Does VAT Rebate Policy Prompt the Export Performance of Mechanical Products?

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Abstract

Value-added tax (VAT) rebate policy plays an important role in China's export growth strategy. In this paper, we use a simple theoretical model to explore the economic effect of changes in the VAT rebate policy. We find that, if foreign aggregate demands remain basically stable, raising the VAT rebate rate may decrease the price of exports and as well as the export. To corroborate the conclusions drawn from the theoretical model, using province level panel data over the 2012-2017 periods, we examine the role of VAT policy on exports of China's mechanical goods industry. To address the potential endogeneity, we rely on a propensity score matching (PSM) technique. Empirical analysis of the panel data shows that VAT rebate has a significant negative effect on China's mechanical goods export. On average, a 1 percentage point increase in VAT rebate rate decreases the exports by 2.07%. Further testing shows that our empirical results are robust. These results do not necessarily suggest inefficiency of China's VAT rebate policy. Further research, suing a longer time series is needed to examine the effectiveness of the VAT rebate policy on other sectors.

Keywords: VAT Rebate Policy, Mechanical goods industry, Propensity Score Matching, China

JEL Classifications: F14; F13; H20; O24

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1. Introduction

Valued-added tax (VAT) rebate policy has played an important role in China's export promotion strategy over the last three decades (Girma et al. 2009; Chandra and Long 2013).VAT is an indirect tax imposed at each stage of the production process based on the amount of value added at that stage. As for the imported raw materials or other intermediate products, VAT levy mainly takes the form of a tariff. A full VAT rebate allows prices of the relevant commodities to equalize their international market prices in the export market. Within the Feldstein and Krugman (1990) framework, an *ideal* VAT rebate system has no effect on a country's exports or imports when full VAT rebate is available (also known as tax neutrality). A VAT system where full rebate on exports is not available is akin to an export tax, which leads to a positive relationship between the VAT rebate rate and export volume. However, Musgrave (1969) believes that, in the presence of an indirect tax system, it may be hard to find an appropriate VAT rebate rate.

VAT rebate policy can nullify the effect of an export subsidiary or protective tariff, if the VAT rebate rate is not consistent with the actual tax levied at each stage of production. This situation can further undermine the neutrality of the VAT tax rebate (Bonis, 1997). More importantly, VAT rebates can also reduce the marginal cost of production as additional cash flows, which eventually affect the export price and volume of exports. When the total aggregate demands remain basically stable in the international market and firms are price-taker, firms facing fierce competition may reduce the price of exports to maintain the share of international market. Under this situation, the price of export products decrease and the quantities of export products keep unchanged, then the total exports will have reduction. So, the role of raising VAT rebate rate in this environment provides the room of reducing the export price for firms. For instance, we take the mechanical exports as an example as follows.

On Jan. 1, 2015, China's government launched a new VAT rebate rate for the mechanical export. A new VAT rebate rate rose from 15% to 17% with a full rebate. According to the Feldstein and Krugman (1990) framework, the mechanical exports should have an increase after on Jan. 1, 2015. However, the exports performance did not increase, but decline (see Figure 1.)

