WPS5309

Policy Research Working Paper 5309

The Effects of Domestic Climate Change Measures on International Competitiveness

Hiau Looi Kee
Hong Ma
Muthukumara Mani

The World Bank
Development Research Group
Trade and Integration Team
&
Environment Department
May 2010

Abstract

Under the Kyoto Protocol, industrialized countries (called Annex I countries) have to reduce their combined emissions to 5 percent below 1990 levels in the first commitment period of 2008–12. Efforts to reduce emissions to meet Kyoto targets and beyond have raised issues of competitiveness in countries that are implementing these policies, as well as fear of leakage of carbon-intensive industries to non-implementing countries. This has also led to proposals for tariff or border tax adjustments to offset any adverse impact of capping carbon dioxide emissions. This paper examines the implications of climate change policies such as carbon tax and energy efficiency standards on competitiveness across industries, as well as issues related to leakage, if any, of carbon-intensive industries to developing countries. Although competitiveness issues have been much debated in the context of carbon taxation policies, the study finds no evidence that the energy intensive 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 initial assumption that recycling the taxes back to the energy-intensive industries by means of subsidies and exemptions may be overcompensating for the disadvantage to those industries. There is, however, no conclusive evidence that supports relocation (leakage) of carbon-intensive industries to developing countries due to stringent climate change policies.

This paper—a product of the Trade and Integration Team, Development Research Group and Environment Department—is part of a larger effort in the department to study the trade impact of the climate change measures on trade. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hlkee@worldbank.org.

The Effects of Domestic Climate Change Measures on International Competitiveness[@]

Hiau Looi Kee*, Hong Ma[%] and Muthukumara Mani[+]

JEL: F13, F18, Q56
Keywords: Carbon tax, energy efficiency standard, trade competitiveness, gravity regressions

---

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

* Corresponding author. Development Research Group, The World Bank, Washington, DC 20433, USA; Tel. (1-202) 473-4155; Fax: (1-202) 522-1159; e-mail: hlkee@worldbank.org

% Department of Economics, SEM, Tsinghua University, Beijing, 100084, China; Tel. (86-10) 6279 4388; e-mail: mahong@sem.tsinghua.edu.cn

+ The World Bank. Tel. (91-11) 4147-9178; E-mail: mmani@worldbank.org.

1. Introduction

There is a wide-spread 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 no have these measures (especially the U.S., China, etc.) 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 carbon tax, or other regulatory measures implemented for GHG emissions reduction. Specifically, the paper focuses on two types of instruments, namely, *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

[1] Two of the many legislative proposals introduced during 2007 are relevant. One is Senate bill 1766, introduced by Senators Bingaman and Specter; the other is Senate bill 2191, introduced by Senators Lieberman and Warner.

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 that underpin our econometric work. We discuss data in section 3 and

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

present the results in section 4. Section 5 provides 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 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 effect gravity model in Feenstra (2003). For export 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 GDP ($\ln(\frac{\text{export}_t^{kij}}{\text{GDP}_t^i \text{GDP}_t^j})$), 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 ($\ln \text{dist}^{ij}$), 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).

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

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 $ct3_t^i$). The first one is if only the exporting country has the carbon tax in the year, the second one is if only the importing country has the carbon tax in the year, and the third one is if both countries have the carbon tax in the year. The coefficients of these carbon tax dummies variables capture the change in export relative to the baseline scenario when neither the importing nor the exporting countries has the 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 export 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 try to 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 standards 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 errors due to macro variable in micro units problems. The expected results are given in Table 1.

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

3. Data

The main data source is the UN Comtrade database, which provides the value of exports at 3 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 various 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, the 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 from the levels of stringency across countries. Nonetheless, by comparing countries with and without measures, they do provide useful insights to the dynamics of climate change measures on 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 regression results of the various specifications. In Column (1), we pooled all manufacturing industries, of all OECD countries in all the sampled years in the regression. First, all the gravity control variables, such as bilateral distance, common border and currency, as well as the 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). The results show that bilateral trade is adversely affected when only importing countries imposed the carbon tax. Carbon tax imposed by exporting countries does not seem to matter. This could be because most countries actively subsidized or exempted their most competitive and energy intensive industries when carbon taxes were implemented.

Column (2) of Table 2 studies the effects of the energy efficiency standard on

trade. Unlike the previous column, we found strong negative effects of such requirement on trade flow. It does not matter when the standard is imposed by exporting countries, importing countries or both; bilateral trade always decreases by nearly 10 percent 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 when it come to affecting 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 the 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 the 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 the 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 outputs that are subjected to energy efficiency standards. Here the interaction terms are overwhelmingly negative, which shows that these industries are adversely affected by such requirement. These large 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 the carbon tax. However, as noted before, most governments also actively subsidize or exempt these industries to neutralize such adverse effects. Therefore we may not be able to identify the impact of the carbon tax on these industries.

