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The employment and wage effects of export VAT rebates: evidence from China

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Abstract

This paper studies the employment and wage effects of VAT rebates to exporters with comprehensive firm-product-level data of China. It is found that the adjustments in VAT rebates significantly and positively affect firm's employment but have no statistically significant effect on firm's wage. Moreover, this paper finds that the employment effect of VAT rebates is heterogeneous across firms. In particular, low-productivity firms are more sensitive to the adjustments of VAT rebates than high-productivity firms, suggesting that an increase of VAT rebates may cause mis-reallocation of resources.

Keywords VAT rebates · Employment · Wage · Firm heterogeneity · Trade policy

JEL Classification F14 · F16 · H32 · J23

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1 Introduction

In open economies, trade policy has been considered as an important influencing factor of the labor market.[1] The input value added tax (VAT) rebates to exporters have been a commonly used and frequently adjusted trade policy in China. On average, VAT rebates have accounted for 1.8% of GDP and 10.8% of government total tax revenue for the last 15 years.[2] The rates of VAT rebates have been adjusted more than 30 times since the country's tax system reform in 1994. However, the impact of VAT rebates on the labor market is so far unclear. Does the benefit from the rebates pass through to the labor market? Do firms increase employment and/or wage when receiving higher rebates? This paper empirically addresses these questions by studying the employment and wage effects of VAT rebates with comprehensive linked firm-product-level data.

Understanding the employment and wage effects of VAT rebates is important for two reasons. First, the trade literature of heterogeneous firms suggests that resource reallocation across firms is a natural consequence of trade liberalization, and it accounts for a significant part of the overall welfare effect of the trade policy.[3] The adjustments of VAT rebates provide a unique setting for evaluating the impact of this specific trade policy on labor (mis-)reallocation across firms. Our study adds labor market evidence to the above-mentioned general literature. Second, the analysis of VAT rebates can shed light on the potential effects of export tax on the labor market, on which the evidence is rather limited. As shown by Feldstein and Krugman (1990), when VAT is only partially rebated, the non-refunded part effectively acts as an export tax.[4] An increase in the rate of VAT rebates is then equivalent to a decrease of export tax. Utilizing the adjustments in the rates of VAT rebates in China, our study thus provides new evidence on the labor market effects of an export tax.

In practice, the rates of VAT rebates are set at the product level. However, the data of employment and wage is usually collected at the firm level. Therefore, we construct a firm-specific rate of VAT rebates and estimate the employment and wage effects of VAT rebates at the firm level. We define the firm-specific rate of VAT rebates as the average of the rates of VAT rebates of all products exported by a firm, weighted by the share of each product in the firm's total exports. Moreover, we follow Yu (2015) to use the export share of each product calculated from firms' data in the initial year during the sample period. This is to mitigate the bias in the estimation of the employment and wage effects of VAT rebates, as the contemporaneous export weights may be correlated with a firm's employment and wage. Another

[1] For example, see Trefler (2004), Goldberg and Pavcnik (2005), Amiti and Davis (2012) and Krishna et al. (2014) on the effects of tariff reduction on the labor market. See Campa and Goldberg (2001), Verhoogen (2008), Nucci and Pozzolo (2010) and Dai and Xu (2017) on the effects of exchange rate shocks on the labor market.

[2] Calculated from China Statistical Year Book compiled by National Bureau of Statistics of China.

[3] For example, see Pavcnik (2002), Melitz (2003) and Trefler (2004).

[4] For example, Garred (2018) and Gourdon et al. (2019) calculate a measure of VAT export tax from the VAT rebates.

estimation bias may arise when the changes in the product-level rate of VAT rebates are endogenous to firm's employment and wage. For example, many changes in the rates of VAT rebates are responses to export shocks, such as the changes after Asian financial crisis in 1997 and the global financial crisis in 2008. An endogeneity issue arises if export shocks affect firm's employment and wage through other channels (than affecting the rate of VAT rebates) that are not controlled for. However, we argue that the changes in the rates of VAT rebates in our analysis are plausibly exogenous to firm's employment and wage. We select the data from January 2003 to December 2006 for our analysis. During this period, as stated in the official circulars, the changes in the rates of VAT rebates were aimed at tackling domestic economic issues such as upgrading the economy structure, optimizing natural resource consumption and reducing environmental pollution. Braakmann et al. (2020) provide evidence that the changes in the rates of VAT rebates during this period were related to product characteristics, such as whether the product is resource intensive, high tech, pollutive or energy consuming, and were unrelated to various measures of export shocks. Therefore, the changes in the rates of VAT rebates in our analysis are plausibly exogenous to firm's employment and wage.

Our preferred empirical specification finds that the adjustments in VAT rebates significantly affect firm's employment while having no statistically significant impact on firm's average wage. More specifically, a one percentage point increase in firm-specific rate of VAT rebates raises firm's employment by 0.236%. Compared with the employment growth of the firms whose VAT rebates are changed in our sample, the changes in VAT rebates reduce employment growth rate by around 3.6%. This indicates that the changes in VAT rebates are an important factor affecting firm's employment. There are two possible explanations of the employment effect: exports and financial constraints. On one hand higher VAT rebates give rise to the increase of export quantity and price, requiring firms to employ more labor (e.g. Chandra and Long 2013; Gourdon et al. 2019; and Braakmann et al. 2020). On the other hand, the increases in VAT rebates essentially represent cash flows back to firms, potentially relaxing firms' financial constraints and enabling them to adjust their employment.

Our estimated employment and wage effects of VAT rebates are qualitatively insensitive to various robustness checks. Firstly, we use alternative export share, including mean share from initial year to last year and export share lagged by one year and two years, to calculate firm-specific rate of VAT rebates. Secondly, we calculate firm-specific rate of VAT rebates considering product entry and exit within firms. The results using these alternative measures of firm-specific rate of VAT rebates are very robust. Thirdly, we estimate employment and wage effects using small exporters as a safeguard to the exogenous adjustments of the rates of VAT rebate in our sample. The intuition is that small exporters are impossible to have a substantial impact on the adjustments of the rates of VAT rebates. Moreover, we conduct robustness checks about the roles of processing trade, product aggregation, bonded materials and export size. All results are consistent.

This paper further studies the heterogeneity of the employment and wage effects in firm productivity. Our results show that employment is more sensitive to the adjustments of VAT rebates in the firms with lower productivity while the wage

effect is insignificant and indifferent between firms with different levels of productivity. Since our results suggest that an increase in VAT rebates raises employment more in the firms with lower productivity, an increase in VAT rebates may cause mis-allocation of resources. A policy implication is that the government should take actions to mitigate the distortions when it considers increasing the VAT rebates.

This paper contributes to the literature of export VAT rebates. The literature has mostly focused on VAT rebates' effects on exports. Theoretically, Feldstein and Krugman (1990) show that a partial rebate on VAT makes non-refunded VAT act as an export tax. This export tax is lower as the rate of VAT rebates becomes higher. As a result, VAT rebates are positively related to export. Chandra and Long (2013) provide firm-level evidence and Gourdon et al. (2019) provide product-level evidence for this prediction. Braakmann et al. (2020) provide additional evidence for this prediction with firm-product-level data. Tang et al. (2019) study the impact of VAT rebates on firm productivity and find that firm productivity is increased by higher rebates. There is also some literature explaining the motivations of the adjustments of the rates of VAT rebates, e.g. environmental considerations (Song et al. 2015; Gourdon et al. 2016; and Eisenbarth 2017) and strategical support to downstream sectors (Gourdon et al. 2016; and Garred 2018). The present paper studies the employment and wage effects of VAT rebates, providing a new dimension of the economic effects of VAT rebates.

