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Border carbon adjustments for exports of the United States and the European Union: Taking border-crossing frequency into account

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HIGHLIGHTS

- Emissions induced by intermediate product trade accounts for a significant share.
- Multiple rebate revenue reaches 422.14 million dollars.
- Consumers of China benefit the most from border carbon adjustments for exports.
- The impact on the electrical equipment sector is more sensitive to border-crossing.
- The rebate rate should be set lower than the carbon price faced by domestic firms.

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ABSTRACT

This paper proposes that not only the size and component of carbon footprints are relevant to environmental policies but the border-crossing frequency associated with carbon footprints also has important policy implications, especially given that the fragmentation of production across national boundaries has been developing quickly in recent years. Based on the World Input Output Database, this paper traces carbon transfer along cross-border supply chains and proposes both the upstream and downstream decomposition of export rebates of the United States and the European Union. The carbon transfer from the United States and the European Union to other countries or regions is mainly through international trade in intermediate products, which may cross national borders multiple times. The multiple rebate revenue reaches 422.14 million dollars, and the problem of multiple rebates is much more serious for the sectors with a greater degree of global production fragmentation, such as the electrical and optical equipment sector. In addition, export rebates are mainly targeted at the carbon emissions that are generated in the electricity generation sector and embodied in exports.

1. Introduction

To address competitiveness concerns and carbon leakage, some developed countries that adopt unilateral climate regulations are considering border carbon adjustments. For instance, the European Union emissions trading system, the American Clean Energy and Security Act of 2010 and the American Opportunity Carbon Fee Act of 2014 have drafted border carbon adjustments into legislative language [1–5]. Through careful design, border carbon adjustments can also be consistent with the World Trade Organization (WTO) rules [6]. However, this problem becomes extremely complex given that international trade has recently been significantly reshaped by global production fragmentation. For example, cross-border intermediate goods account for as much as two-thirds of the international trade. The purpose of this study is to gain a deeper understanding of border adjustments from the perspective of global production fragmentation.

The WTO rules favor border adjustments for carbon footprints of imports and exports [1]. For example, according to the World Trade Organization Agreement on Subsidies and Countervailing Measures, indirect tax rebate schemes allow for the exemption, remission or deferral of prior-stage cumulative indirect taxes levied on inputs that are consumed in the production of the exported product. However, the existing literature mainly focuses on the environmental effects of global production fragmentation from the perspective of the size and components of carbon footprints [7–15]. This present study holds the viewpoint that not only the size and component of carbon footprints are relevant to environmental policies, but also the border-crossing frequency

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associated with carbon footprints may influence the effectiveness of border carbon adjustments.

Global production fragmentation indicates that intermediate products may cross the national border multiple times and are thus repeatedly impacted by border carbon adjustments. Therefore, the spatial fragmentation of production across national boundaries may have an amplification effect on the rebate revenue. Border-crossing frequency has been gradually recognized by researchers and policy makers as an important influence factor on trade policy [16,17]. However, as far as we know, the impacts of border-crossing frequencies on the effectiveness of border carbon adjustments have not been analyzed by the existing literature. This present study attempts to fill this gap by focusing on the border adjustments of the United States and the European Union, which is also the focus of previous studies [2,18–23].

We trace regional emissions along cross-border supply chains and then discuss the effects of the border-crossing frequency on border carbon adjustments for exports of the United States and the European Union. This paper provides both upstream and downstream decomposition of export revenues and discusses whose emissions are stimulated by the export rebate and who finally benefits from the export rebates. We show that not only are the size and components of carbon footprints relevant to environmental policies but also the border-crossing frequency associated with carbon footprints has important policy implications. The remainder is organized into five sections. Section 2 reviews the relevant literature of the present paper. Section 3 describes the methodology, Section 4 presents the simulation results, and Section 5 provides the summary remarks.

2. Literature review

To mitigate global warming, a variety of countries are implementing climate regulations, such as cap and trade [24] and carbon tax [25,26]. Unilateral climate regulations may alter comparative advantages and could result in carbon leakage [27], which indicates that the carbon abatement of regions that adopt climate regulations are offset by the increase in carbon emissions of other regions. Therefore, different types of border carbon adjustments have been proposed in recent years to address carbon leakage. Even though more than 190 countries have signed the Pairs Climate Agreement, the European Commission still states that the carbon leakage provisions of the EU Emissions Trading System will continue as long as other major economies have not adopted comparable climate regulations.[1] It has realistic significance for us to discuss border carbon adjustments.

