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21 June 2015

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Abstract

This paper extends the model of Melitz (2003) to separate the direct and indirect impact of an export tax rebate on the intensive margin of firm-level export sales at the subnational level. The direct impact of the rebate is associated with a reduction of an exporting firms' variable costs, while the indirect impact manifests itself through higher regional wages as a result of increased demand for local labor. First, the empirical results imply that a 1% rise in the export tax rebate rate increases the export sales among continuing exporters by 0.4% through the direct channel. Second, the same rebate increase reduces export sales among continuing exporters by 0.02% through indirect channel. Both effects are statistically significant, and are consistent with the model's predictions.

Keywords: Export Tax Rebate · Regional Labor Market · Direct Impact · Indirect Impact

JEL Classification: D22·F10·F14·L10

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1. Introduction

Value-added taxes are an indirect tax imposed at each stage of the production process based on the amount of value added associated production value. Most of the world's value-added taxes are imposed only on goods and services consumed within their own taxing jurisdiction, also known as destination based VAT(Desai and Hines, 2005). Feldstein and Krugman (1990) show that a destination based VAT system with a complete tax rebate has no effect on exports and imports. Therefore, unlike export subsidies and other measures, the VAT rebate (hereafter, ETR) has been considered to be consistent with the World Trade Organization's (WTO) main function of ensuring free and smooth trade. According to Bird and Gendron (2007), until January 2007, at least 150 nations use an ETR regime. There is a general belief that the ETR rate and firms' exports are positively correlated when the rebate rate is incomplete. A significant number of researches have found evidence to support this claim (e.g. Chao et al., 2001; Chen et al,, 2006; Chandra and Long, 2013). However, all those papers investigate the direct effect of ETR on export volume. In our paper, we argue that in addition to direct effect, the ETR also has an indirect effect on export volume through differential industrial composition. Without taking the indirect effect into account, researches will tend to exaggerate the role of the ETR in promoting international trade.

While the direct effect of the ETR on firms' exports reduces the variable production cost, the indirect effect of the ETR arises from competition for local laborers among exporting firms. Specifically, when an increase in the ETR makes exporting more profitable, exporting firms expand their production thus necessitating the demand for more laborers. This increased demand drives up the laborer's

wage. As a consequence, the firm-level output and exports will be depressed.

We develop a theoretical model to illustrate both the direct and indirect mechanisms and examine them empirically in this paper. The principal goal of the theoretical model is to uncover both the direct and indirect effect of the ETR on firm-level exporting behaviors. In line with most of the recent international trade literature (Melitz, 2003; Melitz and Ottaviano, 2008), we assume that labor is the only input in the production and firms are heterogeneous in their productivity as in Melitz (2003). Within a country, each region is treated as a subeconomy with a different industrial distribution of labor. When labor mobility is limited, the model shows that a nation wide change in the ETR will lead to different firm-level export responses. Intuitively, if other things are equal, and the ETR changes are identical in all industries, the wage changes more in regions where more labor work in the exporting sectors. This implies that the indirect effect is larger in regions experiencing a larger weighted ETR change.

We evaluate the model's testable predictions using Chinese Custom data over 2000 to 2006. This data has several significant implications. First, China offers an ideal setting to investigate the impact of the ETR on firms' exports. On the one hand, it has experienced spectacular growth in international trade since the 1980s (Wang and Wei, 2007), it annually exports the largest volume of products in the world (Lin, 2010), and its outstanding trade growth has attracted considerable attention because of the trade policies implemented by the Chinese government (e.g. Eckaus, 2006; Girma et al,, 2009). On the other hand, the Chinese government frequently adjusts the ETR rates to adjust its exports. Gourdon et al. (2014) indicate that during the 2002 to 2012 period, 87% of products at the HS6-product classifications have undergone at least one ETR change. Second, China's setting also

meets our assumption within the theoretical model, since labor mobility between regions in China is limited. In the era of the planned economy, China introduced the Residence Registration System (Hukou system) to implement its industrial development strategy. Under this system, labor mobility is strictly restricted (Cai et al, , 2002). Although restrictions on labor mobility have gradually relaxed, labor mobility is still broadly restrained. This fact is helpful for identifying the indirect effect of the ETR changes on firms' exports, as exporting firms located in regions, with different industrial composition respond differently to the same national wide ETR changes. Third, we also directly observe the HS code of exporting product and the location of exporting firms in this data set. This feature is essential for us to construct measures of the industrial and regional ETR rates, respectively.

Endogeneity of the ETR rate is one of the biggest concerns in the empirical analysis (e.g. Chandra and Long, 2013; Gourdon et al., 2014). Specifically, the ETR rates may be set higher for industries where the majority of firms have high export growth potential, or set higher for industries where the majority of firms have poor exporting performance to boost their exports. Either case suggests that the OLS estimators might be biased. To ease this concern, we take advantage of China's dual trade regime to obtain our instrument variable. In China, firms export under two regimes. One is the "ordinary" regime, which is common throughout the world. The other is the "processing" regime, under which firms with supplied materials are not eligible to receive any rebate. Since fiscal pressures are often the driving force behind the Chinese government for adjusting the ETR rates, we expect that industries with a larger share of processing trade firms face less fiscal pressure, and thus resulting in higher ETR rates. Meanwhile, the share of processing trade within an industry would be independent of firm-level export

growth. As such, it can be used as an instrument to determine how the ETR affect firms' exports.