This paper also adds to the wider literature on the effects of trade policy on the labor market. Trade liberalization has been found to be associated with the employment and wage.[5] In particular, Amiti and Davis (2012) theoretically and empirically show that the effects of tariff reductions for both input and output on wage are subject to firm-specific engagement into trade. They find that a fall in output tariffs decreases wages in import-competing firms but increases wages in exporting firms. Moreover, they find that a fall in input tariffs increases wages in import-using firms relative to those at firms that only use local inputs. Krishna et al. (2014) emphasize that the impact of tariff reductions on wage is affected by the quality of matching between workers and firms. The impact of exchange rate on the labor market has also been investigated by various studies.[6] In particular, Dai and Xu (2017) construct firm-specific exchange rate shocks and find a significant effect on the labor reallocation across firms. Our paper also highlights the firm-specific shocks due to the changes of trade policies and focuses on the trade policy of VAT rebates.

The rest of this paper is organized as follows. In Sect. 2 we introduce the background and implementation of China's export VAT rebates. We present the empirical strategy in Sect. 3 while describing the data in Sect. 4. In Sect. 5 we report the results of the employment and wage effects of VAT rebates and robustness checks. In Sect. 6, we study the heterogeneity in firm productivity. Section 7 concludes the paper.

[5] For example, see Attanasio et al. (2004), Trefler (2004), Goldberg and Pavcnik (2005), LaRochelle-Côté (2007), Artuç et al. (2010), Amiti and Davis (2012), and Krishna et al. (2014).

[6] For example, see Campa and Goldberg (2001), Klein et al. (2003), Verhoogen (2008), Nucci and Pozzolo (2010), Ekholm et al. (2012) and Dai and Xu (2017).

2 China's VAT rebates

2.1 Background

China started the policy of VAT rebates in 1994, in which exports were exempted from VAT and the paid input VAT for the production of exports was fully refunded.[7] The rates of VAT rebates have been changed many times since 1994. At the beginning, the adjustments were made in response to the heavy fiscal burden of the government and the rebates fraud.[8] However, in the past two decades, the adjustments of the rates of VAT rebates generally served two practical purposes.

The first and foremost purpose is to promote exports. As an export-promoting tool, the rates of VAT rebates have been frequently adjusted when exports face negative shocks, in particular, during the economic crisis. For example, after Asian financial crisis in 1997, as China's exports dropped, instead of depreciating Chinese currency to promote exports, the rates of VAT rebates were adjusted more than 10 times in 1998 and 1999. During this period, a large number of products received higher rates of VAT rebates. During 2008 and 2009, China's exports were hit by the global financial crisis. Consequently, the rates of VAT rebates were increased for the products whose exports dropped most sharply, including textiles, clothing, furniture, toys and electromechanical products.

The other purpose is to upgrade the structure of the economy. For example, from 2003 to 2007, the rates of VAT rebates were adjusted more than 10 times. The main aims of theses adjustments were to reduce resource consumption and to reduce environmental pollution. For example, in *Fa Gai Jing Mao [2005] 1482 Hao and 2595 Hao*[9], the objectives of these circulars are clearly described as "to control the exports of high energy-consuming, high polluting and resource-based products". Stated in these circulars, one of the measures was to adjust the rates of VAT rebates of these products. Consequently, the adjustments from 2003 to 2007 were mainly reductions of the rates of VAT rebates for high energy-consuming and high polluting products (e.g. steel and chemical products), and resource-based products (e.g. rare earth metals, silicon and wooden products).

As this paper studies the employment and wage effects of VAT rebates, it is important to exclude the adjustments that happened in response to (negative) export shocks. The reason is that export shocks may also affect employment and wage through other channels than affecting VAT rebates. If we do not have proper control for these channels, an endogeneity issue will arise (we will discuss more on this

[7] Before 1994, China's trade policy of rebates for exports was based on industrial and commercial standard tax ("Gong Shang Tong Yi Shui" in Chinese).

[8] As documented by Cui (2003), the rebates from the government were increased by 150% to 75 billion yuan in 1994, in which 30 billion yuan were deferred to 1995 due to the state's budget constraint. To relieve the heavy fiscal burden and solve the fraud problem, the rates of VAT rebates for most products were lowered by 3 percentage points in 1995 and further decreased by 4 percentage points in 1996.

[9] Circular No. 1482 and 2595 were jointly issued by National Development and Reform Commission, Ministry of Finance, Ministry of Commerce, Ministry of Land and Resources, General Administration of Customs, State Administration of Taxation and Ministry of Environmental Protection.

problem in the identification issues discussed in Sect. 3). Thus, we select adjustments of the rates of VAT rebates from January 2003 to December 2006, a period when the rates of VAT rebates were (officially) mainly adjusted to reduce resource consumption and to reduce environmental pollution. This is supported by Braakmann et al. (2020), who find that the adjustments during this period were not related to export shocks, but related to product characteristics, such as whether the product is resource intensive, high tech, pollutive and energy consuming.

2.2 Implementation

The input VAT paid by firms for domestic sales is ultimately borne by consumers. Instead, the paid input VAT for exports is fully or partially refunded by the government because exports are exempted from VAT.[10] The process of full VAT rebates is illustrated in Fig. 1. Suppose a firm uses the input of 100 dollars to produce one unit of a product for the domestic sales. To purchase the input, the firm has to pay a VAT of 17%, i.e. 17 dollars. The product is sold at 120 dollars plus a output VAT of 17%, i.e. 20.4 dollars. The firm will use the output VAT, 20.4 dollars, to offset the input VAT, 17 dollars, and then pay the difference, i.e. 3.4 dollars, to the government. For this transaction, all the input VAT paid by the firm is finally borne by domestic consumers. The policy works differently for exporters. Suppose the same firm exports the same product. Because exports are exempted from VAT, the firm cannot collect output VAT from the importers in destinations. Therefore, the input VAT, i.e. 17 dollars, acts as a cost to the firm. Under the policy of VAT rebates, the firm can receive rebates to cover the cost of input VAT from the government. As shown in Fig. 1, the firm can receive the full value of input VAT, i.e. 17 dollars, from the government if the input VAT is fully rebated.

In practice, the process of VAT rebates is more complicated for two reasons. First, the rebates are not always made in full. Take the above firm for example, the government may rebate only a part of the value of input VAT, i.e. setting a lower rate of VAT rebates than the rate of VAT. Second, for some inputs, firms do not have to pay VAT when purchasing them. As a result, no rebates are given for these inputs. A typical example is bonded materials, for which firms in China do not pay duty and VAT when importing them.

Formally, according to *Circular No. 7 Cai Shui [2002]*, the VAT rebates from the government for the eligible firms, disregarding the domestic sales, are:

$$\text{VAT Rebates} = Input\_VAT - (Exports - BM) * (VAT - VATR), \tag{1}$$

where $Input\_VAT$ is the value of VAT paid for the input that is used for the production of exports. VAT and $VATR$ are the rate of VAT and rate of VAT rebates, e.g. 17%

[10] The importing countries often impose VAT to the imports to ensure an equal competitiveness between imports and domestic products. Therefore, to avoid double taxation the exporting countries do not impose VAT for exports.