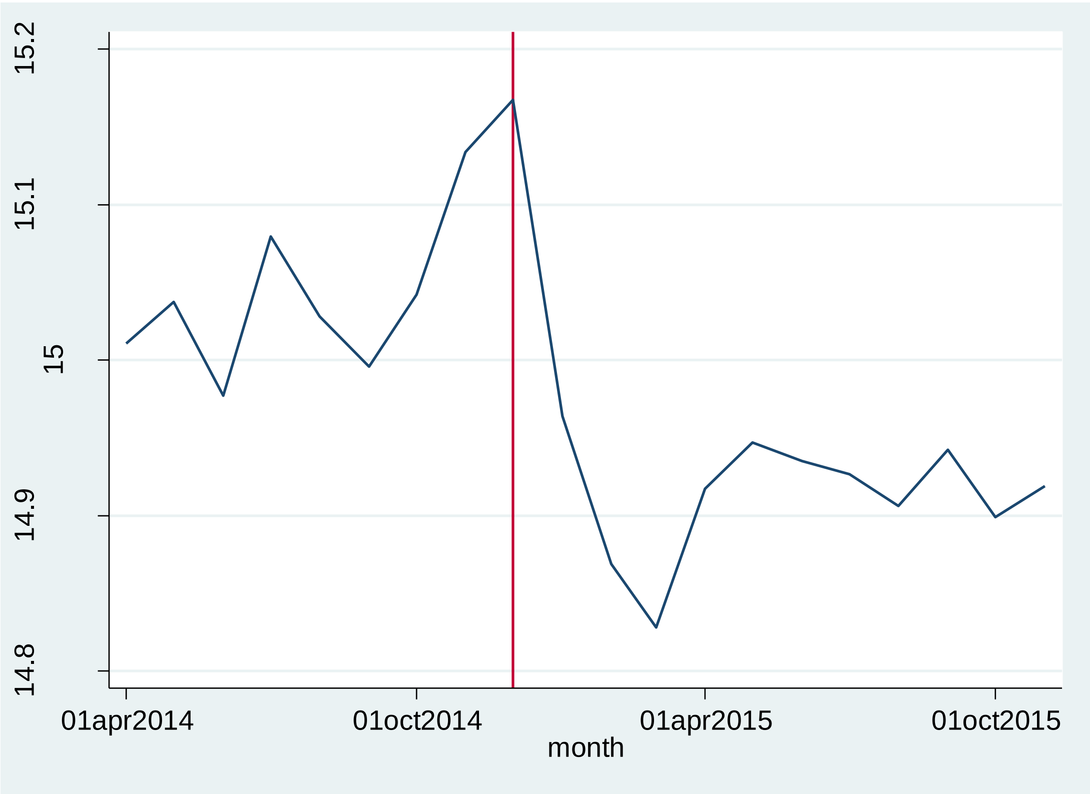

Figure 1.

In this Figure 1, the vertical axis represents the logarithm of mechanical exports and the horizontal axis denotes the month. We can clearly see the decline in the mechanical exports before and after the VAT rebate policy. Before the policy, sample are basically clustered in the range of 15 to 15.2 (vertical axis), while sample mainly oscillate around the 14.9 (vertical axis).

In this paper, we use a Dixit-Stiglitz-type theoretical model to investigate the economic effect of VAT rebate policy on export price and quantity. We then use monthly data over the September 2012 to April 2017 period to examine the effect of the VAT rebate rate on exports of China's mechanical goods industry. We find that the adjustment of VAT rebates in January 2015 has a significant negative impact on exports performance of the mechanical goods. This empirical result, which is consistent with our theoretical prediction, is found to be robust.

An important contribution of this paper is to provide a theoretical link between the VAT rebate rate and export price as well as exports. The existing theoretical studies tend to use either a CGE model or a Cournot quantity competition model (Feldstein and Krugman1990; Chao, Chou, and Yu 2001; Chao, Yu, and Yu 2006; Chen, Mai, and Yu 2006). We use a Dixit-Stiglitz type model where final goods are produced using varieties of intermediate goods. The final good sector is subject to perfect competition. Furthermore, existing studies do not directly explore the economic effect of the adjustment of VAT rebate policy on exports (Desai and Hines2005; Keen and Syed2006; Gourdon et al.2014; Chandra and Long2013). In this paper, we view the adjustment of VAT rebates on January 1, 2015 as a *quasi-natural* experiment, which is used to examine the effect of China's VAT policy on mechanical exports.[2]

We focus on China's mechanical exports because this industry accounts for nearly 50% of total export value over the sample period and hence an investigation on the impact of VAT rebate policy on exports is of practical significance.[3]

The rest of this paper is organized as follows. A theoretical model is presented in Section 2 to examine the impact of VAT rebate on exports. Methodology and data sources are presented in Section 3. Empirical estimation results are presented and discussed in Section 4. Section 5 concludes the paper.

2. An Econometric Model

To focus on the effect of changes in VAT rebate rate, we consider only the export sector (which consists of firms that export). We use a CES production function, which is more general than the one used by other studies (e.g., see Chao, Chou, and Yu 2001; Chao, Yu, and Yu 2006).[4]Firms use varieties of intermediate goods to produce the final goods, which are characterized by perfect competition and price taking behavior.[5]Each firm uses varieties of an intermediate good to produce a final good. We focus on export market, where firms maximize their profits. The production function is as follows:

$$Y_t = \left[\int_0^1 Y_{j,t}^{\frac{\xi-1}{\xi}} dj \right]^{\frac{\xi}{\xi-1}} \quad (1)$$

[2]On December 31, 2014, Ministry of Finance of the People's Republic of China and State Administration of Taxation raised the VAT rebate rate on export of certain products, which includes mechanical products, corn processing products and textile clothing. This policy was implemented on January 1, 2015.

