Energy Policy 34 (2006) 3656–3668

ENERGY POLICY

www.elsevier.com/locate/enpol

Climate policy: Bucket or drainer?

Vlasis Oikonomou[a,*], Martin Patel[a], Ernst Worrell[b]

[a]Department of Science, Technology and Society (STS), Copernicus Institute, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands
[b]Ecofys, PO Box 8408, 3503 RK, Utrecht, The Netherlands

Abstract

Worldwide, industry is responsible for about 40% of greenhouse gas (GHG) emissions, making it an important target for climate policy. Energy-intensive industries may be particularly vulnerable to higher energy costs caused by climate policy. If companies cannot offset rising energy costs and would face increased competition from countries without climate policy, they may decide to relocate their industrial production to the countries without climate policy. The resulting net effect of climate policy on GHG emissions in foreign countries is typically referred to as "carbon leakage". Carbon leakage may lead to higher global GHG emissions due to the use of less advanced technology in less developed countries. Based on a literature review of climate policy, earlier environmental policy and analyses of historical trends, this paper assesses the carbon leakage effects of climate policy for energy-intensive industries. Reviews of past trends in production location of energy-intensive industries show an increased global production share of Non-Annex 1 countries. However, from empirical analyses we conclude that the trend is primarily driven by regional demand growth. In contrast, climate policy models show a strong carbon leakage. Even though future climate policy may have a more profound impact than environmental policies in the past, the modelling results are doubtful. Leakage generally seems to be overestimated in current models, especially as potential positive spillovers are often not included in the models. The ambiguity of the empirical analyses and the modelling results warrants further research in the importance of production factors for relocation.

Keywords: Carbon leakage; Energy-intensive industry; Iron and steel industry

1. Introduction

Worldwide, industry is responsible for about 40% of greenhouse gas (GHG) emissions (IEA, 2003d). About three quarters of these emissions are caused by energy-intensive industries (estimate based on IEA, 2003a, b) that produce iron and steel, aluminium, chemicals, fertilizers, cement and pulp and paper.[1] The emission intensity makes these industries an important target for climate policy. At the same time these industries may be particularly vulnerable if climate policy leads to higher energy costs, and if they are unable to offset these increased costs. Policymakers do not want to affect the international competitiveness of these industries by climate policy because it could lead to relocation (Pellenbarg et al., 2002; Krugman, 1995; Scott, 2000; Schmenner, 1982). In the context of this paper we refer to relocation as the move of industries to countries with less stringent climate policies or lower energy prices. However, since there is so far hardly any experience with the effects of climate policies (and therefore a lack of quantitative information), this paper first analyses the effect of past environmental regulations and then draws conclusions for future climate policies.

The *negative* side effects of climate policy on GHG emissions in foreign countries are typically referred to as "carbon leakage". Carbon leakage reduces the

---

*Corresponding author. Office UvA, Faculty of Economics and Econometrics, University of Groningen, Roetersstraat 11, 1018 WB Amsterdam, The Netherlands. Tel.: +31 30 253 7600; fax: +31 30 253 7601.

E-mail address: V.Oikonomou@chem.uu.nl (V. Oikonomou).

URL: http://www.alpha-lufttechnik.de/unternehmen/alpha_informiert.

[1] The power sector is sometimes also considered as energy intensive sector but it has been excluded from the analysis presented in this paper since relocation of the power sector over large distances has not been observed so far. The main reasons are technical and economic obstacles due to grid losses and grid capacity and, moreover, supply security considerations.

0301-4215/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2005.08.012

effectiveness of a climate policy (IPCC, 2001). It is mainly caused by:

- Relocation of energy-intensive industries to countries with a less stringent climate policy, which can lead to lower production costs.
- Increased net imports of energy-intensive goods from countries which have no or a less stringent climate policy and more carbon intensive production structures.
- Reduction in global energy prices due to reduced energy demand in climate-constrained countries, reducing the incentive for energy-efficiency improvement for energy-intensive industries in countries without climate policy.

On the other hand, energy-efficiency improvement due to climate policy may lower the energy costs and provide ancillary (productivity) benefits to energy-intensive industries. These are the so-called *positive spillovers*. They can be caused by the development of energy efficient and low-GHG technologies in climate-restrained countries and implementation of these technologies around the world including countries that are not participating in climate stabilization regimes.

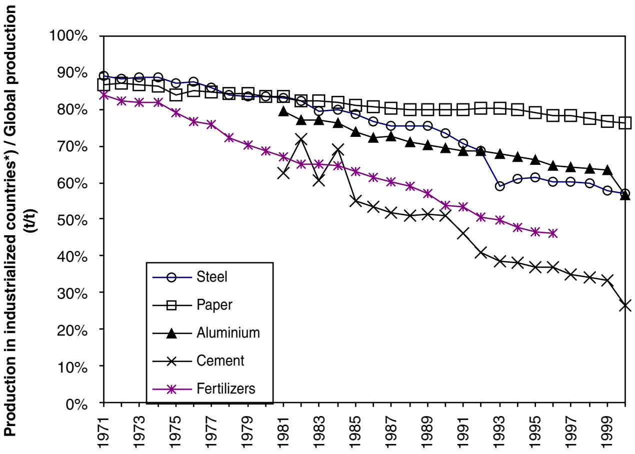
This article is based on the study (Oikonomou et al., 2004), which analysed the effects of both *positive* and *negative* spillovers. In this paper, we address primarily negative spillovers (carbon leakage).

The extent of carbon leakage is likely to differ in all these cases. In this report we analyse carbon leakage primarily using published analyses and some empirical work. While this paper deals with the energy-intensive industry in general, we describe and analyse the developments using the example of the iron and steel industry.

2. Production trends for energy-intensive products

In the context of globalization, the relocation of industries and services to countries with more advantageous production factors is currently widely discussed. To put the discussion around climate policy induced developments into perspective, it is useful to study the macro-trends over longer periods of time.

Fig. 1 shows the global production shares of industrialized countries (without ex-USSR) for five important energy-intensive products. In Organisation for Economic Cooperation and Development (OECD) countries, these five products together account for approximately 50% of the total energy use of the energy-intensive sectors (OECD, 2002). On average, the industrialized countries' global production shares have decreased from 87% to 76% for paper (1971–2000), from 80% to 57% for aluminium (1981–2000), from 89% to 57% for steel (1971–2000), from 67% to 46% for nitrogenous fertilizers (1981–1996) and from 63% to 26% for cement (1981–2000). In the respective periods, production of steel and cement increased in the industrialized countries by 60 Mt (megatonnes = million metric tonnes) and 56 Mt, respectively. Between 1981 and 2000, the production of paper and aluminium in industrialized countries (without ex-USSR) increased by substantial 110–245 Mt (paper) and 2–14 Mt (aluminium) respectively. Still, the production in developing countries and the former USSR grew even faster as is shown in Fig. 1.



*) Without countries of the former USSR.

Fig. 1. Global production shares of energy-intensive products in industrialized countries (IISI, UN Production Statistics).