By using industry-level ETR and regional weighted average ETR to capture direct and indirect effects, respectively, we find that a 1% increase in the ETR rate will increase firm-level exports by 0.5%, while a 1% increase in the weighted average ETR rate will decrease the firm-level exports by 0.2%. After using the instrument variable and controlling for firm's self-selection into exporting, we find that a 1% increase in the ETR rate will increase firm-level exports by 0.2%, and a 1% increase in the regional weighted ETR rate will decrease firm-level exports by about 0.02%. These results verify that the OLS estimator tends to be upward biased. Endogeneity problem should not be ignored when investigating the impact of ETR on export sales among continuing exporters. The estimated indirect effect of the ETR is negative and statistically significant, which is consistent with the model's prediction. This result indicates that the direct effect of the ETR on firms' exports will be offset by the indirect effect caused by local wage changes.

This paper contributes to the literature in two distinct manners. First, we disentangle both the direct and indirect effect of the ETR on firms' export sales among continuing exporters. In theory, Feldstein and Krugman (1990) first point out that the increase in the ETR rate will lead to the rise of exports. Chen et al, (2006) develop a Cournot quantity competition model to examine the effect of the ETR on export performance. Empirically, several papers investigate the relationship between the ETR rate and export performance at the industrial or firm level (e.g. Chen et al,, 2006; Chandra and Long, 2013; Gourdon et al., 2014). However, none of them document the role which industrial composition plays in the implementation of the ETR. Industrial distribution of labor is an essential factor

affecting exports (Cassey and Schmeiser, 2013; Krautheim, 2012), and failing to consider it leads to overestimating the importance of the ETR on boosting exports.

Second, this paper also provides some insights into the recent growing body of work that examines the export spillover effect. For example, Aitken et al (1997) find that the export probability of Mexican plants is positively related with the presence of multinational firms in the same state. Greenaway et al, (2004) find that multinational firms have a positive influence on the export decision of UK domestic firms. Greenaway and Kneller (2008) show that regional and sectoral agglomeration encourages the entry of new firms in export markets. However, Barrios et al (2003), in contrast, find no evidence to indicate that Spanish firms can benefit from other exporters. Bernard and Jesen (2004) conclude the exporting spillover effect does not exist among American manufacturing firms. Our paper which emphasize the competition effect can provide some explanations for these inconsistent findings. That is, although the presence of other exports can have positive externality by sharing information, or knowledge spillovers, it also might exert negative effects on other firms by competing for resources.

The structure of this paper is as follows. In section 2, we describe the model and the hypotheses; Section 3 introduces the ETR system in China and separately identifies its direct and indirect impact on exporting firms' intensive margin. Section 4 concludes.

2. Model

In this section, we develop a model to explain the direct and indirect mechanisms through which the ETR affects firm-level exporting behavior.

2.1. Labor Supply

Consider a country with many regions, indexed by j. Each industry in this economy is denoted by i. Labor is the only input in production Labor is assumed to be mobile between industries, but not across regions. This assumption implies that the wage level is identical across all industries within a region, but varies across regions. The labor supply in region j is given by:

$$L_j = a_j + b_j \omega_j \tag{1}$$

where L_j and ω_j are labor supply and wages in region j. Note that the elasticity of labor supply, which is positively correlated with b_j,[1] may vary across regions.

Further, assume that production exhibits constant returns to scale. As such, the marginal production cost for a firm with productivity ϕ_k is: $MC(\phi_k) = \frac{\omega}{\phi_k}$, where we have dropped the subscript j for notational convenience.

2.2. Labor Demand

A representative consumer's preference for varieties takes the CES form.

$$U = \left[\int_{\iota \in \Omega} q(\iota)^{\frac{1-\sigma}{\sigma}} d\iota \right]^{\frac{\sigma}{1-\sigma}} \tag{2}$$

where σ is the elasticity of substitution between any two products.

Firm k in industry i, maximizes its profits by optimally choosing its output, which determines the firm's labor demand l_i^k. The labor demand in industry i is the sum of the individual firms' labor demand: $L_i = \sum_k l_i^k$. The total regional

[1] The elasticity of labor supply implies by equation (1)is $\frac{1}{\frac{a_j}{\omega b_j}+1}$.

labor demand is constituted by the sum of labor demand in each industry

$$L = \sum_i L_i \tag{3}$$

where L_i is the total labor demand in industry i, which is the aggregate labor demand of firms in industry i. We further divide labor demand for any exporting firm in industry i into domestic and foreign production labor demands. In particular,

$$l_i(\omega, \phi_k, t_i) = l_i^{ne}(\omega, \phi_k) + l_i^e(\omega, \phi_k, t_i) \tag{4}$$

where $l_i(\omega, \phi_k, t_i)$ is the labor demand of an exporting firm at wage level ω, ETR rate t_i and productivity ϕ_k. $l_i^{ne}(\omega, \phi_k)$ is the labor demand of a firm with productivity ϕ_k, hired to serve the domestic market. $l_i^e(\omega, \phi_k, t_i)$ is the labor demand of a firm with productivity ϕ_k, hired to serve foreign markets.[2] Therefore, the total labor demand in industry i of all non-exporting and exporting firms is identical to the aggregate labor demand of individual firms used to serve the domestic and foreign markets. That is,

$$L_i = \sum_{k=1}^{n_i^{ne}} l_i^{ne}(\omega, \phi_k) + \sum_{v=1}^{n_i^e} l_i^e(\omega, \phi_v, t_i) \tag{5}$$

where n_i^{ne} and n_i^e are the total number of firms serving the domestic market and foreign markets in industry i, respectively. Note that the labor demand for any exporting firm has been divided into two parts: one set of labor is hired to serve the

[2]Note that the ETR rate t_i only directly affects the labor demands of exporting firms, used to serve foreign markets, through changing their variable cost, but does not affect the labor demand of firms, used to serve the domestic market.

domestic market, and the other set of labor is hired to serve the foreign markets.

