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Abstract

According to recent theoretical developments, there are three key channels through which trade affects the environment. The first is via its effect on the scale of economic activity, the second is via a composition effect and the third is via a technical effect. This paper argues that, in addition to these traditional factors, the geography of international trade flows does matter. Since, transport activity is also a source of pollution, trading with close countries does not have the same implications as trading with distant ones. However, this geographical distance effect can be offset by a transport sector effect i.e. the use of different modes, techniques and scale of transport. Indeed, when distances increase, it is expected that transport companies use less energy-intensive modes of transport. These two opposite effects are tested for carbon dioxide (CO_2) emissions in a set of 149 countries as well as for different economic groups over the period 1986 to 2003. The main findings show a U-shaped relation between distance and CO_2 emissions: the distance (transport sector) effect dominates long (short) distance travel. This paper underlines the possible high costs in terms of CO_2 emissions of globalized trade as opposed to regionalized trade flows.

ملخص

وفقا للتطورات النظرية الأخيرة ، هناك ثلاث قنوات رئيسية تؤثر على البيئة من خلال التجارة. الأولى هي عن طريق تأثيرها على مقياس النشاط الاقتصادي، والثانية هي عن طريق اثر الانتاج الثالث هو عن طريق تأثير التقنية. تناقش هذه الورقة أنه بالإضافة إلى هذه العوامل التقليدية ، فان جغرافية تدفقات التجارة الدولية لا يهم. لذلك ، فان نشاط النقل هو أيضا مصدر للتلوث، والتجارة مع بلدان قريبة لا نملك نفس الآثار التي تتعامل مع تلك البعيدة. ومع ذلك، يمكن تعويض تأثير المسافة الجغرافية من قبل وسائل النقل القطاع أي استخدام وسائط وتقنيات وحجم نقل مختلفة،. في الواقع، عندما تزداجد المسافات ، فمن المتوقع أن تستخدم شركات النقل وسائل أقل استهلاكا للطاقة النقل. ويتم اختبار هذه الآثار المتناقضين لانبعاثات لثاني أكسيد الكربون (CO_2) في مجموعة من 149 بلدا فضلا عن مجموعات اقتصادية مختلفة خلال الفترة من 1986 إلى 2003. وأظهرت النتائج الرئيسية وجود علاقة على شكل U –بين انبعاثات ثاني أكسيد الكربون والمسافة : المسافة (قطاع النقل) يهيمن على أثر السفر لمسافات طويلة (قصيرة). هذه الورقة تؤكد على ارتفاع التكاليف الممكنة من حيث انبعاثات ثاني أكسيد الكربون من عولمة التجارة في مقابل التدفقات التجارية إقليميا.

1. Introduction

The impact of international trade on pollutants emissions is controversial. International economists have presented evidence showing that in certain conditions trade liberalization may help to decrease the global level of emissions (Antweiler et al. 2001; Cole and Elliot 2003). This view is contested by environment specialists who argue that the method to compute emissions consumption of fossil fuel is basically flawed (Peters et al. 2010). Among the emission sources closely linked to international trade, the impact of international transport has scarcely been studied. This paper aims to help to close this gap.

The economic literature on the link between international trade and the environment has usually focused on the decomposition on three main effects: scale, composition and technique. The scale effect is linked to the size of a country's economy, the composition effect to its capital/labor endowment and the technique effect to new technologies of production. The impact of the geography of international trade on environment has scarcely been studied for the moment, nonetheless, emission originating from transport are far from being anecdotic. Transportation is one of the main emission sources for several pollutants. For example, international shipping emits as much CO2 as the United Kingdom (House of Commons Environmental Audit Committee 2009). It is also an important source of sulphur dioxide (SO2), nitrogen oxide (NOx) and Particulate matter (PM). (Van Essen 2008). Since distance between producers and consumers may differ considerably from one international trade flow to another, there may well be a source of variability in emissions. Two opposite effects may be in play: distance and transport sector effects. Indeed, we expect that longer distances are associated with higher emissions in comparison to shorter distances. However, this link can be offset by differences in the modes of transport used: when distances increase, it is expected that transport companies would use less energy-intensive modes of transport. A straightforward example for this argument is the predominance of maritime transport in international trade.

In order to study the relative importance of these two opposite effects, a model of the emissions determinants which includes the traditional scale, composition and technique effects is augmented with distance measures. The main results indicate that distance between countries does matter. The main findings show a U-shaped relation between distance and CO2 emissions: the distance (transport sector) effect dominates long (short) distance travel. This paper is organized as follows. In section 1 we present the literature review. In section 2, we describe the empirical approach. In section 3, we present the data used as well as the econometric results. Section 4 concludes.