The breakdown per region for steel presented in Fig. 2 shows that the increase of the developing countries' share from 10.8% to 42.8% in the last 30 years was primarily caused by the growth of production in China and that the entire remaining developing world except for Sub-Saharan Africa also increased their shares substantially. Even the share of Asia Pacific OECD increased slightly while the share of North America and of Europe (33 countries) decreased by 14% and 16%, respectively.One can derive from Figs. 1 and 2 that a considerable shift in production shares has been taking place in the last decades. It could possibly be argued that the losses of the industrialized countries' global market shares of energy-intensive products were at least partially caused by environmental policies (in force since the early 1980s, partly also earlier) and by climate policy (in force since the mid- to end-1990s, partly since the early 1990s). Next, we will make an attempt to test the explanatory power of this argument.

3. Relocation of energy-intensive industries

To better understand to which extent relocation has taken place in the past and what the driving forces of the developments have been, we differentiate between Annex-1 countries (industrialized countries which have committed themselves to climate policy) and Non-Annex 1 countries (developing countries without climate policy). We distinguish for these two groups of countries two drivers for changes in global market shares, namely the

(A) *Predominantly competition-based decrease of the global production share of Annex-1 countries* (*Type A*), with

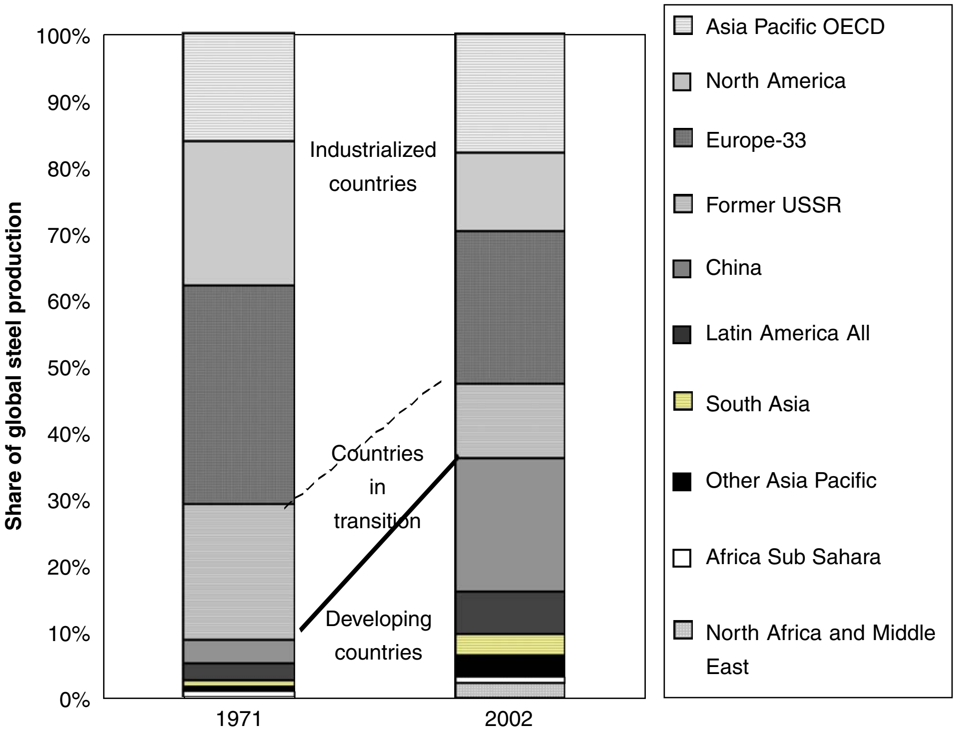


Fig. 2. Global production shares of steel in 1971 and 2002 in mass terms (IISI, 1980; IISI, 2003).

the main driver being the comparative advantage of production factors in Non-Annex 1 countries (wages, energy cost, land, infrastructure, etc.); environmental policies are significant in this case, since they can influence the price of the production factors.

(B) *Predominantly demand-driven decrease of the global production share of Annex-1 countries* (*Type B*), which is mainly caused by the development of new markets in the developing world; this trend can be considered autonomous, i.e. not linked to environmental policies.

Environmental or climate policy has an influence on the production factors (e.g. the price of energy commodities) and hence falls under Type A, i.e. the predominantly competition-based decrease of global production shares. In contrast, the predominantly demand-driven decrease of global production shares according to Type B is rather a consequence of autonomous developments, especially the industrialization of developing countries.[2] We have developed two indicators (PD and MS, see Table 1), which can indicate whether changes in global production shares of energy-intensive products are predominantly competition-based or predominantly demand-driven.

According to indicator PD in Fig. 3 the production (increase) in Non-Annex 1 countries has been mainly demand-driven for steel, paper and cement while it has been strongly export-driven for aluminium. The latter has been the case since the beginning of the 1980s and the development in recent years does not indicate that environmental policy in Annex 1 countries played a major role. According to indicator MS, Annex 1 countries have lost some market share for aluminium in their own region at the beginning of the 1990s but this development stopped quickly and the ratio of net imports to Annex 1 countries to the consumption in Annex 1 countries has been constant since then. Since no meaningful trend for indicator MS can be observed for the other materials we conclude that, in general, there is no significant loss of market shares for Annex-1 countries in their own region (this is identical with the statement that Non-Annex 1 countries have generally not been gaining market shares in the rest of the world), since the 1970s.

This analysis indicates that the decrease of global production shares of Annex-1 countries has been driven predominantly by the development of new markets and demand in the developing world (Type B). We conclude from these observations that so far, environmental policies are unlikely to have influenced the industrialized countries' global market shares to a noticeable extent.

Time series for Foreign Direct Investment (FDI) across regions allow to gain insight into past and ongoing developments in investment trends. As Fig. 4 shows, the developing countries' share of total FDI has changed quite considerably over time: while developing countries received a small share of total FDI until around 1990, their share increased substantially until 1997 when the trend reversed parallel to the explosive growth of FDI among

---

[2] With "autonomous" we mean that the development is not linked to climate or environmental policy.

Table 1
Indicators for identifying the main drivers for observed changes in global market shares

Indicators	Type A: Predominantly competition-based decrease of global production share of Annex-1 countries	Type B: Predominantly demand-driven decrease of global production share of Annex-1 countries
Production drivers: PD = (PROD in NA1)/(CONS in NA1) = 1 + (NET_EXP from NA1 to A1)/(CONS in NA1)	>100% Export-driven ↑	⩽100% Demand-driven ↓
Is the production increase in Non-Annex 1 countries mainly demand-driven or is it largely export-driven?		
Market shares: MS = (NET_IMP to A1 from NA1)/CONS in A1	↑	↓
Are Annex 1 countries losing market shares in their own region? (Identical with: Are Non-Annex 1 countries gaining market shares in the rest of the world?)		

Notes: PROD, Production; CONS, Consumption; NET_EXP, Net exports; A1, Countries with climate policy (Annex 1 countries); NET_IMP, Net imports; NA1, Countries without climate policy (Non-Annex 1 countries).

