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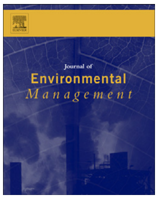

Research article

Adjusting export tax rebates to reduce the environmental impacts of trade: Lessons from China

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ABSTRACT

Export tax rebates are an important policy instrument for stimulating exports, which many developing countries make use of. However, excessive export tax rebates and inappropriate structural arrangements can lead to over-production in highly polluting industries and cause the environment to deteriorate. This paper, taking China as the study case, tests and verifies the statistical significance of the causal relationship between export tax rebates and pollution emissions. With a computable general equilibrium modeling, the current study further analyzes the effectiveness of export tax rebate adjustments aimed at alleviating environmental pressure for different time periods. It is found that before 2003, export tax rebates primarily promoted exports and boosted foreign exchange reserves, and highly polluting sectors enjoyed above-average export tax rebates, which led to increased pollution emissions. Between 2003 and 2010, the export tax rebate system was reformed to reduce support for the highly polluting export sectors, which led to decreases in emissions. Canceling export tax rebates for highly polluting sectors is shown to be the most favorable policy choice for improving the environmental performance of China's international trade. This study can serve as reference for other developing countries which similarly rely on export tax rebates, so that they can adjust their policies so as to combine economic growth with pollution control.

1. Introduction

Widely regarded as an economic miracle, export expansion drives China's economic growth (Duan et al., 2012; Rodrik, 2006). With exports growing faster than gross domestic product (GDP), the share of exports within China's GDP has increased from 6.60% in 1978 to 27.33% in 2012, peaking at 39.13% in 2006 (World Bank, 2013). Since its accession to the World Trade Organization (WTO) in 2001, China has experienced a particularly strong expansion in its trade volume. In 2001, the total volume of exports and the trade surplus were US$ 266.10 billion and US$ 22.55 billion, respectively. By 2012, the total volume of exports and the trade surplus amounted to US$ 2048.71 billion and US$ 230.31 billion, respectively.

However, the magnitude of the export and trade surpluses in terms of monetary value has created a large "deficit" in terms of resources and the environment (George, 2010; Kirkpatrick and Scrieciu, 2008), meaning that China exports products but consumes natural resources and produces pollution (Liu and Diamond, 2005). According to the *China Sustainable Development Strategy Report* 2011, the virtual SO_2, CO_2, and COD emissions embodied in China's 2007 net exports corresponded to 24.43%, 30.82%, and 21.85%, respectively, of the national total of SO_2, CO_2, and COD emissions (Chinese Academy of Sciences (2011)). Many other empirical studies agree that the emissions embodied in China's export products were significant (e.g., Haakon et al., 2007; Peters et al., 2007; Peters and Hertwich, 2008; Weber et al., 2008; Zhang, 2012).

Among the various factors that augment trade expansion and the associated pollution, such as cheap land and labor, opening up policies and WTO accession, "export tax rebates (ETR)" have played an important role, particularly in highly polluting sectors[1] such as

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[1] The *"Guide of Environmental Information Disclosure for Listed Companies (draft)"*, announced in September 2010, defined 16 polluting sectors. In the GTAP database, the counterparts were "coal", "oil", "gas", "other mining", "textiles", "wearing apparel", "leather products", "paper products", "petroleum and coke products", "chemical, rubber, and plastic products", "other mineral products", "ferrous metals", "other metals", "metal products" and "electricity".

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“textiles”, “wearing apparel”, “leather products”, “paper products”, “petroleum and coke products”, “chemical, rubber, and plastic products” and “ferrous metals”. This has been particularly true in the first decade of the 21st century.

The provision of “export tax rebate (ETR)” refers to refunding the value-added, business, and special consumption taxes paid on export goods to encourage a nation's export trade (Mah, 2007). ETR is an important subsidy instrument that leverages exports and plays a vital role in Chinese foreign trade (Chen et al., 2006; Elena, 2004). Using the data series over the period from 1985 to 1998, Chao et al. (2001) firstly proved and indicated a long-run elasticity of 0.34 for ETR on China's exports. Secondly, the authors employed an error-correction model (ECM) to estimate a short-run elasticity of 0.14 for ETR on China's exports. Bai et al. (2011) illustrated an export expansion effect of 3.1% by ETR on total exports in 2007 compared with what would have been if the ETR had not been implemented.

In recent years, the potential causal relationship between highly polluting industries (and their emissions) expansion and ETR has drawn increasing attention from decision makers. ETR between 2003 and 2010 was gradually reduced and even canceled for many product categories identified as highly polluting to combat the serious environmental situation.

In the current study, we first test the statistical significance of the causal relationship between ETR and total pollution emissions using an econometrics regression exercise. Next, using a semi-structured computable general equilibrium (CGE) model, we examine whether and how ETR adjustments can help to alleviate the environmental pressure exerted by export trade on the environment in China.

