phi_{k,k'}$ between two products k and k' is calculated based on the probability that these two products are exported simultaneously by the same country. The underlying idea is that if two products are often co-exported this reflects that they require similar characteristics in various dimensions, notably in terms of production factors, technology and local institutions. It is calculated using international trade flows based on the probabilities that countries with a comparative advantage in one of the goods (k or k') also have a comparative advantage in the other. Revealed comparative advantages (RCAs) are defined using the index in Balassa (1965). A country is said to export a good with a comparative advantage (RCA = 1) when the ratio of the export share of that product in the country's export basket to the analogous worldwide export share is greater than 1. Otherwise RCA is zero.

We define Pr(k | k') as the ratio of the number of countries with RCA in both k and k' over the number of countries with RCA in k', and Pr(k'| k), the ratio of the number of countries with RCA in both k and k' over the number of countries with RCA in k. Proximity between product k and k' is then defined as the minimum of those two pairwise conditional

probabilities:

$$\phi_{k,k'} = min[Pr(k \mid k'), Pr(k' \mid k)] \tag{5}$$

This bilateral relatedness $\phi_{k,k'}$ between products k and k' is calculated for 5111 HS6 products, using data for 238 countries in 2000 from the BACI world trade dataset (Gaulier and Zignago, 2010).

5 Results

5.1 Baseline results

Table 1 presents the results of the regressions of yearly export quantities on the VAT export tax by HS6 product, city and regime type. In Column 1 we estimate Equation 2 without the product-year fixed effects $\gamma_{k,t}$ to get an estimate of the differential repercussions of the VAT export tax on exports for both the eligible and the non-eligible regimes. In the absence of $\gamma_{k,t}$, we add to our control variables a variety of product-year specific variables. Most importantly, we include the VAT export tax in addition to the interaction term with the Eligibility dummy. Following the gravity literature, we account for the demand-side determinants of exports by including the world import value, defined at the product level. Further, we add product-year specific export taxes and import tariffs.[35] Since import tariffs apply only to ordinary exports, we allow the coefficient of import tariffs to be different for non-eligible trade, which

[35]Export 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 Appendix B-1.

consists uniquely of processing trade and thus should not be affected by this tariff.[36]

The non-significant coefficient for the VAT export tax and a negative and highly significant coefficient for its interaction term with Eligibility show that the export tax stemming from incomplete VAT rebates has negative repercussions only for eligible exports. In contrast, and in line with our expectations, the VAT export tax has no significant effect on quantities when exports consist of non-eligible processing with supplied inputs.

Proxies for world demand and supply side dynamics have the expected positive and significant impact on our dependent variable. Other trade policy measures (export tax and import tariffs) fail to be significant. In presence of sector-year dummies, this may reflect that there is limited heterogeneity in these rates between products in the same sector.

Columns 2 and 3 reproduce the estimation of Column 1 on the subsample of eligible and non-eligible exports respectively. This allows all variables to have a different coefficient according to the eligibility status. Our results confirm that the VAT export tax has a negative and highly significant effect on eligible trade, while the coefficient of the VAT export tax for non-eligible trade is insignificant. This latter result confirms that non-eligible trade is a valid control group for evaluating the effectiveness of the changes in the VAT refunds to exporters. Changes in the VAT rebate rate hence do not seem to result in a simple nominal relabeling of the trade regime such that the value of trade going up in an eligible sector is not being reallocated from a non-eligible sector with total trade remaining the same.

In Column 4 we estimate the triple difference specification presented in Equation (2). The added product-year fixed effects account for all time varying product level factors which

[36]We do not know the corresponding import tariffs on imported inputs for an observed export flow since we do not know which inputs are used in the production of ordinary exports. But we include city-sector-year-regime fixed effects which 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.

are common to both regimes so these variables are dropped.

Our key variable of interest, the interaction term between the VAT export tax and the Eligibility dummy, is highly significant. The coefficient of -7 on this interaction term suggests that a one percent increase in the VAT export tax leads to a 7% decrease in eligible export quantities. This effect is economically large, but only about half the size of the estimate by Chandra and Long (2013). By using more disaggregated data at the product level we obtain a more reasonable impact, which is also in line with the estimates of aggregate trade elasticities found in the recent trade literature (Bas et al., 2015; Head and Mayer, 2014) and our simple model in Appendix C-1. To illustrate, we can solve Equation C-9 of the model for exported quantity assuming following Chaney (2008) 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 $P(\tilde{c} < c) = F(c) = c^{\gamma}$ and $dF(c) = f(c) = \gamma c^{\gamma-1}$. This yields an export tax elasticity for the export quantity equal to $(1-\gamma)\frac{\sigma}{\sigma-1}$. The literature proposes estimates of σ for China that average at 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 elasticity between -4.8 and -10.8, which is remarkably consistent with our estimate of -7.

Table A-3 in Appendix A shows that results hold and magnitudes of VAT export tax coefficients remain highly similar when controlling for even stricter fixed effects at the HS4 product-level instead of the sector-level (Column 1) or when including the trade category "others" in the eligible trade (Column 2). Results also remain similar, when reducing the sample to only city-product combinations ("reduced sample I") that report exports under both types of trade during our sample period (Column 3) or using a very strict sample

including only city-product observations ("reduced sample II") that report both types of trade in the same year (Column 4).[37]

5.2 When is a change in VAT rebates most effective?

In Table 2, we investigate possible asymmetry in upward and downward movements in VAT rebates and whether the impact of the VAT rebate evolves over time. The relatively low profit margins of Chinese exporters may make them eager to absorb VAT rebate rises in their margins so that their export quantities are more sensitive to rebate cuts than to rebate increases.[38] In Column 1 we therefore test whether the impact of a change in the VAT rebate depends on its sign. For this, the interaction between VAT rebate and trade regime is further differentiated according to whether the VAT export tax rose or fell from the previous year. We multiply the VAT export tax for eligible trade with two dummies. The dummy *Fall* takes the value 1 in case of a fall in the VAT export tax in the previous period while the dummy *Rise* equals 1 if the VAT export tax rose or stayed constant with respect to the previous year.[39] The coefficients on the *Fall* and the *Rise* interactions are both significant and have a very similar magnitude, suggesting that the export effects of a given change in the VAT rebate are of the same size whether this change corresponds to a rise or a fall. Findings of a comparable sensitivity of exports to cuts and increases in the VAT rebate underpin the effectiveness of this industrial policy tool.