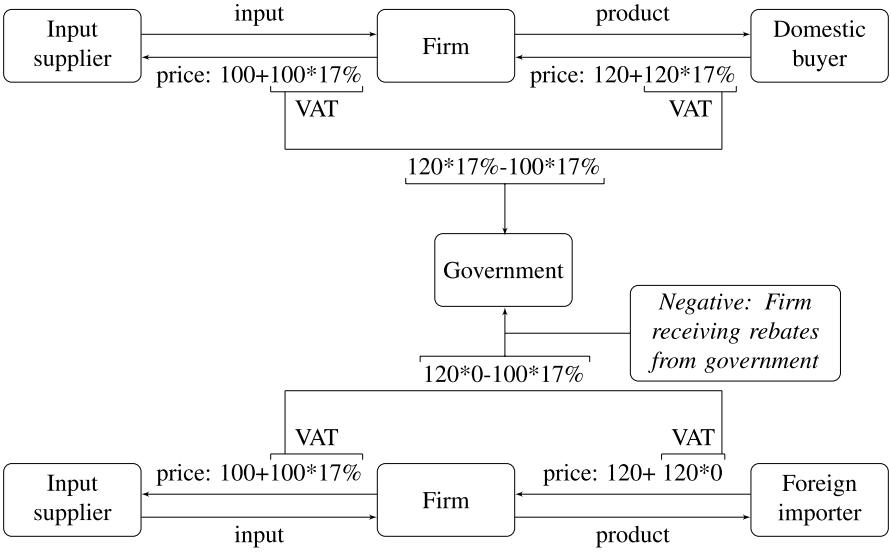

Fig. 1 The policy of export VAT rebates

and 13%, respectively. *Exports* denotes the value of eligible exports.[11] *BM* denotes the value of inputs which are exempted from VAT, typically the bonded materials. The expenditure on these inputs is excluded from the export value for the purpose of calculating VAT rebates.

As shown in Eq. (1), if the rate of VAT rebates is equal to the rate of VAT, the VAT rebates are equal to the value of input VAT. That is to say, the firm is fully refunded of the paid VAT for the input used for the exports, which is the case illustrated in Fig. 1. However, if the rate of VAT rebates of a product is less than the rate of VAT, the VAT rebates are less than the value of input VAT, i.e. the value of input VAT is partially refunded. If the calculated VAT rebates are negative, instead of receiving rebates from the government, the firm has to pay VAT to the government. For example, if the value of input VAT is very small and the value of exports is very large, the calculated VAT rebates can be negative. If the calculated VAT rebates are -100, the firm has to pay 100 as the VAT to the government.

[11] As we explain in Sect. 4.2, non-eligible exports are typically the exports under processing trade with supplied materials, for which firms do not pay any input VAT.

3 Empirical strategy

In this section, we provide a simple illustration on how firm's employment is affected by the changes in VAT rebates. Then we describe the empirical specifications to estimate the employment and wage effects of VAT rebates.

3.1 A simple illustration

Suppose that the production of the exported product in a firm requires the labor l and the input k. The wage rate and the price of the input are w and p_k, respectively. The firm has to pay VAT when purchasing the input. The value of input VAT is $VAT(k)$. Assume that the production function takes a Cobb–Douglas form:

$$q = \varphi \cdot l^{\beta} k^{1-\beta} \tag{2}$$

where q is the output and φ is firm productivity. $0 < \beta < 1$. The fixed cost of producing and exporting the product is f. The firm's profit exporting q units at the f.o.b. export price p is then:

$$\pi = pq - (wl + p_k k) - f - VAT(k) + \text{VAT Rebates} \tag{3}$$

Combining the VAT rebates from Eq. (1) and ignoring the use of bonded materials, the profit can be written as:

$$\begin{aligned} \pi &= pq - (wl + p_k k) - f - VAT(k) + (VAT(k) - pq \cdot (VAT - VATR) \\ &= p(1 - VAT + VATR)q - (wl + p_k k) - f \end{aligned} \tag{4}$$

Equation (4) suggests that if the rate of VAT rebates is smaller than the rate of VAT, there is a tax burden for exporters. More specifically, the non-refunded VAT, i.e. $VAT - VATR$, acts as an export tax, which is in line with Feldstein and Krugman (1990). This export tax is lower as the rate of VAT rebates becomes higher. Therefore, the study of the impact of VAT rebates on the labor market can shed light on the potential impact of export tax on the labor market, on which the literature is very limited.

The firm's problem can be analyzed in two steps. The first step is to minimize the cost $wl + p_k k$ by choosing labor l and inputs k given the output q described in Eq. (2), wage w and the price of input p_k. The second step is to maximize the profit by choosing the export price p given the market demand. In the optimum of the first step, we can find firm's employment for the production of exports as:

$$l = \frac{q p_k^{1-\beta} \beta^{1-\beta}}{\varphi w^{1-\beta} (1-\beta)^{1-\beta}} \tag{5}$$

and the marginal cost of the firm with productivity φ as:

$$c = \frac{w^{\beta} p_k^{1-\beta}}{\varphi \beta^{\beta} (1-\beta)^{1-\beta}} \tag{6}$$

The marginal cost is constant and not affected by VAT rebates. Therefore, the firm's profit exporting q units at the f.o.b. export price p can be rewritten as:

$$\pi = (p(1 - VAT + VATR) - c)q - f \tag{7}$$

To solve the second step, a demand function is required. Assume that the demand in foreign market is given as $Ap^{-\sigma}$, where A is a demand parameter and σ is the elasticity. For example, a CES preference can generate this demand function. Note that with such demand function, the markup is constant. As a result, the pass-through of any adjustments of VAT rebates is complete. We refrain from incomplete pass-through as we only aim at illustrating how firm's employment is related to VAT rebates. The iceberg-type variable trade cost is τ. Therefore, the export price including the variable trade cost is τp. As a result, the output to satisfy the foreign demand is $q = \tau A(\tau p)^{-\sigma}$. Substituting this demand equation into the profit Eq. (7), we can solve the optimal price p by maximizing the profit:

$$p = \frac{\sigma c}{(\sigma - 1)(1 - VAT + VATR)} \tag{8}$$

Then, the output q is:

$$q = A\tau^{1-\sigma} \left(\frac{\sigma c}{(\sigma - 1)(1 - VAT + VATR)} \right)^{-\sigma} \tag{9}$$

Substituting Eqs. (6) and (9) into Eq. (5), we have firm's employment:

$$l = \frac{\delta A \tau^{1-\sigma} \varphi^{\sigma-1} (1 - VAT + VATR)^{\sigma}}{w^{1-\beta+\beta\sigma}} \tag{10}$$

where $\delta = \left(\frac{\sigma}{\sigma-1} \right)^{-\sigma} \frac{p_k^{(1-\beta)(1-\sigma)} \beta^{1-\beta+\beta\sigma}}{(1-\beta)^{(1-\beta)(1-\sigma)}}$. As shown in Eq. (10), an increase in the rate of VAT rebates raises firm's employment. Therefore, firm's employment is positively related to VAT rebates.

3.2 Empirical specifications

To guide our empirical analysis on the employment effect of VAT rebates, we take the logarithm form of Eq. (10) and have $\ln l = f(VATR, \ln w, \ln \varphi, \ln A, \ln \tau, \ln \delta)$. Therefore, our specification of the employment equation is:

$$\ln l_{it} = \gamma^{l} FVATR_{it} + \vartheta^{l} \ln X_{it} + \varsigma_i + \varsigma_t + \varepsilon_{it} \tag{11}$$

where $\ln l_{it}$ is the logarithm of employment, i.e. number of workers, of firm i in year t. $FVATR_{it}$ is firm-specific rate of VAT rebates. X_{it} is a set of control variables. ς_i represents firm fixed effects, which control for all the firm-level time-invariant factors, e.g. ownership, location and etc. ς_t represents year fixed effects. ε_{it} is the error term.

Later we will explain how to construct firm-specific rate of VAT rebates and control variables. In addition to the employment effect of VAT rebates, we estimate the following equation to investigate the wage effect of VAT rebates:

$$\ln w_{it} = \gamma^{w} FVATR_{it} + \vartheta^{w} \ln Y_{it} + \varsigma_i + \varsigma_t + \varepsilon_{it} \tag{12}$$

where $\ln w_{it}$ is the logarithm of wage of firm i in year t. More specifically, the wage is measured as the total wage bill divided by the employment. Y_{it} is a set of control variables.

