









Trade and Climate Change: Leaking Pledges

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International climate policy is rapidly approaching the end of the first period of emission reduction commitments agreed upon in the Kyoto Protocol in 1997. This protocol aimed to reduce global greenhouse gas (GHG) emissions. In particular, the so-called Annex I countries (most OECD countries and the former Soviet Union) agreed upon a reduction of their GHG emissions by five percent in 2012, compared to 1990 emissions. The Protocol did not impose reductions outside Annex I and the coverage of worldwide emissions was reduced to an even lower level than agreed upon in Kyoto, when the United States refused to ratify it. At the time of its negotiation the Kyoto protocol made a lot of sense. Back in 1997 Annex I countries were collectively responsible for 76 percent of global GDP, 71 percent of the world's trade flows and 60 percent of global CO_2 emissions.

Today the world is a very different place. The global economy has changed considerably since 1997. National economies have become increasingly integrated in the international economy through increased trade, foreign investment and capital flows. Over the past decade fast developing countries such as China and India have contributed to export driven GDP growth at a pace that is almost unparalleled in economic history. As a consequence Annex I countries were responsible for 65 percent of global GDP, 61 percent of the world's trade flows and only for 44 percent of global CO_2 emissions in 2009. These changes in the world economy have complicated negotiations on a successor to the Kyoto Protocol enormously. This became very clear when the world gathered together to negotiate this successor in Copenhagen in 2009 and again in Durban in 2011, where agreement was reached to draw up a legal framework by 2015 for climate action by all countries.

Thus the world seems to be left with pledges made by countries around the Copenhagen meeting about the emission reductions they are willing to implement. For instance, the EU offered to reduce its GHG emissions by up to 30 percent if other countries would be willing to contribute their share. Otherwise the EU declared itself willing to stick to its current commitment of 20 percent. Other countries also expressed their willingness to reduce emissions, but whether they will actually do so or not remains to be seen. This is illustrated by the difficult process of introducing CO_2 emission trading in the US, where the Kerry-Lieberman bill on emission trading stranded in the US senate. In Copenhagen, several non-Annex I countries have also indicated emission reduction targets. For China and India, there are, however, intensity targets that cap emissions per unit of GDP. Therefore their amount of absolute emissions depends on economic growth. Moreover, these objectives are set at such levels that it remains to be seen whether these intensity targets will become binding at all. Without binding targets outside Annex I, climate policies will only comprise less than half of worldwide emissions.

This lack of a comprehensive global climate change agreement raises concerns regarding the competitiveness and environmental effectiveness of unilateral climate change policies. Competitiveness can be affected because firms from countries with binding targets face higher costs due to climate change policies, while firms in countries without comparable policies face no or lower cost increases. The magnitude of the cost increase depends mainly on the CO_2 intensity of production, which is directly related to

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energy intensity. Firms in energy intensive sectors such as the iron and steel sector, aluminum, cement and fertilizer are therefore more at risk than firms in other sectors. Whether the cost increase will reduce sales also depends on the openness of the sector to trade with countries outside Annex I. Iron and steel and aluminum are sectors that operate in a global market, with ample competition from countries without binding limits. Such firms find it harder to pass on their higher costs. Electricity markets, on the other hand, are almost completely sheltered, with very limited connections to producers in countries without binding limits. Power companies can therefore pass on their carbon costs more easily to their customers. The power generators within the EU, for example, simply included the price of the CO_2 allowances in the electricity price.

In this policy brief we quantify the concerns about competitiveness and trade by analyzing the welfare impacts of current 'unilateral' pledges, i.e. the emission reductions that countries are willing to implement without a global agreement, as well as some complementary measures to reduce potential adverse impacts. Our focus is on the EU in particular because the EU has pledged the largest reductions of GHG even in the absence of a global agreement. We use the applied general equilibrium model of the world economy WorldScan, which is calibrated to the most recent data and to a post-crisis baseline.