Similar to Melitz (2003), the labor demand of a firm with productivity ϕ_k, hired to serve the domestic market, is given by

$$l_i^{ne}(\omega, \phi_k) = A_i \left(\frac{1}{\phi_k}\right)^{1-\sigma} \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} \omega^{-\sigma} \tag{6}$$

where A_i is the domestic residual demand for the products of industry i, respectively.[3]

Accordingly, the labor demand of an exporting firm with productivity ϕ_v, used to serve the foreign markets, is given by

$$\begin{aligned} l_i^e(\omega, \phi_v, t_i) &= A^* \left(\frac{1}{\phi_v}\right)^{1-\sigma} \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} (\widetilde{\tau}\omega)^{-\sigma} \\ \text{where } \widetilde{\tau} &= \frac{\tau}{\left(1 + \frac{\tau_2}{\tau}\sigma\right)^{\frac{1}{\sigma_i - 1}}}, \tau_2 = r - t_i \end{aligned} \tag{7}$$

where A_i^* is the residual demand of products of industry i in foreign markets, r is the official VAT rate collected, τ_2 is the actual VAT rate paid after receiving the rebate, τ is the iceberg transportation cost, and $\widetilde{\tau}$ is the rebate adjusted trade cost.[4]

2.3. The Impact of the ETR on Exporting Firms' Intensive Margin

From equation (7), the change in the ETR affects the variable cost of exporting firms through the adjusted trade cost $\widetilde{\tau}$. We can derive the following negative

[3]Differing from Melitz (2003), we consider the per period fixed cost is paid by using capital instead of labor to simplify the model. If the per period fixed cost is also considered as a part of labor demand, the results will not be affected.

[4]The proof is in the Appendix.

relationship between the ETR rate, t_i, and the adjusted trade cost $\widetilde{\tau}$.

$$\frac{\partial \widetilde{\tau}}{\partial t_i} = \frac{\partial \widetilde{\tau}}{\partial \tau_2} \frac{\partial \tau_2}{\partial t_i} = \tau_1 \left(-\frac{1}{\sigma - 1} \right) (1 + \tau_2)^{-\frac{\sigma}{\sigma-1}} \left(\frac{\sigma}{\tau} \right) < 0. \tag{8}$$

Equation (8) implies that, an increase in the ETR is identical to a decrease in rebate adjusted trade cost $\widetilde{\tau}$. From this it is evident that we can demonstrate the following inequalities:

$$\frac{\partial l_i^{ne}(\omega, \phi_k)}{\partial \omega} < 0 \tag{9.1}$$

$$\frac{\partial l_i^{e}(\omega, \phi_v, t_i)}{\partial \omega} < 0 \tag{9.2}$$

$$\frac{\partial l_i^{e}(\omega, \phi_v, t_i)}{\partial t_i} > 0 \tag{9.3}$$

$$\frac{\partial \omega}{\partial t_i} > 0 \tag{9.4}$$

Inequalities (9.1) and (9.2) imply that the labor demand of firms, used to serve the domestic and foreign markets, is decreasing in the regional wage level ω. Inequality (9.3) implies that the direct impact of the ETR on exporting firms' labor demand, used to serve the foreign markets, is positive. At last, (9.4) indicates the positive correlation between ETR rate and the regional wage level[5]. The intuition for this result is that when industry i receives a higher ETR, exporting firms start to expand their production, and as such increase the labor demand hired to serve the foreign markets. All other things equal, the equilibrium wage level increases.

From the above analysis, the ETR affects the firm-level intensive margin of exports through two respective channels. The first is the direct channel, in which

[5]The detailed proof is in the Appendix.

the ETR affects the variable cost of exporting firms through refunding them the tax they pay. The other is the indirect channel in which the ETR affects the intensive margin through changing the regional wage. To evaluate the impact of ETR changes on exporting firms' behavior, we have to disentangle the direct and indirect impact of ETR changes.

Regions are heterogeneous in the distribution of labor across industries. The differences in industrial composition across regions could be caused by regional level comparative advantages, e.g. geographic or policy advantage (Cai et al, , 2002). A consequence of different industrial composition across regions is that the regional wage adjusts differently in response to the ETR changes. This model yields the following relationship between wage changes and regional level weighted average ETR changes.

$$\Delta\omega = \sum_i \beta_i \Delta t_i \tag{10}$$

$$\text{where, } \beta_i = \frac{L_i^e\,(-\sigma)\,\widetilde{\tau}\frac{\partial\widetilde{\tau}}{\partial t_i}}{b - \frac{\sigma}{\omega}L}, \;\; L_i^e = \sum_v l_i^e(\omega, \phi_v, t_i)$$

where L_i^e is the total labor demand of exporting firms hired to serve foreign markets, in industry i. Equation (10) implies a positive correlation between the weighted average ETR change, $\sum_i \beta_i \Delta t_i$, and the change in the regional wage, $\Delta\omega$. β_i is positively correlated with $\alpha_i = \frac{L_i^e}{\sum_j L_j}$[6], the share of laborers in industry i for export production. We summarize the predictions of the model in the following proposition.