2. Literature Review

2.1 Trade and the environment: scale, technique, composition and transport effects

The consequences of economic activity on the environment were first proposed by Grossman and Krueger (1993), for the case of the North American Free Trade Agreement (NAFTA), who empirically assessed the relative magnitudes of three effects associated to trade liberalization in Mexico: scale, technique and composition effect. This decomposition was first modeled in Copeland and Taylor (1994). Grossman and Krueger (1993) defined the scale effect as the increase in pollution that would be generated by an increase in the level of economic activity, holding constant the mix of goods produced and the production techniques. This effect is assumed to be negative for the environment. The composition effect is captured by the change in the share of dirty goods in national income. If we hold the scale of the economy and emissions intensities constant, then an economy that dedicates more of its resources to producing the polluting good will pollute more. This composition effect depends on the comparative advantages that can be explained by factor endowments differences and environmental policy differences between the trading countries. On the one hand, according to the factor endowments hypothesis (FEH), countries that are relatively abundant in factors used intensively in polluting industries will, on average, get dirtier as trade liberalizes. On the other hand, according to the pollution haven hypothesis (PHH), countries with relatively weak environmental policies will specialize in dirty industries leading to the emergence of pollution haven and a race to the bottom. As a consequence, the impact of the composition effect on the level of emissions is ambiguous. Finally, the technical effect assumes that a reduction in emissions intensity will reduce pollution through three different channels. First, increased trade may promote the transfer of cleaner techniques from developed to developing countries. Second, if trade raises income, people may demand higher environmental quality and, third, increased globalization increases competition, and to stay competitive firms have to invest in the most efficient techniques. Hence, the technique effect has a clear positive effect on the environment (Korves and Martínez-Zarzoso 2010).

The seminal work of Antweiler et al. (2001) develops a theoretical model that decomposes the impact of trade on pollution into the abovementioned three effects and tests empirically the theoretical findings using panel data technique for SO2 concentration. They conclude that the FEH dominates the PHH, and therefore high income countries tend to have a comparative advantage in pollution-intensive goods. Thus, increased trade causes a decline in SO2 concentrations. In other words, freer trade seems to be good for the environment. Cole and Elliot (2003) rely on Antweiler et al. (2001) to empirically test for the effects of trade on emissions (per capita), emissions intensities and concentration levels for different air and water pollutants. They find that the results depend on how the dependent variable is measured (concentrations versus emissions) and varies also by pollutant. More recently, Korves and Martínez-Zarzoso (2010) give support to the PHH for CO2 emissions and energy consumption but not for SO2. Managi et al. (2009) use instrumental variable estimations to correct for the endogeneity problems encountered in the previous studies. These problems make difficult comparisons between scale and composition effects induced by trade. They find that trade has a beneficial effect on the environment depending on the pollutant and the country. OECD countries benefit for trade, whereas for non-OECD countries trade increases the emission of pollutants.

International trade requires international transport, which in turn generates polluting emissions. Do the preceding three effects account for this channel? Basically, the answer is scarcely. The scale effect encompasses the increase of emissions due to national transport; the technical effect may show preference for some mode of transport but once again at the national level; and finally the composition effect's impact is through the national regulations governing the transport sector. However, most environmental norms for international transport are decided at the supra-national level[1]. None of these effects highlight the importance of distance and directionality of trade on emissions. In fact, if all the trade of a particular country sails in one direction—from East to West for example—economies of scale in term on the number of vehicles used to transport the merchandizes can be realized in comparison with a situation of a country exports in many directions. We do so by proposing a transport effect that works very similarly to the composition effect because two forces, which are sometimes antagonistic, are in operation: a distance effect allowing emissions to grow when distance between trading partners increases and a transport mode effect allowing emissions to decrease when a more fuel-efficient mode of transport is used. These modes of transport are generally used when distance is increased.

[1] For example, the International Maritime Organization (IMO) through the MARPOL convention establishes the environmental norms concerning international shipping.

3. Trade and CO_2 Emissions: The Role of International Transport

Figure 1 shows the source of CO_2 emission according to human activities in 2008. Transport accounts for 23% of global emission generated. Inside the transport sector it is rather straightforward to allocate the emission according to the mode of transport used: bunker fuel from maritime shipping accounts for 8.7% of total transport emission, international aviation accounts for 6.7%, and trucks and cars for 73.3 %. When it comes to international trade, it is more difficult to assess the quantity of emissions generated by the movement of goods across borders. At a minimum the vast majority of emissions due to the utilization of maritime bunker fuel[2] are generated by international trade. Nonetheless, trucks in Europe and most of the developing countries make an important contribution to the international transport of goods. Figure 2 shows the evolution of emissions due to maritime bunker fuel from 1994 to 2008 for several groups of countries. We can observe that, for the OECD European countries, Asia (excluding OECD pacific and China) and the Middle East, emissions originating from burning maritime bunker fuel strongly built up.