Our findings are remarkable. This study shows the relocation concerns of energy-intensive production to be exaggerated. In fact, we find only limited leakage due to relocation of these sectors or to shifts in the carbon intensity of imports and exports. Nevertheless, we still find considerable leakage reducing the effectiveness of the pledged reductions in Annex I and these carbon leakage rates are considerably higher compared with earlier studies. This leakage arises from the indirect effect of lower fossil fuel prices due to the carbon constraint in the countries imposing pledges. Accordingly fossil fuel usage in countries without absolute emission ceilings will rise due to the pledged reduction in Annex I and this impact is remarkably large. Moreover, some of the complementary measures to prevent leakage, such as Border Measures, only have a limited effect. Carbon border measures do not noticeably affect overall carbon leakage because they do not affect the fossil fuel price channel, which is the main cause for the overall leakage.

Background

Differences in climate change policies not only have an impact on competitiveness and trade, but may also increase emissions in regions with no or less ambitious climate change policies. Three main reasons explain this so-called carbon leakage. Firstly, imports of carbon intensive products from countries without carbon policies are likely to increase, whereas exports of these products will suffer in countries with carbon policies. Secondly, carbon leakage might occur due to relocation of production from countries with high carbon costs to countries with low or no carbon costs. In the longer run, investments in new or replacement plants may move to low carbon cost countries. Thirdly, climate policies will reduce global demand for fossil fuel, which will cause fossil fuel prices to fall. This, in turn, should increase demand for fossil fuels and raise CO_2-emissions in those countries that do not have a binding limit on those emissions. These different types of carbon leakage reduce the global effectiveness of emission reductions in those countries that impose CO_2controls unilaterally.

Competitiveness and trade effects strongly depend on the extent to which carbon costs increase, which, in turn, also depends on the design of the policy instrument used to reduce greenhouse gases. The main carbon policy initiative in the world to date is the European Union Emission Trading Scheme (EU ETS) for CO_2 emissions in the energy intensive sectors within the EU. This EU ETS caps CO_2 emissions and thereby creates a pricing scheme for CO_2 emissions. Firms within the EU ETS need allowances to cover their emissions. Such allowances could either be auctioned or handed out for free based on historic emissions. In the last case, called grandfathering, firms do not have to pay for the allowances. Even if the allowances are received for free, however, opportunity costs arise because firms might also sell the allowances in the market instead of using them. Therefore costs also increase with grandfathering. While grandfathering reduces the out-of-pocket costs compared to auctioning or a tax, it does not alter a firm's decision at the margin. Marginal costs increase, whether allowances are allocated for free or auctioned. Firms which maximize profits will still pass-through much of the opportunity costs, realizing profits at the expense of some loss of market share (Smale et al. 2006). Grandfathering is therefore of limited use in protecting firms from foreign competition, because

marginal costs still increase (Grubb and Neuhoff 2006).

Several complementary measures can be imposed to alleviate the impact of unilateral action, like EU ETS, on competitiveness and leakage. We evaluate output based allowance allocation (OBA), the use of the clean development mechanism (CDM) and Border Measures (BM). If allowances are allocated on the basis of the output produced by a firm, the allocation also has a subsidy effect equal to the value of the number of allowances allocated per unit of output. This subsidy partly offsets the cost increase due to the allowance price. The entrance and closure provisions in the EU ETS, with free allocation to new firms and the obligation to surrender allowances received for free in case of plant closure, has a comparable effect. This provides an incentive to expand production capacity in order to obtain additional, valuable emission rights. The additional capacity results in additional pollution, which must be reduced by other, less efficient measures. Furthermore, companies that invest in additional capacity for a coal fired power plant receive valuable emission rights whereas companies investing in wind power do not. These rules induce excessive investment in relatively dirty capacity.