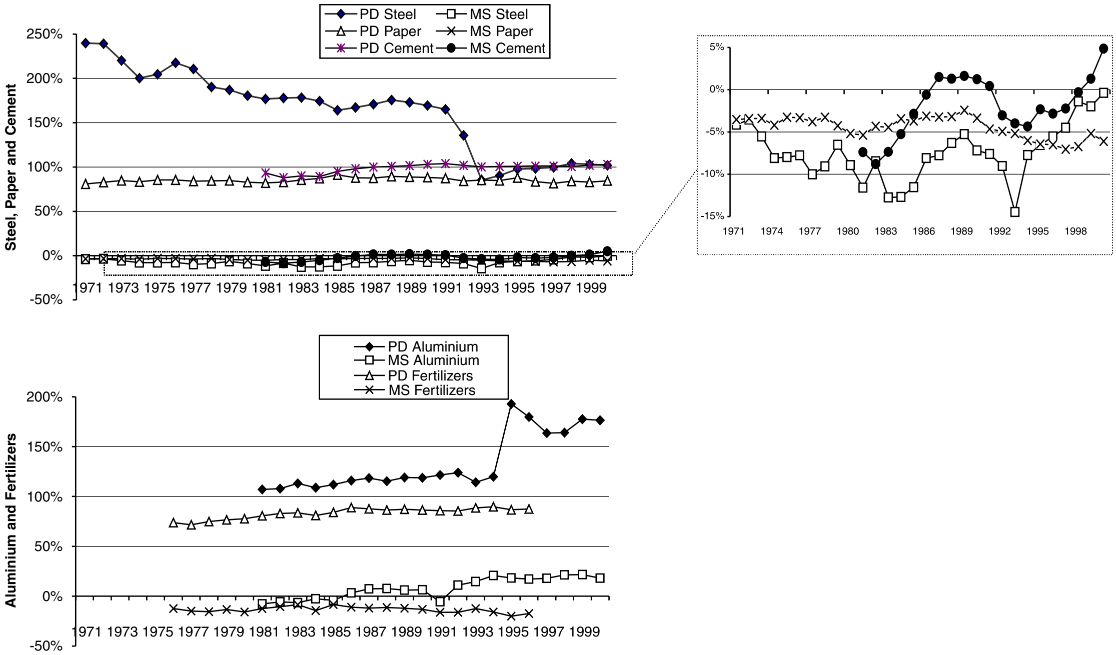


Fig. 3. Indicators PD and MS for five energy-intensive products. The graphs refer to an aggregation of all countries to Annex I and Non-Annex I countries. Former USSR is excluded in the graphs for aluminium and cement, due to lack of data for the period 1980–1990. The graph for fertilizers is also limited up to 1996 because of lack of data.

industrialized countries, which collapsed again largely after 2000. Industrialized countries remain the main recipients of FDI but the developing countries today receive a larger share of the total flow than in the 1980s (see Fig. 4).

To obtain deeper insight into the developments, more detailed data would be required especially on FDI flows by origin (FDI from Annex 1 to Non-Annex 1) while the values in Fig. 4 represent the total inflows by recipient; moreover, the developments in FDI should be compared with *local* investment flows in developing countries; and finally a subset for the energy-intensive industry would be required to avoid biases by investments in sectors for which the influence of climate policy is negligible, e.g. relocation of services related to low labour costs. Fig. 5 presents the FDI inward stock for 3 energy-intensive sectors as a share of total of FDI inflows for 1988 and 1999. A basic finding

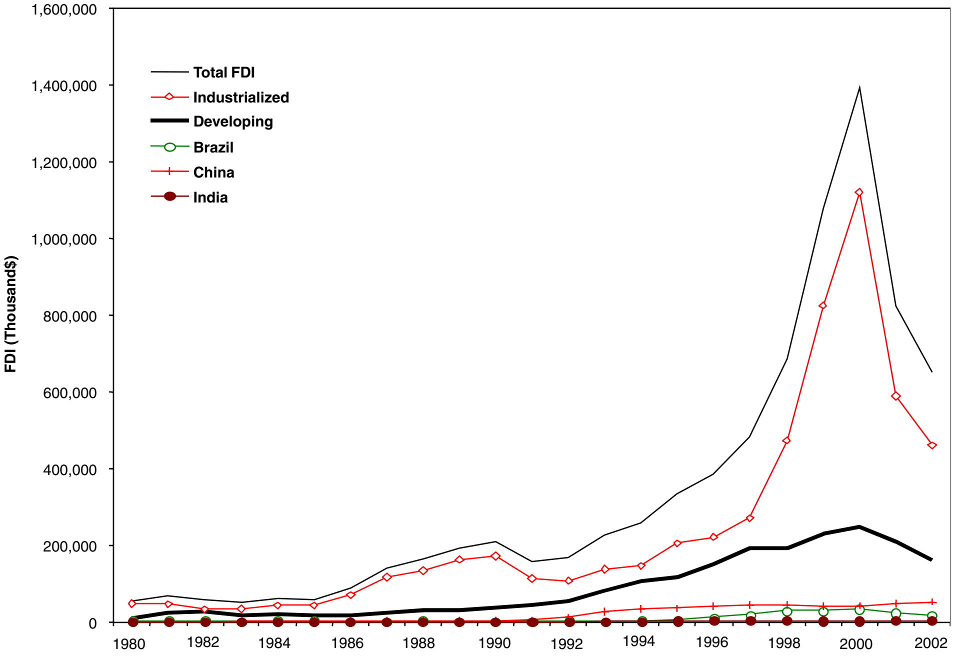


Fig. 4. FDI flows from 1980 until 2002 to industrialized and developing countries (UNCTAD, 2003). The data in this figure were taken from the World Investment Report and are based on the UNCTAD, FDI/TNC database (UNCTAD, 2001). The sectoral disaggregation in the World Investment Report includes the fertilizers, among others, in the category of chemicals, the cement in non-metallic mineral products and the iron, steel and aluminium in the metal and metal products. The countries belonging to the two groups are the same in these calculations with the only exception that for 1988, the Central and Eastern European countries are excluded from the developing ones. The latter does not affect the results presented, since the Central and Eastern European countries initiated receiving FDI investments after the political changes in 1990.

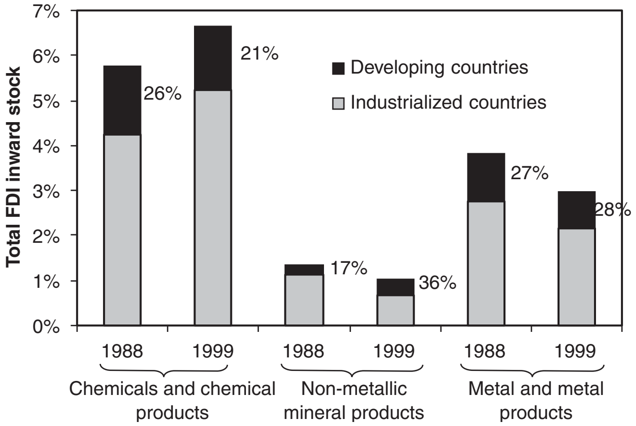


Fig. 5. FDI inward stock for energy-intensive sectors as a percentage of total FDI inflows (UNCTAD, 2001).

is that the shares of the FDI stock for energy-intensive sectors in industrialized and developing countries have not changed significantly and that no trend is observable towards preferred investment in developing countries. The total amount of the FDI inward stock for all sectors increased by a factor of 3 between 1988 and 1998, but the total share of the energy-intensive sectors (except FDI for electricity, gas and water supply) remained at a similar level (around 25–30%). The same findings are presented also in a UNCTAD study (2004), where sectoral FDI flows have been projected for 2004–2005.