[37] In unreported results, we also ensure that results hold for the reduced sample I when observations with zero exports are included and using quantities in levels or ln(1 + quantity) as the dependent variable. Due to the high dimensional fixed effects, we cannot provide standard Tobit estimates including zero-value trade flows.

[38] Evenett et al. (2012) quote a range of estimates for gross profit margins of Chinese exporters in 2010 from 1.8 to 5 per cent.

[39] Our independent variables are all lagged by one year with respect to exports. The fall in the VAT export tax refers thus to a change in the rebate between t-2 and t-1 with respect to exports in year t.

In Columns 2 and 3 of Table 2, we test whether the impact of the VAT rebate evolves over time. For this, we split our sample into two periods: 2003-2007 (Column 2) and 2008-2012 (Column 3). The effect of the VAT rebates appears to be slightly lower after 2008 during the years of the global recession. To better understand how changing conditions on the world market can affect the effectiveness of the VAT rebates as policy tool, Column 4 interacts our variable of interest with *World growth*, which is defined as the growth rate of world exports in product k between year *t-1* and t (excluding China's exports). We find that a booming economic activity for product k reinforces the effect of the VAT export tax on its export performance. The positive effect of an increase in the VAT rebate is thus dampened by worsening economic conditions.

We can thus conclude that even if the effect of the VAT rebate was lower during the crisis, the massive rise in Chinese VAT rebates in 2008 helped to maintain the profitability of domestic exporters amid declining world prices, and resulted in greater Chinese export quantity and value. The rise in the average export rebate from 6.09% in 2008 to 6.68% in 2009 amounts to an increase of 1% and thus would be responsible for 6% higher exports over that crisis year than in the counterfactual of no policy change. This is not negligible even in the context of China's average export growth of about 20% per year over the last decades. The adoption of a full VAT rebate system, as in many Western countries, would potentially induce a relative increase of 30% in the Chinese exports of eligible activities.[40]

[40]This number is obtained by multiplying the VAT export tax rate in 2012 (4.2) with our average elasticity of 7 (Column 4 of Table 1).

5.3 The role of product density

In this section, we further refine our identification by exploiting variations in the expected impact of the VAT export tax depending on the density of links between the taxed product and the local productive structure. We thus filter out the impact of the export tax policy using the density index which captures the intrinsic predisposition to benefit from export-promoting policies.

In Table 3 we show the estimates of our benchmark specification (Eq. 3) which includes the triple interaction between the VAT export tax, the Eligibility dummy and the city specific product density. As in Table 1, we start in Column 1 with a simpler specification which excludes the product-year fixed effects. This way, we can see the effect of the VAT export tax for the two trade regimes as well as the conditioning role of the density indicator. Neither the coefficient for the VAT export tax nor its interaction with density is significant, suggesting again no link between VAT rebates and non-eligible export performance. Our key variable of interest, the triple interaction term, attracts a negative and highly significant coefficient while the coefficient on the VAT export tax for eligible exports becomes slightly less negative. This indicates that product-level relatedness with the local productive structure magnifies the repercussions of a change in the VAT rebate.

Columns 2 and 3 report results separately for eligible and non eligible trade, confirming our findings of a negative effect of the VAT export tax for eligible trade that grows with pre-existing productive knowledge. None of the interactions are significant for non-eligible trade.

Column 4 contains our benchmark specification (Eq. 3). Since the triple interaction

between the VAT export tax, the Eligibility dummy and local product density varies also by city, we can add product-regime-year fixed effects which capture all time-varying differences between the two trade regimes for a given product. In the presence of these fixed effects, we focus on within city variations in the policy repercussions. Controlling for the average effect of VAT rebates on eligible exports, we test whether the efficiency of the VAT rebate policy is magnified when it applies to products with denser links with the local productive structure.

In spite of these strong controls, we still identify a significant negative effect of the interaction term between density and the VAT export tax for eligible trade. The negative coefficient on the triple interaction term suggests that for a given city export benefits from the VAT export tax policy are greater for eligible products with denser links with the local productive structure. An increase in density by one standard deviation brings an additional rise of 2 percentage points in exports after an increase in the VAT rebate.

We interpret our results as evidence that when the city has already an advantage in producing goods that are similar to product k, increasing exports of k in response to an increase in the VAT rebate is easier because there are product spillovers emanating from consistent specialization, such as knowledge externalities, economies of scale and scope spillovers. A national industrial policy such as the VAT export tax can thus have highly differential effects across locations, depending on the structure of the local economy.

To avoid any endogeneity concerns, the product density measure does not incorporate any information on the local export performance for product k. To further ensure that our density interaction is not solely reflecting the specific export capacity of city c in terms of the product k, Column 5 accounts for a direct measure of local comparative advantage of the city c in product k. We interact the VAT export tax for eligible exports with a dummy

that takes the value one if city c has a comparative advantage in product k with respect to the world in 2000, and is zero otherwise. We further need to include the double interaction of the VAT export tax with the local comparative advantage. These additional interaction terms are not significant and the sign of the coefficients on the density interaction terms are not affected. This reinforces the findings that products having a better connection to the local economy experience higher repercussions of a change in the VAT rebate. This leads to potentially higher benefits for these exporters.

In the last column of Table 3, we want to check whether our findings are not driven by the local degree of competition and hence do not solely correspond to Aghion et al.'s (2015) argument that the degree of competition is a key determinant of how an industrial policy affects firm performance. When a product is central in the local product mix, it is also potentially facing a stronger local competition from other exporters of the same or similar goods. In Column 6 we therefore interact the VAT export tax for eligible exports with a measure of the competition intensity in sector s that product k faces in city c.[41] This last interaction term is however not significant.

5.4 Robustness checks

This section checks robustness across various subsamples on our benchmark results of Column 4 of Table 3.

First, Table 4 verifies that our estimates do not reflect the specific features of some pro-

[41] We use the Lerner Index which measured the importance of markups (the difference between prices and marginal costs) relative to the firm's total value added. We thank Ann Harrison for sharing the stata code used to compute the Lerner index with the data from China's annual firm-level industrial surveys. The restriction to industrial sectors results in a reduction of the sector-city combinations compared to our main sample.

ducts 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 magnification effect of product density remain throughout.[42]

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 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.[43] Finally, our results also hold when dropping high-skill intensive products (Column 5).[44]

In Table 5 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 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

[42] All results presented in this section hold for our baseline specification (Equation 2) which shows solely the differential effect of the VAT export tax on the two trade regimes.

[43] High-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.

[44] For details on how we identify the products to drop, see Appendix B-2.

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 change only little.