Another option to alleviate the cost of unilateral action is to allow the use of emissions reduction credits generated by CDM projects. CDM projects are emission reduction projects in countries without emission targets. Under the Kyoto protocol emission reductions credits produced by CDM projects can be used by Annex I countries to meet their emission targets and by firms in the EU ETS to cover their emissions instead of using ETS allowances. Emission reduction credits are attractive for these firms because of the relatively low costs of reducing emissions in non-Annex I countries. EU use of CDM credits reduces the costs of emission reduction and therefore also diminishes the effect of EU ETS on competitiveness and carbon leakage. The drawback of CDM, however, is a subsidy effect in the host countries, where dirty sectors may expand because of the CDM transfer. This effect is similar to the effect of output based allocation of allowances in the EU ETS.

Finally, the use of border measures (BM) also helps to shelter firms from non-Annex I competition. BM impose a carbon levy on imports and may also provide a rebate on exports. Such a levy or rebate will be based upon the carbon emissions released in the production process of the dirty products. Determining the exact emissions brought about in producing a specific product can be daunting, especially for imported goods. Instead, estimates can be used based, for example, on emission benchmarks which are being developed by the EU for the allocation of ETS allowances. Making the lifting of BM conditional to participation into the international agreement means that they can also be used as a strategic instrument to encourage this participation.

Baseline and policy scenarios

To assess the effects of the pledges and different policy instruments on economic welfare, carbon and production leakage and emissions in 2020 we measure policy impacts relative to a baseline scenario. Our business-as-usual scenario does not assume new climate and energy policies and follows the World Energy Outlook (WEO) (IEA 2009). However, we remove the ETS-caps from the WEO in order to establish a level playing field for our assessments of the mitigation pledges in an international context. So we simply assume in our baseline that there is no emission trading in the EU after 2012 and no renewable energy target that increases the use of renewable energy above the level to be expected with current policies.

According to our baseline, global population will continue to expand. Combined with worldwide economic growth of 2.7 percent per year global demand for energy will be almost 30 percent higher in 2020 compared to 2004. This expansion predominantly takes place in non-Annex I, thus partially reducing the gap in energy consumption per capita with the industrialized countries.

In the baseline, energy- and GHG-intensities are declining worldwide, and especially in non-Annex I. Fossil fuel prices are expected to rise with oil reaching a price of $100 per barrel in 2020. In Europe the gas price is expected to lag behind the oil price. Regional coal prices are expected to remain constant at their 2009 level. This baseline takes into account the consequences of the financial crisis and the subsequent recession for the level of economic activity, and also reflects continuing globalization of the world economy.

To assess the impact of EU climate policy on competitiveness and trade we have analyzed two main variants of pledges. The first variant refers to the pledges that were made at negotiations up to and after the summit in Copenhagen, see Table 1. These so called AMBITIOUS PLEDGES are conditional to other countries also implementing sufficiently ambitious emission reductions, such as the EU target of 30 percent emission reduction compared to 1990 emissions. For this variant we assume emission trading to be allowed between all Annex I countries and between all sectors in these countries. As a result, one common CO_2 price will exist in all sectors of all Annex I countries. Within the EU the distinction between ETS and non-ETS sectors will no longer prevail.

The second variant, simply labeled PLEDGES, reflects the emission reduction targets that countries have indicated that they will adopt even when they judge the reduction targets of the other major emitting countries to be insufficient. China and India have also announced national climate change policies. However, according to our baseline analysis, these targets will largely be met even without climate policies and will therefore not become binding. Moreover, emission trading is restricted in the PLEDGES scenario because of the assumption that no permit trade between countries will occur. In the EU, however, trade in CO_2 allowances is possible among firms within the EU ETS sectors, and governments can trade their emission reductions from sectors not covered by the EU ETS. Accordingly, two different carbon prices exist within the EU, one for the EU ETS sectors and one for households and the non-ETS sectors. Table 1 summarizes the emission reduction targets for both the ambitious and modest pledges of the major Annex I countries.

Table 1
Pledged emission reduction targets for selected countries (in %)

	Ambitious pledges Emissions 2020 compared to baseline 2020	Pledges Emissions 2020 compared to baseline 2020
Annex I	-14	-7
EU-27	-29	-21
Russia	3	17
USA	-12	-12
Japan	-18	-18
Australia	-37	-20

Source: Bollen, Koutstaal and Veenendaal (2011).