[6] $\beta_i = \frac{(-\sigma)\widetilde{\tau}\frac{\partial\widetilde{\tau}}{\partial t_i}}{\frac{b}{L} - \frac{\sigma}{\omega}}\alpha_i$

Proposition 1. *When the mobility of the regional labor force is limited, an ETR increase have a positive direct impact and a negative indirect impact on intensive margin of firm-level export sales. The impact of industry-level ETR changes on firm-level exports is smaller in regions experiencing larger weighted average ETR changes.*

The proposition implies that if the ETR changes are identical in all industries, the intensive margin of exporting firms will change less in regions, where more of labor is allocated to exporting sectors.

3. Background and Data

In China, industrial composition differs significantly across regions. Candelaria et al. (2013) show that the regional differences in industrial composition explain about half of regional wage differences. The ratio of provincial exports to provincial GDP also varies considerably across provinces. During the period 2002-2006, the minimum regional export share was less than 5%, while the maximum counterpart was more than 70%. Table 1 reports the 25th, 50th and 75th percentile of export shares between 2002-2006.

[Table 1 is to be here]

Table 1 indicates significant differences in regional export shares. The data shows that the maximum regional export share is 20 times larger than the minimum. These regional differences reflect the regional variation in industrial composition.[7]

[7] The data is available in *CEnet Statistics Database*: http://db.cei.gov.cn/page/Default.aspx

Export revenue is an important component in China's GDP. In 2006, Chinese export revenue accounted for 37% of GDP. Knowing the important role exports play in its economy, the Chinese government announced a series of policies to stimulate exports. ETR system was established to encourage exports. It partially refunds exporting firms the value-added and consumption tax they pay for their inputs. In particular, the ETR is applicable for exporting firms engaged in ordinary trade or processing trade with imported materials. For firms engaged in processing trade with supplied materials, the value-added tax has already been exempted when they purchase the inputs, and as such they cannot receive any ETR. The ETR rates vary substantially across industries with a range from 0 to 17% in 2006. As a policy tool to adjust the exporting structure (e.g. shifting China's exports toward more value-added and high-tech products by providing a high ETR in these industries), the ETR rate has been frequently adjusted. From 2002 - 2012, more than 80% of products at 4 digit HS classification level underwent at least one ETR change. The ETR system has proved effective in boosting exports in China. Gourdon et al. (2014) show that every 1% increase in the ETR rate in a given industry causes a 6% increase in export sales in the same industry. In addition, the Chinese government increased the ETR rates several times when faced with the East-Asian Crisis in 1997, which stabilized Chinese exports and the economy. After 1999, a four-tired ETR system (17%, 15%, 13%, and 5%) was implemented with an average ETR rate of 15%. In October 2003, the Chinese government announced a reduction in the average ETR rate from 15.11% to 12.11% due to the fiscal pressure. Since January of 2004, a five-tired ETR system (17%, 13%, 11%, 8%, and 5%) was implemented.

To conduct the empirical analysis, we match three sources of information. One of the data sources is collected by the Chinese Customs Trade Statistics (CCTS) and contains a report of export quantities, and f.o.b values for exporting firms in the eight-digit Harmonized System over the 2000-2006 period. The second data source is from the Chinese Annual Survey of Industrial Firms (CASIF). The CASIF dataset covers all state-owned enterprises (SOEs) and non-SOEs with annual sales above RMB 5 million, which is equivalent to approximately 700 thousand US dollars.

We carefully matched the two datasets following Brandt and Zhang (2012) using firm names, telephone numbers, and zipcodes. Using the matched dataset, we compute the firm-product level TFP following Foster et al. (2008), and developed by Hu et al. (2015):

$$\ln TFP_{ikt} = \ln q_{ikt} - \alpha_k \ln k_{ikt} - \alpha_l \ln l_{ikt} - \alpha_m \ln m_{ikt} \tag{11}$$

where q_{ikt} is the physical units of output i exported by firm k in year t across all destinations. k_{ikt}, l_{ikt} and m_{ikt} represent the firm-product-year measures of capital, labor and materials, respectively. α_k, α_l, and α_m are the input share for capital, labor and intermediate materials, respectively.[8]

The third data source is the ETR rates from the Chinese Customs Information Release Center[9], which covers all exported products between 2002 - 2006. We match this dataset with the CCTS data using HS codes. The weighted average

[8]The detailed procedures of construction input shares is in the Appendix.
[9]The web page is: http://www.china-customs.com

ETR in each region is constructed as follows:

$$ETR\_prov_{jt} = \sum_i ETR_{it} \frac{\exp_{ijt}}{GDP_{jt}} \tag{12}$$

where ETR_prov_{jt} is the weighted average ETR of province j in year t, and exp_{ijt} is the export revenue of industry i in province j at year t, and GDP_{jt} is the total GDP of province j in year t. The regional weighted average ETR, ETR_prov_{jt}, varies across provinces and over time.