Our main findings remain unchanged in all specifications. We confirm that the effect of the VAT rebate policy is felt stronger when applied to products which have closer links to the local productive structure. 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 but that effects vary across cities depending on the local product mix.

5.5 Prices and misreporting issues

In this section, we provide some evidence on the effect of the VAT export tax and the conditioning role of product density on export prices measured by unit values (calculated as the ratio of export value to export quantity) and on export values.

Our empirical approach has so far deliberately relied on export quantities because of two main reasons. First, there are potential measurement problems from the underreporting of export values by firms to avoid paying taxes based on export value. If these practices affect values and not quantities as suggested by Fisman and Wei (2004), export prices should be underreported. However, an increase in the VAT rebate may also incite exports to cheat less and to declare actually a higher price to the Customs.

Second, it is not clear what is the expected net impact of a change in the VAT rebate on prices. Our theoretical setting (Appendix C-1) can provide a clear prediction regarding the VAT export tax elasticity for export quantities but the net effect on prices is ambiguous:

the direct negative repercussion of the tax on firm-level export price may be more than compensated by the composition effect related to the exit of the less productive firms, those charging high prices. Furthermore, the repercussions of the changes in rebates on export prices depend also on the extent to which exporters pass rebates through to prices. Exporters could well absorb the changes in rebates in their margins. Also, considering that unit values are also a common proxy for product quality, we could expect a positive effect on unit values when a decrease in the VAT export tax leads to quality improvements. The sign of the overall effect is thus not clear.

Table 6 investigates empirically the net impact of VAT export taxes on prices and export values. Column 1 reports the estimates of the baseline specification (Column 4 of Table 1) using unit values as the dependent variable. Column 2 contains our benchmark which includes also the triple interaction with the density variable (Column 4 of Table 3). Conditional on our strict controls, we find no significant differential negative effect of VAT rebates on unit prices in 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 VAT export tax. For completeness, we report in Columns 3 and 4 the same regressions using export values. The coefficients for all variables of interest are very close to those found for the quantity exported. This confirms that the main effect of a change in VAT rebates is on the quantity exported.[45]

In the light of our simple model with heterogeneous firms, findings that the elasticities are the same for export values as for export quantities suggest that while exporters pass

[45]Results on unit values and export values hold when carrying out the same robustness checks as those conducted for the export quantity.

VAT rebate changes through to prices a substantial entry/exit by inferior firms leads to a compositional change such that there is no change in average prices. Assuming a Pareto distribution in the export value equation (Equation C-10) yields an export tax elasticity for the export value equal to $\frac{\sigma(1-\gamma)-1}{\sigma-1}$. Using again $\sigma = 6$ following Broda and Weinstein (2006) and considering as above that $\gamma/(\sigma-1)$ can range between 1 and 2, the range for the export value elasticity is between -5 and -11, almost identical to that for the export quantity elasticity. 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 but are not significantly different from zero.

Despite our strict controls and the numerous robustness checks presented above, we cannot rule out that there is still a bias from misreporting of exports for the purpose of tax evasion. Misreporting can happen either through the underreporting of the export value or through the misclassification of goods within sectors. We undertake two additional robustness checks to ensure that our findings of a negative effect of the VAT tax on export quantity is not merely reflecting some misreporting.

First, we investigate the possibility that firms may declare their product in a different HS6 category when its rebate decreases. Since it is likely to be easier to misclassify within a similar category as the descriptions are quite similar, we construct for every HS6 the average of the VAT tax within its sector, excluding the own tax. If misclassification is common, this variable should attract a positive and significant coefficient. When we add this variable to our baseline specification, we find a low positive but non-significant effect of this variable,

while the other estimates are not affected. We thus do not report these results and conclude that by this test at least there is no evidence for systematic misclassification.

Our second approach to check that our results do not reflect misreporting by exporters consists in excluding ordinary trade: Ferrantino et al. (2012) argue that the stricter enforcement applied to processing trade at the Chinese border makes processing exporters less likely to underreport than normal exporters.

Table 7 considers only processing trade, and so excludes ordinary trade. Limiting the sample to processing trade also allows to reduce two other concerns. First, we can check that our estimates do not simply reflect the determinants of export structure into ordinary and processing trade which are correlated with the VAT rebate changes.

Second, it makes our sample more homogenous: ordinary exports embody more than twice as much domestic value added per USD as do processing exports (Koopman et al., 2012; Kee and Tang, 2012). Greater domestic value-added content means a higher payable VAT cost for a given VAT rebate, and larger refunds from any given rise in the export VAT rebate. The focus on processing trade allows us to eliminate this source of potential bias due to differences in local value-added content.

Column 1 reports the baseline regression on the sample of processing trade only. Even though the coefficient is slightly lower compared to Column 4 in Table 1, the negative effect of VAT tax holds also for this restricted subsample. Column 2 shows our benchmark specification with the VAT export tax interacted with the local product density. We find again a negative and significant effect of the triple interaction term, while the simple interaction term between VAT export tax and the density is not significant. This confirms the effectiveness of the VAT rebate tool also for processing activities and that the sensitivity of export

flows to VAT export tax is stronger when the product is central in the local product space. In Column 3 and 4, the dependent variable is the average unit value and in Column 5 and 6 it is the export value. Also here, the coefficients of the VAT export tax on prices are not significant even though the coefficient is positive. As a result, the elasticities for values are a little lower than for quantities, but not statistically different.

Overall, our results are consistent. We find that the VAT export tax repercussions are the same for export quantities as for export values. We hence verify the absence of a VAT-rebate effect on unit values for this sample restricted to processing activities and conclude that it is unlikely that there is a large bias from misclassification or misreporting.

6 Conclusion

In this paper, we have provided an empirical investigation of the effectiveness of one of China's major industrial policies, its VAT export rebate system. For this, we have appealed to a product-level database on Chinese exports at the city level to consider how export performance is affected by VAT export rebates and how the effect of this nationwide policy varies across products and locations.

To overcome the typical endogeneity problems encountered in policy evaluations, our empirical strategy exploits an eligibility rule that disqualifies processing trade with supplied materials from the rebates. Our estimates rely on export-quantity data for a panel of 329 Chinese cities at the HS6 product-level over the 2003-2012 period, and provide evidence of negative and significant VAT-export tax effects on eligible exports. Our baseline estimate suggests that a one percent decline in the VAT export tax will lead to a 7% increase in

eligible trade flows.