3.2.1 Firm-specific rate of VAT rebates

The rates of VAT rebates are set at the product level in practice. However, the data of employment and wage is collected at the firm level. Given a multi-product firm, it is hard to infer the product-level employment and wage from the firm-level employment and wage. Unfortunately, multi-product firms are prevalent (e.g. Bernard et al. 2010). Thus, we construct the a firm-specific rate of VAT rebates and estimate the employment and wage effects of VAT rebates at the firm level. The intuition behind the construction of firm-specific rates of VAT rebates is as follows. On the one hand, different firms export different products whose rates of VAT rebates may be adjusted differently; on the other hand, even when some firms export the same mix of products, the share of each product in their export portfolio is usually different. Thus, the perceived rates of VAT rebates are very different across firms.

According to Eq. (1), if ignoring bonded materials,[12] the value of VAT rebates of a firm i in year t that exports a set of products Ω_{it} is:

$$\text{VAT Rebates}_{it} = Input\_VAT_{it} - Export_{i,t} * \left(VAT - \sum_{j \in \Omega_{it}} \frac{Export_{ij,t}}{Export_{i,t}} VATR_{jt} \right)$$

where $Input\_VAT_{it}$ is the value of VAT that firm i pays for the input used for the production of exports in year t. $Export_{ij,t}$ is the value of eligible exports of product j of firm i in year t and $Export_{i,t} = \sum_{j \in \Omega_{it}} Export_{ij,t}$ is the value of eligible exports of firm i in year t. $VATR_{jt}$ is the rate of VAT rebates of product j in year t. For cases where the rates of VAT rebates of some products are adjusted within a year, $VATR_{jt}$ is constructed as the average of the rates of VAT rebates of product in that year. The firm-specific rate of VAT rebates can be defined as the second term in the bracket of the above equation, i.e. an export-weighted average of the rates of VAT rebates across products:

$$VATR_{it} = \sum_{j \in \Omega_{it}} \frac{Export_{ij,t}}{Export_{i,t}} VATR_{jt}. \tag{13}$$

[12] We ignore the bonded materials when calculating firm-specific rates of VAT rebates in the main analysis. In one of our robustness checks, we explain the reason and explicitly address this concern.

If the exported products have the same rates of VAT rebates, the firm-specific rate of VAT rebates calculated as above is simply the rate of VAT rebates of the products.

However, the firm-specific rates of VAT rebates constructed in Eq. (13) could be endogenous. On the one hand, when the rate of VAT rebates of a product is increased, the export value of the product increases (e.g. Chandra and Long 2013; Gourdon et al. 2019; and Braakmann et al. 2020). As a result, the export weights may be correlated with the rates of VAT rebates. If the export weights are positively correlated with the rates of VAT rebates, there will be an upward bias in the firm-specific rate of VAT rebates.[13] On the other hand, the allocation of exports across products is an endogenous decision. For example, high-quality products require skilled labor to produce (Verhoogen 2008). Thus, the exports of different products (with different quality) may be decided by firms' skill intensity of the employment. Another example is that the products within a firm usually have different capital intensities (Ma et al. 2014) and consequently their exports may be decided by the firm's capital intensity.

To mitigate the endogeneity concern associated with the export weight, we follow Yu (2015) to measure the export weight of each product using a firm's initial year's data in the sample:

$$FVATR_{it} = \sum_{j \in \Omega_{it}} \frac{Export_{ij,Initial\_year}}{Export_{i,Initial\_year}} VATR_{jt} \tag{14}$$

With this method, the export weights are time-invariant. Therefore, the firm-specific rate of VAT rebates is not correlated with the reallocation of exports across the products.

3.2.2 Control variables

In the employment Eq. (11), the control variables include firm wage, firm productivity, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value-added in total output, the share of domestic sales, the share of non-eligible exports and firm age. Firm wage corresponds to $\ln w$ in the model. Firm productivity, corresponding to $\ln \varphi$ in the model, is measured by value added per capita.[14] Firm-level demand shocks in the foreign market correspond to the parameter $\ln A$ in the model. We measure firm-level demand shocks with two variables: $\ln\left(\sum_{c \in C_{it}} \frac{Export_{ic,t}}{Export_{i,t}} Pop_{ct}\right)$ and $\ln\left(\sum_{c \in C_{it}} \frac{Export_{ic,t}}{Export_{i,t}} GDPPC_{ct}\right)$. Pop_{ct} and $GDPPC_{ct}$ are the total population and GDP per capita of county c in year t,

[13] The intuition is similar to the downward bias in the measurement of firm-specific tariff when using contemporaneous import weights (e.g. Yu 2015).

[14] The results are very robust when using total factor productivity (TFP) estimated from Levinsohn and Petrin (2003) approach in which materials are used to control for the unobservable productivity as a control variable. In Appendix A.5, we also show the results with TFP estimated from Olley and Pakes (1996) approach in which investment is used to control for the unobservable productivity as well as Ackerberg et al. (2015) approach. All results are robust.

respectively. C_{it} is the set of countries that firm i exports to in year t. $Export_{ic,t}$ is the value of exports of firm i to country c in year t and $Export_{i,t} = \sum_{c \in C_{it}} Export_{ic,t}$ is the total value of exports of firm i in year t. These two variables measure the population of the countries served by a firm and their income levels. Firm-level variable trade cost, corresponding to $\ln \tau$ in the model, is measured by $\ln \left(\sum_{c \in C_{it}} \frac{Export_{ic,t}}{Export_{i,t}} Dist_{ct} \right)$, in which $Dist_{ct}$ is the distance between country c and China. Capital intensity and the share of value-added in total output are used to control for the parameters of production function that are included in the δ of the model. As VAT rebates are based on the eligible exports, we use the share of domestic sales in total sales and the share of non-eligible exports in total exports to control for the impacts of domestic sales and non-eligible exports.

The control variables in the wage Eq. (12) are selected to control for the factors that affect how wages are set across firms. For example, a line of research suggests that firms consider efficiency or fair wages as a mechanism to induce workers' effort (e.g. Egger and Kreickemeier 2009; Davis and Harrigan 2011; Amiti and Davis 2012). Therefore, we include labor productivity, i.e. value-added per capita, in the specification.[15] Another strand of literature finds that search and matching frictions in the labor market result in bargaining power of workers in the negotiation of wage (e.g. Davidson et al. 2008; Helpman and Itskhoki 2010; and Helpman et al. 2010). Therefore, we add control variables measuring the characteristics of local labor market where the firm is located, including unemployment rate, labor market tightness, and labor market matching efficiency. More specifically, we calculate the ratio between job vacancies and job seekers that are registered in the careers services, as an indication of labor market tightness. The labor market matching efficiency is measured by the share of placed job-seekers in total job-seekers registered in the careers services. These labor market characteristics have been considered as important factors when workers negotiate wages with employers (e.g. Helpman and Itskhoki 2010; and Helpman et al. 2010). All other control variables used in the employment Eq. (11) are also included in the estimation of the wage equation.

3.2.3 Identification issues

The key parameters of interest are γ^l and γ^w, which capture the employment and wage effects of VAT rebates respectively. The estimation of γ^l and γ^w could be biased due to the potential endogeneity of $FVATR_{it}$. When calculating $FVATR_{it}$ with the initial export share, the only source of changes in $FVATR_{it}$ is the changes in product-level rates of VAT rebates. However, the changes in product-level rates of VAT rebates can be endogenous. For example, a number of changes in the rates of VAT rebates are responses to the export shocks during economic crisis, e.g. Asian financial crisis in 1997 and the global financial crisis in 2008. The endogeneity issue arises if these export shocks affect firm's employment and wage through other channels that are not controlled for. For example, Chodorow-Reich (2014) and Popov and

[15] The results are robust if we control for total factor productivity as in the employment equation.