Note that our model is best suited for manufacturing firms which export directly, but a considerable number of Chinese exporters are intermediary firms. Following Ahn et al. (2011), we identify the set of intermediary firms by their name[10] and drop all of them in the empirical regressions.

Finally, we have a matched dataset of exporting firms with variables containing firm-level export quantities and TFP, industry-level ETR rates, and the regional revenue weighted ETR rates.

3.1. Empirical Evidence

In this section, we test the model's prediction of the direct and indirect impact of the ETR on the firm-level intensive margin of exports. The direct and indirect effects are captured by the industry-level ETR and regional weighted average ETR,

[10]Specifically, we identify the set of intermediary firms by their Chinese name that mean "trading", "importer", and "export". In pinying, the name containing these phrases: "jin4chu1kou3", "jing1mao4", "ke1mao", and "wai4jing1" is treated as intermediary firms.

respectively.

$$\ln Q_{kit} = \beta_0 + \beta_1 \ln ETR_{it} + \beta_2 \ln (ETR\_prov_{jt}) + \beta_3 \ln TFP_{kt} + \chi_t + \chi_i + \chi_k + \varepsilon_{kit} \tag{13}$$

where Q_{kit} is the export units of product i produced by firm k in year t. ETR_{it} is the ETR rate of industry i in year t, and ETR_prov_{jt} is the regional revenue weighted ETR in year t. χ_t, χ_i and χ_k are used to control for the year, industry and firm fixed effects, respectively. The results are reported in Table 2.

[Table 2 is to be here]

Table 2 indicates that an increase in the industry ETR rate will increase the intensive margin of exports, while an increase in the regional weighted average ETR will have the opposite effect. A positive impact of the industry ETR on firms' exports captures the impact of the firm-level rebate adjusted trade cost $\widetilde{\tau}$, defined in equation (7). The negative impact of the weighted average ETR on the intensive margin of exports captures the impact of changing regional wages. In particular, the regions experiencing a weighted average ETR increase will expand their exports and hence raise the regional labor demand. The rising regional labor demand pushes up the regional wage, which in turn increases the exporting firms' production cost. As such, a weighted average ETR increase has a negative impact on firm-level exports. The direct impact of ETR changes on a firm's exports dominates the indirect impact. These results are consistent with the model's predictions.

As mentioned in a series of papers by Dai et al (2014), Yu (2013) and Gourdon et al. (2014), processing trade is organized differently from ordinary trade. In

particular, firms engaged in processing trade are of lower productivity, and rely more on global supply chains. Most importantly, the processing trade firms with supplied materials are not qualified to receive the ETR as they are exempted from paying value added tax when they purchase their inputs. To ease the concern that the firms engaged in processing trade may potentially bias the empirical results in Table 2, we estimate the coefficients in equation (13) using only firms engaged in ordinary trade.

[Table 3 is to be here]

In Table 3, the results show a similar pattern to that in Table 2. Every 1% increase in industry ETR rate will increase the firm-level intensive margin of export sales by 0.5%, while every 1% increase in the weighted average ETR rate will decrease firm-level intensive margin of export sales by about 0.2%.

A second concern arises from reverse causality: the Chinese government may use the ETR to subsidize poor-performing industries and boost their exports. Alternatively, the ETR may subsidize industries with high export-growth potential. In either case, our regression framework may potentially suffer from endogeneity bias. To address this issue we use instrumental variable estimation. During the 2002 - 2006 period, the Chinese government adjusted the ETR rates frequently because of fiscal pressures (Chandra and Long, 2013). For each industry, the fiscal pressure partially depends on the share of processing trade firms with supplied materials, because these firms are not eligible to receive any rebate. This implies that industries with a larger share of processing trade firms with supplied materials, will account for less fiscal pressure on the government, and will be subject to smaller ETR reductions. Meanwhile, the share of processing trade within a

industry does not affect the firm-level export growth. Therefore, the exporting share of processing trade with supplied materials in each exporting industry can be used as an instrument. The results are reported in the second column of Table 4 and Table 5 for the full sample and ordinary trade firms, respectively.

A third concern is selection bias. In particular, all firms experiencing changes in the intensive margin of export sales are survivors. These firms may have higher growth potential compared to those firms which exit. This implies that the impact of the ETR on the firm-level intensive margin of export sales might be upward biased. To control for the selection bias, we implement the estimation in two steps. In the first step, we compute the firm-level survival probability using a Probit regression;[11] in the second step, we add the survival probability into equation (13) and use IV regressions to obtain the final estimates. We report the results with the selection bias correction in the third column of Table 4 and Table 5 for the full sample and ordinary trade, respectively.

[Table 4 is to be here]

[Table 5 is to be here]

The results in Table 4 and Table 5 imply that although the impact of the weighted average ETR on firms' exports fall, the effect is still negative and statistically significant after controlling for the endogeneity and selection bias. The results support the predictions of our model.

