The World Economy

The World Economy (2010)
doi: 10.1111/j.1467-9701.2010.01286.x

The Effects of Domestic Climate Change Measures on International Competitiveness

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1. INTRODUCTION

THERE is widespread concern among the countries that have undertaken measures to reduce greenhouse gas (GHG) emissions that this will adversely affect the international competitiveness of their major industries, especially in the energy-intensive sector. Industry groups especially worry that higher energy costs not only burden them domestically, but also give competitors in countries that do not have these measures a competitive edge and an unfair advantage. This has also taken a political dimension with the idea of a 'Kyoto Tax' against non-complying countries being echoed by many, including the French President and Prime Minister. There are also proposals in the US Congress that would require purchases of greenhouse gas emission allowances in order for imported goods to be allowed to enter from countries that are not making satisfactory efforts to mitigate greenhouse gas emissions.[1]

This paper examines whether the competitiveness of countries implementing climate change measures has suffered as a result of the implementation of a carbon tax, or other regulatory measures implemented for GHG emissions reduction. Specifically, the paper focuses on two types of instruments, namely,

We thank Aaditya Mattoo for comments. Research funding from the World Bank is cordially acknowledged. The findings, interpretations and conclusions expressed in this paper are entirely ours, and do not necessarily reflect the views of the World Bank, its Executive Directors, or the countries they represent.

[1] Many legislative proposals introduced during 2007–09 are relevant. One is Senate bill 1766, introduced by Senators Bingaman and Specter; another is Senate bill 2191, introduced by Senators Lieberman and Warner, as amended by Boxer. In the House of Representatives, the Waxman Markey bill (H.R. 2454) is another example.

carbon taxes and *energy efficiency standards*. While both measures aim to reduce GHG emissions by reducing energy consumption, they use very different mechanisms. Carbon taxes focus on the carbon emissions during the production process which disproportionately affects those energy-intensive industries. On the other hand, energy efficiency standards set energy consumption standards on industrial products, which could be considered as a costly product quality upgrade that pushes industries to manufacture better output at a higher cost.

We use a standard gravity model in trade to study the effects of these two measures on exports. Focusing on the OECD countries, the study finds no evidence that industries' competitiveness is affected by carbon taxes. In fact, the analysis suggests that exports of most energy-intensive industries increase when a carbon tax is imposed by the exporting countries, or by both importing and exporting countries. This finding gives credence to the general assumption that governments often recycle the taxes back to the energy-intensive industries by means of subsidies and exemptions and may in fact be overcompensating for the disadvantage to those industries.[2] A closer examination of specific energy-intensive industries in OECD countries shows that only in the case of the cement industry has the imposition of a carbon tax by the exporting country adversely affected trade. In the case of the paper industry, trade actually increases as a result of a carbon tax. On the other hand, energy efficiency standards are found to have negative effects on trade, when they are required by either the importing country, or the exporting country, or both.

The paper proceeds as follows. In Section 2, we present the empirical specifications underpinning our econometric work. We discuss the data in Section 3 and present the results in Section 4. In Section 5 we provide the concluding remarks.

2. EMPIRICAL SPECIFICATIONS

To study the effects of climate change measures on export performance, the study uses a standard gravity model of trade. The basic gravity model – as developed by Tinbergen (1962) and Linnemann (1966) – predicts bilateral trade flows based on the economic sizes of (often using GDP measurements) and distance between two units. Some models include, alongside distance, the areas of the trading partners (proxy for transport cost within the country), tariff and price variables, as well as a variety of proxies for 'closeness' between the

[2] Mattoo et al. (2010) find, using a CGE model rather than our econometric approach, that a carbon tax would affect the competitiveness of energy-intensive industries in industrial countries but only to a limited extent.

trading partners, such as contiguity, common language (cultural affinity), and trading bloc membership. This model is often used to examine bilateral trade patterns in search of evidence on 'natural' (non-institutional) regional trading blocs, the estimation of trade creation and trade diversion effects from regional integration, and the estimation of trade potential for new entrants to a trading bloc.