Rocholl (2018) show that credit market disruptions due to economic crisis have considerable effects on the firm's employment. Dai and Xu (2017) show that exchange rate shocks affect firm's employment significantly. Apparently, export shocks may be accompanied by credit market disruptions during economic crisis and exchange rate shocks, thereby affecting firm's employment. As a result, the estimated employment and wage effects of VAT rebates will be subject to a downward bias.[16]

However, the impact of this source of endogeneity on our estimation should be fairly minor. The reason is that we select the period from January 2003 to December 2006 in our sample. During this period, the adjustments of the rates of VAT rebates were aimed at upgrading the economy structure, optimizing natural resource consumption and reducing environmental pollution. These objectives are clearly stated in the official circulars, which have been discussed in Sect. 2. As documented by Braakmann et al. (2020), the adjustments during this period were indeed related to product characteristics, such as whether the product is resource intensive, high tech, pollutive and energy consuming; but were unrelated to various measures of export shocks. Therefore, the changes in the rates of VAT rebates in our analysis are plausibly exogenous.

4 Data

Our study draws on three main sources of disaggregated data: product-level rates of VAT rebates, transaction-level trade and firm-level production.

4.1 Rate of VAT rebates

Firstly, we collect the rates pf VAT rebates of all products after the last adjustment in our sample period, i.e. September 2006, from the website of Minister of Commerce.[17] Secondly, we collect all the circulars on the adjustments of VAT rebates between January 2003 and December 2006 in SAT Taxation Law Database.[18] These circulars state the changes of the rates of VAT rebates for the adjusted products. Since our data on exports is at 8-digit HS level, we drop the few 8-digit HS products that have different rates of VAT rebates or the adjustments of the rates of VAT rebates at 10-digit or 11-digit HS level. With this exercise, we have monthly rates of VAT rebates for 7308 8-digit HS products from 2003 to 2006.

In our sample, around 1800 (240) products experienced negative (positive) adjustments of VAT rebates. In total, the rates of 28% of products, i.e. 2055 products, were adjusted. Among them, around 100 products were adjusted more than

[16] More specifically, the rates of VAT rebates are usually increased in response to the negative export shocks. Therefore, the estimated (positive) effect of VAT rebates is offset by the negative effect of credit market disruptions and exchange rate shocks.

[17] http://cws.mofcom.gov.cn/accessory/200703/1174376723900.xlshttp://cws.mofcom.gov.cn/accessory/200703/1174376723900.xls accessible on 15 August 2017.

[18] See Appendix A.1 for details.

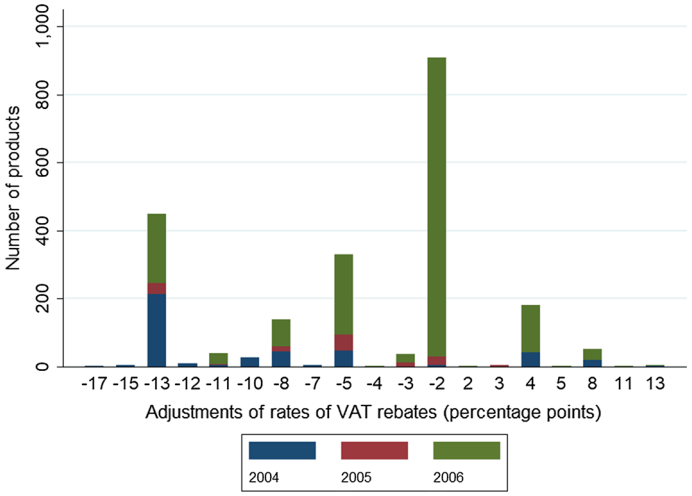

Fig. 2 The adjustments of VAT rebates

once.[19] The changes in the rate of VAT rebates were between − 17 percentage points and 13 percentage points. As shown in Fig. 2, most (around 40%) of the changes are the reductions in the rate of VAT rebates by 2 percentage points, which involves around 900 products. The second most (around 20%) of the changes are the reductions by 13 percentage points involving around 450 products. The third and fourth most (around 15% and 8%) of the changes are the reductions by 5 percentage points involving around 330 products and the increases by 4 percentage points involving around 180 products, respectively. The fifth most (around 6%) of the changes are the reductions by 8 percentage points involving around 140 products. Compared with the maximum rate of VAT rebates, 17%, these changes were substantial. For most adjustments, the period between the announcement and the time of these adjustments coming into effect varied from one day to ten days. This indicates that the anticipation effects, i.e. firms adjusting employment and wage in anticipation of adjustments coming into effect, are highly unlikely.[20]

4.2 Transaction-level trade

Our export transactions are from Chinese Customs Trade Database (CCTD) collected by the General Administration of Customs of China. This database reports export (and import) values and quantities by product-firm-destination (source

[19] More specifically, 1949 products, 85 products, 18 products and 3 products were adjusted once, twice, three times and four times, respectively.

[20] The adjustments in January 2004 were an exception, for which the time gap is 75 days as shown in table A1 in Appendix A.1. However, Braakmann et al. (2020) explicitly test the possible anticipation effects of these adjustments and find no evidence of anticipation effects.

country for imports) at a monthly frequency. Moreover, the trade mode is recorded for every transaction. There are three major trade modes, i.e. "processing trade with purchased materials (PTPM)", "processing trade with supplied materials (PTSM)" and "ordinary trade (OT)", which account for more than 90 percent of the exports.[21] Under PTPM, firms purchase materials from abroad as an input used in the production of exports. During the process, firms have to pay input VAT for the materials from abroad. Therefore, the exports under PTPM are eligible for VAT rebates. However, under PTSM, firms are supplied with the materials from abroad and mainly conduct assembly work. During the process, firms do not pay any input VAT for the supplied materials and only get assembly fees after shipping the output abroad. Therefore, exports under PTSM are not eligible for VAT rebates. We use eligible exports, i.e. exports under OT and PTPM, to construct firm-specific rates of VAT rebates. We clean the data by dropping observations with missing values on any of the following variables: product HS code, firm name, export value and export quantity.

4.3 Firm-level production

The firm-level production data comes from Chinese annual survey of manufacturing firms (CASMF) collected by the National Bureau of Statistics of China. There are around 100 thousand firms in 1999 to 410 thousand firms in 2008. The survey records information on firm's employment and wage. The survey also records firm-level data on asset, intermediate input, sales, exports and etc. We clean the data by dropping observations that satisfy any of the following criteria: (1) missing values on firm name or duplicated firm name in each year; (2) missing values or non-positive values on firm employment and total wage bill; (3) non-positive values of sales and total asset; (4) export value larger than total sales; (5) fixed asset or variable asset larger than total asset.

4.4 Merged data

To construct firm-specific rates of VAT rebates, we merge product-level rates of VAT rebates and transaction-level trade to get detailed information on the exports for each exporter, including the products exported and exports for each product. This exercise provides us a sample of around 87,000 exporters in 2003 and around 160,000 exporters in 2006. Then, we merge it with the production-level data to get the sample for the empirical regression.[22]

In the merged data, we have around 27,000 firms in 2003 and around 51,000 firms in 2006. On average, The merged data accounts for 35% of exporters and nearly 50% of export value in CCTD. It also accounts for 58% of exporters and 67% of export

[21] See Appendix A.2 for the definitions of trade modes of PTPM and PTSM.