[11] In the selection equation, the selection variables contain firm-level TFP, quantity sales in the last period and industry-year fixed effect

4. Conclusion

In this paper, we extend the model of Melitz (2003) to investigate the impact of ETR changes on the firm-level intensive margin of export sales. The model predicts that an increase in the ETR will have both direct and indirect impacts on firms' exports due to the immobility of the regional labor force. On the one hand, the increase in the ETR decreases firm-level variable costs, and hence increases firm-level exports. On the other hand, the increase in the ETR increases local labor demand as production expands among exporting firms. Rising local labor demand raises the regional wage, which drives up the variable production costs. As a result, firm-level export volumes decline. Using Chinese firm-level export data and industry-level ETR rates during the 2002 - 2006 period, we test the predictions of the model. The results indicate that an increase in the industry-level ETR increases firm-level exports, while the increase in the weighted average ETR drives down firm-level exports. The results are robust to controlling for potential endogeneity and selection bias. This paper suggests that, due to the unbalanced industrial composition across regions, a national wide ETR policy would have differential impacts on exports across Chinese provinces.

Appendix (Tables)

Table 1: The Export Shares in Different Percentiles

Year	25th	50th	75th	Min	Max
2002	4.07%	5.72%	17.32%	3.20%	73.00%
2003	4.70%	7.10%	18.98%	3.84%	80.30%
2004	5.14%	6.84%	20.48%	4.26%	84.42%
2005	4.80%	7.78%	21.63%	3.53%	87.54%
2006	5.81%	8.39%	24.31%	4.35%	91.61%

Notes: Guandong Province has the largest export share during the period 2002-2003. The inland provinces, e.g. Henan and Hunan, normally have the lowest export shares.

Table 2: The Impact of ETR on Firms' Intensive Margin (Full Sample)

$lnETR_{it}$	0.5540***	0.5542***
	(*0.0236*)	(*0.0236*)
$lnETR\_prov_{jt}$		-0.1522***
		(*0.0107*)
$lnTFP_{kt}$	0.6160***	0.6160***
	(*0.0017*)	(*0.0017*)
Ownership	Yes	Yes
R^2	0.53	0.53
Obs	1,082,046	1,082,046

Notes: Table 2 presents the impact of ETR on firms' intensive margin. Industry, year and firm fixed effects have been included. Standard errors are in parenthesis, ***, ** and *, respectively, denoting significance at the 1%, 5%, and 10% levels.

Table 3: The Impact of ETR on Firms' Intensive Margin (Ordinary Trade)

$lnETR_{it}$	0.4668***	0.4810***
	(0.0258)	*(0.0258)*
$lnETR\_prov_{jt}$		-0.2022***
		(0.0124)
$lnTFP_{kt}$	0.6761***	0.6762***
	(0.0020)	*(0.0020)*
Ownership	Yes	Yes
R^2	0.56	0.56
Obs	777,060	777,060

Notes: Table 3 presents the impact of ETR on ordinary trade firms' intensive margin. Industry, year and firm fixed effects have been included. Standard errors are in parenthesis, ***, ** and *, respectively, denoting significance at the 1%, 5%, and 10% levels.

Table 4: The Impact of ETR on Firms' Intensive Margin (Full Sample-IV)

	IV	IV+Selection
$lnETR_{it}$	0.2024***	0.1540***
	(0.0404)	*(0.0415)*
$lnETR\_prov_{jt}$	-0.055***	-0.0129**
	(0.0045)	*(0.0046)*
$lnTFP_{kt}$	0.6420***	0.7075***
	(0.0031)	*(0.0035)*
Ownership	Yes	Yes
R^2	0.47	0.47
Obs	1,082,061	1,082,061

Notes: Table 4 presents the impact of ETR on exporting firms' intensive margin by using IV regression and controlling for firms' exit. Industry, year and firm fixed effects have been included. Standard errors are in parenthesis, ***, ** and *, respectively, denoting significance at the 1%, 5%, and 10% levels.

Table 5: The Impact of ETR on Firms' Intensive Margin (Ordinary Trade-IV)

	IV	IV+Selection
$lnETR_{it}$	0.1350**	0.1879***
	(0.0439)	*(0.0465)*
$lnETR\_prov_{jt}$	-0.0579***	-0.0172**
	(0.0053)	*(0.0056)*
$lnTFP_{kt}$	0.6775***	0.7926***
	(0.0036)	*(0.0042)*
Ownership	Yes	Yes
R^2	0.49	0.49
Obs	777,052	777,052

Notes: Table 5 presents the impacts of ETR on ordinary trade firms' intensive margin by using IV regression and controlling for firms' exit. Industry, year and firm fixed effects have been included. Standard errors are in parenthesis, ***, ** and *, respectively, denoting significance at the 1%, 5%, and 10% levels.

Input Shares

We assume that the output of each product is produced by a Cobb-Douglas function. To compute firm-product level productivity, we need to calculate input shares for labor, materials and capital, α_l, α_m and α_k, respectively, for each product. Let $\tilde{\omega}_{kt}$ denote firm k's total nominal wage payments in year t. Hsieh and Klenow (2008) suggest that the wage bill, $\tilde{\omega}_{kt}$ tends to underestimate the labor share in the Chinese manufacturing data. Following their approach, we multiply each firm's wage bill by a constant parameter, $\tilde{\rho}$, to inflate the wage bill in each firm. We determine the size of the constant parameter by choosing the parameter so that the aggregate labor compensation in the manufacturing sector matches the labor share in national accounts (roughly 50 percent).

