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Carbon motivated regional trade arrangements: Analytics and simulations

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ABSTRACT

This paper presents both analytics and numerical simulation results relevant to proposals for carbon motivated regional trade agreements summarized in Dong and Whalley (2010). Unlike traditional regional trade agreements, by lowing tariffs on participant's low carbon emission goods and setting penalties on outsiders to force them to join such agreements, carbon motivated regional trade agreements reflect an effective merging of trade and climate change regimes, and are rising in profile as part of the post 2012 Copenhagen UNFCC negotiation. By adding country energy extraction cost functions, we develop a multi-region general equilibrium structure with endogenously determined energy supply. We calibrate our model to business as usual scenarios for the period 2006–2036. Our results show that carbon motivated regional agreements can reduce global emissions, but the effect is very small and even with penalty mechanisms used, the effects are still small. This supports the basic idea in our previous policy paper that trade policy is likely to be a relatively minor consideration in climate change containment.

1. Introduction

This paper presents both analytics and numerical simulation results relevant to recent debate on carbon motivated regional trade agreements (see Chatham House, 2007 and Dong and Whalley, 2010). Proposals which circulate include explicitly lowering or eliminating tariffs among parties to a regional agreement on low carbon intensive goods and products used in low carbon technologies, border adjustments on trade with parties outside the area based on differential emission content of goods, and the use of trade sanctions against countries outside the area to enforce compliance with emission reduction targets set for them. Such proposals reflect an effective merging of trade and climate change regimes, and are rising in profile as part of the post 2012 Copenhagen UNFCC negotiations (see Walsh and Whalley, 2008 and Lockwood and Whalley, 2010). Here we discuss carbon motivated regional agreements in terms similar to customs union and regional trade agreements based literature (see Viner, 1950).

We note that agreements with lower within-region barriers on low carbon intensive products need not reduce emissions globally if emission intensities of production differ sharply within and inside the region. This reflects the differential impact of trade creation and trade diversion on emissions. We also note that unlike conventional customs union literature the welfare effects of a regional agreement now also include welfare impacts on climate change from emission changes.

We use a multi-region general equilibrium structure in which countries produce commodities of varying emission intensities using substitutable fossil fuel based energy and non-energy inputs. Commodities are differentiated by country of origin following Armington (1969). Preferences are defined over both consumption of goods and climate change, with lower utility from higher global temperature change.

Unlike in conventional trade models in which there is a fixed endowment of factor inputs for each country, here we model energy supply globally as integrated with a single global market and price, and there being a supply function for each country reflecting increasing extraction costs. We do not separately differentiate between fossil and non fossil fuels, but in a further model extension we could do so. We model the extraction cost function in constant elasticity form to yield a specification consistent with alternative values of the supply elasticity of energy. We then treat emissions in each country as fixed coefficient in energy use, and in this way incorporate endogeneity of emission levels. Global emission levels can thus rise or fall under any given regional trade agreement. This differs from other equilibrium structures (see OECD, 1993; Bhattacharyya, 1996; and Wing, 2004) in which the energy endowment is fixed (perfectly inelastic supply).

We next turn to numerical simulation, and using a number of data sources construct a benchmark global equilibrium data set based on data for 2006. This covers production, consumption and trade for each of a number of regions (US, EU, China, ROW) which we then project forward using 2004–2006 average growth rates for the period 2006–2036. In our static equilibrium model we thus treat the 30-year period 2006–2036 as a single period. The data set also contains

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estimates of energy use by sector and emissions for 2006 which are growth rate projected forward for period 2006–2036. We calibrate our model to this data set using literature based estimates of key elasticities.

Results from our analysis support the conjecture made verbally in our previous policy paper (see Dong and Whalley, 2010) that carbon motivated trade policies such as carbon free trade areas can only have a relatively small role in reducing carbon emissions. Carbon motivated regional agreements may increase world welfare, but the effects on participating countries may be negative or positive, when with penalties, the effect of carbon motivated trade policies on carbon emissions is still small. Though the carbon motivated regional agreements will have larger effects with emissions of high and low emission intensities countries involved, the effects are still small.

2. Relevant literature and model structure

2.1. Literature review

Discussion of both the form and impact of carbon free trade agreements is related to the long studied customs union issue originally analyzed by Viner (1950). Viner, the initiator of subsequent customs union literature, pointed out that regional trade agreements do not necessarily result in gains to members, even though bilateral tariffs are eliminated by the agreement. He developed what later became known as the trade creation — trade diversion approach to regional trade agreements to help understand this ambiguity. Following Viner's work, for many years trade creating regional agreements were seen as good, and trade diverting regional agreements were seen as bad.