[3]Over the sample period, this industry accounts for nearly 60% of total export value in 2012, while this industry accounts for nearly 40% of total export value in 2016. So, we give a mean of this proportion in our paper. This data is from General Administration Custom, P. R. China.

[4] Other studies, such as Chen, Mai, and Yu. (2006), use a Cobb-Douglas production function.

[5] An important feature of Dixit-Stiglitz type models is that aggregate demand is assumed to be stable.

Where Y_t is a final product at time *t*. the $Y_{j,t}$ is the *j*-th intermediate good; the ξ is the elasticity of substitution between the intermediate products, and this parameter is greater than unit.[6]

Given the price of intermediate products $P_{j,t}$ and the final products P_t, the representative firm maximizes profit as follows:

$$\max_{Y_{j,t}} \Pi_t = P_t Y_t - \int_0^1 P_{j,t} Y_{j,t} dj \quad (2)$$

We now introduce a VAT rebate policy to boost the competitiveness of domestic products in the world market.[7] In China, firms that export do not need to pay the entire tax in advance. Firms only pay the difference between the total amount of VAT in the production process and total amount of VAT rebate after their products is sold in the international market. Accordingly, equation (2) will be re-written as follows,

$$\max_{Y_{j,t}} \Pi_t = P_t Y_t - \left| \frac{\tau}{1+\tau} P_t Y_t - \tau \int_0^1 P_{j,t} Y_{j,t} dj \right| + \frac{s}{1+\tau} P_t Y_t - (1+\tau) \int_0^1 P_{j,t} Y_{j,t} dj \quad (3)$$

where τ represents the VAT rate in production process[8]; *s* denotes VAT rebate rate; $-\left| \frac{\tau}{1+\tau} P_t Y_t - \tau \int_0^1 P_{j,t} Y_{j,t} dj \right| + \frac{s}{1+\tau} P_t Y_t$ denotes the difference generated by the VAT rebates; $\frac{s}{1+\tau} P_t Y_t$ is the amount that government refunds to the firms in accordance with VAT rebate policy; $\left| \frac{\tau}{1+\tau} P_t Y_t - \tau \int_0^1 P_{j,t} Y_{j,t} dj \right|$ indicates the difference between the input tax and output tax.

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[6]For simplicity, this parameter is assumed to be time invariant.

[7] Total value of the rebate = CIF price of export products $\times$ the tax rate.

[8]China's VAT rebate rate varies across goods. The common VAT rebate rates are 17%, 13%, 11% or 6%.

We assume that the output tax is more than the input tax and hence $\frac{\tau}{1+\tau}P_tY_t - \tau\int_0^1 P_{j,t}Y_{j,t}dj > 0$.Equation (2) can be re-written as

$$\max_{Y_{j,t}} \Pi_t = \frac{1+s}{1+\tau}P_tY_t - \int_0^1 P_{j,t}Y_{j,t}dj \quad (4)$$

Unit root testing results suggest that, foreign aggregate demand (i.e., China's export of mechanical goods) in our sample keep basically stable. Hence, we assume foreign aggregate demands, *C*, is fixed, and we further assume that total export supply of domestic firms is less than or equal to the total demand in the international market and hence

$$P_t \cdot Y_t \le C \quad (5)$$

Equations (4) and (5) give rise to the following nonlinear dynamic system.

$$\max_{Y_{j,t}} \Pi_t = \frac{1+s}{1+\tau}P_tY_t - \int_0^1 P_{j,t}Y_{j,t}dj \qquad (6)$$

$$\text{s.t. } P_t \cdot Y_t \le C$$

The corresponding Lagrange function is as follows:

$$\ell = \frac{1+s}{1+\tau}P_tY_t - \int_0^1 P_{j,t}Y_{j,t}dj + \lambda(C - P_t \cdot Y_t) \quad (7)$$