4. Importance of production factors, investment drivers and environmental regulation for the location of new production facilities

While we have so far taken a rather phenomenological approach of interpreting past trends in production volumes, production locations and investment flows, this section takes the perspective of investment decision making in energy-intensive industries. In the first part we provide an overview of *all* production factors which are of key relevance for investment decisions in the energy-intensive sectors and we briefly discuss how these production factors differ between industrialized countries and developing countries. In the following part, we summarize empirical analyses on the importance of *environmental regulation* for the decision on the investment location.

4.1. Overview of factors of production leading to relocation

In each business investment decision, apart from the elements determined in a cost calculation for a given product there are also intangible or hidden costs (or benefits) that are taken into account. In this section we identify and analyse the most important investment criteria, as they were, for example, distinguished in EBRD studies (Bevan and Estrin, 2000) and the assessment method applied by the US Country Assessment Service of Business International, as described by Wheeler and Mody (1991).

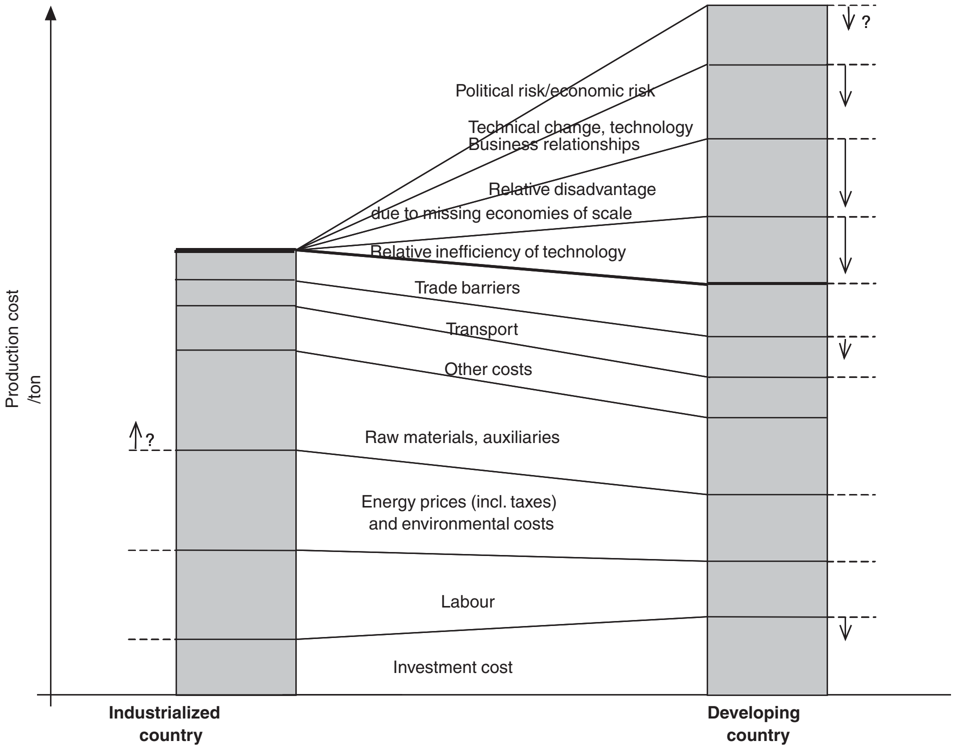


Fig. 6. Schematic overview of investment drivers for industrial production in industrialized and developing countries (this figure is merely illustrative; the relative size of the various drivers is based on empirical research).

There are several studies on the importance of the various factors for investment decisions related to manufacturing. Some are based on regression analyses that depict the statistical significance of each of the investment drivers. Others observe the dynamics of these drivers in a changing global market environment. A stylized overview of production factors and investment drivers for industrial production and their influence on total production costs in industrialized and developing countries is presented in Fig. 6.

Several studies that depict the statistical importance of these drivers conclude that low wages and large market size (in million tonnes) and/or high market growth (in % GDP growth) that capture potential economies of scale are very decisive investment criteria (Bevan and Estrin, 2000; Lankes and Venables, 1996; Patibandla, 2001; Singh and Jun, 1995). In this context, proximity of product to market customers is a key criterion since it (partly) compensates for other cost factors.

Furthermore, market analysis reveals that labour, energy (including taxes and environmental expenses) and—depending on the product and the country—raw materials and auxiliaries are often cheaper in developing countries compared to industrialized countries, while other production factors tend to be more expensive, with considerable margins in some cases. For example, with regard to investment cost, Yachir (1988) stated that monopolistic prices were charged for equipment to investors in the Third World. Transportation cost tend(ed) to be high for the same reason (monopolistic prices charged by shipping companies) and/or because of lacking critical mass and inadequate infrastructure in the developing country. The economies of scale in the developing countries can be enhanced through investments for promotion of specialized inputs (e.g. technology infrastructure, specialized labour, marketing, etc.), which hence reduce the average variable costs of the new incoming industries. Trade barriers can—at least theoretically—influence decisions about relocation. These barriers consist mainly of tariff measures (most commonly an ad valorem duty) or non-tariff measures that include quotas, regulations, specific policies, which are still common practice in the energy-intensive sectors. Depending on the product and the policy regime, import barriers are either to the benefit of the developing country or the industrialized country (in the sense of income increase). With the increasing implementation of WTO agreements, trade related barriers are, however, being reduced (Rumbaugh and Blancher, 2004). Other important drivers are export subsidies and public guarantees (for exports), capital flow restrictions and price controls. However, no studies were found that deal explicitly with the significance of import tariffs or other political parameters. Further research seems warranted also in this issue.

In the case of less advanced technology, disadvantages for developing countries can accrue from lower efficiencies. Smaller plants in developing countries (due to smaller markets or lack of capital) lack the economies of scale that their competitors in industrialized countries can exploit. Intangible production factors (political and economic risk, expropriation risk and the adaptability to technological changes, which is related to the extent of human capital and research facilities and the quality of the technology/business relationships) tend(ed) to work out unfavourably for investors in developing countries. Another economic factor identified in the studies is the volatility of exchange rate. Developing markets under appreciation of their currency,[3] can import iron ore and other raw materials at lower real cost than other countries. It has been argued in the past (when relocation was no issue) that this advantage can be compensated by overpriced equipment and raw materials sold to Third World countries (Yachir, 1988). In the past, the exchange rates favoured exports from the developing Asian countries, but during 2002–2003, Thailand, Indonesia and Taiwan have sold their currencies for dollars, thus weakening their currency (IWA, 2003). Since appreciation is a benefit for imports while it is a disadvantage for exports, the exchange rates in developing countries typically favour the establishment of industries for serving local demand but not export driven investments (competition-based decrease of the production share of Annex 1 countries, compare Section 3). However, exchange rates seem to have an ambiguous effect with regard to investment decisions since they depend on the development stage of a country, its fiscal policy and other macroeconomic parameters.