Viner's work was also the driving force behind later literature that subsequently sought to set out the conditions under which regional trade agreements would either improve or worsen welfare. This work was still based on trade creation — trade diversion considerations, but Meade (1955), Lipsey (1957) and others discovered that preference considerations also enter in trying to make such determinations. This was to lead to Lipsey and Lancaster's (1956) characterization of the general theory of the second best, confirmation that no general customs union results were possible. Dissatisfaction with the trade creation — trade diversion dichotomy resulted in Lipsey (1970), Kemp and Wan (1976), Riezman (1979) and others trying to develop other approaches that would yield clear propositions. The approach known as the terms of trade-volume of trade approach became popular, under which the impact of a regional trade agreement can be summarized by its effects on both terms of trade (prices) and trade volumes. Most traditional literature on regional trade agreements falls into the traditional Vinerian framework.

In Dong and Whalley (2010), we proposed three different forms of possible carbon motivated regional trade arrangements. One is regional trade agreements with varying types of trade preferences towards low carbon intensive products, low carbon new technologies and inputs to low carbon processes being used to stimulate trade (and hence consumption) in low carbon intensive products. In this way they are designed to contribute directly to emission reduction through changed trade patterns. A second type focuses on the anti-competitive effects on domestic producers when significant joint emission reduction commitments are made which others do not follow. Such commitments raise costs for domestic producers and whether there should be offsets for these relative cost effects compared to third country producers operating outside of such arrangements is an issue, as well as the form they should take. The perceived need for border tax adjustments had already arisen in Europe who saw themselves as going farther and faster on emission reductions than partner countries. A third type of arrangement could be where countries enter into free trade or other regional trade agreements and use joint and discriminatory carbon motivated trade barriers against third parties as a way of pressuring countries to join their joint environmental agreement. This form of trade arrangement is similar to that contained in the Montreal Protocol of 1987.

This paper follows Dong and Whalley (2010), and numerically evaluates the economic effects of type one and type three carbon free trade areas in that paper. In their simplest form, carbon free trade areas would involve free trade in low carbon containing products among countries jointly committing to significant emission reductions or renewable commitments, and also with external trade barriers against third countries that do not follow. Discussion of both their form and impact is related to the long studied customs union issue originally analyzed by Viner (1950), but now there are also impacts of carbon pricing/reduction policies on emissions via endogenous energy supply. The paper focuses on two departures from Vinerian form, one includes climate change effects in utility, and the other changes traditional free trade areas and Customs Unions to carbon motivated free trade areas and Customs Unions. In carbon free trade agreements, traditional zero-tariffs on all goods changes to structural preferential trade policies setting high tariffs on high carbon intensive products and zero tariffs on low carbon intensive goods. We also consider a new form of carbon motivated Customs Unions of only setting zero tariffs on low carbon intensive goods.

We argue that agreements with lower within region barriers on low carbon intensive products need not reduce emissions globally if emission intensities of production differ sharply within and outside the region. This reflects the differential impact of trade creation and trade diversion on emissions. We also note that unlike conventional customs union literature the welfare effects of a regional agreement also include welfare impacts on climate change from emission changes.

2.2. The model

We present our carbon free trade area model in algebraic form. In its simplest form, there are three regions, $i = 1,2,3$, where regions 1 and 2 form a carbon free trade agreement, although in empirical implementation we can consider more regions. There are two goods, $j = 1,2$, in production, good 1 has high energy intensity, and good 2 has low energy intensity. The model specifies two factors, N a non-energy input, which is immobile across countries, but mobile across sectors within a country, and E an energy input which is mobile across both countries and sectors.

On the production side, we consider a two sectors (a high emission good and a low emission good), two factors (energy and non energy inputs) structure. We assume production is CES. The production function for each good in each country can be written as

$$Y_{ij} = \Phi_{ij}\left[{a_{ij1}}^{1/\sigma_{ij}} E_{ij}^{\sigma_{ij}-1/\sigma_{ij}} + {a_{ij2}}^{1/\sigma_{ij}} N_{ij}^{\sigma_{ij}-1/\sigma_{ij}} \right]^{\sigma_{ij}/\sigma_{ij}-1} \quad i = \text{country},\ j = \text{sector} \tag{1}$$

where Y_{ij} is the output of good j produced in country i, p_E is the price of energy, σ_{ij} is the elasticity of substitution between the two inputs. We assume that energy is mobile across countries, so that the energy price in each country (the world price) is the same. p_{iN} is the price of the non-energy input in country i, goods prices are P_{ij}.

First order conditions imply the following:

$$E_{ij} = Y_{ij}\Phi_{ij}^{-1} a_{ij1} p_E^{-\sigma_{ij}} \left[a_{ij1} p_E^{1-\sigma_{ij}} + a_{ij2} p_{iN}^{1-\sigma_{ij}} \right]^{\sigma_{ij}/1-\sigma_{ij}} \tag{2}$$

$$N_{ij} = Y_{ij}\Phi_{ij}^{-1} a_{ij2} p_{iN}^{-\sigma_{ij}} \left[a_{ij1} p_E^{1-\sigma_{ij}} + a_{ij2} p_{iN}^{1-\sigma_{ij}} \right]^{\sigma_{ij}/1-\sigma_{ij}} \tag{3}$$