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Impacts of border carbon adjustments on China's sectoral emissions: Simulations with a dynamic computable general equilibrium model

Qin BAO [a], Ling TANG [b], ZhongXiang ZHANG [c,d,e,*], Shouyang WANG [a]

[a] Center for Forecasting Science, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing, China
[b] School of Economics and Management, Beijing University of Chemical Technology, Beijing, China
[c] Department of Public Economics, School of Economics, Fudan University, Shanghai, China
[d] Center for Energy Economics and Strategy Studies, Fudan University, Shanghai, China
[e] Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

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ABSTRACT

Carbon-based border tax adjustments (BTAs) have recently been proposed by some OECD (Organization for Economic Co-operation and Development) countries to level the carbon playing field and target major emerging economies. This paper applies a multi-sector dynamic, computable general equilibrium (CGE) model to estimate the impacts of the BTAs implemented by the US and EU on China's sectoral carbon emissions. The results indicate that BTAs will decrease export prices and transmit the effects to the whole economy, affecting sectoral output and demand from both the supply side and demand side. On the supply side, sectors might move away from exporting towards the domestic market, thereby increasing sectoral supply, while on the demand side, the domestic income may be strikingly cut down due to the decrease in export price, decreasing sectoral demand. Furthermore, such shrinkage of demand may similarly reduce energy prices, which would lead to an energy substitution effect and somewhat stimulate carbon emissions. Depending on the relative strength of the output–demand effect and energy substitution effect, sectoral carbon emissions and energy demands will vary across sectors, with increases, decreases or shifts in different directions. These results suggest that an incentive mechanism to encourage the widespread use of environment-friendly fuels and technologies will be more effective than BTAs.

1. Introduction

As an essential part of post-Kyoto international climate negotiations, carbon-based border tax adjustments (BTAs) have been proposed to "level the playing field" by the US, EU and other OECD (Organization for Economic Co-operation and Development) countries against countries without compatible emissions-reduction commitments, including China (Cosbey, 2008; Dong & Whalley, 2009a; Weber & Peters, 2009; Zhang, 2009, 2010b, 2010c, 2011). The US House of Representatives (2009) passed the American Clean Energy and Security Act of 2009 (HR2998) on June 26, 2009, in which a carbon-based border-adjustment provision was proposed to protect the competitive advantages of American producers against their competitors in countries without comparable emissions-reduction commitments. In the EU, the EC-commissioned High Level Group on Competitiveness, Energy and Environmental Policies proposed the BTA issue in its second report early in 2006. Moreover, BTAs have been

* Corresponding author at: School of Economics, Fudan University, 600 Guoquan Road, Shanghai 200433, China. Tel.: +86 21 65642734; fax: +86 21 65647719.
E-mail address: ZXZ@fudan.edu.cn (Z. Zhang).

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recommended as useful policy tools to protect the competitiveness of domestic industries in the EU (Asselt & Biermann, 2007; Monjon & Quirion, 2010, 2011a; Zhang, 2012b) and Canada (Rivers, 2010).

BTA measures are actually not new topics (Lockwood & Whalley, 2008), and the related policies mainly concentrate on two issues (Babiker & Rutherford, 2005; Dong & Whalley, 2009b; Kuik & Hofkes, 2010; Monjon & Quirion, 2010; Zhang, 2012b). One issue is addressing concerns regarding competitiveness, providing offsets for producers from participating regions that take on the emissions-reduction commitments against producers from non-participating regions with low carbon-abatement costs. Therefore, BTAs are designed to charge imported goods the equivalent of what the producers would have had to pay had the goods been produced in the participating regions (Asselt & Brewer, 2010). The other issue is avoiding carbon leakage, i.e., that the carbon-emissions reductions in participating countries would increase emissions elsewhere as firms relocate (Babiker, 2005; Zhang, 2012b). BTAs are also believed to encourage more countries to participate in the global carbon emissions-reduction commitment (Droege, 2011). However, the legality of BTAs has raised great concerns, and some people have argued that BTAs be considered WTO-consistent only if they are carefully designed (Bhagwati & Mavroidis, 2007; Houser, Bradley, Childs, Werksman, & Heilmayr, 2008; Zhang, 1998c, 2004, 2009, 2010b, 2010c; Zhang & Assunção, 2004).