The choice of a particular transport mode on the international level can be driven by several factors: distance, time, weight of goods, existence of infrastructure and price. For transoceanic transport, choices are basically limited to maritime and air transport. For shorter distances, many other options come into play: short/medium sea shipping, road transport or train to give a few examples. As shown by Kim and van Wee (2010), different transport modes have very different CO_2 emission intensities for comparable distances and equivalent transport loads. Figure 3 shows that the best alternative for moving 1000 containers from Rotterdam to Gdansk in terms of CO_2 emission is by train propelled by electricity generated by nuclear energy (75 tons of CO_2), followed by train propelled by electricity generated by diesel combustion (470 tons) and by sea (475 tons). The worst solutions are by trucks (1000 tons) or by train propelled by electricity generated by coal and oil combustion (1300 tons).

Our main variable of interest is related to distance. This geographical variable mainly captures the existence of a threshold between the level of use of road/train and sea transport in which, According to the geographic situation of a particular country (being far from or close to its commercial partners) and the directionality of its trade, the level of CO_2 emissions might be reversed.

3. Empirical Strategy

In this section we specify the empirical model by following a framework similar to Copeland and Taylor (2004), Cole and Elliott (2003) and Managi et al. (2009). These empirical investigations of the determinants of pollutants breakup emissions into scale, technique and composition effects. The considered pollutant varies from one study to another. Antweiler al. (2001) test for SO_2 concentrations. Cole and Elliott (2003) extend the same framework to NOx, CO2 and Biochemical Oxygen Demand (BOD), the last being a water pollutant whereas SO2, NOx and CO2 are air pollutants. Finally, Managi et al. (2009) included CO_2, SO_2 and BOD in their study.

The basic estimated model is given by:

$$\ln(Em_{it}) = \alpha + \beta_1 S_{it} + \beta_2 S_{it}{}^2 + \beta_2 KL_{it} + \beta_3 KL_{it}{}^2 + \beta_4 S_{it} KL_{it} + \beta_5 Open_{it} + \beta_6 Open_{it}.rKL_{it}$$
$$+ \beta_7 Open_{it}.rKL_{it}^2 + \beta_8 Open_{it}.rS_{it} + \beta_9 Open_{it}.rS_{it}^2 + \beta_{10} Open_{it}.rKL_{it}.rS_{it} + trend + \varepsilon_{it} \quad (1)$$

where:

[2] Bunker maritime fuel is also used by passenger ships and military vessels. For example, according to Bruss and Barbour (1998), the military consumption of bunker fuel by the U.S. navy represent 9% of the total U.S. consumption of international maritime bunker fuel.

Em_{it} denotes a pollution measure for country i in year t. This variable can be defined as emissions per capita (emissions/population), emissions intensities (emissions/GDP) or concentrations. In this paper we focus exclusively on CO_2 emissions per capita.

S_{it} is per capita real GDP for country i in year t whereas rS_{it} is the same variable expressed in relative terms (with respect to the world average).

KL_{it} denotes a country's capital-labor ratio whereas rKL_{it} is the same variable expressed in relative terms (with respect to the world average).

$Open_{it}$ denotes openness ratio for country i, year t. This ratio is represented by the sum of exports and imports over GDP.

$trend$ is a linear time trend.

ε_{it} is a two component error term containing a time invariant and an idiosyncratic term .

Concerning the interpretation and expected signs, S_{it} represents the effect of income and production on emissions. It is intended to capture the scale effect. The quadratic term is expected to capture the Environmental Kuznets Curve (EKC) hypothesis (Grossman and Krueger 1993). The EKC states that there is an inverted-U-shaped relation between income and environmental quality: growth harms the environment at low levels of development and helps it in more advanced stages. One of the main explanations of the shape of the EKC is that it reflects changes in demand for environmental quality as income rises. At low income levels, pollution rises with growth because increased consumption is preferred to environmental quality. As income increases, the willingness to pay for environmental quality rises, and increasingly large sacrifices in consumption are made to provide greater environmental benefits.

Trade intensity ($Open_{it}$) is included as a measure of trade frictions in order to test for the trade induced composition effect.

In addition, a country's relative capital-labor ratio (KL_{it} and rKL_{it}) is included in order to capture the effect of comparative advantage. A country's comparative advantage is a major factor influencing the composition effects. A capital-abundant country will specialize in capital-intensive production, whereas a labor-abundant country has a comparative advantage in labor-intensive goods. Hence, a country with a higher capital-labor ratio tends to have higher emissions because capital-intensive goods are associated with higher emissions.