From Kuhn-Tucker Theorem, we know that

$$\frac{\partial \ell}{\partial Y_{j,t}} = \left[\frac{1+s}{1+\tau} - \lambda\right] \cdot P_t \cdot \left[\int_0^1 Y_{j,t}^{\frac{\xi-1}{\xi}} dj\right]^{\frac{\xi}{\xi-1}-1} \cdot Y_{j,t}^{\frac{\xi-1}{\xi}-1} - P_{j,t} \le 0, \quad Y_{j,t} \ge 0, \quad Y_{j,t} \cdot \frac{\partial \ell}{\partial Y_{j,t}} = 0 \quad (8)$$

$$\frac{\partial \ell}{\partial \lambda} = C - P_tY_t \ge 0, \quad \lambda \ge 0, \quad \lambda \cdot \frac{\partial \ell}{\partial \lambda} = 0 \quad (9)$$

It is known from equation (8) that, if $Y_{j,t} > 0$, marginal profits of firms that export equal to the marginal cost of export firms $\left(\frac{\partial \ell}{\partial Y_{j,t}} = 0\right)$. From equation (9), if $\lambda > 0$, all resources will be fully utilized $\left(\frac{\partial \ell}{\partial \lambda}=0\right)$. As $\lambda > 0$, we have

$$\frac{\partial \ell}{\partial \lambda} = C - P_t Y_t = 0 \quad (10)$$

Equation (10) implies that $P_t Y_t = C$. Because $Y_{j,t} > 0$, we can derive the following first order condition.

$$\frac{\partial \ell}{\partial Y_{j,t}} = \left[\frac{s-\lambda}{1+\tau}\right] P_t \cdot \left[\int_0^1 Y_{j,t}^{\frac{\xi-1}{\xi}} dj\right]^{\frac{\xi}{\xi-1}-1} \cdot Y_{j,t}^{\frac{\xi-1}{\xi}-1} - P_{j,t} = 0 \quad (11)$$

Equation (11) holds for each intermediate good. We assume two kinds of intermediate goods; i and j. We calculate the first derivative with respect to the two intermediate goods and divide them. We then aggregate the expression with respect to all intermediate goods *j*, which is the integral of all the intermediate products *j* in equation (12) as follows:

$$\int_0^1 P_{j,t} Y_{j,t} dj = P_{i,t} \cdot Y_{i,t}^{\frac{1}{\xi}} \cdot \int_0^1 Y_{j,t}^{\frac{\xi-1}{\xi}} dj \quad (12)$$

Because of free entry and exit, the long-run profit will be zero. Combining zero profit condition with equation (12), we have

$$\frac{1+s}{1+\tau} \cdot P_t Y_t = P_{i,t} \cdot Y_{i,t}^{\frac{1}{\xi}} \cdot \int_0^1 Y_{j,t}^{\frac{\xi-1}{\xi}} dj \quad (13)$$

Equation (13) can be re-written as

$$Y_t = \left(\frac{1+\tau}{1+s}\right)^{\xi} \cdot \left(\frac{P_{i,t}}{P_t}\right)^{\xi} \cdot Y_{i,t} \quad (14)$$

Equation (14) shows that demand for intermediate goods is decreasing in relative prices of the intermediate goods but increasing in the output of the final good *i*. By aggregating over all the intermediate good *i*, we get.

$$Y_t = \left(\frac{1+\tau}{1+s}\right)^{\xi} \cdot P_t^{-\xi} \cdot \int_0^1 P_{i,t}{}^{\xi} Y_{i,t} di \quad (15)$$

Combining equation (15) with (1), we can derive a relationship between the export price of final goods and the price of intermediate goods as follows:

$$P_t = \left(\frac{1+\tau}{1+s}\right) \cdot \left[\int_0^1 P_{i,t}{}^{\xi} Y_{i,t} di\right]^{\frac{1}{\xi}} \cdot \left[\int_0^1 Y_{i,t}{}^{\frac{\xi-1}{\xi}} di\right]^{\frac{1}{1-\xi}} \quad (16)$$

Equation (16) shows that the export price of final product (P_t) is inversely proportional to VAT rebate rate (s). This means that an increase in the VAT rebate rate decreases the export prices. In the other words, raising VAT rebate rate allows exporters to decrease the export prices. When foreign demands keep constant or fall, domestic firms may maintain or expand their international market share by reducing the export price.

