[*RESTRICTED INTERNATIONAL EMISSIONS TRADING IN THE PRESENCE OF GENERAL EQUILIBRIUM EFFECTS*]

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Overview

International emissions trading (IET) has great potential to improve the cost-effectiveness of global abatement. However, despite being theoretically attractive, the case for successfully linking different permit trading systems remains rare so far. A key policy concerns is whether IET benefits all participants, as jurisdictions are unlikely to participate unless they find it welfare-improving compared to independent permit markets. Although most studies applying partial equilibrium models suggest mutual benefits for buyers and sellers, these results heavily rely on their simplified, partial equilibrium settings, thus could be somewhat unrealistic, since in the real-world economy, IET extends its effects into rest of the economy and lead to so-called 'general equilibrium (GE)' effect, engendering indirect welfare costs. A direct (full) linkage between regional permit markets is therefore not necessarily beneficial for all regions if such indirect costs outweigh primary efficiency gains. This argument is also supported by results from computable general equilibrium (CGE) models where some jurisdictions (especially permit sellers) might even be worse off after engaging in IET.

In face of difficulties to achieve an unrestricted, direct IET regime, transitional restricted IET as a progressive intermediate step has gained increasing attention. A growing body of literature evaluates welfare effects of restricted (or limited) permit markets linkage, pointing to its potential to reconcile jurisdictional interests and to achieve win-win outcomes. Most of these papers, however, are solely based on numerical methods such as CGE, and cannot analytically characterize welfare effects of different IET agreements (Gavard et al., 2016; Li and Duan, 2021; Winkler et al., 2021). To the best of our knowledge, only Quemin and de Perthuis (2019) conducted an in-depth analysis on restricted IET, but their model did not consider indirect welfare costs induced by GE effect. Alternatively, Babiker et al. (2004) explicitly focused on the role of GE effect in shaping the economic outcomes of IET, but their analysis was limited to direct linkage, without discussing the possibility of restricted IET. From a policy-making perspective, it is important for jurisdictions to comprehensively perceive the potential implications from direct or restricted IET, particularly in the presence of GE effect.

To fill these gaps, this paper mainly addresses three questions: 1) What are the welfare implications of restricted IET when GE effect are taken into consideration? 2) How to design an IET agreement that is bilaterally beneficial for both buyer and seller jurisdictions? And 3) How will policies targeting GE effect (e.g., carbon border adjustment or carbon revenue recycling) alter the outcomes and willingness of countries to participate in IET? We combine theoretical analysis and numerical simulations to answer these questions. By constructing a simple, transparent analytical model, we analyze welfare effects of direct and restricted IET under different agreement designs (e.g., trading price and volumes) and GE effect magnitudes. Within this framework, we derive jurisdictional optimal trading volumes and acceptable ranges under different conditions, and investigate how policies could affect these key outcomes. To complement our theoretical considerations, we employ a global multi-sector CGE model to perform simulations based on empirical data. Results highlight the role of GE effect in determining the final outcomes of IET between different regions, as well as the importance of reasonable trading price in forging bilaterally acceptable trading agreements. This paper makes its main contribution to theoretically characterize restricted IET with GE effect, thereby is expected to explain results from numerical CGE models. Policy implications could also be drawn from our results to enhance participation in IET through mitigating negative GE effect.

Methods

This study comprises two interrelated parts: theoretical considerations and numerical simulations. In theoretical part, we formulate a two-region analytical model to understand the welfare implications of IET under the presence of GE effect. The model is extended from Quemin and de Perthuis (2019) by distinguishing MAC and marginal welfare cost (MWC) curves, which draws upon Babiker et al. (2004). By assuming a simplified, linearized cost curve, we are able to explicitly derive jurisdictional optimal and maximum acceptable trading volumes as functions of two key parameters: the relative monopoly (resp. monopsony) power, θ (resp. $1-\theta$), and marginal indirect welfare costs due to GE effect, τ. We prove that with GE effect, direct permit markets linkage could be welfare-decreasing for seller region, as in Babiker et al. (2004). On this basis, we characterize the bilaterally acceptable range for trading volumes when θ and τ vary. Furthermore, Babiker et al. (2004) identified two important kinds of GE effect, namely the 'terms-of-trade effect' and the 'tax-interaction effect'. Correspondingly, we analyze effects of two relevant policies, the carbon border adjustment (which affect terms-of-trade) and carbon revenue recycling (which affect pre-existing distortionary taxes), on optimal trading volumes and bilaterally acceptable range.