Our empirical specification follows the fixed effects gravity model in Feenstra (2003). For exports of country i to country j in industry k and year t, we regress the log of industry-level bilateral export between the two countries relative to the product of the two GDPs $(\ln(export_t^{kij}/GDP_t^i GDP_t^j))$, on an exporter fixed effect (α_i), an importer fixed effect (α_j), a year fixed effect (α_t), an industry fixed effect (α_k), the log of distance between the two countries ($\ln dist^{ij}$), dummy variables on common borders ($border^{ij}$), common currency ($currency_t^{ij}$), and common free trade agreements (FTA_t^{ij}). Using separate importing and exporting country fixed effects, we are thus able to capture the 'multilateral resistance' terms in Anderson and van Wincoop (2003):

$$\ln\left(\frac{export_t^{kij}}{GDP_t^i GDP_t^j}\right) = \alpha_i + \alpha_j + \alpha_t + \alpha_k + \beta_1 \ln dist^{ij} + \beta_2 border^{ij} + \beta_3 currency_t^{ij} + \beta_4 FTA_t^{ij} + \gamma_1 ct1_t^i + \gamma_2 ct2_t^j + \gamma_3 ct3_t^{ij} + \delta_1 ees1_t^i + \delta_2 ees2_t^j + \delta_3 ees3_t^{ij}.$$

Additionally, based on the year the carbon tax is implemented in a country, we construct three dummy variables ($ct1_t^i$, $ct2_t^i$ and $ct3_t^i$). $ct1_t^i$ applies if only the exporting country has carbon tax in the year, $ct2_t^i$ is if only the importing country has carbon tax in the year, and $ct3_t^i$ is if both countries have carbon tax in the year. The coefficients of these carbon tax dummy variables capture the change in exports relative to the baseline scenario when neither the importing nor the exporting countries have carbon tax. Similarly, based on the year the energy efficiency standard is implemented in a country, three dummy variables ($ees1_t^i$, $ees2_t^i$ and $ees3_t^i$) are constructed to capture the effects on exports relative to the baseline scenario when no such standard is in place.

To understand the separate impact of carbon taxes and energy efficiency standards, we also introduce the two sets of dummy variables separately. Finally, to study the effect of these climate measures on some specific industries, we also run the regression industry by industry. Note that our variables of interests are not industry specific – all the carbon taxes and energy efficiency standard dummy variables only vary by exporting countries, importing countries and years. We will need to cluster the standard errors of the regression by exporter-year or importer-year to avoid underestimation of the standard

TABLE 1
Expected Effects of Carbon Taxes and Energy Efficiency Standards on Exports

Carbon Tax	*Effects on Industry Export*	*Energy Efficiency Standard*	*Effects on Industry Export*
Carbon tax by an exporting country	Negative	Energy efficiency standards in the exporting country	Neutral or marginally negative
Carbon tax by an importing country	Positive	Energy efficiency standards in the importing country	Negative
Both exporting and importing countries have carbon tax	Neutral or marginal decline in trade	Energy efficiency standards in both exporting and importing country	Neutral or marginal decline in trade

errors due to macro variable in micro unit problems. The expected results are given in Table 1.

3. DATA

The main data source is the UN Comtrade database (United Nations, 2006), which provides the value of exports at three-digit ISIC level for all the OECD countries from 1988 to 2005. We also obtain GDP figures from the *World Development Indicators* (World Bank, 2006). The gravity variables such as bilateral distance between country pairs, and common border variable are from Nicita and Olarreaga (2004). Information on carbon taxes and energy efficiency standards is obtained from national sources.

Some caveats are in order. First, a limitation of this analysis is that climate change measures, namely carbon taxes and energy efficiency standards, are used as dummy variables in this analysis. They do not reflect the differentiated levels of standards and taxes that are levied in different countries and across the different fuels. To this effect, results need to be interpreted with some degree of caution, as the analysis is unable to provide a direct assessment of the extent of trade loss or gain associated with variations in the levels of stringency across countries. Nonetheless, by comparing countries with and without measures, they do provide useful insights into the dynamics of climate change measures and country competitiveness. It is this issue that has dominated the debates, not the actual levels. Second, carbon tax values or energy efficiency standards could change with time even for a given country. However, degrees-of-freedom constraints prevent a more detailed examination of this phenomenon.