In total, these factors have typically led to higher production costs in developing countries compared to industrialized countries explaining why—until recently—there was rather limited FDI in the developing world (Fig. 4). However, the conditions are improving in developing countries. With globalization and the advent of multinationals in developing countries, a substantial decrease of costs can be achieved for several production factors (see vertical arrows in Fig. 6). Moreover, the buildup of modern infrastructure is in full swing in many developing countries and the availability of skilled personnel has been rapidly improving—reaching the level of industrialized countries in some cases, albeit with increasing production costs and relatively lower multifactor productivity.

Ideally, one would base an estimate of the effect of climate policy on relocation on a complete overview of the costs according to Fig. 6 for representative production facilities in industrialized countries and developing countries. However, this type of detailed information is generally not publicly available. Among the scarce quantitative information related to production factors is the data on cost categories by industrial sector as published by statistics offices. With regard to relocation induced by climate and energy policy, the most relevant indicator that can be extracted from this source is the share of energy cost as a fraction of total cost. For the Dutch energy-intensive industry, for instance, this fraction is around 15% for bricks and tiles, 12% for iron and steel, 8% for basic chemicals, 9.5% for pulp and paper, 7% for glass and 6% for cement (Ramirez et al., 2004). While the comparison of this type of information for developing countries and countries in transition could provide some insight, a meaningful cross-country analysis would need to correct for important differences across countries, especially the product mix, the extent of further processing and the importance of non-productive activities such as trade and engineering services. To summarize, it is rather difficult to sketch a complete picture about the drivers for investments in energy-intensive production facilities in developing countries. The basic obstacle is the lack of concrete quantitative information that could lead to robust conclusions. In order to reduce this uncertainty, further research is hence indispensable.

4.2. *Empirical analysis on the role of environmental factors*

In this section we discuss the effects of environmental regulations and climate policy on relocation. A usual effect of environmental regulations can be the end-of-pipe technologies or fuel switching, which increase production costs. Strong environmental regulations drive up fixed and variable costs by requiring certain equipment, increasing running costs, e.g. for auxiliaries and for waste disposal and by prohibiting or setting limits to the use of certain polluting inputs (Xing and Kolstad, 1998). This may result in lower profitability and hence a reduction of competitiveness. In contrast, climate policies may also lead to cost savings due to improved energy-efficiency and the implementation of energy-efficient technologies may also result in additional ancillary benefits such as higher product quality (Worrell et al., 2003). Moreover, the Porter Hypothesis suggests that unilateral environmental regulations might enhance the competitiveness of domestic firms and raise profits (Porter and van der Linde, 1995). Porter argues that firms complying with environmental regulation will simultaneously deal with X-inefficiencies[4] of production that have accumulated over time. Still, there is not enough empirical evidence to prove this hypothesis (Bouman, 1998).

There is a body of empirical work testing the hypothesis that industries relocate production facilities to countries with less stringent environmental requirements. This work is generally referred to as literature on the "*pollution*

---

[3] A typical example is China, that from 1988 to 1993 had a dual exchange rate system, where the fixed rate with the US $ coexisted with a market determined rate in the swap centres. In 1994, the official rate was devalued and unified with the market rate. Since 1995, China has a floating exchange rate system (i.e. appreciated rate until 1997) although the Chinese Yuan/$ rate is set (Wang, 2004).

[4] In economics, X-inefficiency is the lack of effectiveness, with which a given set of inputs is used to produce outputs. If a firm is not producing the maximum output it can, given the resources it employs, such as men and machinery, and the best technology available, it is said to be X-inefficient. In terms of policy implications, it means that the industries face higher production costs than their optimal level.

haven" or "race to the bottom" hypothesis.[5] Most of these studies apply a similar methodology: they establish panel data for several countries (mainly including the US) and several decades. They conduct a regression analysis to understand up to which level the environmental requirements and the other production factors can play a role. As last steps, they show the statistical significance of their results and conduct sensitivity analyses. The major part of this type of analysis seems to be referring to production processes which require end-of-pipe emission or waste treatment; however, it is usually not very clear to which extent energy-intensive processes are included.

The prevailing conclusion of the pollution haven literature is that environmental requirements have a small to negligible effect on relocation. Xing and Kolstad (1998) actually provide some evidence that especially energy-intensive production[6] facilities tend to relocate to countries with less environmental obligations and these regulations could constitute a factor of the companies' investment decisions. Nevertheless, they conclude in their study that "it would not be appropriate to conclude that environmental regulation alone can decide the direction of FDI for a polluting industry", since they assume that all the rest of the parameters (tax rates, market size and profitability) are constant across the host countries and the number of observations is low.

The relationship of pollution havens with low-wage havens for the energy-intensive industries was examined in depth in a study by Mani and Wheeler (1999). The basic finding is that indeed energy-intensive industries shifted part of their production to non-OECD economies, when their marginal abatement cost was rising. On the other hand, they clearly state that the pollution haven effect did not have major significance for a number of reasons. In contrast pollution haven was identified as key driver to cover the demand in the developing countries for a long period (1960–1995), which was until then covered by domestic production. The only case where investment from energy-intensive multinational firms as a share of total inward FDI is smaller for host countries with higher environmental standards is when the latter participate in international environmental treaties; however, these findings do not survive sensitivity and robustness checks (Smarzynska and Wei, 2001).

On the other hand, another category of studies (see Smarzynska, 2003) prove through an extensive literature study that there is little evidence for supporting the significance of the environmental regulations to explain relocation of energy-intensive industry and they argue that the driving factor for relocation is primarily economic growth in developing countries. The same evidence is presented by Eskeland and Harrison (2003)[7] who conclude that cost differences related to pollution abatement are insignificant for investment decisions and foreign investments in high-polluting sectors are not more than those for "cleaner" sectors. In the same context, other studies show that the cost effects of the environmental regulation are not only negligible, but that increased environmental quality even results in lower social costs (see Leonard and Duerksen, 1980; Pearson, 1982; Leonard, 1988; Lucas et al., 1992; Low and Yeates, 1992; Tobey, 1990).

Leonard (1988) and Albrecht (1998) dealt explicitly with the FDIs of the US and found that environmental costs, as a result of environmental policy, are relatively limited in pollution intensive industries. They conclude that *other* factors of production, as they were explained in the previous section, seem to be more decisive. Albrecht (1998) especially observed the investment flows in relation to lower environmental standards for the period 1991–1995 for a category of industries (clean, medium polluting and dirty industries) and concluded that more polluting industries are not significantly attracted by pollution havens.