We further show how the VAT export tax on a given product has differential effects across locations. For this, we rely on an indicator that measures the density of the links between a product and the local product space. This density measure hence combines information on the intrinsic relatedness of a good with that on the local pattern of specialization. Our results indicate that VAT export taxes are more effective when applied on goods with denser links with the local productive structure. This is consistent with the density of links between products giving rise to export-enhancing spillovers.

The size of our estimates on the VAT export tax allows us also to better understand the resistance of China's exports over the global recession. VAT rebates seem to be an effective tool for boosting a country's international competitiveness in difficult times and when exchange rate devaluations are not an option. Our results hence show the key role of trade policy in China's rising advantage in global markets.

Table 1: Exports and VAT export taxes: Baseline results

Dependent variable	Ln Exported quantity (city/product/regime/year)			
	(1)	(2)	(3)	(4)
Specification		Elig.	Non elig.	baseline
Ln VAT export $\text{tax}_{k,t-1} \times$ Elig.^{R}	-7.740^a			-7.167^a
	(1.230)			(1.329)
Ln VAT export $\text{tax}_{k,t-1}$	0.364	-7.362^a	0.107	
	(1.168)	(0.560)	(1.226)	
Export $\text{growth}_{ck,t-1}$	0.156^a	0.158^a	0.112^a	0.156^a
	(0.002)	(0.002)	(0.008)	(0.002)
Foreign export $\text{share}^R_{ck,t-1}$	0.408^a	0.398^a	0.501^a	0.395^a
	(0.011)	(0.011)	(0.029)	(0.010)
State export $\text{share}^R_{ck,t-1}$	0.015^c	-0.001	0.245^a	-0.010
	(0.008)	(0.008)	(0.032)	(0.008)
Export $\text{growth}_{k,t-1}$	0.114^a	0.116^a	0.102^a	
	(0.012)	(0.012)	(0.032)	
World $\text{demand}_{k,t-1}$	2.148^a	2.171^a	1.937^a	
	(0.161)	(0.159)	(0.354)	
Export $\text{tax}_{k,t-1}$	-1.543	-1.586	0.974	
	(1.108)	(1.103)	(2.409)	
Import $\text{tariffs}_{k,t-1}$	0.007	0.003	0.008	
	(0.012)	(0.006)	(0.013)	
Import $\text{tariffs}_{k,t-1} \times$ Elig.^{R}	-0.004			0.013
	(0.012)			(0.011)
Fixed effects by:				
City-regime-product	Yes			Yes
City-regime-sector-year	Yes			Yes
City-product		Yes	Yes	
City-sector-year		Yes	Yes	
Product-year				Yes
Observations	1939237	1750246	188991	1939237
R^2	0.898	0.897	0.907	0.905
No. of products	3346	3346	3346	3346
No. of cities	329	329	329	329

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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.

Table 2: Exports and VAT export taxes: testing for an asymmetric impact

Dependent variable	Ln Exported quantity (city/product/regime/year)			
Period	(1) All	(2) 2003-2007	(3) 2008-2012	(4) All
Ln VAT export $\text{tax}_{k,t-1}\times$ Elig.^{R}		-11.178^a	-6.061^a	-7.084^a
		(1.946)	(1.438)	(1.332)
Ln VAT export $\text{tax}_{k,t-1}\times$ Elig.^{R} $\times$ Rise	-7.171^a			
	(1.331)			
Ln VAT export $\text{tax}_{k,t-1}\times$ Elig.^{R} $\times$ Fall	-7.365^a			
	(1.808)			
Ln VAT export $\text{tax}_{k,t-1}\times$Elig.^{R} $\times$ World growth $\text{rate}_{k,t}$				-2.287^c
				(1.281)
World growth $\text{rate}_{k,t}\times$ Elig.^{R}				0.128^c
				(0.074)
Import $\text{tariffs}_{k,t-1}\times$ Elig.^{R}	0.013	0.016	-0.009	0.014
	(0.011)	(0.011)	(0.016)	(0.011)
Export $\text{growth}_{ck,t-1}$	0.156^a	0.122^a	0.118^a	0.156^a
	(0.002)	(0.002)	(0.002)	(0.002)
Foreign export share$^R_{ck,t-1}$	0.395^a	0.270^a	0.219^a	0.395^a
	(0.010)	(0.013)	(0.012)	(0.010)
State export share$^R_{ck,t-1}$	-0.010	-0.035^a	-0.012	-0.010
	(0.008)	(0.010)	(0.012)	(0.008)
Fixed effects	city-product-regime & product-year city-sector-regime-year			
Observations	1939237	901723	1037514	1939237
R^2	0.905	0.928	0.937	0.905
No. of products	3346	3344	3183	3346
No. of cities	329	326	329	329

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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.

Table 3: Exports and VAT export taxes: the role of density

Dependent variable	Ln Exported quantity(city/product/regime/year)					
Specification	(1)	(2) Elig.	(3) Non elig.	(4) benchmark	(5)	(6)
Ln VAT export $tax_{k,t-1}\times$ Elig.^{R}	-5.963^a					
	(1.686)					
Ln VAT export $tax_{k,t-1}$	0.261	-5.683^a	-0.197			
	(1.628)	(0.567)	(1.689)			
Ln VAT export $tax_{k,t-1}\times$ Elig.$^R\times$ $Density_{ck}$	-1.829^b			-2.004^b	-2.007^b	-1.884^c
	(0.786)			(0.936)	(0.936)	(1.138)
Ln VAT export $tax_{k,t-1}\times$ $Density_{ck}$	0.070	-1.764^a	0.209	0.627	0.630	0.533
	(0.772)	(0.210)	(0.805)	(0.914)	(0.914)	(1.113)
Ln VAT export $tax_{k,t-1}\times$Elig.$^R\times$Comp. Adv_{ck}					0.683	
					(0.688)	
Ln VAT export $tax_{k,t-1}\times$Comp. Adv_{ck}					-1.036	
					(0.632)	
Ln VAT export $tax_{k,t-1}\times$Elig.$^R\times$$Competition_{ck}$						14.772
						(14.803)
Ln VAT export $tax_{k,t-1}\times$$Competition_{ck}$						-14.520
						(14.801)
Export $growth_{ck,t-1}$	0.157^a	0.159^a	0.111^a	0.156^a	0.156^a	0.160^a
	(0.002)	(0.002)	(0.008)	(0.002)	(0.002)	(0.002)
Foreign export share$^R_{ck,t-1}$	0.407^a	0.397^a	0.501^a	0.391^a	0.391^a	0.422^a
	(0.011)	(0.011)	(0.029)	(0.010)	(0.010)	(0.012)
State export share$^R_{ck,t-1}$	0.014^c	-0.002	0.245^a	-0.017^b	-0.017^b	-0.005
	(0.008)	(0.008)	(0.032)	(0.008)	(0.008)	(0.009)
Export $growth_{k,t-1}$	0.114^a	0.116^a	0.102^a			
	(0.012)	(0.012)	(0.032)			
World $demand_{k,t-1}$	2.147^a	2.170^a	1.936^a			
	(0.161)	(0.159)	(0.354)			
Export $tax_{k,t-1}$	-0.014	-0.014	0.009			
	(0.009)	(0.009)	(0.022)			
Import $tariffs_{k,t-1}$	0.007	0.003	0.008			
	(0.012)	(0.006)	(0.013)			
Import $tariffs_{k,t-1}\times$ Elig.^{R}	-0.004					
	(0.012)					
Fixed effects by:						
City-regime-product	Yes			Yes	Yes	Yes
City-regime-sector-year	Yes			Yes	Yes	Yes
City-product		Yes	Yes			
City-sector-year		Yes	Yes			
Product-regime-year				Yes	Yes	Yes
Observations	1939237	1750246	188991	1939237	1939237	1209097
R^2	0.898	0.897	0.907	0.906	0.906	0.901
No. of products	3346	3346	3346	3346	3346	3187
No. of cities	329	329	329	329	329	250