The results show that the carbon tax has negative effects on the paper and paper products industry (341) and the non-metallic industry (369). For the non-metallic industry, trade significantly reduces when only the exporting country imposes the tax but trade is not affected when both countries impose the tax. This suggests that a unilateral domestic climate measure hurts 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 the 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 subsidized this industry which causes the expansion in trade. When both importing and exporting countries have the carbon tax, intense competition from the expansion of production due to subsidies leads to a reduction in trade. Another industry that also may have benefited from the 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 the transport equipment industry (384). In both industries, it does not matter whether such standard requirement was imposed by the exporting country or the importing country or both; trade is reduced by 20 to 30 percent. 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 the carbon tax. Bilateral trade, in some cases such as the electronic industry, reduces by as much as 40 percent which indicates that some third countries that do not have the carbon tax may have benefited from the situation when both exporting and importing countries imposed the tax. Given that these are not the energy intensive industries, they are normally not directly subsidized or exempted by the governments, which thus provides the direct evidence that the carbon tax is trade

reducing.

5. Conclusions

This paper provides 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 outputs 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 subsidized by governments.

This adverse effect is missing 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 often not directly supported by the governments, such as the transport equipment industry and the metal industry, the negative effect of the 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 policy are also quite evident.

References

Anderson, James A., and Eric van Wincoop (2003). "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93: 170-192.

Feenstra, Robert (2003). *Advanced International Trade*. Princeton University Press.

Linnemann, H. 1966. *An Econometric Study of International Trade Flows*. Amsterdam: North-Holland.

Mattoo, A., A. Subramanian, D. van der Mensbrugghe, and J. He (2010), "Reconciling Climate Change and Trade Policy," World Bank Policy Research Working Paper #5123.

Nicita, Alessandro and Marcelo Olarreaga (2004) "Exports and Information Spillovers," the World bank.

Tinbergen, J. 1962. Shaping the World Economy: Suggestions for an International Economic Policy. New York: The Twentieth Century Fund.

United Nations (2006), *Comtrade Database*.

World Bank (2006). *World Development Indicators*.

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)
ct1	0.034		0.029	-0.051
	(0.033)		(0.033)	(0.034)
ct2	-0.040*		-0.043*	-0.016
	(0.024)		(0.024)	(0.023)
ct3	-0.013		-0.017	-0.071
	(0.045)		(0.045)	(0.048)
ees1		-0.105***	-0.102***	-0.075**
		(0.036)	(0.036)	(0.038)
ees2		-0.090***	-0.093***	-0.062*
		(0.033)	(0.033)	(0.035)
ees3		-0.099***	-0.100***	-0.027
		(0.036)	(0.036)	(0.037)
ct1*energy intensive input industry				0.462***
				(0.022)
ct2*energy intensive input industry				-0.151***
				(0.034)
ct3*energy intensive input industry				0.317***
				(0.036)

ees1*energy intensive output industry				-0.154***
				(0.044)
ees2*energy intensive output industry				-0.172***
				(0.049)
ees3*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	307957	307957	307957	307957
R-squares	0.6103	0.6103	0.6104	0.6114

Notes: *, **, *** indicates statistical significant at 90%, 95% and 99% level respectively.
Standard errors in parentheses are clustered by country-year pair.
Sample is pooled across all 3-digit ISIC manufacturing industries.

Table 3

Dependent variable: Log of bilateral export relative to the product of GDP in two countries

	(1)	(2)	(3)	(4)	(5)
Industry	341	351	369	371	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)
ct1	0.122**	0.033	-0.174***	0.148**	0.041
	(0.055)	(0.039)	(0.049)	(0.058)	(0.062)
ct2	0.026	0.017	-0.060	0.004	0.081
	(0.042)	(0.044)	(0.047)	(0.049)	(0.060)
ct3	-0.449***	-0.057	0.041	0.025	0.049
	(0.068)	(0.063)	(0.071)	(0.078)	(0.094)
ees1	0.055	0.109**	-0.224***	0.071	-0.111
	(0.085)	(0.047)	(0.061)	(0.065)	(0.090)
ees2	0.020	-0.034	-0.129**	-0.075	-0.107
	(0.080)	(0.045)	(0.063)	(0.067)	(0.094)
ees3	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	10918	11383	10635	10979	10525
R-squares	0.7666	0.7265	0.7221	0.7085	0.6179

Notes: *, **, *** indicates statistical significant 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

	(1)	(2)	(3)	(4)	(5)
Industry	381	382	383	384	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)
ct1	0.003	-0.112***	0.066	-0.118**	0.040
	(0.044)	(0.040)	(0.043)	(0.054)	(0.040)
ct2	-0.013	0.014	-0.077*	-0.016	0.159***
	(0.036)	(0.035)	(0.040)	(0.054)	(0.044)
ct3	-0.273***	-0.369***	-0.464***	-0.439***	-0.258***
	(0.060)	(0.061)	(0.066)	(0.082)	(0.061)
ees1	-0.307***	-0.050	0.027	-0.251***	-0.015
	(0.054)	(0.046)	(0.048)	(0.072)	(0.058)
ees2	-0.082*	-0.054	-0.018	-0.137**	0.041
	(0.050)	(0.042)	(0.045)	(0.067)	(0.056)
ees3	-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	11568	11742	11602	11272	11451
R-squares	0.7667	0.7663	0.746	0.6307	0.7412

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