Some authors argue that the pollution haven hypothesis cannot be tested since it lacks empirical coverage for a number of reasons (Neumayer, 2001). Firstly, pollution abatement costs, as calculated by OECD, are considered to account for less than 2% of the GDP for most countries (equivalent to 1.9% of the gross fixed capital formation).[8] The same expenditures as a percentage of total gross fixed capital formation amount (only in one case) up to 1.9%. (OECD, 2003). In this context, industries with increasing returns to scale will not relocate easily, if the pollution abatement costs do not exceed a rather high threshold cost level (Markusen et al., 1995). Another reasoning in the study of Neumayer (2001) is that even when environmental costs are high, international investors might not be deterred, as long as the implemented policies ensure a level playing field with other domestic competitors. Furthermore, an interesting point stated by Neumayer (2001) is that both the World Bank and the World Economic forum do not include environmental compliance costs in the published competitiveness indicators, referred to as attractiveness to invest in a country (World Bank, 1998; WEF, 1999).

For energy-intensive industries, high-income elasticities for basic industrial inputs are found in particular for developing countries. With increasing income, the elasticities decline for basic industrial inputs. Moreover, as a result of increasing income, the developing countries

---

[5] Another hypothesis not explicitly examined in this paper is the "industrial flight" (Leonard, 1988) hypothesis that refers to the "push" of the energy intensive industries out of the industrialized countries.

[6] Referred to as pollution intensive industries. However, this term is subject to a wide variety of interpretations (Leonard, 1988).

[7] Eskeland and Harrison examined the FDI flows patterns for Mexico, Morocco, Cote D'Ivoire and Venezuela.

[8] This study distinguishes between expenditure from the public and business sector. For the public sector, they range from 0.2% to 1.4% of the GDP, while for the business sector from 0.1% to 1.2% of the GDP.

gradually demand stricter environmental regulations and therefore these countries should normally not attract energy-intensive industries in the long term. A general result stemming from most of the empirical studies is that there is hence no significant evidence that more stringent environmental regulation in the past has promoted the relocation of energy-intensive industries.

There are two important limitations when drawing conclusions from the pollution haven literature for relocation due to environmental policy. Firstly, the pollution haven work is mainly limited to the fixed cost component of the abatement technologies because it refers, in particular, to end-of-pipe technologies. Environmental taxes that reflect mostly variable costs are often not observed, because the focus of the pollution haven literature lies on direct regulations and cannot capture integrated solutions of environmental technology processes (Bouman, 1998). As mentioned above, the pollution abatement costs are not presented to be significantly high. This can also be expected for energy and climate policy: since the share of energy cost generally amounts to about 10% in energy-intensive industries in industrialized countries ambitious environmental policy could lead to higher extra expenditures than 2%. Besides, most global players tend to use the most recent technology worldwide since this minimizes planning and maintenance cost (typical examples: basic chemicals, cement, pulp and paper). Secondly, as pointed out in Section 4.1, the competitiveness of plants in developing countries is nowadays higher than in the period to which most of the pollution haven analyses refer. In total, we conclude that the existing studies cannot provide a clear picture about the effect of environmental policy on the relocation of energy-intensive industries; but they do indicate that—if a relation between environmental policy and relocation should exist—it is statistically weak. There is need for further research on future trends in production costs and environmental (and climate) policy compliance.

Table 2
Characteristics of the models

Model	Time coverage	Climate policy introduced in[a]	Price elasticity of demand
STEAP	1960–2040	Japan and EU	0.2
SIM	Static	Global	0.3
POLES	1997–2030	EU	0.2

[a] All models distinguish several countries (or regions) in the world area without climate policy.

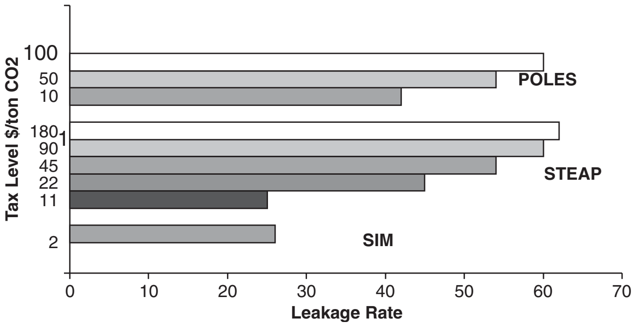


Fig. 7. Carbon leakage (%) in the steel sector for different policy scenarios in the three models and resulting leakage-corrected abatement cost.

5. Results from climate policy models on the iron and steel sector

Numerous models have been developed and applied to project future developments of economic activity, trade, energy use and GHG emissions. Models have also been used to estimate the extent of carbon leakage as a function of various policy measures. In this section the models refer explicitly to climate policies and not to environmental regulations in general. For instance, in most of the studies, traditional policies for energy efficiency improvement and emission reduction (such as taxes and subsidies) are compared to modern market-based instruments like emissions trading (Maestad, 2000). Most of the models do not distinguish between different sectors of the economy and a very limited number of models distinguishes between the total of all energy-intensive sectors (grouped) on the one hand and the total of all non-energy-intensive sectors on the other.[9] Even fewer models deal with single energy-intensive sectors. In this section we deal with the latter and limit ourselves to three models that study the steel sector in detail. These are the models Steel Industry Model (SIM) (Mathiesen and Moestad, 2002), Steel Environmental strategy Assessment Program (STEAP) (Gielen and Moriguchi, 2001) and Prospective Outlook for the Long term Energy System (POLES) (Hidalgo et al., 2003). All three models take different steel production technologies into account. The key parameters included are:

- Elasticity of demand for steel.
- Elasticity of supply for steel.
- Elasticity of supply for production inputs (iron ore, coal, scrap).
- Armington elasticities for the trade of steel products.
- Elasticity of substitution of production inputs.

Table 2 provides an overview of important features of the three models and Fig. 7 presents results for carbon leakage. Carbon leakage (more precisely referred to as *leakage ratio*) is defined as the ratio of the *increase in GHG emissions in Non-Annex I* countries (or: total of all countries *without* climate policy) relative to the *decrease of GHG emissions in Annex I* countries (alternatively: total of all countries *with* climate policy). The logic of this indicator is that it quantifies how much of the

---

[9] For a further model discussion, see Kuik (2004), Kuik and Gerlagh (2003) and Sijm (2004).

policy-induced emission reduction in Annex I countries is "eaten up" by emission increase in Non-Annex I countries. If the leakage is 100%, the net effect of climate policy is negligible. While the concept of this indicator seems plausible, its usefulness for policy making is nevertheless limited, because it does not account for the fact that relocation does *not* lead to a net increase of worldwide GHG emissions if the relocated plant has the same energy efficiency level as the original plant (i.e. *leakage* does not correct for "climate-neutral" relocation). Further shortcomings originate from the fact that leakage is a *derived* indicator expressing a change in relative terms. For a critical discussion on the indicator *leakage* see Oikonomou et al. (2004). In conclusion, it is not advisable to make comparisons and to draw policy conclusions on the basis of the indicator "leakage" *only*. On the other hand, it is very common to use the indicator "leakage" for the comparison of model results and we therefore chose to do so also in this paper. However, we refer to the limitations, which we discuss in more detail in Oikonomou et al. (2004).