To study the impact of optional complementary measures, like OBA, CDM and BM, we take the PLEDGES scenario as point of departure. In the scenario PLEDGES WITH OBA we simulate a variant where free allocation of allowances amounts to a subsidy being given on production costs of five percent of the value of the grandfathered allowances. This subsidy more or less reflects the effect of the entry provision in the ETS, which is equal to a reserve of five percent of all allowances that is marked for free allocation to new firms. In PLEDGES WITH CDM firms within the ETS are allowed to use CDM emission reduction credits up to one third of their reduction effort. We have assumed that this limit also applies to other non-Annex I countries. The non-ETS sectors have a ceiling of three percent of their 2005 emissions for the use of CDM-credits. Finally, the PLEDGES WITH BM variant includes a carbon levy on imports and a refund on exports for the energy intensive manufacturing sector. The levy and rebate are based on direct and indirect CO_2 emissions of EU production and the level of the carbon price.

Results: costs and welfare

The carbon emission reductions pledged by Annex I countries (as shown in Table 1) put a burden on the economy. Figure 1 presents the welfare effects[1] for the different policy scenarios compared to the baseline scenario. As expected, the welfare effects for the world are largest for the AMBITIOUS PLEDGES scenario. Interestingly, the difference with the PLEDGES scenario is very small. Although the emission reduction target of PLEDGES is only half of the reduction target of AMBITIOUS PLEDGES, the extra loss of global economic welfare is only 0.03 percent of national income in the baseline.

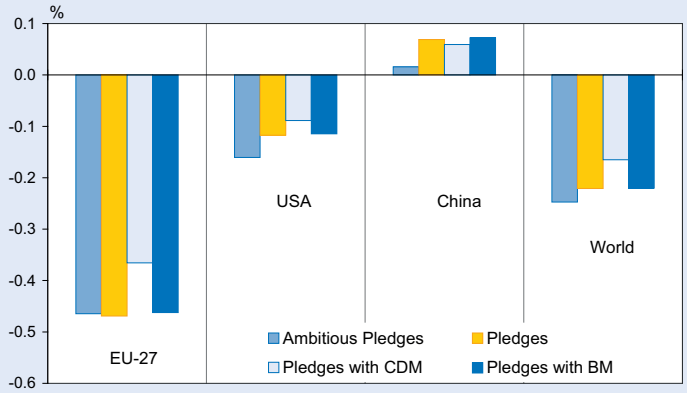
Apparently the possibility for global emission trading reduces abatement cost for CO_2 to the extent that it is possible to double the reduction in worldwide emissions for the same welfare burden. Indeed, the CO_2 price in AMBITIOUS PLEDGES is only EUR nine per ton CO_2 in

[1] Measured in terms of equivalent variation as percent of national income in the baseline.

2020, whereas the (differentiated) CO_2 prices in the PLEDGES case are (much) higher. In the PLEDGES scenario emission trading is restricted to the EU countries, separately within the EU ETS and between governments that can trade in non-ETS targets. We find that the ETS price for this scenario is EUR 31 per ton CO_2 versus EUR 11 per ton CO_2 in the non-ETS sectors. Other Annex I countries face CO_2 prices that range from EUR 12 to EUR 51 per ton CO_2.

Figure 1

WELFARE EFFECTS COMPARED TO THE BASELINE IN 2020



CMD = Clean Development Mechanism, BM = Border Measures.
Source: Bollen, Koutstaal and Veenendaal (2011).

In terms of global distribution of welfare costs it is hardly surprising that the EU welfare loss is considerably higher compared to other regions like the USA in both scenarios, as the EU pledge is much more stringent. With its non-binding pledge China even benefits from the binding commitments in the Annex I regions. Whereas the welfare gain is small in the AMBITIOUS PLEDGES variant, China faces considerably larger welfare gains in the unilateral policy scenario. Looking at the welfare effects for the complementary policy variants, the PLEDGES WITH CDM scenario clearly offers a welfare improving alternative for the Annex I countries relative to the unilateral PLEDGES scenario. As explained before, CDM facilitates the use of relatively low cost emission reduction options in non-Annex I countries. Indeed, the carbon price of EUR nine in the EU ETS and EUR six in the non ETS sectors in the EU is substantially lower than in PLEDGES. The same holds for carbon prices in other Annex I countries, where these prices are about 20–50 percent lower.