Border carbon adjustments can be divided into different types. For instance, the government could levy carbon tariffs on imports [28,29] or adopt export rebates [30] to protect the comparative advantages of domestic firms. The sum of the carbon tariffs and export rebates are called full border carbon adjustments [31,32]. In addition, border carbon adjustments can also be divided by coverage. Border adjustments may be targeted at only direct emissions or both direct and indirect emissions [21,33]. Fischer and Fox [31] provided a comparison among different border adjustments and concluded that it is difficult to rank order different types of border adjustments. The present study focuses on border carbon adjustments for exports, which is an important anti-leakage measure [34].

The existing studies mainly discuss the legality of border carbon adjustments [19,35], explore the design of border carbon adjustments [15,21,36], and evaluate the application effectiveness of border carbon adjustments [30–32,37–40]. The literature shows that different border adjustment measures face different legal hurdles and correspond to different anti-leakage effects [31]. Some studies [37,41,42] conclude that border carbon adjustments can effectively reduce carbon leakage. However, other studies find that border adjustment is not an effective approach for reducing carbon leakage [15,43–47] and report that border adjustment does not necessarily result in less leakage. The effectiveness of border adjustments depends on the design features of border adjustments and economic parameters[2] [31,32]. The inconsistent results in the literature indicate that a more in-depth analysis on border carbon adjustments is necessary. This present study attempts to enrich the literature on border adjustments by taking border crossing frequencies into account.

There is rapidly growing literature on the environmental effects of cross-border economic activity, such as emissions embodied in trade flows [48–52] and the pollution haven effect associated with foreign direct investment (FDI) flows [53–55]. Cross-border activities not only play significant roles in shaping the pattern of global emissions but may also influence the stringency and effectiveness of climate regulations. For instance, Cole and Fredriksson [56] find that cross-border FDI flows may have a positive or negative influence on the stringency of the environmental policy, and the impact is determined by the number of legislative units. Global production fragmentation makes cross-border activities more complicated, and intermediate products may cross borders multiples times. Therefore, this paper mainly focuses on the border-crossing frequencies of traded products.

Hummels et al. [17] were perhaps the first to note that intermediate product trade may incur trade costs multiple times. In addition, a growing amount of literature on the numerical estimates of cumulated trade costs have emerged [57–61]. Border adjustment is a trade measure that corresponds to extra trade costs. Bueb et al. [16] noted that border carbon adjustments may also face the problem of double regulation. However, as far as we know, the effects of border-crossing frequencies on the effectiveness of border carbon adjustments for exports have not been quantitatively evaluated by previous studies. This study attempts to fill this gap by tracing carbon emissions along border-crossing supply chains and discusses the effects of the border-crossing frequency on border carbon adjustments for exports.

This paper is also closely related to the literature that characterizes the functional and spatial fragmentation of production systems. For instance, Dietzenbacher et al. [62] proposed a method to calculate the number of production stages, which was used to indicate the relative positions in the global value chains [63–66]. Some literature focuses on spatial fragmentation and analyzes the number of transnational production stages that involve border-crossing. Wang et al. [66] calculated the number of border crossing frequency of value added. Muradov [60] proposed a method to calculate the number of border crossing of exports. This study attempts to apply the concept of border crossing frequency into the discussion on carbon footprint and provides a bridge to understand the relationship between carbon transfer and global value chains. Specifically, we focus on border crossing frequencies associated with carbon footprints.

The numerical simulation of this study is based on the input-output model [67], which can be further divided into the

[1] Sources: http://carbonmarketwatch.org/wp-content/uploads/2015/12/The-impact-of-the-Paris-agreement-on-the-EU-climate-policies_FINAL.pdf.

[2] First, the effectiveness of border carbon adjustments depends on their design features. Zhang [32] point out that the coverage of regulations, the source of emissions, the scope of adjustments, and the carbon intensity criterion would influence the effectiveness of climate regulations. Second, the effectiveness of border carbon adjustments is determined by the economic parameters. Fischer and Fox [31] conclude that the effectiveness of climate regulations is determined by the relative carbon intensities, substitution elasticities, and consumption volumes.