In the SIM model, the level of the tax is set to 25$/ton CO_2 For the STEAP model and the POLES, the results for different taxation scenarios are presented in Fig. 6.

According to the model results shown in Fig. 7, climate policy would substantially affect steel production in various world regions and could lead to serious carbon leakage. As expected, stricter policy is shown by the models to lead to higher leakage rates. The leakage rates differ substantially across the three models: at around 10 €/t CO_2 leakage ranges between 25% (STEAP) and 40% (POLES). In contrast, around 20–25$/t CO_2 the leakage rates according to STEAP and POLES coincide well, while leakage according to SIM is nearly only half as high. Since it is not obvious how the differences in regional and time scope can explain these ranges, this diversity of results seems to indicate that the results are subject to major uncertainties. Also, these models are exclusively based on price differences and price elasticities and are not able to describe policy-induced technological progress and neither technology transfer.

According to the SIM results, the climate tax initially leads to a reduction of the worldwide steel production by 24 Mt (3.2%). It also leads to a relocation of production to developing countries, where energy efficiency of steel production is assumed in the SIM model to be identical with the world-wide average energy efficiency.The emission reduction of 153 Mt CO_2 in Annex I countries (17.2%) is therefore partially outweighed by a 39 Mt CO_2 increase in Non-Annex I countries, as an effect of relocation. The carbon leakage is thus 25% (Mathiesen and Moestad, 2002). According to the STEAP model (and to a lower extent, also according to POLES) marginal tax increases lead to much higher increases of leakage at low tax levels (10–50 dollar;/t CO_2) than at high tax levels (around 100$/t CO_2 and beyond). This non-linear behaviour indicates a strong sensitivity of leakage to small tax increases compared to the status quo. At low tax rates the impact on leakage is even stronger according to the POLES model as compared to the STEAP model (compare leakage for 10 €/t CO_2 and 11$/t CO_2, respectively) while leakage increases less severely with higher tax rates compared to STEAP. At the high end of carbon taxes, both STEAP and POLES indicate very substantial leakage rates of 50% to more than 60%.

As a plausibility check, Table 3 presents the increase in production costs in the steel industry as a result of different carbon tax levels. We argue that a leakage rate of 45–50% seems too high for a tax level of 25$/t CO_2 (see Fig. 7) cannot be explained considering the very moderate rise in production costs (6.5% according to Table 3). Furthermore, a leakage rate of 25% to more than 40%, according to Fig. 7 seems too high in view of an increased production cost of only 2.6%. Since the increase in production costs are rather modest in all cases, the large leakage rates according to Fig. 7 seem unlikely in view of the multiple obstacles presented in Fig. 6.

In general, studies on carbon leakage disagree on the *size* and *distribution* of the leakages generated by the implementation of the Kyoto Protocol (OECD, 1999). These differences between the various estimates are partly related to differences in the underlying model and their relevant parameters, especially on the elasticities and sectoral coverage (Kuik, 2004). Some models are applied general equilibrium (AGE) models, while others are partial equilibrium models. AGE models explicitly model the behaviour of each economic agent that is distinguished in the model (Kuik, 2004). According to a literature study on AGE models (Kuik and Gerlagh, 2003), when countries comply to CO_2 reduction targets without emissions trading, the leakage rates range between 5% in OECD's GREEN model to 20–21% in WorldScan and the model by Light et al. (1999). These figures for the whole economy, as represented in an AGE model are significantly smaller than the results we found for the iron and steel sector.

Table 3
Change of production costs of steel sector under carbon taxes

Assumed carbon tax in €/t CO_2	Production cost increase by tax in €/t steel	Percentage of assumed steel production cost
10	14.2 (= 10∗1.42)	2.6%
25	35.5 (= 25∗1.42)	6.5%
50	71.0 (= 50∗1.42)	12.9%
100	142 (= 100∗1.42)	25.8%

1. Assumed steel production cost: 550 €/t steel (see Alpha-lufttechniek).
2. Primary energy use for combined primary and secondary steel 14.15 GJ/t steel (derived from Kim and Worrell, 2002). This value comprises primary, secondary, hot and cold rolled steel, with a share of secondary steel of 40.5% (IISI, 2004). For pig iron, the primary energy is 15.7 GJ/t, for EAF-slab 4.6 GJ/t and for hot and cold rolling 3.0 GJ/t. In total, this gives $40.5\%*4.6+59.5\%*15.7+3.0 = 14.2$ GJ/t average weighted factor for steel mixed.
3. Multiplication with the assumed emission factor of 100 kg/GJ gives $100*14.2 = 1.42\,tCO_2/t$ steel.

As discussed in the introduction there are not only *negative* spillovers (leakage) but also *positive* spillovers. Positive spillovers occur when climate policy induces the increased development of energy efficient and low-GHG technologies and when these technologies are implemented around the world including countries that are not participating in climate stabilization regimes. The main positive spillover is the potential "technological spillover" from increased efforts in industrialized countries (with a GHG-emission reduction policy) to implement and develop technologies with a relatively lower GHG-intensity. This spillover can take three forms (IPCC, 2001):

1. R&D will refocus on low-GHG development paths for technology development.
2. Increased market share of low-GHG technologies will result in technology improvement and reduce the costs of these technologies.
3. GHG-policies in countries that focus on technology performance will send a strong signal to foreign competitors.

Some researchers have argued that these positive spillovers will counteract or even offset the negative spillovers or leakage (IPCC, 2001). While this paper focuses primarily on *negative* spillovers, *positive* spillovers should actually be taken into account in the models. But, in practice, none of the models used in the analysis of spillovers of climate policies has an endogenous representation of technological change in order to account for policy-induced accelerated innovation and implementation. Given the complexity of the underlying mechanisms and the lack of empirical data, this simplification is understandable. When interpreting the results it must, however, be considered that the results are biased by not taking into account these beneficial effects of energy and climate policies. The extent of positive spillovers may be sizable as a trend analysis discussed by Oikonomou et al. (2004) indicates: Developing countries adopt more and more energy efficient state-of-the-art technologies and this process is not necessarily driven by energy prices or climate concerns, but is the consequence of the natural development paths within those countries, if these countries have access to the technology. This highlights the need to better understand the role of technology transfer for future energy use and GHG emissions.

6. Conclusions and further research

Based on the historical development of the production of energy-intensive products by regions, we conclude that the global production shares of Annex-1 countries (industrialized countries) have been falling continuously in the last decades. The factors that drive investment decisions to favour location in developing countries are changing globally, so that the historical comparative advantages of a country cannot be considered as a given for future investments. As a consequence of the advent of multinational corporations in developing countries, the production factors seem to be converging across the globe. It was, however, not possible to conduct a comparative analysis of investment decision criteria for industrialized versus developing countries, since the required regional data on production costs were not available.