Specifically, we denote the total, observed payments to workers as

$$t\omega = \sum_k \sum_t \tilde{\rho}\tilde{\omega}_{kt} = \tilde{\rho} \sum_k \sum_t \tilde{\omega}_{kt} = \tilde{\rho}\widetilde{t\omega}$$

where $\tilde{\rho}$ is the unknown inflation parameter we need to determine and $\widetilde{t\omega}$ denotes the total observed labor compensation. We denote total revenues tr and total intermediate materials tm. Hsieh and Klenow (2009) suggest that the ratio of total wage payments to value-added is roughly 50% from the Chinese national accounts and input-output tables. This implies that

$$\frac{t\omega}{tr - tm} = 0.5 \Rightarrow \frac{\tilde{\rho}\widetilde{t\omega}}{tr - tm} = 0.5 \Rightarrow \tilde{\rho} = 0.5\frac{tr - tm}{\widetilde{t\omega}}$$

After $\tilde{\rho}$ is determined, we calculate the labor share in each of exporting industries we focus on as:

$$\alpha_l = \frac{1}{\tilde{N}} \sum_t \sum_k \frac{\tilde{\rho}\tilde{\omega}_{kt}}{\tilde{r}_{kt}}$$

where $\tilde{r}_{kt}$ are the firm k's nominal revenues, and $\tilde{N}$ is the total number of firm observations in each year. Similarly, we calculate the intermediate materials share as the average share of intermediate inputs in total revenues,

$$\alpha_m = \frac{1}{\tilde{N}} \sum_t \sum_k \frac{\tilde{\rho}\tilde{m}_{kt}}{\tilde{r}_{kt}}$$

where $\tilde{m}_{kt}$ is the total value of intermediate materials firm k used in year t. Finally, in the absence of reliable capital share information, we follow Hsieh and Klenow (2009) and assume constant returns to scale so that $\alpha_k = 1 - \alpha_l - \alpha_m$. We have alternatively tried estimating the input shares, and productivity, using control

function methods (De Loecker et al., 2012). We find very similar measures of input shares and productivity.

Appendix (For Reviewer)

The labor demand of a pure domestic firm with productivity ϕ_k is given by

$$
\begin{aligned}
l_i^{ne}(\omega, \phi_k) &= \frac{q_i}{\phi_k} \\
q_i &= A p_i^{-\sigma} \\
p_i &= \frac{\sigma}{\sigma - 1}\left(\frac{\omega}{\phi_k}\right) \\
&\Rightarrow l_i^{ne}(\omega, \phi_k) = A_i \left(\frac{1}{\phi_k}\right)^{1-\sigma} \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} \omega^{-\sigma}
\end{aligned} \tag{A1}
$$

The ETR system refunds the pure exporting firms according to their export revenues: $\frac{t_i}{\tau} p_v^* q_v^*$, where $p_v^* = \tau \frac{\sigma}{\sigma-1} \frac{\omega}{\phi_v}$, and $q_v^* = A_i^* \left(p_v^*\right)^{-\sigma}$. However, the incomplete ETR system in China only partially refunds most exporting firms, which makes the non-rebatable part, $r - \widetilde{\tau}_2$ (r is the official tax collection rate), an effective tax on exports. The pure exporting firm's optimization problem becomes:

$$
\begin{aligned}
\max_{p_v^*} \left(p_v^* - \tau \frac{\omega}{\phi_v}\right)\left(A_i^* p_v^{*-\sigma}\right) - \frac{1}{\tau} p_v^* \cdot A_i^* p_v^{*-\sigma}(r - t_i) \\
\Rightarrow p_v^* = \frac{\sigma}{\sigma - 1}\left(\widetilde{\tau} \frac{\omega}{\phi_v}\right) \\
\text{where, } \widetilde{\tau} = \frac{\tau}{\left(1 + \frac{\tau_2}{\tau}\sigma\right)^{\frac{1}{\sigma-1}}}, \tau_2 = r - t_i
\end{aligned} \tag{A2}
$$

From equation (A2), the optimal quantity and the corresponding labor demand

for foreign markets are as follows:

$$
\begin{aligned}
q_v^* &= A_i^* \left(p_v^*\right)^{-\sigma} \\
&= A_i^* \left[\frac{\sigma}{\sigma-1}\left(\widetilde{\tau}\frac{\omega}{\phi_v}\right)\right]^{-\sigma} \\
&\Rightarrow l_i^e(\omega,\phi_v,t_i) = A^* \left(\frac{1}{\phi_v}\right)^{1-\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\left(\widetilde{\tau}\omega\right)^{-\sigma}
\end{aligned}
\tag{A3}
$$

To show the inequality of (9.4), we only need to show the opposite is impossible. Assume $\frac{\partial\omega}{\partial t_i} < 0$.This implies the following inequality:

$$
\begin{aligned}
\frac{\partial L}{\partial t_i} = &\sum_k \left(\frac{\partial l_i^{ne}(\omega,\phi_k)}{\partial\omega}\frac{\partial\omega}{\partial t_i}\right) + \sum_v \left(\frac{\partial l_i^e(\omega,\phi_v,t_i)}{\partial\omega}\frac{\partial\omega}{\partial t_i} + \frac{\partial l_i^e(\omega,\phi_v,t_i)}{\partial t_i}\right) \\
&+ \sum_{n\neq i}\left[\sum_k \left(\frac{\partial l_n^{ne}(\omega,\phi_k)}{\partial\omega}\frac{\partial\omega}{\partial t_i}\right) + \sum_v \left(\frac{\partial l_k^e(\omega,\phi_v,t_n)}{\partial\omega}\frac{\partial\omega}{\partial t_i}\right)\right] > 0 \\
&\Rightarrow \frac{\partial L}{\partial t_i} > 0 \\
&\Rightarrow \frac{\partial\left(a+b\omega\right)}{\partial t_i} > 0 \\
&\Rightarrow \frac{\partial\omega}{\partial t_i} > 0
\end{aligned}
\tag{A4}
$$

The second inequality is because of the equilibrium, $L = a + b\omega$ (Labor market clearing). The last inequality is a contradiction, therefore, we have proved inequality (9.4).