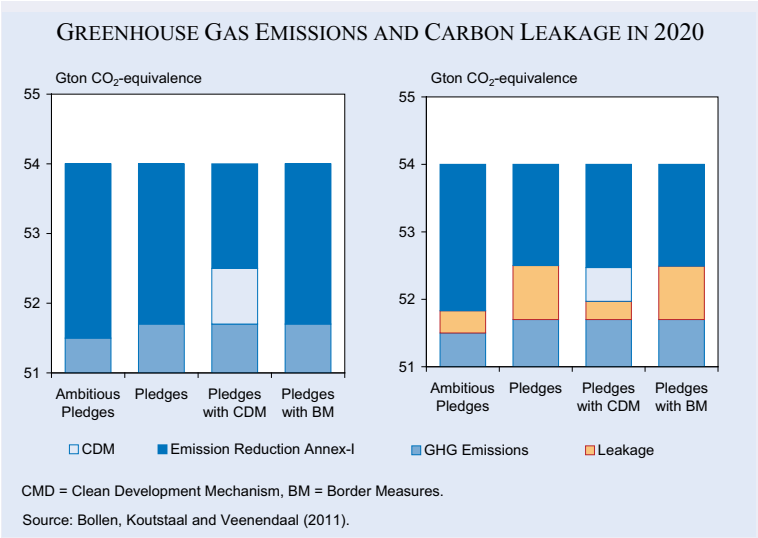
However, we do not find similar impacts for the alternative complementary policies, PLEDGES WITH OBA and PLEDGES WITH BM. The differences between PLEDGES WITH OBA and PLEDGES are negligible. Hence, we do not show the effects for this scenario separately. The reason is that the production cost subsidy in PLEDGES WITH OBA scenario is too small to change the results noticeably. In the PLEDGES WITH BM the differences in welfare with PLEDGES are small. Apparently the price in the EU ETS sectors increases (on average) only by one euro. At a more disaggregate level, however, the sectoral impacts will differ, which we will see in the next section.

Results: emission reduction and leakage

The overall welfare effects obviously not only depend on regional reduction efforts, but also on the impact on global emissions. Climate policy aims to reduce global GHG emissions in the first place. As one might expect, emission reduction in Annex I countries is highest in the AMBITIOUS PLEDGES scenario. Reductions are estimated at 2.5 Gton CO_2 equivalents, which is illustrated by the blue bar in the left-hand diagram in Figure 2.[2] However, carbon leakage is responsible for increases in emissions in non-Annex I countries, which is illustrated by the red bar in the right-hand diagram of Figure 2. Emission reductions in Annex I countries in the PLEDGES scenario are slightly lower and equal to 2.3 Gton CO_2 -equivalent. For this unilateral case carbon leakage is considerably larger, reducing the net effect to 1.5 Gton CO_2 -eq. In the CDM variant, 0.8 Gton is realized through emission reductions in non-Annex I countries, while Annex I countries reduce their own emissions by 1.5 Gton. Carbon leakage in this scenario is considerably smaller due to much lower carbon emission prices. Finally, we also find that the PLEDGES WITH BM scenario is almost similar to the PLEDGES variant, with almost no difference in terms of leakage, showing

[2] Our baseline scenario GHGs estimate for 2020 comprises 43 Gton CO2 emissions, 6.5 Gton CO2 equivalent emissions of CH4 and N2O, 1.7 Gton F gases and 3 Gton of emissions related to land use, land use change and forestry (LULUCF).

Figure 2



CMD = Clean Development Mechanism, BM = Border Measures.