[22] The details of the merged data, including the number of firms and the description of merging quality for each year, and the descriptive statistics of the data used for our regressions are presented in Appendix A.2.

value in the cleaned CASMF. Moreover, the merged data contains more than 50% of the sales, employment and asset of exporters in the cleaned CASMF. As a comparison, in the merged data of Yu (2015), 40% of the exporters and 53% of the export value in CASMF are covered. Therefore, our merged data is very comparable to Yu (2015).

5 Results

5.1 Baseline results

The results on the employment and wage effects of VAT rebates are reported in Table 1.[23] As shown in columns (3) and (4) of panel A, the employment effect becomes significantly positive as we include firm and year fixed effects. Our preferred specification from Eq. (11) with control variables is shown in column (4), in which the coefficient of *FVATR* is significantly positive at the value of 0.236. This

Table 1 The employment and wage effects of VAT rebates

	(1)	(2)	(3)	(4)
	Panel A: ln employment			
FVATR	0.128	0.041	0.283	0.236
	(0.087)	(0.076)	(0.088)***	(0.077)***
Adj.R^2	0.918	0.940	0.920	0.942
# Observations	97,115	97,115	97,115	97,115
	Panel B: ln wage			
FVATR	− 0.676	− 0.381	− 0.060	− 0.027
	(0.101)***	(0.093)***	(0.092)	(0.091)
Adj.R^2	0.557	0.637	0.615	0.654
# Observations	93,362	93,362	93,362	93,362
Controls	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes

The control variables in the employment equation include firm wage, value added per capita, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. The control variables in the wage equation include firm employment, value added per capita, unemployment rate, labor market tightness, labor market matching efficiency, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. Standard errors are clustered at firm level and stated in parentheses below point estimates. ***, ** and * mean 1%, 5% and 10% significant levels, respectively

[23] The full tables on the employment and wage effects, showing the coefficients of all control variables, are presented in Appendix A.3.

suggests that a one percentage point decrease (increase) of firm-specific rate of VAT rebates significantly reduces (raises) employment by 0.236%.

However, as shown in columns (3) and (4) of panel B, the wage effect of VAT rebates is not significant when including firm and year fixed effects. Our preferred specification from Eq. (12) with control variables is presented in column (4). The coefficient is very small and statistically insignificant, suggesting VAT rebates have no significant impact on firm's average wage. Combining the employment and wage effects together, we find that firms receiving higher (lower) VAT rebates employ more (less) workers but do not pay higher or lower average wage. This is probably because China had a big labor pool during the period in our sample. As a result, firms can expand the employment without paying higher wage.

To understand the scale of the employment effect, we calculate firms' employment growth from the initial year to the last year in our sample and the adjustments of employment induced by the changes in VAT rebates. The employment growth is calculated as $\Delta \ln l$ from the initial year to the last year. The adjustments of employment induced by the changes in VAT rebates are calculated in two steps. Firstly, we calculate the change in the firm-specific rate of VAT rebates for each firm from the initial year to the last year, $\Delta FVATR$. Secondly, we apply the estimated coefficients of $FVATR$ to calculate adjustments of employment induced by the changes in VAT rebates, i.e. $0.236 \times \Delta FVATR$. On average, the employment growth for the firms whose VAT rebates are changed in our sample is 7.3%. There is an overall decrease in the rates of VAT rebates during this period, thereby reducing employment by 0.26%. Therefore, the changes in VAT rebates reduce employment growth by around 3.6%.[24] This indicates that the changes in VAT rebates are a important factor affecting firm's employment.

There are two potential explanations of the employment effect of VAT rebates. The first explanation is about exports: higher VAT rebates give rise to the increase of export quantity and price, requiring firms to employ more labor. There has been evidence in the literature that higher VAT rebates raise export quantity (e.g. Chandra and Long 2013; Gourdon et al. 2019; and Braakmann et al. 2020). In Appendix A.4, we estimate the effects of firm-specific rate of VAT rebates on firm's exports using our firm-level data. Indeed, we find higher VAT rebates significantly increase firm's export value, export quantity and export price (firm's export value divided by export quantity).[25] The second potential explanation is about financial constraints. Financial constraints have been considered an important factor when firms make decisions in the labor market (e.g. Michelacci and Quadrini 2005; Caggese and Cuñat 2008; Borisov et al. 2015; Falato and Liang 2016; and Benmelech et al. 2019). The increases in VAT rebates essentially represent cash flows back to firms, potentially relaxing firms' financial constraints and enabling them to adjust their employment.

[24] Note that the change in firm-specific rate of VAT rebates is smaller than the product-level changes in the rate of VAT rebates. Using the changes in the product-level rates as shown in Fig. 2, the employment effect would be much larger.

[25] If we consider export price as a proxy of export quality, the result suggests that firms may upgrade export quality with higher VAT rebates, which may require more (skilled) labor.

This is relevant in the context of China given the tight financial constraints faced by many Chinese exporters (e.g. Manova and Yu 2016). In Appendix A.4, we show that an increase of VAT rebates indeed raises firms' liquidity and decreases firm's leverage, suggesting that higher VAT rebates make firms become less financially constrained.

5.2 Robustness check

In this section, we present some robustness checks of the employment and wage effects.

5.2.1 Alternative export share

In the main analysis, we use initial export share of each product to calculate firm-specific rate of VAT rebates. The idea is that the time-invariant export share is not correlated with any contemporaneous shocks on firm's employment and wage. As a robustness check, we use the mean export share of each product from the initial year to the last year in our sample, which is also time-variant, to calculate firm-specific rate of VAT rebates. The employment and wage effects are presented in column (1) of Table 2, respectively. The results are very robust. Moreover, we use lagged export share of each product by one year and two years, which are not correlated with contemporaneous shocks, to calculate firm-specific rate of VAT rebates. The results are presented in columns (2)-(3) of Table 2, respectively. Again, they are consistent with the main results.

5.2.2 Product entry and exit

In our calculation of firm-specific rate of VAT rebates, the initial export share is not available for the products that are newly added by a firm after the initial year. Moreover, if a firm drops products after the initial year, the initial export shares of the survival products cannot be used. Therefore, for the firms that add or drop products after the initial year, it is not feasible to use the initial export share to calculate firm-specific rate of VAT rebates. Here, we provide a robustness check on this issue. For every firm, we construct its product mix that consists of all products exported from the initial year to the last year in our sample. Then, the export shares of the products that are not exported in a year are treated as zero. For example, if a firm exports $ 400 of product A and $ 600 of product B in 2003 and exports $ 500 of product A and $ 500 of product C in 2004, the product mix of this firm consists of A, B and C. The export shares of A, B and C are 40%, 60% and 0% in 2003, and are 50%, 0% and 50% in 2004. Again, we use the initial export share to calculate firm-specific rate of VAT rebates and use mean export share to calculate an alternative firm-specific rate of VAT rebates. The employment and wage effects are presented in columns (4) and column (6) of Table 2, respectively. They are very consistent with

Table 2 Robustness checks on alternative export share and product entry and exit

	(1) Mean	(2) Lag_1	(3) Lag_2	(4) Initial	(5) Initial	(6) Mean	(7) Mean
	Panel A: ln employment						
FVATR	0.236	0.224	0.228	0.422	0.405	0.393	0.359
	(0.078)***	(0.078)***	(0.079)***	(0.060)***	(0.078)***	(0.066)***	(0.075)***
Adj.R^2	0.942	0.942	0.942	0.943	0.962	0.943	0.962
# Observations	95,372	95,236	94,681	130,472	69,773	130,472	69,773
	Panel B: ln wage						
FVATR	− 0.044	− 0.048	− 0.038	− 0.037	0.041	− 0.063	0.019
	(0.091)	(0.092)	(0.092)	(0.072)	(0.098)	(0.077)	(0.094)
Adj.R^2	0.654	0.654	0.654	0.668	0.699	0.668	0.699
# Observations	91,683	91,546	91,009	126,042	62,847	126,042	62,847
Product entry/exit	–	–	–	No	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	YES
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