The impact of the ETR change in industry i on the regional wage is as follows:

$$
\begin{aligned}
b\frac{\partial \omega}{\partial t_i}\Delta t_i &= \frac{\partial L}{\partial t_i}\Delta t_i \\
&= \sum_j \left[\sum_k \left(\frac{\partial l_j^{ne}(\omega,\phi_k)}{\partial \omega}\right) + \sum_v \left(\frac{\partial l_j^{e}(\omega,\phi_v,t_j)}{\partial \omega}\right)\right]\frac{\partial \omega}{\partial t_i}\Delta t_i + \sum_v \frac{\partial l_i^{e}(\omega,\phi_v,t_i)}{\partial t_i}\Delta t_i \\
&= \sum_j \frac{-\sigma}{\omega}\left[\sum_k l_j^{ne}(\omega,\phi_k) + \sum_v l_j^{e}(\omega,\phi_v,t_i)\right]\frac{\partial \omega}{\partial t_i}\Delta t_i + \sum_v l_i^{e}(\omega,\phi_v,t_i)\,(-\sigma)\,\widetilde{\tau}\frac{\partial \widetilde{\tau}}{\partial t_i}\Delta t_i \\
&= \left(\sum_j \frac{-\sigma}{\omega}L_j\right)\frac{\partial \omega}{\partial t_i}\Delta t_i + L_i^e\,(-\sigma)\,\widetilde{\tau}\frac{\partial \widetilde{\tau}}{\partial t_i}\Delta t_i \\
&\Rightarrow \frac{\partial \omega}{\partial t_i}\Delta t_i = \frac{L_i^e\,(-\sigma)\,\widetilde{\tau}\frac{\partial \widetilde{\tau}}{\partial t_i}\Delta t_i}{b + \sum_j \frac{-\sigma}{\omega}L_j} \qquad \text{(A5)}
\end{aligned}
$$

where L_i^e is the total labor demand for pure exporting firms in industry i, and L_j is the total labor demand in industry j. The third equation is derived as follows:

$$
\begin{aligned}
\frac{\partial l_j^{ne}(\omega,\phi_k)}{\partial \omega} &= \frac{-\sigma}{\omega}l_j^{ne}(\omega,\phi_k) \qquad \text{(A5.1)} \\
\frac{\partial l_j^{e}(\omega,\phi_v,t_j)}{\partial \omega} &= \frac{-\sigma}{\omega}l_j^{e}(\omega,\phi_v,t_j) \qquad \text{(A5.2)} \\
\frac{\partial l_i^{e}(\omega,\phi_v,t_i)}{\partial t_i} &= A_i^*\left(\frac{1}{\phi_v}\right)^{1-\sigma}\left(\frac{\sigma_i}{\sigma_i-1}\right)^{-\sigma}(\omega)^{-\sigma}\,(-\sigma_i)\,\widetilde{\tau}^{-\sigma-1}\frac{\partial \widetilde{\tau}}{\partial t_i} \\
&= A^*\left(\frac{1}{\phi_v}\right)^{1-\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(\widetilde{\tau}\omega)^{-\sigma}\,(-\sigma)\,\widetilde{\tau}\frac{\partial \widetilde{\tau}}{\partial t_i} \\
&= l_i^{e}(\omega,\phi_v,t_i)\,(-\sigma)\,\widetilde{\tau}\frac{\partial \widetilde{\tau}}{\partial t_i} \qquad \text{(A5.3)}
\end{aligned}
$$

From (A5), we can derive the impact of ETR changes in all industries on the

regional wage:

$$
\begin{aligned}
\Delta\omega &= \sum_i \frac{\partial\omega}{\partial t_i}\Delta t_i \\
&= \sum_i \frac{L_i^e\left(-\sigma_i\right)\widetilde{\tau}\frac{\partial\widetilde{\tau}}{\partial t_i}}{b+\sum_j \frac{-\sigma_j}{\omega}L_j}\Delta t_i \\
&= \sum_i \beta_i \Delta t_i \qquad \text{(A6)} \\
\text{where } \beta_i &= \frac{L_i^e\left(-\sigma_i\right)\widetilde{\tau}\frac{\partial\widetilde{\tau}}{\partial t_i}}{b+\sum_j \frac{-\sigma_j}{\omega}L_j}
\end{aligned}
$$

Define $\alpha_i = \frac{L_i^e}{\sum_j L_j}$, the share of labors in industry i for exporting production. If σ_i, the substitution elasticity, is not correlated with L_i, nor L_i^e, α_i and β_i is positively correlated.

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