Another point which should be made is that the ETR has been an important policy tool for promoting exports not only in China, but in a variety of other highly protected, developing countries around the world (Elena, 2004). Economies which have made a significant use of ETR to promote their exports include South Korea (Mah, 2007), Pakistan (Lahiri and Nasim, 2006), Bangladesh (Faisal et al., 2014), Malaysia (Ayob and Freixanet, 2014), Brazil (Jarvis, 2005) and Mexico (Olivier et al., 2003), etc. There are many studies confirming that there is a great volume of pollutant emissions embedded in international trade in its entirety (such as Chung, 2005; Jakob and Marschinski, 2012; Limmeechokchai and Suksuntornsiri, 2007; Machado et al., 2001; Peters and Hertwich, 2008). It can thus be assumed that similar environmental concerns as the ones which there are in China can be associated with the ETR in other countries as well. This paper tries to test and verify the assumption that ETR adjustment is a good policy option to reduce the environmental impact of trade in the context of China. We hope that other developing countries which implement ETRs can draw lessons from this study on how to ensure that this policy can promote both economic growth and environmental protection.

2. Material and methods

2.1. Significance test of the ETR's impact on the environment

Total ETR values showed an increase from RMB 107.15 billion in 2001 to RMB 732.8 billion in 2010, with an average annual growth rate of 23.8%. This increase led to an almost doubling of the proportion of ETR to GDP between 2001 (0.98%) and 2010 (1.83%) (Chao et al., 2001).

In the current study, pollution emissions are defined as dependent on the total domestic output volume and the pollution emission intensity (PEI, or the emission per unit output value), which reflects technical and efficiency levels.

In macroeconomic theory, total output is used to mean domestic consumption and foreign demand, i.e., exports. Previous empirical studies have verified that ETR plays a significant role in expanding Chinese exports. Accordingly, we identify total pollution emissions (the dependent variable) as the function of the domestic consumption (D), ETR and PEI (the three independent variables). The scatterplot matrix on the log scale of pollutant emissions versus the independent variables support log–log type regression models. A similar regression function form has been widely used, for instance by Zheng et al. (2004) and Costa et al. (2015). Therefore, a log–log type regression model is constructed as Equation (1):

$$\ln P_{i,t} = \delta_i + \alpha_i \ln D_t + \beta_i \ln ETR_t + \gamma_i \ln PEI_{i,t} + \varepsilon_{i,t} \tag{1}$$

where$P_{i,t}$ denotes the pollution emissions for pollutant i in time t,δ_i is the intercept, D_t is the domestically consumed output in time t, ETR_t is the value of ETR in time t,$PEI_{i,t}$ is the PEI of pollutant i in time t, and $\varepsilon_{i,t}$ is the random error term in time t. α_i, β_i and γ_i are the coefficients.

Because the ETR policy was implemented in 1985, the time-series data for the regression is taken for the years 1985–2012. Outputs, ETRs and export data are drawn from the *China Statistical Yearbook*. Due to data availability issues, pollution emissions mainly include industrial wastewater (IWW), sulfur dioxide (SO_2), particulate matter (PM, including soot and dust), and industrial solid waste (ISW), which are drawn from the *China Environment Yearbook*. Using an ordinary least squares (OLS) method, the regression results are worked out and listed in Table 1.

Table 1 shows that all four sets of regressions have a small square root of the mean square residual/error (Root MSE) but large adjusted R^2 (Adj. R-squared). For the F-statistics or the t-statistics,

Table 1
Four pollutant emissions as a function of the domestic use of outputs, the ETR and the PEI, ordinary least squares (OLS) model results.

	(1) LIWW	(2) LSO_2	(3) LPM	(4) LISW
Estimate				
LDOMES	0.735^{***}	0.934^{***}	1.014^{***}	0.991^{***}
	(16.27)	(15.57)	(29.70)	(32.83)
LETR	0.0416^{**}	0.0564^{*}	0.0776^{***}	0.0639^{**}
	(2.89)	(2.77)	(4.02)	(3.48)
LPEI_IWW	0.778^{***}			
	(17.47)			
LPEI_SO_2		0.985^{***}		
		(15.01)		
LPEI_PM			1.079^{***}	
			(35.46)	
LPEI_ISW				1.031^{***}
				(74.66)
Intercept	1.537^{***}	0.468	−0.194	0.236
	(6.07)	(1.15)	(−0.73)	(1.48)
Diagnostics				
F-statistics	113.80	245.23	868.46	9597.91
Prob > F	0.0000	0.0000	0.0000	0.0000
Adj. R-squared	0.9261	0.9645	0.9897	0.9991
Root MSE	0.0242	0.0346	0.0306	0.0315
N	28	28	28	28

t statistics in parentheses.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.
Note: All variables are in natural logarithms. Thus all coefficients indicate percentage changes (elasticities). The four models differ in terms of pollution, as follows: (1) LIWW = Ln (industrial wastewater); (2) LSO_2 = Ln (SO_2); (3) LPM = Ln (particulate matter), and (4) LISW = Ln (industrial solid waste). Independent variables LDOMES = Ln (outputs used domestically); LETR = Ln (the volume of export tax rebates); LPEI_IWW = Ln (the pollution emission intensity of industrial wastewater); LPEI_SO_2 = Ln (the pollution emission intensity of SO_2); LPEI_PM = Ln (the pollution emission intensity of particulate matter), and LPEI_ISW = Ln (the pollution emission intensity of industrial solid waste). N is the number of annual datasets from 1985 to 2012.