Moreover, an increase in trade encourages an increase in the production of capital-intensive goods in countries with a comparative advantage in these goods and a decrease in the production of capital-intensive goods in countries with a comparative disadvantage. This is captured by the interaction terms between relative capital-ratio and openness.

Trade intensity is also incorporated with relative per capita income to test for the environmental regulations and the PHH: a country with relatively more stringent regulations has a comparative disadvantage in capital-intensive goods because production would be constrained by these regulations. Since countries with a comparative advantage in capital-intensive goods also have stringent environmental regulations the environmental regulations' effect may reverse the effect of factor endowments. As a consequence, the comparative advantage could be weakened and emissions would decrease in high income countries. The interaction term $S_{it}.KL_{it}$ reflects this effect.

Finally, an increase in trade might encourage a shift in the production of capital-intensive goods from countries with more stringent environmental regulations (higher income countries) to countries with less stringent environmental regulation (lower income countries). This effect is captured by the interaction terms that contain rS_{it} .

After estimating the same model as in the previously cited papers, we extend it by including a Remoteness index, which is our main variable of interest. This index is a weighted average of the distance of country *i* with its trade partners (d_{ij}):

$$\text{Remoteness}_{it} = \sum_{j=1..n} (\alpha_{ijt} d_{ij}) \qquad (2)$$

The weights are defined as the shares of the different trading partners $\left(\alpha_{ijt} = X_{ij} \Big/ \sum_j X_{ij} \right)$ in the country *i* exports. Hence, the more the country *i* exports to remote countries, the higher the remoteness index.

The augmented model is then given by:

$$\begin{aligned} \ln(Em_{it}) &= \alpha + \beta_1 S_{it} + \beta_2 S_{it}^2 + \beta_3 KL_{it} + \beta_4 KL_{it}^2 + \beta_5 S_{it} KL_{it} + \beta_6 Open_{it} + \beta_7 Open_{it}.rKL_{it} + \\ &+ \beta_8 Open_{it}.rKL_{it}^2 + \beta_9 Open_{it}.rS_{it} + \beta_{10} Open_{it}.rS_{it}^2 + \beta_{11} Open_{it}.rKL_{it}.rS_{it} + \beta_{12} \ln(\text{Remoteness})_{it} + \\ &+ \beta_{13} \ln(\text{Remoteness})_{it}^2 + trend + \varepsilon_{it} \end{aligned} \qquad (3)$$

We hypothesize that the Remoteness index could have two competing effects:

A distance effect: If the distance between an exporting country and its partners increases, emissions will also increase. All things being equal (technique of transport, mode of transport, scale of the vessel), every kilometer induces an increase in pollution emissions.

A transport sector effect: When distances increase, transport companies will use bigger vessels and less energy-intensive modes and techniques of transport. Those are expected to induce less emissions if we consider a per unit index (by volume).

The Remoteness index will have a significant positive (negative) effect on the exporting country's emissions if the distance effect is higher (lower) than the transport sector effect. Moreover, we include the square of the variable *Remoteness* in order to test for a quadratic relation with emissions.

4. Data, Stylized Facts and Econometric Results

Our framework is first implemented for the largest sample of available countries (149). Second, it is implemented for different country groups: OECD, non-OECD, Middle East and North African (MENA), OPEC-MENA, countries and non-OPEC MENA countries.[3] Annual data, from 1986 to 2003 is used. Real GDP and openness are from Penn World Table (PWT 6.3). Capital-Labor ratios are from Extended Penn World Tables and CO_2 emissions are from World Development Indicators (World Bank). As for the remoteness variable, distances are from CEPII (www.cepii.fr) and market shares are calculated from COMTRADE (United Nations).

Figure 4 shows the time evolution of per capita CO_2 emissions for the different groups. Not surprisingly, OECD countries show the highest levels of CO_2 emissions. They are followed by Middle-East OPEC countries. Per capita CO_2 emissions are less important in non-oil exporting Middle-East countries. Interestingly, a different time evolution of CO_2 emissions is observed for OPEC and other groups. Oil price evolution is most probably the main reason.

In Figure 5, we display some stylized facts on the relation between our Remoteness index in logarithms (lconnect) and the logarithm of CO_2 emissions. In the enlarged sample, it seems that the relation is negative (albeit with a smooth trend) for MENA and OECD countries,

[3] MENA is defined as the Arab world, Turkey and Iran (see Table 4 in appendix for a list of countries belonging to each group).

however the relation does not seem to be significant. for MENA non-oil-exporting countries and non-OECD countries, we can expect a significant negative relation between the geography of international trade and CO_2 emissions. Finally, the case of oil-exporting countries seems to be very particular since the relation is clearly positive.

These early conclusions are only stylized facts and need to be confirmed by the econometric study described below.