To concretize our theoretical insights, we then employ a global multi-region, multi-sector CGE model to simulate IET based on empirical data. The model is extended from GTAP-E in GAMS. A new inter-regional emissions trading mechanism is introduced into the model to make it fit this study. To contrast impacts of IET between different trading pairs, our policy scenarios feature three cases: 1) Europe-China; 2) Europe-India; and 3) Europe-USA. It is revealed that even if the buyer region is unchanged (always Europe), the different characteristics of seller regions lead to divergent outcomes.

Results

The analytical model reveals the following key findings:

1) Direct permit markets linkage could be welfare-decreasing for seller region when GE effect is relatively large.

2) For buyer region, when GE effect is relatively small, initially increases as a convex function of monopoly power θ before reaching full linkage. If GE effect is sufficiently high, full linkage is always optimal for buyer.

3) For seller region, when GE effect is relatively small, the optimal trading volume equals full linkage initially but then decreases convexly as θ increases. When GE effect exceeds a threshold, the optimal trading volume would be 0 at small θ, and gradually rise with θ as a concave function. If GE effect is very large, the seller might completely opt out of IET, maintaining zero trading volume across all θ.

4) The bilaterally acceptable range: there exists two thresholds, τ_2^a and τ_2^b, that satisfy: when $\tau_2 < \tau_2^a$, the range always exists for all $\theta \in [0,1]$; when $\tau_2^a \leq \tau_2 < \tau_2^b$, the range disappears when θ is small; and when $\tau_2 \geq \tau_2^b$, the range does not exist for all $\theta \in [0,1]$.

5) Carbon border adjustment would incentivize seller to link when τ_2 is relatively large, but may also discourage buyer when τ_1 is small. The more progressive carbon revenue recycling, however, could improve both regions' willingness to participate IET.

Simulation results from CGE model are broadly in line with our theoretical insights. We find that the buyer region, Europe, suffers from strikingly high GE effect due to carbon pricing. Therefore, it always prefers full linkage (i.e., no restrictions) regardless of its trading partners. The more interesting findings lie in seller regions. It is found that for China and USA, due to relatively high GE effect, they will not accept full linkage, nor restricted linkage with low trading price (θ). Only when θ is sufficiently high will they agree to link, and there exists optimal trading volumes lower than full linkage. For India, however, it is less affected by GE effect, hence it is willing to accept all trading agreements and consistently favors full linkage, irrespective of θ. The implementation of carbon border adjustment turns out to encourage sellers but discourage buyers in IET. This is particular in Europe-China case where China would accept full linkage if Europe uses (ex-ante) border adjustment as a 'threat'.

Conclusions

Conclusions are laid out to answer questions proposed in overview. For question (1), The welfare effects of IET under GE effect differ significantly between buyers and sellers. Buyers tend to favor full linkage due to the influence of GE effect, but it is hard to be accepted by sellers. Higher GE effect will decrease sellers' optimal trading volume, and even make them withdraw from IET. As for question (2), when GE effect comes into play, a sufficiently high θ is required to ensure the existence of bilaterally acceptable range, within which the negotiated trading volume must be located. Finally, regarding question (3), it is affirmed that policies beyond permit markets could also influence welfare effects of IET through GE interactions. The proper use of carbon border adjustment or progressive revenue recycling policy could thus improve the feasibility and negotiating scope of IET agreement. A critical policy insight is that jurisdictions should leverage the flexible design of restricted IET agreements to promote beneficial climate cooperation.

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