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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, s for sector, 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.

Table 4: Exports and VAT export taxes: excluding sensitive sectors

Dependent variable	Ln Exported quantity (city/product/regime/year)				
	(1) only manuf	(2) w/o rare earths	(3) w/o energy-intensive	(4) w/o high-tech	(5) w/o high-skilled int.
Ln VAT export $\text{tax}_{k,t-1} \times \text{Elig.}^R \times \text{Density}_{ck}$	-1.991^b	-1.999^b	-1.917^b	-2.337^b	-2.022^b
	(0.962)	(0.937)	(0.948)	(0.936)	(0.944)
Ln VAT export $\text{tax}_{k,t-1} \times \text{Density}_{ck}$	0.583	0.631	0.557	0.969	0.628
	(0.940)	(0.915)	(0.925)	(0.914)	(0.922)
$\text{Export growth}_{ck,t-1}$	0.156^a	0.156^a	0.157^a	0.156^a	0.155^a
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$\text{Foreign export share}^R_{ck,t-1}$	0.396^a	0.391^a	0.389^a	0.377^a	0.383^a
	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
$\text{State export share}^R_{ck,t-1}$	-0.016^b	-0.017^b	-0.018^b	-0.021^a	-0.018^b
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Fixed effects	city-product-regime & city-sector-regime-year & product-regime-year				
Observations	1898234	1936816	1921534	1819973	1900026
R^2	0.906	0.906	0.907	0.905	0.906
No. of products	3202	3339	3307	3080	3265
No. of cities	329	329	329	329	329

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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.

Table 5: Exports and VAT export taxes: alternative samples

Dependent variable	Ln Exported quantity (city/product/regime/year)		
	(1) only VAT rate = 17%	(2) no full VAT rebate	(3) no zero VAT rebate
Ln VAT export $\text{tax}_{k,t-1} \times \text{Elig.}^R \times \text{Density}_{ck}$	-1.730^c	-3.985^a	-1.749^c
	(0.978)	(1.504)	(1.042)
Ln VAT export $\text{tax}_{k,t-1} \times \text{Density}_{ck}$	0.436	2.397	0.439
	(0.953)	(1.483)	(1.017)
$\text{Export growth}_{ck,t-1}$	0.155^a	0.166^a	0.156^a
	(0.002)	(0.002)	(0.002)
$\text{Foreign export share}^R_{ck,t-1}$	0.391^a	0.402^a	0.388^a
	(0.011)	(0.013)	(0.011)
$\text{State export share}^R_{ck,t-1}$	-0.013	-0.028^b	-0.021^a
	(0.008)	(0.011)	(0.008)
Fixed effects	city-product-regime & city-sector-regime-year & product-regime-year		
Observations	1782680	1116713	1791655
R^2	0.908	0.880	0.910
No. of products	2977	2098	2898
No. of cities	329	329	329

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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.

Table 6: Export values and prices

Dependent variable	$\ln(\text{uv}^R_{ckt})$		$\ln(\text{value}^R_{ckt})$	
Specification	(1) baseline	(2) benchmark	(3) baseline	(4) benchmark
Ln VAT export $\text{tax}_{\text{k,t-1}}\times$ Elig.^{R}	-0.003		-7.170^a	
	(0.502)		(1.256)	
Ln VAT export $\text{tax}_{\text{k,t-1}}\times$ Elig.$^R\times\text{Density}_{\text{ck}}$		-0.137		-2.141^b
		(0.376)		(0.878)
Ln VAT export $\text{tax}_{\text{k,t-1}}\times$ $\text{Density}_{\text{ck}}$		0.216		0.842
		(0.369)		(0.860)
$\text{Export growth}_{\text{ck,t-1}}$	0.002^a	0.002^a	0.158^a	0.158^a
	(0.001)	(0.001)	(0.002)	(0.002)
Foreign export $\text{share}^R_{\text{ck,t-1}}$	0.024^a	0.024^a	0.418^a	0.415^a
	(0.004)	(0.004)	(0.010)	(0.010)
State export $\text{share}^R_{\text{ck,t-1}}$	-0.010^a	-0.010^b	-0.020^a	-0.026^a
	(0.004)	(0.004)	(0.007)	(0.007)
Fixed effects by:				
City-regime-product	Yes	Yes	Yes	Yes
City-regime-sector-year	Yes	Yes	Yes	Yes
Product-year	Yes		Yes	
Product-regime-year		Yes		Yes
Observations	1939237	1939237	1939237	1939237
R^2	0.943	0.944	0.871	0.873
No. of products	3346	3346	3346	3346
No. of cities	329	329	329	329

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. In the last three columns, only exports under processing regime are considered. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. ^{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 or processing trade with imported materials.