Column (1) in Table 1 shows the results for the benchmark model given by equation (1) without the remoteness variable. We find the expected results: real GDP has a positive effect of CO_2 emissions and its square has a negative effect. This result confirms the EKC hypothesis: emissions increase with income but only up to a certain level, after which they decrease.

The capital-labor ratio also has a positive effect: CO_2 emissions increase for countries with a comparative advantage in capital-intensive goods. This is also an expected result since capital-intensive goods are associated with higher emissions. On the other hand KL^2 has no significant effect.

The interaction between real GDP per capita and capital-labor ratio has a negative significant effect confirming that countries with a comparative advantage in capital-intensive goods have more stringent environmental regulations. The effect of comparative advantage is reversed by the stringency of environmental regulations.

Trade openness, which describes trade frictions, has a positive and significant effect on emissions. The interaction between openness and capital-labor ratio has an unexpected negative effect: trade liberalization in capital-abundant countries leads to a decrease in CO_2 emissions. With respect to environmental stringency, when interacted with trade openness, it also has a negative (although not always significant) effect (more stringent environmental regulations lead to a decrease in pollution emissions when countries trade more).

Column (2) in Table 1 shows that when including The variable Remoteness in the regression, this variable presents a significant negative effect, thus indicating that trade with remote countries has a significant negative impact on CO_2 emissions. Consequently, the abovementioned "transport sector" effect seems to dominate the "distance effect". Transport companies use bigger vessels or/and less energy-intensive techniques and modes of transport. However, when estimating equation (2) and then, the quadratic term of the variable remoteness is included, the relation becomes non-linear as $Remoteness^2$ has a significant positive effect. Therefore, for longer distances, the distanceeffect dominates and remoteness has a positive effect on emissions.

In Table 2, we estimate equation (2) for each country group separately. The results for non-OECD countries are the same as for the whole sample in Table 1: *S, KL, Open, Open.rKL.rS* have a positive significant effect, whereas S^2, KL^2, *KL.S, Open.rKL* and *Remoteness* have a negative significant effect. The variable $Remoteness^2$ also has a positive sign. for MENA countries, the coefficient of Remoteness is not statistically significant. Since this result is an average effect, we split the sample in two groups containing oil -exporting countries (OPEC) and non-OPEC countries. Results are shown in columns (4) and (5) of Table 2 and indicate that for OPEC countries, the coefficient is significantly positive indicating that trading with closer partners decreases CO_2 emissions and the distance effect is higher than the transport-sector effect up to a certain level[4]. Whereas for non-oil-exporting MENA countries, Remoteness ($Remoteness^2$) has a significant negative (positive) effect, thus indicating that

[4] This interesting result may be explained by the use of pipelines to transport oil and gas from this region to neighboring countries. Pipelines emit less than supertankers but are expensive to build particularly if they have to cross large seas. As distance increases, supertankers are used to transport these two products.

shorter distances are at first associated with higher emission levels (the transport sector effect dominates short distance travel), then that relationship is reversed as the distance increases between trading partners (the distance effect dominates long distance travel).

5. Conclusions

This paper argues that, in addition to the scale, composition and technique effects cited in the literature, the geography of trade flows does in fact matter in explaining the impact of international trade on the environment. Indeed, since transport activity is also a source of pollution, trading with close countries does not have the same implications as trade with remote ones. However, the geographic distance effect can be offset by the use of different techniques, modes, and scale of transport: when distances increase, transport companies are expected to use less energy-intensive modes, techniques and scales of transport.

Testing these hypotheses for CO_2 emissions for a large sample of countries, as well as for different economic groups, we show that the relationship is non-linear. Indeed, an increase in distance first decreases CO_2 emissions but only up to a certain level. for long distances, the relation is reversed. However, this result is not found for OECD countries, with high CO_2 emissions levels.

The case of MENA countries is particularly interesting since the effect of Remoteness differs across countries within the country-group. In oil-exporting countries, where CO_2 emissions are high due to low energy prices, trading with closer partners decreases CO_2 emissions and the distance effect is higher than the transport-sector effect up to a certain level. However, for the non-OPEC MENA countries, shorter distances are at first associated with higher emission levels (the transport sector effect dominates short distance travel), then that relationship is reversed as the distance increases between trading partners (the distance effect dominates long distance travel).

This paper underlines the possible high costs in terms of CO_2 emissions of global trade as opposed to regional flows. Although polluting emissions are logically expected to increase with distance, this paper shows that the link between distance and CO_2 emissions is more subtle. The transport sector is important for completing the picture and needs to be considered.