To capture the relationship between exports and VAT rebate rate, we use the following relationship

$$Q_t = Y_t \cdot P_t \quad (17)$$

Substituting equation (14) and (16) into equation (17), we have

$$Q_t = \frac{1+\tau}{1+s} \cdot P_{i,t}{}^{\xi} \cdot \left[\int_0^1 P_{i,t}^{\xi} Y_{i,t} dj\right]^{\frac{1-\xi}{\xi}} \cdot \int_0^1 Y_{i,t}{}^{\frac{1-\xi}{\xi}} dj \quad (18)$$

Equation (18) can be used to derive the following result.

$$\frac{\partial Q_t}{\partial s} = -\frac{1+\tau}{(1+s)^2} \cdot \Phi_{i,t} \quad (19)$$

where Q_t is the total export volume of the representative firms and

$$\Phi_{i,t} = P_{i,t}^{\ \xi} \cdot \left[\int_0^1 P_{i,t}^{\xi-1} dj \right]^{1-\xi} \cdot Y_{i,t} \ .$$

Equation (19) shows the exports of representative firms is inversely proportional to the VAT rebate rate. As government increases the VAT rebate rate, the quantities of exports will decrease.

In sum, our theoretical model shows that an increase in VAT rebate decreases both prices and firm exports. Now we turn our attention to empirical evaluation of these results.

3. Methodology and data

We use provincial-level panel data to test the effects of VAT rebate on China's mechanical exports. The theoretical model is based on the assumption that aggregate exports are basically stable. We test this assumption using unit root tests in the Appendix. The results of Augmented Dickey-Fuller (ADF) and Phillip-Persson (PP) test show that the export data series used in this paper is stationary.

3.1Empirical Model

The empirical analysis presented in this paper is based on Propensity Score Matching (PSM) Methodology. PSM is often used to evaluate the impact of public policy changes on various economic variables (Smith and Todd 2001; Lechner 2002; Becerril and Abdulai 2010; Gitonga et al. 2013; DeFond, Erkens, and Zhang 2017; Shipman, Swanquist, and Whited 2017). Compared with the other methods, PSM has some important advantages. PSM technique reduces the severity of potential endogeneity. Furthermore, this technique estimates both the average treatment effect (ATE) as well as the Average Treatment Effects on the Treated (ATT). PSM technique can be viewed as a kind of resampling. PSM makes observational data as close to the random experimental data as possible, which improves the robustness.

The empirical estimated equation is as follows:

$$lnExorpt_{i,t} = \alpha + \beta_1 \cdot T_t + \gamma \cdot x_{i,t} + \tau_t + \sigma_i + \mu_{i,t} \quad (20)$$

where i indicates the province where the firm is located, and t represents the time period of firm exports; $lnExorpt_{i,t}$ is the natural logarithm of mechanical exports; T_t is a dummy variable, which controls for time; $x_{i,t}$ is a vector of independent variables, which includes export price index, per capita GDP, seasonal dummy variable, dummy variable whether the firms are located in coastal province, and foreign-invested firm, and a usual error term is also include on the right hand side of equation (20).

3.2 Endogeneity and Strategy

Generally, endogeneity problems can be caused by three factors: self-selection, causal relationship between dependent variable and independent variable and omission of relevant variables. As for self-selection problem, once VAT rebate policy is implemented, firms cannot choose freely to enter the treatment groups or control groups in our paper. Therefore, the possibility of endogeneity caused by self-selection problem in our paper is likely to be small. As far as the causal relationship is concerned, in our sample, the adjustment of VAT rebate takes place only once and hence the possibility of endogeneity arising from causal relationship between the independent and dependent variables is also likely to be negligible. Omitted variables are a common issue in empirical research. After all, data on all variables are not always available and hence omitted variables can lead to endogeneity in our paper. We use a two-step approach. In step one, we attempt to weaken the potential endogeneity by adding covariates to the regression equation, but significant endogeneity may still exist and hence in step two we also employ the Treatment Effect Model proposed by Heckman (1979) and Maddala (1983). This allows us to confirm whether adding covariates has sufficiently reduced the endogenous problem.