Table 7: Processing trade

Dependent variable:	$\ln(\text{quantity}^R_{ckt})$		$\ln(\text{uv}^R_{ckt})$		$\ln(\text{value}^R_{ckt})$	
Specification	(1) baseline	(2) benchmark	(3) baseline	(4) benchmark	(5) baseline	(6) benchmark
Ln VAT export $\text{tax}_{k,t-1}\times$ Elig.^{R}	-4.651^a		0.848		-3.803^a	
	(1.520)		(0.712)		(1.402)	
Ln VAT export $\text{tax}_{k,t-1}\times$ Elig.$^R\times$ Density_{ck}		-2.563^b		-0.154		-2.717^b
		(1.224)		(0.553)		(1.119)
Ln VAT export $\text{tax}_{k,t-1}\times$ Density_{ck}		0.754		0.168		0.923
		(0.974)		(0.394)		(0.917)
Export $\text{growth}_{ck,t-1}$	0.145^a	0.148^a	0.011^a	0.011^a	0.156^a	0.158^a
	(0.006)	(0.006)	(0.002)	(0.002)	(0.006)	(0.006)
Foreign export $\text{share}^R_{ck,t-1}$	0.681^a	0.665^a	-0.067^a	-0.067^a	0.615^a	0.598^a
	(0.027)	(0.028)	(0.009)	(0.009)	(0.024)	(0.025)
State export $\text{share}^R_{ck,t-1}$	0.039	0.012	-0.009	-0.009	0.030	0.003
	(0.024)	(0.025)	(0.010)	(0.011)	(0.022)	(0.023)
Fixed effects by:						
City-regime-product	Yes	Yes	Yes	Yes	Yes	Yes
City-regime-sector-year	Yes	Yes	Yes	Yes	Yes	Yes
Product-year	Yes		Yes		Yes	
Product-regime-year		Yes		Yes		Yes
Observations	489905	489905	489905	489905	489905	489905
R^2	0.925	0.930	0.970	0.973	0.902	0.909
No. of products	3209	3209	3209	3209	3209	3209
No. of cities	320	320	320	320	320	320

Heteroskedasticity-robust standard errors clustered at the product level appear in parentheses. In the last three columns, only exports under processing regime are considered. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. ^{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 or processing trade with imported materials.

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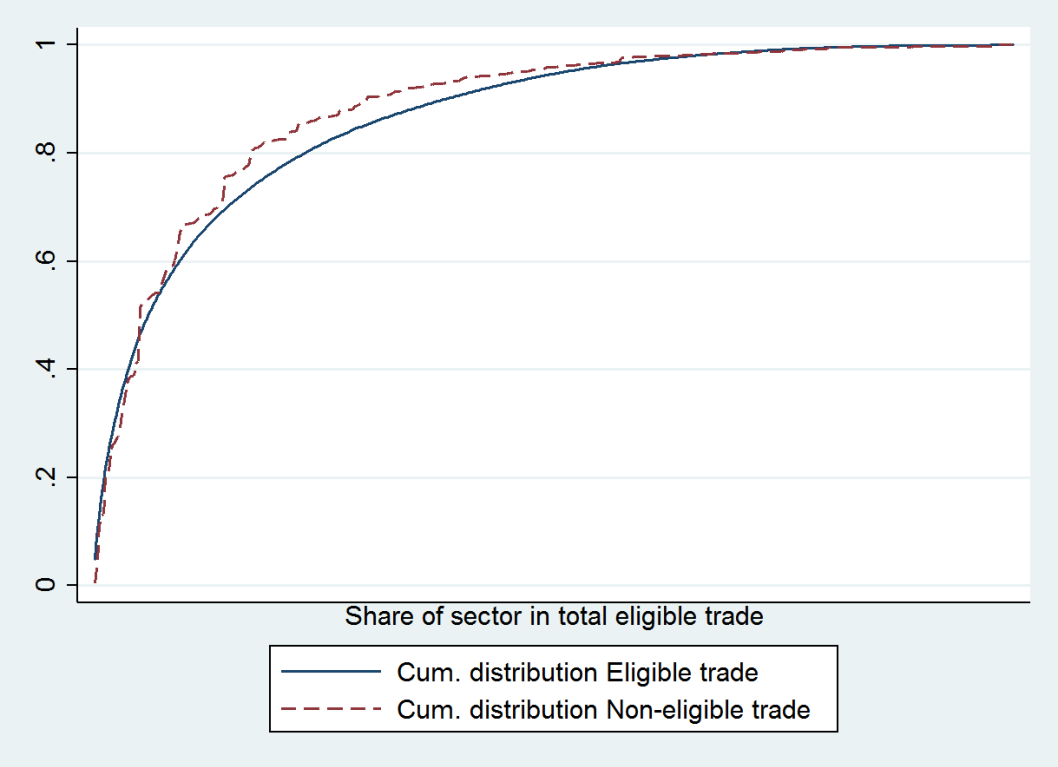
Appendix A - Additional tables and figures

Figure A-1: Evolution of the VAT rebate share (over VAT rate) 2002-2012

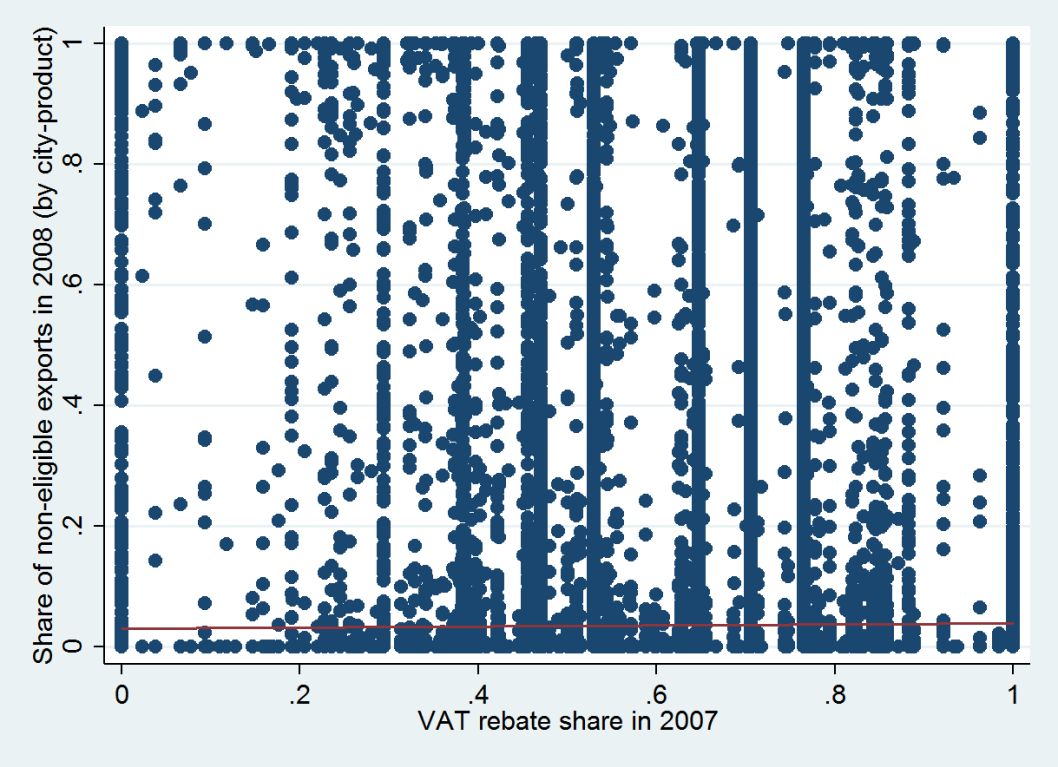
Note: The VAT rebate share is calculated as the simple average over all products.