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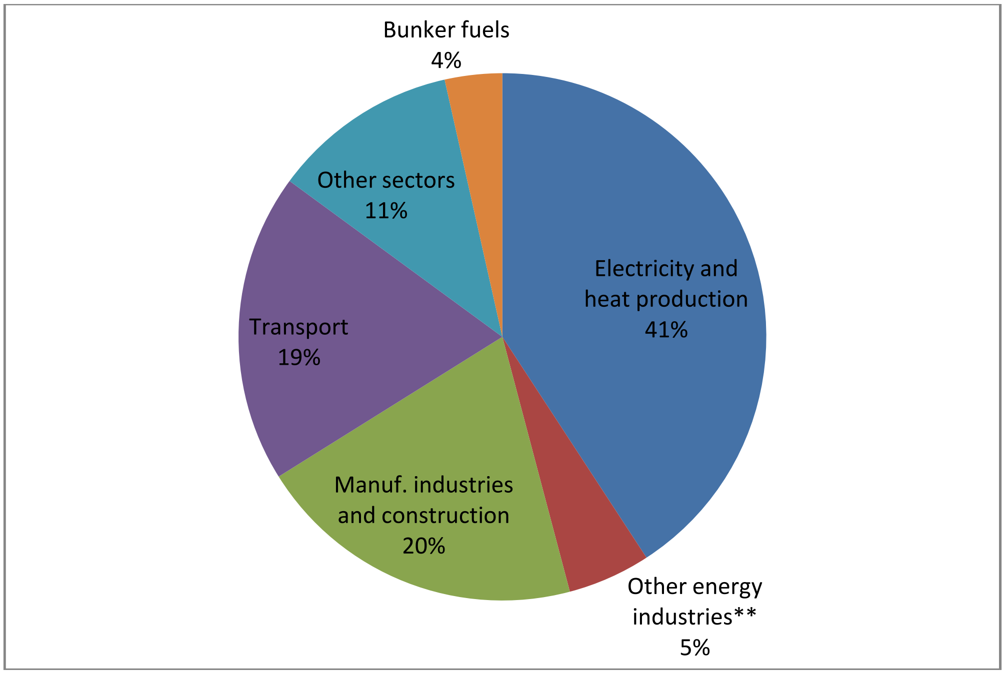
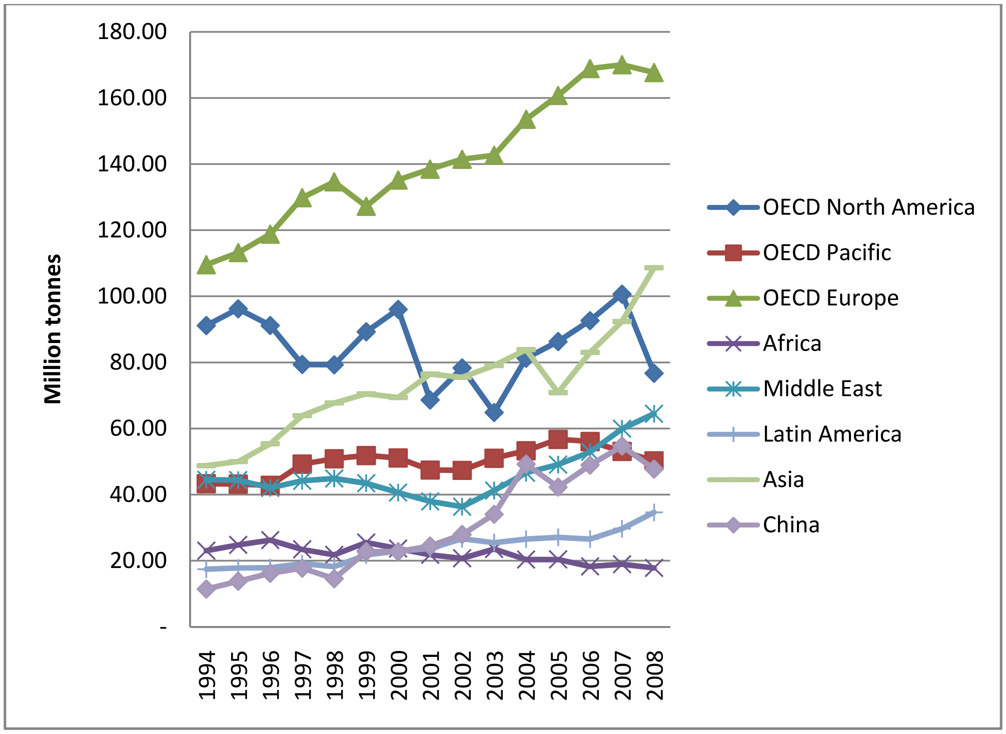
Figure 1: Total CO_2 Emissions by Sector of Origin in 2008



Source: CO_2 Emissions from Fuel Combustion (2010 Edition), International Energy Agency, IEA, Paris.