3.3 Data and variable measurement

We use monthly data over the September 2012 to April 2017 from China's mechanical industry. The panel data covers 27 provinces and 4 cities. The data on mechanical goods is drawn from *China Custom Statistics Monthly.* To reduce the scale effect, we use the natural logarithm allay the heteroscedasticity in our regression; we take that the natural logarithm for the independent variable. In terms of variables, this paper intends to use export value as the dependent variables and use the adjustment of VAT rebate as independent variables. The dependent variables ($lnExorpt_{i,t}$) is a real value processed by deflator index with taking 2012 as benchmark year. On January 1, 2015, VAT rebate rate for mechanical goods was adjusted from original 15% to 17%. This policy change is captured by a dummy variable. Before January 1, 2015, the dummy variable takes a value of 0 and 1 after this date.

Following Chandra and Long (2013), we include the natural logarithm of (i.e., $\ln pgdp_{i,t}$) on the right-hand side of equation (20). Following existing studies, such as Rauch (1999), we also include the natural logarithm of mechanical export price index

($lnpriceindex_t$) as an control variable. This variable captures the overall effect of changes in the prices all mechanical goods exports over a given time-period. We also account for seasonal factors and firm characteristics such as geographical location of firms. These factors can also have a significant impact on exports performance. We use a dummy for geographical location, which takes a value of 1 if the firm is located in a coastal province (Loc_i). In addition, China has a large number of foreign-invested firms that export most of their output. We also control foreign-invested firms as a variable in our empirical model.

The data on per capita GDP is collected from the *China Statistical Yearbook*. The export price index is from *CEInet Statistics Database*. The data on foreign-invested firm is from *China Statistical Yearbook on Science and Technology*. The summary statistics of the sample are presented in Table 1.

Table 1: the Summary Statistics of Main Variables

variables	mean	Std.dev.	Min.	Max.
$\ln Exorpt_{i,t}$	9.4163	2.6083	0.0000	13.9662
T_t	0.5000	0.5001	0.0000	1.0000
$Exchrate_t$	6.3391	0.2468	6.0969	6.9370
$\ln priceindex_t$	4.6313	0.1419	4.1092	4.8354
$\ln pgdp_{i,t}$	4.7583	0.4490	3.5603	5.8481
Season_t	0.3573	0.4793	0.0000	1.0000
Loc_i	0.3225	0.4675	0.0000	1.0000
$\ln fdi_{i,t}$	12.8207	2.7057	0.6931	17.4422

Data Sources: *China Custom Statistical Monthly*, *CEInet Statistics Database*, *China Statistical Yearbook on Science and Technology*. The data are sorted by the authors.

4. Empirical results and discussion

Using equation (20), we test the economic effects of VAT rebate policy adjustment on export of mechanical exports by PSM technique. Based on reference and contrast, we also report OLS estimation results in Table 2. The coefficient of the dummy variable T_t, which captures the effect of VAT rebate policy, is negative and significant at least the 10% level, which means that raising VAT rebate rate has a negative effect on export of mechanical exports. To capture the average effects of VAT rebate policy after, we also report the average treatment effects on the treated (ATT) in Table 2. In 1:1 matching pair, test results show the coefficient of ATT is negative and significant at the 1% level (see row 4 of column 2). In the case of 1:4 matching pair, we find that the estimated coefficient of ATT is also negative and significant at the 1% level (see row 4 of column 3). That means the VAT adjustment on January 1, 2015 has a negative and statistically significant effect on China's mechanical exports. The estimated results in Table 2 show that a 1 percentage point increase in VAT rebate rate leads to 2.07% decrease in export volume on average[9]. These empirical results are consistent with the theoretical results presented in the previous section as well as with other related empirical studies (e.g., see Desai and Hines 2005; Keen and Syed 2006; Gourdon et al. 2014).