Source: Bollen, Koutstaal and Veenendaal (2011).

the very limited effect of BM on climate change emissions at home and abroad.

Carbon leakage in terms of the emission increase in non-Annex I countries as a percentage of the decrease in Annex I countries may reach rates of up to 36 percent depending on the specific scenario (Table 2). Such large impacts on carbon leakage are surprising, although a recent study by Böhringer et al. (2010) reports similar results.[3] Our rates are considerably higher compared with earlier studies showing leakage rates of only 3–11 percent (e.g. Manders and Veenendaal 2008). An important difference with these earlier studies is the use of more recent data for 2004, which reflects the increasing integration of the world economy and the increase in energy use in fast-growing countries such as China and India. Moreover, fossil energy markets are now characterized by lower supply elasticities, which is consistent with the higher fossil energy prices in our baseline (USD 100 per barrel in 2020) that results from an enduring underinvestment in production capacity of oil supply.

The usual perception is that unilateral policy has major competitiveness effects through the relocation of energy-intensive sectors. Our leakage rates seem to confirm these concerns at first sight. In fact our study shows such relocation concerns to be exaggerated. The leakage we find is almost entirely due to the indirect effect of lower fossil fuel prices due to the carbon constraint in the countries imposing pledges. Climate change policies in Annex I countries reduce worldwide consumption of fossil fuels and lower demand causes fossil fuel prices to fall, depending on the scenario. For instance, in the unilateral PLEDGES scenario global prices fall on average 3.2 percent relative to the baseline (Table 2). This fossil fuel price reduction induces a rebound effect at the global level, with lower prices stimulating demand in countries without a binding emission target. Given that the volume of energy use in these countries is substantial, even a small percentage increase will have a considerable absolute impact on energy use and therefore on CO_2 emissions at the global level.

To illustrate that the fossil fuel price effect of climate policy is far more important for leakage than the trade channel, we keep fossil fuel prices at the level of the baseline scenario and find that the leak-

[3] Böhringer et al. (2010) report that leakage is never reduced by more than 15 percent for different climate policy scenarios, including various border measure variants.

Table 2

Leakage rates and fossil fuel prices

	GHG leakage rate [a] %	GHG leakage rate trade channel [b] %	Global fossil fuel prices % deviation from baseline
Ambitious Pledges	16	0	-1.8
Pledges	36	2	-3.2
Pledges with CDM	13	-3	-2.8
Pledges with BM	35	0	-3.3

[a] The GHG leakage rate is defined as the increase of GHG-emissions in non-Annex I countries relative to the emissions reduction in Annex I countries; in the case of CDM the leakage rate reflects CDM efforts from the perspective of the Annex I countries that buy CDM credits.

[b] The GHG leakage rate as defined in a) when fossil fuel prices are kept at baseline levels.

Source: Bollen, Koutstaal and Veenendaal (2011).

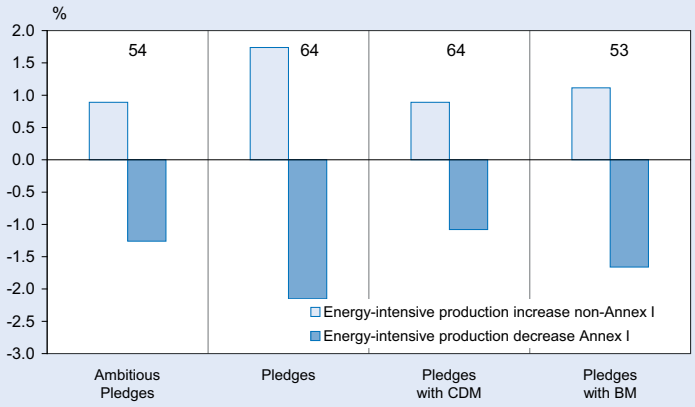
age rates are at most two percent in the PLEDGES scenario (see the GHG leakage rate trade channel column in Table 2). The relative weight of trade in energy intensive products between different regions can hardly be taken to explain the large leakage rates found. In the Baseline scenario, the OECD countries import six percent of their total demand for energy intensive manufacturing products from the rest of the world. Exports from the OECD to the rest of the world amount to ten percent of total demand outside OECD. In the PLEDGES scenario, imports in the OECD increase by one percentage point to seven percent, while exports fall by one percentage point. The impact of climate change policies on trade flows in energy intensive products is therefore limited, which underlines the limited effect of the trade channel on carbon leakage.