Figure 2: Evolution of Maritime Bunker Emission



Source: CO_2 Emissions from Fuel Combustion (2010 Edition), International Energy Agency, IEA, Paris.

Figure 3: CO_2 Emitted by Seven Alternative Modes of Transport to Move 1000 Containers From Rotterdam To Gdansk

	alt1	alt2	alt3	alt4	alt5	alt7
Transport Mode	Truck	Train powered by Diesel	Train powered by EU mix	Train powered by Coal/oil mix (50/50)	Train powered by Nuclear Energy	Short See Shipping
Tons of CO2 emitted	> 1000	> 450	> 700	> 1300	>75	> 475

Source: Kim and van Wee (2010)

Figure 4: Evolution over Time of CO_2 Emissions for Different Country Groups

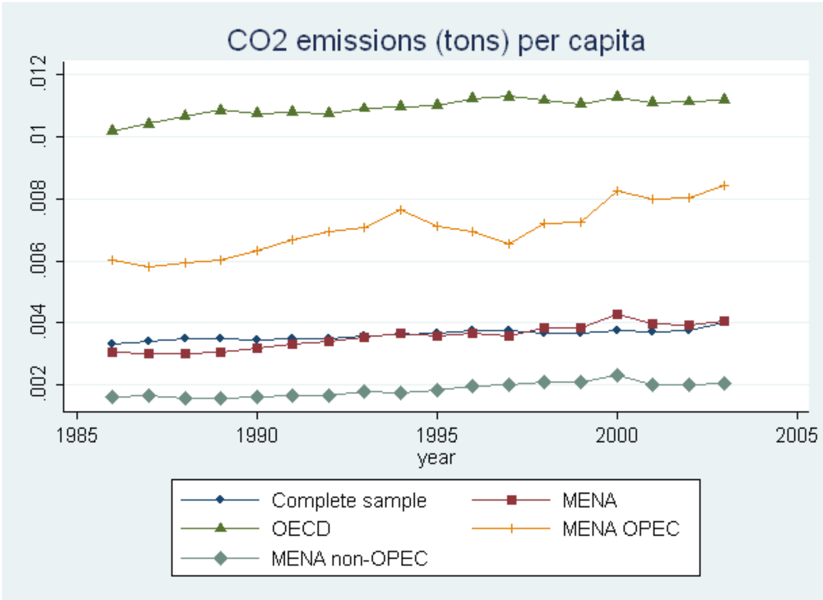


Figure 5: Remoteness Index and CO_2 Emissions (by country)

Table 1: Main Results (Extended Sample)

	[1]	[2]	[3]
S	.000131***	.0000732***	.000074***
	8.67	7.84	7.95
S²	-6.61e-10***	-3.93e-10***	-4.24e-10***
	-3.93	-4.13	-4.45
KL	.145***	.19***	.183***
	3.01	6.53	6.3
KL²	.000559	-.00201	-.0018
	.133	-.891	-.798
KL.S	-7.62e-06***	-5.79e-06***	-5.65e-06***
	-5.05	-6.95	-6.8
Open	.00497***	.00311***	.00311***
	7.25	5.3	5.32
Open.rKL	-.000331	-.00238***	-.00229***
	-.341	-4	-3.85
Open.rKL²	-1.04e-06**	4.35e-08	-1.67e-08
	-2.28	.157	-.0605
Open rS	-.0066***	-.000956	-.00104
	-5.65	-1.1	-1.2
Open.rS²	2.87e-06***	-4.61e-07	-2.67e-07
	3.12	-.788	-.457
Open.rKL.rS	.000909***	.000659***	.000634***
	4.55	4.82	4.65
Trend	.0047***	.0105***	.0108***
	2.64	8.08	8.37
lRemoteness		-.0468*	-2.83***
		-1.87	-3.78
lRemoteness²			.109***
			3.72
Constant	-.879***	.259	17.9***
	-10.8	.787	3.76
R^2	0.126	0.340	0.345
Groups	149	141	141
N	2446	1830	1830

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. The corresponding t-statistic is reported below each coefficient

Table 2: Estimation Results (by country group)