Table 2: Empirical Results

	Dependent Variable: Exports of Mechanical Goods		
	(1)	(2)	(3)
Independent Variables	OLS	1:1 matching	1:4 matching
T_t	-0.1443^{***}	-0.1818^{***}	-0.1890^{***}
	(0.0475)	(0.0376)	(0.0350)
$\ln priceindex_t$	0.4169^{*}	-5.7610^{***}	-5.7610^{***}
	(0.2144)	(0.6843)	(0.6843)
$\ln pgdp_{i,t}$	-0.0465	0.9837	0.9837
	(0.0375)	(0.1879)	(0.1879)
$Season_t$	-0.0578^{**}	0.0712	0.0712
	(0.0293)	(0.1455)	(0.1455)

[9] That is, 0.1890/9.4163=0.0207, where 9.4163 is the sample mean of $\ln(export_{i,t})$in Table 4.

Loc_i	0.0245 (0.0297)	-0.2110 (0.1701)	-0.2110 (0.1701)
$\ln fdi_{i,t}$	-0.0799*** (0.0304)	-0.0799*** (0.0304)	-0.0799*** (0.0304)
ATT		-0.2091*** (0.0507)	-0.2022*** (0.0463)
Constant	-1.4324 (0.9126)	23.4680*** (3.0843)	23.4680*** (3.0843)
Observation Number	1187	1187	1187

Notes: The dependent variable is dln($exports_{i,t}$). Cluster-robust standard errors are reported; the estimated coefficient of the Dummy Variable (T_t) represents the average treatment effects of VAT rebate adjustment; ATT is the average treatment effects on the treated;***, **, and *, respectively, denote significance at the 1%, 5% and 10% level.

5. Endogeneity test and robust test

5.1 Endogeneity Test

Although we have used covariates to account for potential endogeneity problem, the problem may still be present and hence we employ the maximum likelihood estimation-based Treatment Effect Model proposed by Heckman (1979) and Maddala (1983). Before using the Treatment Effect Model, we need to identify a suitable instrumental variable. In existing literature, Roberts *et al*.(2012) the wage rate as an instrument, whereas Piveteau and Smagghue (2017) use exchange rate. We follow Piveteau and Smagghue and use currency exchange rate ($Exchrate_t$) as an instrumental variable.

The choice of exchange rate as an instrumental variable in primarily based on two reasons: (i) policymakers might adjust the VAT rebate rate based on fluctuations in the exchange rate and (ii) although the exchange rate may be one of factors that affect mechanical exports over the long term. However, this effect may be very limited in the short term, because the duration of export contracts is usually short (normally one year) and hence exchange rate fluctuations would not have large effect on exports in the short term. In our paper, the dependent variable is the difference between the values of two adjacent mechanical exports, which means that the difference between two monthly export values represents the fluctuation in mechanical exports. Once the export order has been placed, exchange rate fluctuations would have very little effect on exports. The data on exchange rate is collected from the website of State Administration of Foreign Exchange.

Table 3: Treatment Effect Model Estimation and Endogeneity Test

	coef.	Std.Err.	z	P>|z|
dln$Exorpt_{i,t}$				
$Season_t$	-0.0575	0.0307	-1.8700	0.0620
Loc_i	0.0239	0.0355	0.6700	0.5010
ln$fdi_{i,t}$	0.0039	0.0064	0.6200	0.5380
ln$pgdp_{i,t}$	-0.0443	0.0386	-1.1500	0.2500
ln$priceindex_t$	0.4241	0.1109	3.8200	0.0000
T_t	-0.1883	0.0424	-4.4400	0.0000
_cons	-1.6907	0.5030	-3.3600	0.0010
$Exchrate_t$	8.2413	0.6696	12.3100	0.0000
_cons	-50.9816	4.1244	-12.3600	0.0000
athrho	8.2413	0.6696	12.3100	0.0000
lnsigma	-0.7997	0.0206	-38.8200	0.0000

LR test of indep. eqns. (rho = 0): chi2(1) =1.18 Prob > chi2 = 0.2779

Notes: 1. Data is from *China Custom Statistics Monthly*, *CEInet Statistics Database*. *China Statistical Yearbook on Science and Technology*, and sorted by author; IV estimation is used in Table 3, exchange rate is the instrument.

The results of endogenous test are presented in Table 3. The value of *LR* test statistic is 0.2779, which means that the null hypothesis $rho = 0$ cannot be rejected, which implies endogeneity in our empirical model is not a serious problem. The model estimation results presented in Table 3 are qualitatively similar to those presented in Table 2 and hence our main result still holds.