4. RESULTS

Table 2 presents the pooled regressions results of the specifications. In column (1), we pooled all manufacturing industries of all OECD countries in all the sampled years in the regression. All the gravity control variables, such as bilateral distance, common border and currency, as well as FTA dummy variables, are of the right signs and are statistically significant. The magnitudes of the coefficients are also in line with the previous findings in the literature. We only include carbon tax dummies in column (1). Results show that bilateral trade is adversely affected when only importing countries imposed carbon tax. Carbon taxes imposed by exporting countries do not seem to matter. This could be because most countries actively subsidise or exempt their most competitive and energy-intensive industries when carbon taxes are implemented.

Column (2) of Table 2 reveals the effects of energy efficiency standards on trade. Unlike the previous column, we found strong negative effects of such requirements on trade flow. It does not matter whether the standard is imposed by exporting countries, importing countries or both; bilateral trade decreases by nearly 10 per cent as a result. Column (3) includes both carbon taxes and energy efficiency standards in the regression, and the results are similar to the first two columns, indicating that these two policies do not interfere with each other in their effects on export competitiveness.

Column (4) of Table 2 allows industries that use energy intensively to have different coefficients on the carbon tax dummies, by interacting the carbon tax dummies with industry dummies. These industries are paper and paper products (ISIC 341), industrial chemicals (351), non-metallic products (369), iron and steel (371) and non-ferrous metal (372). Similarly, we interact the energy efficiency standard dummy variables with those industries which have products that are subjected to an energy efficiency standard. Such industries are metal products (ISIC 381), machinery (382), electrical machinery (383), transport equipment (384) and scientific equipment (385).

The results show that only when carbon tax is imposed by the importing countries do we see the negative effect on trade of the energy-intensive industries. Exports of energy-intensive industries actually increase when a carbon tax is imposed by the exporting countries or both importing and exporting countries. This once again indicates that subsidies and exemption of the exporting countries on those energy-intensive industries have overcome the disadvantage imposed by the carbon tax.

On the other hand, a very different picture appears when we focus on those industries which produce output that are subjected to energy efficiency standards. Here the interaction terms are overwhelmingly negative, which shows that these industries are adversely affected by such requirements. These large

TABLE 2
Dependent Variable: Log of Bilateral Export Relative to the Product of GDP in Two Countries

	(1)	*(2)*	*(3)*	*(4)*
Log of bilateral distance (km)	−1.387***	−1.386***	−1.387***	−1.387***
	(0.018)	(0.018)	(0.018)	(0.018)
Common border dummy variable	0.961***	0.963***	0.963***	0.963***
	(0.051)	(0.050)	(0.051)	(0.051)
Common currency dummy variable	0.171***	0.173***	0.174***	0.174***
	(0.036)	(0.037)	(0.036)	(0.036)
FTA dummy variable	0.408***	0.412***	0.409***	0.409***
	(0.069)	(0.069)	(0.069)	(0.069)
*ct*1	0.034		0.029	−0.051
	(0.033)		(0.033)	(0.034)
*ct*2	−0.040*		−0.043*	−0.016
	(0.024)		(0.024)	(0.023)
*ct*3	−0.013		−0.017	−0.071
	(0.045)		(0.045)	(0.048)
*ees*1		−0.105***	−0.102***	−0.075**
		(0.036)	(0.036)	(0.038)
*ees*2		−0.090***	−0.093***	−0.062*
		(0.033)	(0.033)	(0.035)
*ees*3		−0.099***	−0.100***	−0.027
		(0.036)	(0.036)	(0.037)
*ct*1 ∗ energy intensive input industry				0.462***
				(0.022)
*ct*2 ∗ energy intensive input industry				−0.151***
				(0.034)
*ct*3 ∗ energy intensive input industry				0.317***
				(0.036)
*ees*1 ∗ energy intensive output industry				−0.154***
				(0.044)
*ees*2 ∗ energy intensive output industry				−0.172***
				(0.049)
*ees*3 ∗ energy intensive output industry				−0.402***
				(0.041)
Constant	−28.044***	−27.963***	−27.961***	−28.007***
	(0.217)	(0.217)	(0.216)	(0.215)
Exporting country fixed effects	Yes	Yes	Yes	Yes
Importing country fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Sample size	307,957	307,957	307,957	307,957
R-squares	0.6103	0.6103	0.6104	0.6114

Notes:
*, ** and *** indicate statistical significance at 90%, 95% and 99% level, respectively.
Standard errors in parentheses are clustered by country–year pair.
Sample is pooled across all three-digit ISIC manufacturing industries.

negative effects are in addition to the negative effects that are common across all manufacturing industries.