	OECD	non OECD	MENA	MENA OPEC	MENA Non OPEC
S	.0000529***	.0000916***	.0000999***	.0000126	.000214*
	3.38	8.24	2.76	.248	1.83
S^2	2.25e-10	-6.80e-10***	-5.10e-10	1.75e-10	-5.66e-11
	.529	-6.12	-1.65	.434	-.0116
KL	.174***	.282***	-.0817	.302	-.19
	4.34	7	-.874	1.35	-.472
KL^2	.00486	-.0107***	.0102	-.0184	.155**
	1.1	-2.88	.813	-1.07	2.2
KL.S	-7.28e-06***	-5.13e-06***	-5.79e-06**	-9.60e-06**	-.0000669
	-2.84	-4.25	-2.2	-2.51	-1.49
Open	-.00271*	.00326***	-.00278	-.0175***	.000511
	-1.89	4.8	-1.41	-2.83	.127
Open. rKL	-.00324***	-.0023***	.00552**	.00554	.0119
	-3.5	-3.14	2.44	1.57	.909
Open. rKL^2	2.89e-06***	1.71e-07	-2.49e-06*	-8.56e-07	-.0000556
	3.28	.52	-1.7	-.458	-1.07
Open. rS	.00308*	-.000348	-.000809	.0124**	-.00838
	1.76	-.317	-.21	2.08	-.584
Open. rS^2	-4.65e-06***	-4.97e-07	-4.74e-08	-.0000135**	.000026
	-3.81	-.67	-.0114	-2.09	.446
Open. rKL.rS	.000304	.000532***	-.000317	.0003	-.000394
	1.11	2.93	-.637	.364	-.0536
Trend	-.00265	.0132***	.0155***	.0579***	.00921
	-1.03	8.99	4.36	3.58	1.42
lRemoteness	-.475	-3.11***	-2.37	6.25*	-5.96**
	-.294	-3.74	-1.18	1.75	-2.25
$lRemoteness^2$	.0208	.12***	.0968	-.23*	.236**
	.324	3.67	1.24	-1.68	2.3
Constant	3.48	19.2***	14.9	-41.5*	37.1**
	.342	3.64	1.15	-1.77	2.18
R^2	0.509	0.409	0.510	0.675	0.517
Groups	32	109	18	7	11
N	513	1317	239	89	150

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. The corresponding t-statistic is reported below each coefficient

Table 3: Countries Included in the Enlarged Sample

Afghanistan	Comoros	Honduras	Mozambique	Slovakia
Algeria	Congo	Hungary	Namibia	Slovenia
Argentina	Costa Rica	Iceland	Nepal	Solomon Isds
Australia	Croatia	India	Netherlands	Somalia
Austria	Cuba	Indonesia	New Zealand	South Africa
Bahamas	Cyprus	Iran	Nicaragua	Spain
Bahrain	Czech Rep.	Iraq	Niger	Sri Lanka
Bangladesh	Côte d'Ivoire	Ireland	Nigeria	Sudan
Barbados	Denmark	Israel	Norway	Suriname
Belgium	Dominica	Italy	Oman	Swaziland
Belize	Dominican Rep.	Jamaica	Pakistan	Sweden
Benin	Ecuador	Japan	Panama	Switzerland
Bhutan	Egypt	Jordan	Papua New Guinea	Syria
Bolivia	El Salvador	Kenya	Paraguay	TFYR of Macedonia
Botswana	Estonia	Kuwait	Peru	Thailand
Brazil	Ethiopia	Laos Rep.	Philippines	Togo
Brunei Darussalam	Fiji	Liberia	Poland	Trinidad and Tobago
Burkina Faso	Finland	Libya	Portugal	Tunisia
Burundi	France	Luxembourg	Qatar	Turkey
Cambodia	Gabon	Madagascar	Rep. of Korea	USA
Cameroon	Gambia	Malawi	Romania	United Arab Emirates
Canada	Germany	Malaysia	Russian Federation	United Kingdom
Cape Verde	Ghana	Maldives	Rwanda	Tanzania
Central African Rep.	Greece	Mali	St Vincent & the Grenadines	Uruguay
Chad	Grenada	Malta	Saudi Arabia	Venezuela
Chile	Guatemala	Mauritania	Senegal	Viet Nam
China	Guinea	Mauritius	Seychelles	Yemen
China, Hong Kong SAR	Guinea-Bissau	Mexico	Sierra Leone	Zambia
China, Macao SAR	Guyana	Mongolia	Singapore	Zimbabwe
Colombia	Haiti	Morocco		

Table 4: Countries Included in the Split Sample

OECD		**MENA**	
		OPEC	**Non-OPEC**
Australia	Luxembourg	Algeria	Comoros
Austria	Mexico	Bahrain	Egypt
Belgium	Netherlands	Iran	Jordan
Canada	New Zealand	Iraq	Mauritania
Chile	Norway	Kuwait	Morocco
Czech Rep.	Poland	Qatar	Oman
Denmark	Portugal	Saudi Arabia	Somalia
Finland	Rep. of Korea	United Arab Emirates	Sudan
France	Slovakia		Syria
Germany	Slovenia		Tunisia
Greece	Spain		Turkey
Hungary	Sweden		Yemen
Iceland	Switzerland		
Ireland	Turkey		
Israel	USA		
Italy	United Kingdom		
Japan			