5.2 Robustness test

The empirical results presented in Table 2 involve 1:1 nearest pair matching and 1:4 pair matching. In the case of non-exact matching, if 1:1 nearest pair matching is performed, the deviation is small, but the variance is large. In contrast to 1:1 pair matching, 1:4 pair matching can reduce the variance but may cause larger deviation due to the use of farther sample information (Abadie et al, 2004). Hence, it is necessary for us to try other matching methods to test the robustness of our empirical results. Accordingly, we first re-estimate the model employing the caliper matching. This method can overcome the problem of variance and deviation in 1:1 nearest pair matching and 1:4 pair matching, which improves the comparability of the sample and increases the range of common values. Second, we use the nearest-neighbor matching within caliper and local linear regression matching to re-examine the effects of VAT rebate policy on exports of China's mechanical exports. The estimation results are reported in Table 4.

Table 4: Robustness Test

Dependent variable:	ln$(export_{i,t})$		
independent variable	caliper matching	the nearest-neighbor matching within caliper	local linear regression matching
ATE	-0.1891*** (0.0328)	-0.1871*** (0.0311)	-0.2015*** (0.0315)
ATT	-0.2065*** (0.0413)	-0.2073*** (0.0361)	-0.2149*** (0.0396)
observational number	1187	1187	1187

Notes: For the sake of brevity, Table 3 reports only the results of ATE and ATT, and don't report the results of other variables; Data is from *China Custom Statistics Monthly*, *CEInet Statistics Database*. *China Statistical Yearbook on Science and Technology*, *State Administration of Foreign Exchange*, and sorted by author; "***",

"**", and "*", respectively, denote significance at the 1%, 5% and 10% level.

The estimated coefficients of both ATE and ATT are negative, and the size of these coefficients is not very different from those reported in Table 2. The estimated results are significant at the 1% level, which suggests that the results presented in Table 2 are robust.

6. Concluding remarks

In Feldstein and Krugman (1990)'s *idealized* framework, a value-added (VAT) rebate policy is viewed as tax neutral. However, this proposition is not consistent with empirical observations. In this paper, we try to interpret this phenomenon by using a theoretical model and evaluating the effect of VAT rebate on exports. We find that raising VAR rebate rate decreases the export prices as well as export quantities. Then we examine the effect of the VAT rebate on China's mechanical exports by using a propensity score matching (PSM) technique.

Empirical evaluation using monthly data, over the September 2012 to April 2017 period, from China's mechanical exports shows that an increase in the VAT rebate rate from 15% to 17% leads to a significant decrease in the exports. For each percentage point increase in the average VAT rebate rate, the mechanical exports will decrease by 2.07% on average.

Some caveats are in order. First, our analysis shows a negative relationship between the VAT rebate and export performance for mechanical goods, while these results do not necessarily suggest inefficiency of China's VAT rebate policy. Second, our sample period just consists of one policy experiment. Further analysis using more policy experiments is highly desirable. Third, we focus on China's mechanical exports. Further research on other industries is required. It is possible that the effect of VAT rebate on other sectors is positive.

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Appendix

Data on exports and imports can be found at WTO website (https://www.wto.org/english/res_e/statis_e/merch_trade_stat_e.htm). We focus on merchandise trade data, which is available on monthly basis. From Jan 2006 to Apr 2018. We use the data from Sept 2012 to Apr 2017 as this sample period does not involve any missing values.

An important assumption of our analysis is that aggregate demand is stable, which means that it does not change with time (and its variance is also constant over time). If these two conditions are satisfied then the data series is stationary. In other words, in order to establish that aggregate demand for exports is stable, we test the data series for unit roots. Specifically, we use the Dickey-Fuller (DF) and Phillip-Perron (PP) tests. The results of these two tests are shown in Table A1.

Table A1: Unit root testing results

Aggregate Demand	Dickey-Fuller	Phillip-Perron
Import	Z(t)=0.0238	Z(t)=0.0415
Export	Z(t)=0.0086	Z(t)=0.0113

In Table A1, z(t) indicates the MacKinnon approximate *p*-value. As all of the p-values are less than 0.05, it can is possible to reject the null hypothesis of unit roots. This means that both exports and imports of China's mechanical goods exports are stationary, which implies that aggregate demand does not change significantly with time.