Tables 3 and 4 present the regression results by industries. In this specification, we do not constrain all the coefficients to be common across all industries, which may yield additional insight into the issues. Table 3 focuses on those industries that use energy intensively in their production. These are the industries that should be adversely affected by a carbon tax. However, as noted before, most governments also actively subsidise or exempt these industries to neutralise such adverse effects. Therefore, we may not be able to identify the impact of carbon tax on these industries.

TABLE 3
Dependent Variable: Log of Bilateral Export Relative to the Product of GDP in Two Countries

Industry	*(1)* *341*	*(2)* *351*	*(3)* *369*	*(4)* *371*	*(5)* *372*
Log of bilateral distance (km)	−1.911***	−1.416***	−1.514***	−1.891***	−1.737***
	(0.034)	(0.028)	(0.026)	(0.032)	(0.043)
Common border dummy variable	0.490***	0.773***	1.054***	0.555***	1.056***
	(0.065)	(0.068)	(0.073)	(0.065)	(0.095)
Common currency dummy variable	0.180***	0.075	−0.046	0.240***	0.262***
	(0.052)	(0.048)	(0.050)	(0.067)	(0.076)
FTA dummy variable	0.217*	−0.025	0.302***	−0.018	−0.330**
	(0.114)	(0.113)	(0.104)	(0.158)	(0.160)
*ct*1	0.122**	0.033	−0.174***	0.148**	0.041
	(0.055)	(0.039)	(0.049)	(0.058)	(0.062)
*ct*2	0.026	0.017	−0.060	0.004	0.081
	(0.042)	(0.044)	(0.047)	(0.049)	(0.060)
*ct*3	−0.449***	−0.057	0.041	0.025	0.049
	(0.068)	(0.063)	(0.071)	(0.078)	(0.094)
*ees*1	0.055	0.109**	−0.224***	0.071	−0.111
	(0.085)	(0.047)	(0.061)	(0.065)	(0.090)
*ees*2	0.020	−0.034	−0.129**	−0.075	−0.107
	(0.080)	(0.045)	(0.063)	(0.067)	(0.094)
*ees*3	0.011	0.150***	−0.177**	−0.022	0.042
	(0.085)	(0.055)	(0.063)	(0.072)	(0.097)
Constant	−19.855***	−23.517***	−24.426***	−19.726***	−19.371***
	(0.410)	(0.322)	(0.321)	(0.372)	(0.473)
Exporting country fixed effects	Yes	Yes	Yes	Yes	Yes
Importing country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Sample size	10,918	11,383	10,635	10,979	10,525
R-squares	0.7666	0.7265	0.7221	0.7085	0.6179

Notes:
*, ** and *** indicate statistical significance at 90%, 95% and 99% level, respectively.
Standard errors in parentheses are clustered by country–year pair.

TABLE 4
Dependent Variable: Log of Bilateral Export Relative to the Product of GDP in Two Countries