Figure A-2: Distribution of trade across sectors



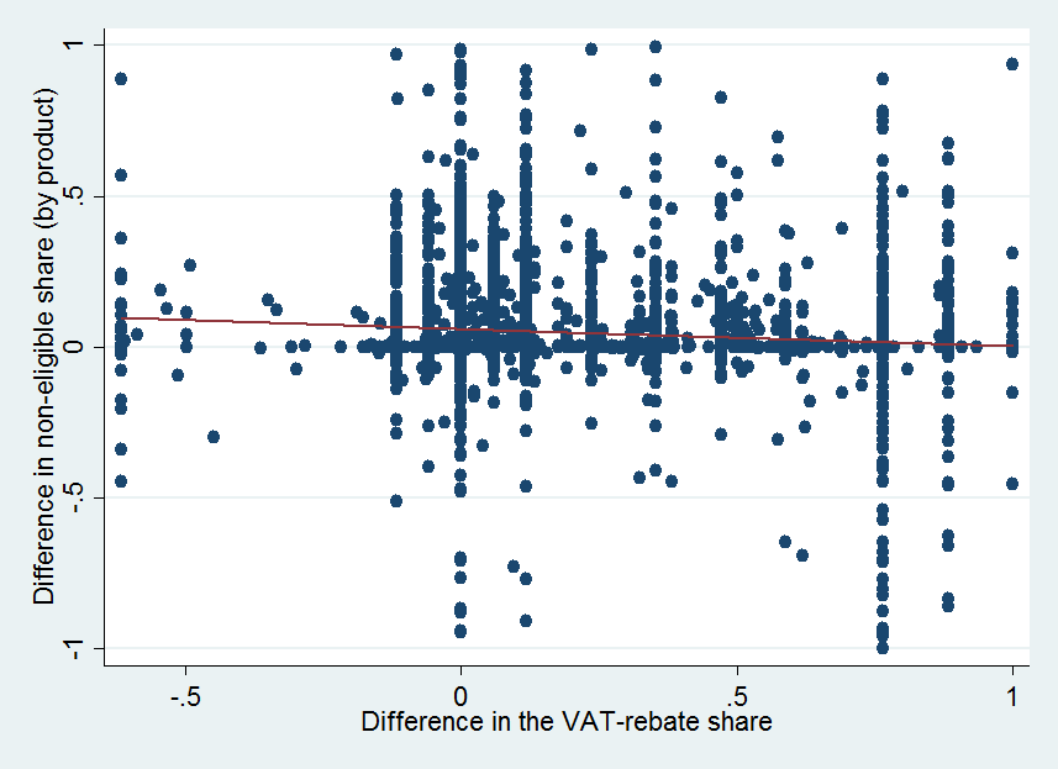
Note: Numbers are based on trade for the years 2003 to 2012. Non-eligible exports is the export value share of processing trade with supplied inputs. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products.

Figure A-3: VAT-rebate share and share of non-eligible exports (city-product)



Note: The share of non-eligible exports is the export value share of processing trade with supplied inputs. City-product pairs are those in the main sample.

Figure A-4: Change in VAT-rebate share and share of non-eligible exports (product) between 2002 and 2012.



Note: The share of non-eligible exports is the export value share of processing trade with supplied inputs.

Figure A-5: Share of non-eligible exports over time

Note: The share of non-eligible exports is the export value share of processing trade with supplied inputs.

Table A-1: Regime switching

Dependent variable	Share of destinations$^{R}_{ck,t}$ that switched regime	
	(1) from eligible to non-eligible	(2) from non-eligle to eligible
Ln VAT export $\text{tax}_{\text{k,t-1}}$	0.001	0.065
	(0.003)	(0.050)
$\text{Export growth}_{\text{ck,t-1}}$	0.000	-0.000
	(0.000)	(0.001)
Foreign $\text{export share}^{R}_{\text{ck,t-1}}$	0.001^{b}	0.019^{a}
	(0.000)	(0.002)
State $\text{export share}^{R}_{\text{ck,t-1}}$	0.001^{a}	0.016^{a}
	(0.000)	(0.002)
$\text{Export growth}_{\text{k,t-1}}$	-0.000	-0.000
	(0.000)	(0.002)
$\text{World demand}_{\text{k,t-1}}$	0.001	-0.002
	(0.001)	(0.012)
$\text{Export tax}_{\text{k,t-1}}$	0.000^{c}	0.000
	(0.000)	(0.001)
$\text{Import tariffs}_{\text{k,t-1}}$	0.000	-0.000
	(0.000)	(0.000)
Fixed effects	city-product & city-sector-year	
	1750246	188991
R^2	0.301	0.425
No. of products	3346	3346
No. of cities	329	329

Standard errors are clustered at the product level. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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.