If leakage undermines emission reduction efforts in Annex I through the fossil fuel price channel instead of the trade channel, the effectiveness of complementary measures, like Border Measures and CDM, is likely to be smaller as well. To illustrate, Figure 3 presents the impact of higher carbon costs on output reductions of energy intensive manufacturing in Annex I countries. The decrease in output is presented as a percentage deviation from baseline production levels in Annex I countries. As expected the reduction in output is smallest in the coordinated policy case AMBITIOUS PLEDGES due to the encompassing emission trading scheme. The decline is largest in PLEDGES with a 2.2 percent reduction of baseline production. Both complementary policies reduce the impact on production of energy intensive manufacturing relative to this unilateral case. Border measures reduce the competitiveness impact on production through the levy on energy intensive imports and the refund on exports. CDM credits reduce the abatement costs for energy intensive firms even more and therefore soften the impact on production as well.

However, the carbon impact of this production reduction is quite limited. Firstly, part of the output reduction will be taken over by firms in the energy intensive sectors outside Annex I. Figure 3 shows this increase using the same denominator as for the production decline of Annex I energy intensive manufacturing, i.e., Annex I baseline production. The increase in energy intensive production in non-Annex I reflects increased consumption within these countries due to lower fossil fuel prices, as well as the increase in exports from energy intensive manufacturing to Annex I countries. The numbers shown in Figure 3 are the energy intensive production leakage rates and they are always above 50 percent.

Secondly, because the fossil fuel input mix in non-Annex I has a higher emission-intensity than the fuel mix in Annex I, leakage in terms of carbon is even larger. In the case of BM reduced production leakage is more than compensated for by the increase in more carbon intensive input use outside Annex I due to lower fossil fuel prices, which explains the overall ineffectiveness of carbon based BM for climate policy.

Figure 3



CDM = Clean Development Mechanism, BM = Border Measures.

Source: Bollen, Koutstaal and Veenendaal (2011).

Conclusions

The impact of climate change policies on the competitiveness of energy-intensive sectors in countries that implement more ambitious climate change policies than other countries appears to be limited. The decrease in energy intensive manufacturing production in Annex I countries as a percentage of baseline production is a maximum of 2.2 percent. Over half of this production loss is replaced by an increase in the production of energy intensive manufacturing in non-Annex I countries.

In contrast to earlier studies, which reported carbon leakage rates of 3–11 percent, carbon leakage in our analysis even reaches a level of 36 percent in the PLEDGES scenario in which non-Annex I countries do not have binding limits on their emissions. The major reason for the high carbon leakage is the fossil fuel price channel. Climate change policies in Annex I countries reduce world fossil fuel prices. Accordingly, fossil fuel use in non-Annex I countries increases, which partly reverses the emission reductions realized in Annex I countries. Our simulations show that carbon leakage through the trade channel is very limited and responsible for at most two percentage points of the leakage rate. The main reason for the increased leakage is that fossil energy markets are now characterized by lower supply elasticities than in the past. Inelastic oil supply is typically consistent with the high energy prices in our baseline and results from an enduring underinvestment in the production capacity of crude oil.

A consequence of the negligible impact of the trade channel on carbon leakage is that border measures will be ineffective in reducing carbon leakage. However, they do affect the competitiveness of energy intensive manufacturing, reducing production loss from 1.4 percent to 0.9 percent of baseline production. Allowing the use of CDM credits is most effective in reducing carbon leakage. With CDM, emission reductions are realized at lower costs and the impact of Annex I climate policies on fossil fuel prices is more limited. Consequently, carbon leakage through the fossil fuel price channel is also reduced.

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