Industry	*(1)* *381*	*(2)* *382*	*(3)* *383*	*(4)* *384*	*(5)* *385*
Log of bilateral distance (km)	−1.389***	−1.112***	−1.171***	−1.313***	−0.937***
	(0.022)	(0.021)	(0.024)	(0.029)	(0.020)
Common border dummy variable	0.883***	0.630***	0.502***	0.646***	0.947***
	(0.049)	(0.055)	(0.058)	(0.068)	(0.064)
Common currency dummy variable	−0.041	−0.076	−0.066	−0.091*	−0.032
	(0.048)	(0.053)	(0.050)	(0.053)	(0.051)
FTA dummy variable	0.747***	0.628***	1.537***	1.482***	0.345***
	(0.080)	(0.081)	(0.117)	(0.126)	(0.102)
*ct*1	0.003	−0.112***	0.066	−0.118**	0.040
	(0.044)	(0.040)	(0.043)	(0.054)	(0.040)
*ct*2	−0.013	0.014	−0.077*	−0.016	0.159***
	(0.036)	(0.035)	(0.040)	(0.054)	(0.044)
*ct*3	−0.273***	−0.369***	−0.464***	−0.439***	−0.258***
	(0.060)	(0.061)	(0.066)	(0.082)	(0.061)
*ees*1	−0.307***	−0.050	0.027	−0.251***	−0.015
	(0.054)	(0.046)	(0.048)	(0.072)	(0.058)
*ees*2	−0.082*	−0.054	−0.018	−0.137**	0.041
	(0.050)	(0.042)	(0.045)	(0.067)	(0.056)
*ees*3	−0.214***	0.005	0.039	−0.242***	0.036
	(0.057)	(0.047)	(0.053)	(0.068)	(0.060)
Constant	−24.224***	−25.087***	−25.925***	−24.286***	−27.934***
	(0.266)	(0.255)	(0.291)	(0.373)	(0.234)
Exporting country fixed effects	Yes	Yes	Yes	Yes	Yes
Importing country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Sample size	11,568	11,742	11,602	11,272	11,451
R-squares	0.7667	0.7663	0.746	0.6307	0.7412

Notes:
*, ** and *** indicate statistical significance at 90%, 95% and 99% level, respectively.
Standard errors in parentheses are clustered by country–year pair.

Results show that a carbon tax has negative effects on paper and paper products industry (341) and non-metallic industry (369). For non-metallic industry, trade significantly decreases when only the exporting country imposes the tax, but trade is not affected with both countries impose the tax. This suggests that unilateral domestic climate measures hurt the export performance of a country, which is the argument most governments use in order to justify direct subsidies to these industries to offset the adverse shock of carbon tax. On the other hand, for the paper and paper products industry, trade actually increases if only exporting countries impose the tax. This indicates that the governments may have overly subsidised this industry which results in the expansion in trade. When both importing and exporting countries have a carbon tax, intense competition from the expansion of product due to subsidies leads to a reduction in

trade. Another industry that may also have benefited from a carbon tax due to government subsidies is the iron and steel industry (371), where trade increases when only exporting countries impose the tax.

Table 4 focuses on those industries that produce goods that use energy intensively. Here we expect energy efficiency standards to have negative impacts on trade. The results show that most of these industries are adversely affected by the standard requirement, and the effects are particularly strong for the metal products industry (381) and transport equipment industry (384). In both industries, it does not matter whether such standard requirements were imposed by the exporting country or the importing country or both, trade is reduced by 20 to 30 per cent. This result is in line with the pooled regression presented in Table 1.

Perhaps the most interesting finding of Table 4 is that all these industries are adversely affected by a carbon tax. Bilateral trade, in some cases such as for the electronics industry, declines by as much as 40 per cent, which indicates that some third world countries that do not have carbon tax may have benefited from the situation when both exporting and importing countries impose the tax. Given that these are not energy-intensive industries, they are normally not directly subsidised or exempted by governments, which thus provides direct evidence that a carbon tax is trade reducing.

5. CONCLUSIONS

This paper provides some preliminary econometric evidence suggesting that domestic climate change policies may have adverse effects on international trade. We focus on two policies – carbon taxes that target those industries that use energy intensively, and energy efficiency standards that affect those industries that produce output that use energy intensively. Through a panel of industry data of the OECD countries from 1988 to 2005, this paper shows that both carbon taxes and energy efficiency standards have a statistically significant negative effect on competitiveness through impacts on bilateral trade flows (depending on the model specification). This is particularly true when the focus is on those industries that are subject to higher energy efficiency standards and are not subsidised by governments.

This adverse effect is not evident, however, when the focus is on energy-intensive industries that usually receive some degree of protection from their governments. In some cases the subsidies are so generous that trade actually increases as a result. However, when we focus on other industries that use energy, but are often not directly supported by the governments, such as the transport equipment industry and metal industry, the negative effect of carbon tax on trade is clear.

On the other hand, energy efficiency standards require that firms produce goods that are more environmentally friendly, which affects a broader range of industries. In this case, the adverse effects of such a policy are also quite evident.

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