A number of researchers have examined the impacts of BTAs and related policies. Most of the researchers have focused on the effectiveness of BTAs for protecting competitiveness and avoiding carbon leakage. No general agreement has been found to date. On the one hand, some researchers have argued that BTAs would have positive effects on environmental improvements and a competitive-disadvantage offset (Majocchi & Missaglia, 2002; Veenendaal & Manders, 2008). For example, Lessmann, Marschinski, and Edenhofer (2009) found the influences of carbon tariffs on international cooperation to be significantly positive. Ross, Fawcett, and Clapp (2009) suggested BTAs an effective method for US climate mitigation. Dissou and Eyland (2011) found that competitiveness would be hindered by BTAs in Canada. Monjon and Quirion (2011b) discussed the leakage-avoiding effect of the EU's BTAs. Gros (2009) found that BTAs would increase global welfare. Böhringer et al. (2010) studied the impacts of climate policies by the EU and US on the global economy and environment, and the results suggested that the climate policies would not necessarily cause damage to the targeted developing countries.

On the other hand, some studies have concluded that BTAs would be ineffective either to increase domestic competitiveness or to improve the global environment (Dong & Whalley, 2009a,b; Elliott et al., 2010; Weber & Peters, 2009). For example, Fischer and Fox (2009) suggested that BTAs would be beneficial for domestic production but not be effective to reduce global emissions. McKibbin and Wilcoxen (2009) found a modest effect of BTAs to reduce leakage and to defend against import-competing industries without carbon costs. Kuik and Hofkes (2010) focused on the carbon leakage-avoidance effects of the EU Emissions Trading System and suggested that BTAs might reduce the sectoral leakage rate of the iron and steel industry, but the overall leakage-reduction effect was modest.

While most of the existing studies focused on the effects of BTAs in developed countries, little attention has been paid to developing countries, especially China, the country that BTAs mainly target, either implicitly or explicitly. Most of the existing discussions about China are theoretical, and few numerical simulations have been carried out to extensively measure the quantitative impacts of BTAs on China (Shi, Li, Zhou, Yuan, & Ma, 2010; Zhang, 2010a,b). Some numerical studies that did consider China built global energy-economy models and just treated China as a nonspecific country with few detailed sectoral settings (Böhringer et al., 2010; Dong & Whalley, 2009a,b; McKibbin & Wilcoxen, 2009).

However, as a rapidly growing developing country, China has been one of the largest sources of carbon emissions, with its share in global CO_2 emissions increasing rapidly from 5.7% in 1973 to 22.3% in 2008 (Fredrich & David, 2008; IEA, 2010). China's share in the global total final energy consumption has more than doubled over the past 30 years from 7.9% in 1973 to 16.4% in 2008 (IEA, 2010). Furthermore, ever since 1978, China's economy has been growing rapidly, and this pattern is expected to continue in the near future. Such rapid development of the economy will inevitably increase China's energy demand and carbon emissions.

The question is then raised regarding whether BTAs would lead China's industries to emit less carbon. Against this background, this study aims to analyze the impacts of the BTAs implemented by the US and EU on China's sectoral carbon emissions by using a recursive dynamic computable general equilibrium (CGE) model. The CGE model may be the most popular modeling tool for the assessment of energy and environment policies globally (Böhringer et al., 2010; Burniaux, Chateau, & Duval, 2011; Hübler, 2011; Kuik & Hofkes, 2010; McFarland, Reilly, & Herzog, 2004; Rivers, 2010; Ross et al., 2009; Shoven & Whalley, 1972; Xu & Masui, 2009; Zhang, 1998a,b). Compared with other policy-assessment methods, such as partial equilibrium analysis and input–output (IO) analysis, the CGE method is able to reveal the comprehensive relationships in the whole economy and conduct policy simulations under the assumption of general equilibrium. Moreover, detailed sectoral information, e.g., industrial prices and outputs, can be well characterized. China's CGE model has been widely used to analyze economy, energy and environmental policies (Fan, Liang, Wei, & Okada, 2007; He, Zhang, Yang, Wang, & Wang, 2010; Horridge & Wittwer, 2008; Liang, Fan, & Wei, 2007; Toh & Lin, 2005; Zhang, 1995, 1998a, 1998b). In this paper, a multi-sector CGE model including 7 energy sectors and 30 non-energy industrial sectors is developed and facilitates a detailed sectoral analysis. The model is calibrated based on data from the year 2007 and runs recursively to the year 2030. In the proposed model, a BTA module is specifically built to describe the border carbon tax imposed by the US and EU against China beginning in the year 2020.

The rest of the paper is organized as follows. The recursive dynamic CGE model for China is described in Section 2. Data descriptions, model calibration and business-as-usual (BAU) simulation scenarios are presented in Section 3. Results about the impacts of BTAs on China's industrial emissions and the further analysis are reported in Section 4. Robustness analyses of the model are performed in Section 5. Section 6 provides some concluding remarks and policy implications.