In columns (1)–(3), we use alternative export share to calculate firm-specific rate of VAT rebates: the mean export share from the initial year to the last year, the export share lagged by one year and the export share lagged by two years. In columns (4)–(7), we consider product entry and exit within firms. We construct every firm's product mix that consists of all products exported from the initial year to the last year in our sample and use the initial export share of each product (columns (4)–(5)) and mean export share from the initial year to last year (columns (6)–(7)) to calculate firm-specific rate of VAT rebates. "Product entry/exit" indicates a dummy variable to denote whether the firm drops a product and a dummy variable to denote whether the firm adds a product. The control variables in the employment equation include firm wage, value added per capita, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. The control variables in the wage equation include firm employment, value added per capita, unemployment rate, labor market tightness, labor market matching efficiency, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. Standard errors are clustered at firm level and stated in parentheses below point estimates. ***, ** and * mean 1%, 5% and 10% significant levels, respectively

the main results. Additionally, we check the results controlling for product entry and exit. More specifically, we include a dummy variable to denote whether the firm drops a product and a dummy variable to denote whether the firm adds a product in the control variables. The employment and wage effects are presented in columns (5) and (7). The results are again consistent with the main results.

Table 3 Robustness checks on small exporters, processing trade, product aggregation, bonded materials and export size

	(1) Small Exporter	(2) Small Exporter	(3) Ordinary Trade	(4) Aggregation 6-Digit HS	(5) Bonded Material	(6) Export Size
	Panel A: ln employment					
FVATR	0.219	0.261	0.457	0.214	0.237	0.279
	(0.085)**	(0.101)***	(0.155)***	(0.078)***	(0.077)***	(0.103)***
Adj.R^2	0.936	0.941	0.938	0.942	0.942	0.942
# Observations	82,394	14,147	51,562	94,494	97,106	97,115
	Panel B: ln wage					
FVATR	− 0.043	0.075	0.091	− 0.041	− 0.025	− 0.124
	(0.098)	(0.136)	(0.166)	(0.093)	(0.090)	(0.113)
Adj.R^2	0.631	0.680	0.664	0.652	0.653	0.654
# Observations	79,267	13,542	49,574	90,787	93,370	93,362
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	YES	Yes	Yes	Yes	Yes

In columns (1) and (2), we use the sample of small exporters: defined as firms whose export share for each HS 8-digit product out of total export value of the product is less than 5% and as firms whose total export value is below the 20th percentile in the firms in the same sector. In column (3), we use the sample of firms that only conduct ordinary trade. In column (4), we aggregate the trade data at 6 digit HS level and then calculate firm-specific rate of VAT rebates. In column (5), we exclude bonded materials from export value. In column (6) , we use the firm-specific rate of VAT rebates scaled by the initial share of exports in total sales. The control variables in the employment equation include firm wage, value added per capita, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. The control variables in the wage equation include firm employment, value added per capita, unemployment rate, labor market tightness, labor market matching efficiency, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. Standard errors are clustered at firm level and stated in parentheses below point estimates. ***, ** and * mean 1%, 5% and 10% significant levels, respectively

5.2.3 Small exporters

As a safeguard to the exogenous adjustments of the rates of VAT rebates in our sample, we estimate the effects using a sample of small exporters. The intuition is that small exporters are impossible to have an impact on the adjustments of the product-level rates of VAT rebates. We construct the sample of small exporters using two methods. In the first method, a small exporter is a firm whose export share of every product, i.e. the firm's export value of the product out of the total export value of the product, is less than 5%. The results are shown in column (1) of Table 3. They are very consistent with the main results. In the second method, a small exporter is a firm whose total export value is below the 20th percentile in the firms in the same sector. The results are shown in column (2). The results are consistent with the main results.

5.2.4 Processing trade

As described in Sect. 4.2, exports under PTPM and OT are both eligible for VAT rebates. However, as discussed in Manova and Yu (2016), the exporting behavior of firms conducting PTPM is different from firms conducting OT. To attenuate the concern that the employment and wage effects of VAT rebates may be affected by PTPM, we investigate the effects by excluding firms conducting PTPM as a robustness check. The results are presented in columns (3) of Table 3. The employment effect is significantly positive while the wage effect is not significant.

5.2.5 Product aggregation

The rate of VAT rebates for exports is set and changed at 8-digit HS product level. It is interesting to study whether the product aggregation affects the employment and wage effects.[26] As a robustness check, we aggregate the data at 6-digit HS product level. More specifically, we calculate 6-digit HS product level rate of VAT rebates as the average of the rates across all sub-8-digit HS products and use the initial export share of each 6-digit HS product to calculate firm-specific rate of VAT rebates. The results are presented in column (4) of Table 3 and are consistent with the main results.[27]

5.2.6 Bonded material

As shown in Sect. 2.2, bonded materials should be excluded from the value of exports when calculating VAT rebates. However, in the main analysis we ignore bonded materials when calculating firm-specific rate of VAT rebates. The main reason is that only a small portion of firms use bonded materials in our sample. For those firms using bonded materials, the value of bonded materials is usually small relative to the value of exports. Moreover, we do not observe how bonded materials are used across products within a firm. Here, we provide a robustness check assuming that bonded materials are used within the same 8-digit HS product. Since we observe the bm_{ijt} for each 8-digit HS product j of firm i in year t, we can easily exclude them from exports. Therefore, we use $x_{ijt} - bm_{ijt}$ to replace x_{ijt} when calculating firm-specific rate of VAT rebates. The results of the employment and wage effects are reported in column (5) of Table 3, and are similar to the main results.[28]

[26] For example, Gourdon et al. (2019) estimate the effect of rebates on exports at 6-digit HS product level. The aggregation is also able to partly alleviate the issue of product entry and exit.

[27] The employment and wage effects based on the aggregation at 4-digit HS product level are also very consistent.

[28] We have also checked the results assuming that bonded materials are used within the same 6-digit (4-digit) HS product. We first aggregate bonded materials at 6-digit (4-digit) HS product level for every firm and then allocate bonded materials to 8-digit HS products according to their export shares in total 6-digit (4-digit) HS product level export. The results are very consistent.

5.2.7 Export size

As domestic sales are not eligible for VAT rebates, it is crucial to control for the importance of exports for each firm. For example, a firm with a large (small) change in firm-specific rate of VAT rebates could have a very small (large) amount of export. Then, the employment and wage effects of VAT rebates may be small (large) on this firm. In the main analysis, we have dealt with this problem using the share of domestic sales in total sales as one of the control variables. Therefore, the employment and wage effects are estimated by comparing firms with a similar level of exports. To further provide robustness checks on this issue, we scale firm-specific rate of VAT rebates by multiplying it with the initial share of exports in total sales.[29] With the scaled firm-specific rate of VAT rebates, export size of firms is taken into consideration. The results are reported in column (6) of Table 3. Again, the employment effect is significantly positive while the wage effect is not significant.