Table A-2: Summary statistics of variables

	Mean	Std. Dev.	Min	Max
$\ln(\text{exported quantity})^R_{ck,t}$	9.89	3.67	0.00	24.12
$\ln(\text{export value})^R_{ck,t}$	11.66	2.89	0.00	23.96
$\ln(\text{unit value})^R_{ck,t}$	1.76	2.40	-10.13	19.97
VAT export $\text{tax}_{k,t-1}$ (%)	1.04	0.04	0.99	1.17
VAT $\text{rebate}_{k,t-1}$ (%)	12.44	3.92	0	17
VAT $\text{rate}_{k,t-1}$(%)	16.83	0.72	13	17
VAT $\text{rebate/VAT}_{k,t-1}$	0.74	0.23	0	1
World $\text{demand}_{k,t-1}$)	0.21	0.18	0	1
Export $\text{tax}_{k,t-1}$ (%)	0.08	1.39	0	106
Import $\text{tariffs}_{k,t-1}$ (%)	10.81	6.21	0	68
Export $\text{growth}_{k,t-1}$	0.20	0.33	-2	2
Export $\text{growth}_{ck,t-1}$	0.26	1.19	-2	2
Foreign export $\text{share}^R_{ck,t-1}$	0.24	0.38	0	1
State export $\text{share}^R_{ck,t-1}$	0.25	0.38	0	1
Density_{ck}	0.93	0.92	0	4
$\text{Comparative advantage}_{ck}$	0.01	0.33	0	86
Competition_{ck}	-0.01	1.18	-256	4

Please refer to Section 4 and Appendix B-1 for a detailed description of these variables. The statistics are based on the sample in our baseline specification (1,939,237 observations) (last column of Table 1), except for *Competition*, which is based on 1,209,097 observations. VAT rates, VAT rebate rates, VAT export taxes, the share of the VAT rebate over VAT rates, export taxes and import tariffs are measured as percentages. 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.

Table A-3: Additional results

Dependent variable	$\ln(\text{quantity}^R_{ckt})$			
	(1) HS4 controls	(2) including "other"	(3) reduced sample I	(4) reduced sample II
Ln VAT export $\text{tax}_{k,t-1} \times$ Elig.^{R}	-6.322^a	-7.268^a	-5.991^a	-5.334^a
	(2.130)	(1.319)	(1.436)	(1.574)
Import $\text{tariffs}_{k,t-1} \times$ Elig.^{R}	0.025^c	0.015	0.014	0.016
	(0.015)	(0.011)	(0.012)	(0.012)
Export $\text{growth}_{ck,t-1}$	0.156^a	0.155^a	0.175^a	0.150^a
	(0.002)	(0.002)	(0.005)	(0.006)
Foreign export $\text{share}^R_{ck,t-1}$	0.402^a	0.381^a	0.391^a	0.397^a
	(0.013)	(0.010)	(0.019)	(0.023)
State export $\text{share}^R_{ck,t-1}$	-0.021^b	-0.018^b	0.044^a	0.103^a
	(0.009)	(0.007)	(0.017)	(0.022)
Fixed effects:				
City-HS6 product-regime	Yes	Yes	Yes	Yes
HS6 product-year	Yes	Yes	Yes	Yes
City-sector-regime-year		Yes	Yes	Yes
City-HS4 product-regime-year	Yes			
Observations	1939237	1995389	528400	348620
R^2	0.932	0.906	0.930	0.945
No. of HS6 products	3346	3347	3271	3184
No. of cities	329	329	318	314

Standard errors are clustered at the product level. Sectors are defined following the Chinese 4-digit GB/T industry classification and regroup several products. Our main sample with 3,346 products at the HS6-level consists of 401 sectors. ^{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. The sample is limited to the 39,269 city-product pairs that export under both regimes (restricted sample I) in column 3 and to the 37,654 city-product pairs that export in the same year in both regimes (restricted sample II) in column 4.

Appendix B - Data sources and classifications

B-1 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$^{R}_{ck,t-1}$ and State export share$^{R}_{ck,t-1}$.

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$^{R}_{ck,t-1}$ and State export share$^{R}_{ck,t-1}$ 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.[46]

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 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.

[46]This 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.

The Lerner index of local competition used in Table 3 is calculated using firm level data from the Chinese Business Surveys data from 2001 to 2003.

B-2 Different classifications of products

In Section 5.4, 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.[47]

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.

[47]Recently 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 processing of these metals and secure a better position in the global value chain.

Appendix C - 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 described above, 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 volume and export price.

C-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[48] 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:

$$p_k(c_i) = \frac{\sigma}{\sigma - 1} c_i \tag{C-1}$$

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

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 includes also the VAT export tax:[49]

$$p_{kj}(c_i) = \frac{\sigma}{\sigma - 1} c_i \ (1 + t_k) \tag{C-2}$$

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:

$$m_{kj}(c_i) = p_{kj}(c_i) \ q_{kj}(c_i) = [p_{kj}(c_i)]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} \tag{C-3}$$

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

C-2 Export tax, trade volume and price

Using profit-maximizing prices (Equation C-1), we can write the profit for firm i from exporting good k to country j as:

$$\pi_{kj}(c_i) = \frac{m_{kj}(c_i)}{(1 + t_k)} - c_i q_{kj}(c_i) - C_j = \frac{m_{kj}(c_i)}{\sigma(1 + t_k)} - C_j \tag{C-4}$$

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 C-3 and C-2 in Equation C-4 gives:

$$m_{kj} = [\frac{\sigma}{\sigma - 1} \bar{c}_i \ (1 + t_k)]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} = C_j \sigma (1 + t_k) \tag{C-5}$$

[49] For simplicity we abstract from transportation costs.

Hence the marginal-cost threshold value is:

$$\bar{c}_j = \lambda_j \frac{1}{C_j}^{1/(\sigma-1)} \frac{1}{(1+t_k)}^{\frac{\sigma}{\sigma-1}}, \tag{C-6}$$

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

All firms with marginal cost lower or equal to $\bar{c}_j$[50] will export to j a quantity equal to:

$$q_{kj}(c_i) = [\frac{\sigma}{\sigma-1} c_i \ (1+t_k)]^{-\sigma} \frac{E_j}{P_j^{1-\sigma}} \tag{C-7}$$

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:

$$N_j = \int_0^{\bar{c}_j} N f(c) dc \tag{C-8}$$

with the marginal-cost threshold $\bar{c}_j$ falling with the export tax (Equation C-6). A drop in $\bar{c}_j$ corresponds to a higher productivity threshold for exporting and hence fewer exporters.

The exported quantity is:

$$Q_j = \int_0^{\bar{c}_j} N q_{kj}(c_i) f(c) dc \tag{C-9}$$

It is straightforward to see that the intensive margin (average quantity per exporting firm in Equation C-7) and the extensive margin (total number of firms in Equation C-8) of the bilateral exported quantity to j, Q_j, are negative functions of the export tax t_k.

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

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

$$V_j = \int_0^{\bar{c}_j} N m_{kj}(c_i) f(c) dc = \int_0^{\bar{c}_j} N [p_{kj}(c_i)]^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} f(c) dc \tag{C-10}$$

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

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 C-2). 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.

Our empirical analysis hence primarily focuses on export quantities. We nevertheless elaborate in our discussion of the results on whether our estimates (for quantity and price elasticity) are consistent with the use of a Pareto distribution for marginal cost as in Chaney (2008).