5.2.8 Other robustness checks

Our estimation may be affected by the selection bias due to firm's exit from foreign markets. The bias arises when decision to exit is affected by VAT rebates. For example, even conditional on the control variables and fixed effects used in Eqs. (11) and (12), a firm with higher VAT rebates may export strategically just to reap VAT rebates. In this case, firms with higher VAT rebates are more likely to survive in the foreign market. Following Olley and Pakes (1996), we address this potential bias by modeling the probability to survive in the foreign market as a function of observed variables and using the predicted probability to survive as an additional control variable to estimate the employment and wage effects. Another practical concern is that it may take time for the employment and wage to adjust to the changes in VAT rebates. There is also a concern about the reverse causality between employment/wage and VAT rebates as the initial year's export weights may be affected by the initial year's employment and wage. To attenuate these concerns, we investigate the effects of lagged firm-specific rate of VAT rebates by one year on the contemporaneous employment and wage. Moreover, we estimate the employment (wage) effect by excluding the outliers whose employment (wage) is at the top 5% or the bottom 5% of all firms in each sector. The results are presented in Appendix A.5 and are consistent with the main results.

6 Heterogeneity in firm productivity

Firm productivity has been a very important dimension of heterogeneity in the literature of international trade. In this section, we investigate whether the employment and wage effects are heterogeneous across firms with different levels of productivity.

[29] It is equivalent to replace the initial export share of each product in firm total export with the initial export share of each product in firm total sales in Eq. (14).

Table 4 The heterogeneity of the employment and wage effects in firm productivity

	(1) Low	(2) High	(3) All	(4) All	(5) All
	Panel A: ln employment				
FVATR	0.313	0.122	0.739	0.874	0.993
	(0.103)***	(0.114)	(0.262)***	(0.314)***	(0.291)***
TFP_initial ×*FVATR*			− 0.135		
			(0.067)**		
TFP_2003 ×*FVATR*				− 0.188	
				(0.083)**	
TFP ×*FVATR*					− 0.200
					(0.073)***
TFP					0.154
					(0.011)***
Adj.R^2	0.909	0.942	0.942	0.942	0.944
# Observations	48,930	48,185	97,115	54,349	97,115
	Panel B: ln wage				
FVATR	− 0.015	− 0.073	0.513	0.062	0.194
	(0.120)	(0.138)	(0.450)	(0.635)	(0.379)
TFP_initial ×*FVATR*			− 0.149		
			(0.124)		
TFP_2003 ×*FVATR*				− 0.045	
				(0.176)	
TFP ×*FVATR*					− 0.061
					(0.101)
TFP					0.023
					(0.014)*
Adj.R^2	0.611	0.670	0.653	0.658	0.653
# Observations	47,160	46,202	93,362	52,699	93,362
Controls	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes

In columns (1) and (2) we use firms with low initial productivity and firms with high initial productivity, respectively. In columns (3)-(5) we introduce interaction terms between firm-specific rate of VAT rebates and initial productivity, productivity in 2003 and contemporaneous productivity. Note that in columns (3) and (4), the coefficients of initial productivity and productivity in 2003 are absorbed by firm fixed effects. The control variables in the employment equation include firm wage, value added per capita, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. The control variables in the wage equation include firm employment, value added per capita, unemployment rate, labor market tightness, labor market matching efficiency, firm-level demand shocks, firm-level variable trade cost, capital intensity, the share of value added in total output, the share of domestic sales, the share of non-eligible exports and firm age. Standard errors are clustered at firm level and stated in parentheses below point estimates. ***, ** and * mean 1%, 5% and 10% significant levels, respectively

We firstly estimate firms' total factor productivity (TFP) using Levinsohn and Petrin (2003) approach in which materials are used to control for the unobserved productivity.[30] Then, we use firms' TFP at their initial year to divide the sample into two groups: low-productivity firms and high-productivity firms. More specifically, within each sector, the firms with productivity lower than the median value are classified as low-productivity firms while the rest firms high-productivity firms.[31] Finally, we estimate the employment and wage effects for each group.

The results are presented in columns (1) and (2) of Table 4. As shown in panel A, the coefficient of *FVATR* in the employment equation is significantly positive at 0.313 in low-productivity firms and not significant in high-productivity firms. This suggests that a one percentage point decrease (increase) in firm-specific rate of VAT rebates reduces (raises) low-productivity firms' employment by 0.313% while having no statistically significant impact on high-productivity firms' employment. As shown in panel B, the wage effect is not significant in both low-productivity and high-productivity firms. In Appendix A.6, we report the robustness checks with TFP estimated from various methods, including Olley and Pakes (1996) approach and Ackerberg et al. (2015) approach. In all these measures of firm productivity, the pattern about the heterogeneity of the employment and wage effects in firm productivity holds.

To provide further evidence on the heterogeneity in firm productivity, we estimate Eqs. (11) and (12) with an interaction term between firm-specific rate of VAT rebate and the values of firms' TFP. Firstly, we use firms' TFP in their initial year. The results are presented in column (3) of Table 4. As shown in panel A, the coefficient of the interaction term is significantly negative in the employment equation while being insignificant in the wage equation as shown in panel B. Secondly, we use firms' TFP in 2003. The results are presented in column (4). Again, the coefficient of the interaction term is significantly negative in the employment equation but not significant in the wage equation. Thirdly, we use firms' contemporaneous TFP. As shown in column (5), the results are very consistent: the coefficient of the interaction term is significantly negative (not significant) in the employment (wage) equation. These results suggest that the employment effect is larger in the firms with lower productivity while the wage effect is insignificant and indifferent between firms with different levels of productivity.[32] This finding is consistent with the previous specification that firms are divided into low-productivity and high-productivity firms. As a result, an implication to policymakers is that when considering a decrease of VAT rebates, it is important to provide support to low-productivity firms to mitigate the negative effect on employment.

[30] We use sector-wide price index as in Brandt et al. (2012) to deflate the value of output, capital and material.

[31] It is worth noting that VAT rebates may have an impact on firms' TFP (Tang et al. 2019). Therefore, the changes in VAT rebates may affect firms' classification of groups. As a result, we use TFP at the initial year to address this issue. The results are very robust when using the TFP in the first year, i.e. 2003, to classify firms.

[32] In Appendix A.6, we show that the results are robust when controlling for additional interaction terms between firm-specific rate of VAT rebates and capital (and skill) intensity.

Our analysis consistently suggests that the employment is more sensitive to the adjustments of VAT rebates in the firms with lower productivity. In our sample period, there is an overall decrease in VAT rebates. Therefore, employment is reduced more in the firms with lower productivity. The possible explanation to this heterogeneity is that firms with lower productivity are less capable of passing through the negative shocks, i.e. the decrease of VAT rebates, to consumers (i.e. the importers in the foreign countries), thereby having to absorb more of the shocks internally and reducing the employment more. This is consistent with the findings in Braakmann et al. (2020) that smaller exporters and exporter charging lower prices (which tend to be less productive in China) have very limited abilities to increase export price when receiving lower VAT rebates. The lower abilities to pass through shocks to consumers in firms with lower productivity are also consistent with the theoretical models of endogenous markup and incomplete pass through of shocks in trade literature (e.g. Melitz and Ottaviano 2008; and Berman et al. 2012). Moreover, since our results suggest that an increase in VAT rebates raises employment more in firms with lower productivity, an increase in VAT rebates may cause mis-allocation of resources.

7 Conclusion

VAT rebates are a commonly used trade policy. This paper studies the employment and wage effects of VAT rebates using a comprehensive Chinese firm-product-level data set. The paper highlights the role of firm-level heterogeneity when firms are exposed to product-level adjustments of the rates of VAT rebates. Our results show that higher VAT rebates raise firm's employment while having no impact on firm's average wage. Moreover, we find significant heterogeneity of the employment effect across firms with different levels of productivity. In particular, an increase of VAT rebates raises employment more in the firms with lower productivity. This suggests that the policy of increasing VAT rebates may distort the factor market and lead to inefficient use of resources. A policy implication is that the government should take actions to mitigate the distortions when it considers increasing the VAT rebates.

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