Furthermore, we examined the literature on the effect of the environmental regulations on relocation of the energy-intensive sectors. In theory, environmental regulations drive up fixed and variable costs, which should result in lower profitability and hence a reduction of competitiveness. However, available studies have shown that environmental policies in the *past* generally have *not* been a significant decision criterion for the relocation of investment and do not represent a key explanatory factor for the investments in the developing world. This implies that other criteria are more decisive for investment, with the most important ones being the market size and growth (regional demand) and the wage level. This conclusion on the insignificant effect of environmental policy on relocation observed in the past was drawn based on the outcome of empirical analyses on the so-called "pollution haven" hypothesis.

The limited effect of environmental policies seems plausible also in view of the companies' pursuit of higher value added products and their concomitant *relatively* low interest in conventional energy-intensive products. It is also supported by statements of industry representatives who point out that countries that are attractive for foreign investment have rather stringent environmental legislation and that secondly, multinationals would risk their reputation by investing in *pollution havens* (Veenenbos, 2004). There might even be a cost argument for global players to use the most recent technology worldwide since this minimizes planning cost and operation and maintenance cost.

These empirical findings are in contrast to the results from climate models that explicitly address energy-intensive industries. According to these models even very moderate climate policies (tax or allowance levels of 10–25$/t of CO_2) lead to severe leakage (and hence also to substantial relocation). The different results compared to empirical studies on pollution control raise questions about the reliability of the models. Part of the reason for the difference in results may be that the models do not seem to account for differences in elasticities across countries/regions and time periods (past, present, future). None of the models reviewed seems to be calibrated for longer periods in the past (no publications are known on this subject matter) raising further doubts.

We conclude that the current modelling results are subject to major uncertainties and that they are probably overestimating the effects of climate policy on relocation. At the same time, globalization is gradually changing the business conditions in favour of Non-Annex 1 countries; a development that tends to promote the risk of *leakage*. In addition, climate policy has still not been strict, which is also the case for most environmental policy. Climate policy might hence have a stronger impact on business decisions in the future than observed in the past. However, this argument seems to explain only partly the contradictory results of the empirical analyses versus the models since according to two of the three steel models reviewed, substantial leakage rates are to be expected even at (very) low CO_2 tax levels (see Fig. 7). One of the key factors being undervalued in the current models seems to be that location of production facilities is determined to a large extent by regional demand. Factoring this element into the model could lead to less drastic results for the potential risk of relocation due to (climate) policy.

The ambiguous results hence warrant further research in this field. Empirical research is needed to improve the understanding of technology development in industry, especially focusing on the role of policy and international technology transfer patterns (e.g. global suppliers, changing trade patterns, role of FDI, and potential spillovers on local firms), which can be significant for energy-intensive industries. Further research needs to be conducted to better understand the production factors and their importance for investment decisions. This could help modellers to construct more realistic mechanisms for projecting carbon leakage and technological change in climate models.

We conclude that

- the indicator "leakage rate" (or "leakage"), per se, is insufficient for policy making;
- the beneficial effect of technology transfer to developing countries on the reduction of GHG emissions (positive spillovers) is likely to be substantial for energy-intensive industries, but has so far not been quantified in a reliable manner;
- leakage (negative spillover effects) generally seems to be overestimated in current models while the positive spillover effects are underestimated (for the latter see Oikonomou et al, 2004);
- environmental policy has so far been a subordinate criterion for investment decisions; and
- even in a world reducing its CO_2 emissions, there is a good chance that the net spillover effects are positive given the unexploited no-regret potentials and the technology and know-how transfer by foreign trade, direct investment and co-operation in education and R&D (Oikonomou et al, 2004).

Acknowledgements

We acknowledge the support of this subproject by the Dutch National Research Programme on Global Change (NRP-CC-WAB) in the context of the research project "Carbon leakages and induced technological change: the negative and positive spill-over impacts of stringent climate change policy". We wish to thank Timo Marquez Arreaza (Utrecht University) for his contribution to the data compilation, Ignacio Hidalgo (Institute for Prospective Technological Studies, Sevilla) for providing us with additional information on the POLES model analysis for the steel sector and Prof. Eberhard Jochem for his valuable comments. We also thank the other research partners (Netherlands Energy Research Centre (ECN), Free University of Amsterdam and Wageningen University) for their comments on previous versions of the paper.

References

Albrecht, J., 1998. Environmental policy and the inward investment position of the US "dirty" industries. Intereconomics July/August, 186–194.

Bevan, A., Estrin, S., 2000. The determinants of foreign direct investment in transition economies. CEPR Discussion Paper No. 2638.

Bouman, M., 1998. Environmental costs and capital flight, Tinbergen Institute Research Series No. 177. University of Amsterdam, The Netherlands.

Eskeland, G.S., Harrison, A.E., 2003. Moving to greener pastures? Multinationals and the pollution haven hypothesis. Journal of Development Economics 70, 12–23.

Gielen, D.J., Moriguchi, Y., 2001. Environmental strategy design for the Japanese iron and steel industry, a global perspective. Working document NIES, Tsukuba.

Hidalgo, I., Szabo, L., Calleja, I., Ciscar, J.C., Russ, P., Soria, A., 2003. Energy consumption and CO_2 emissions from the world iron and steel industry. IPTS, EUR 20686EN, European Commission Joint Research Center.

IEA, 2003a. Energy Balances of OECD Countries 2000–2001. IEA/OECD, Paris, France.

IEA, 2003b. Energy Balances of Non-OECD Countries 2000–2001. IEA/OECD, Paris, France.

IEA, 2003d. Policies to reduce greenhouse gas emissions in industry—successful approaches and lessons learned. Workshop Report, IEA/OECD, Paris, France.

IISI, 2004. Multiple years. Steel Statistical Yearbook. International Iron and Steel Institute, Brussels.

IPCC, 2001. Climate Change 2001, Mitigation (WG III). Cambridge University Press, Cambridge, UK.

IWA, Economics Network, 2003. US Treasury calls for more flexible exchange rates. Newsletter published by IWA, October 30.

Krugman, P., 1995. Development, Economic Geography and Economic Theory. MIT Press, Cambridge, MA, UK.

Kuik, O., 2004. Spillovers owing to carbon leakage. Assessment for the National Research Programme on Climate Change, prepared in the project: carbon leakages and induced technological change: the negative and positive spill-over impacts of stringent climate change policy.

Kuik, O., Gerlagh, R., 2003. Trade liberalization and carbon leakage. The Energy Journal 3 (24), 97–120.

Lankes, H.P., Venables, A.G., 1996. Foreign direct investment in economic transition: the changing pattern of investments. Economics of Transition 4, 331–347.

Leonard, J.H., 1988. Pollution and the Struggle for the World Product. Cambridge University Press, Cambridge, UK.

Leonard, H., Duerksen, C., 1980. Environmental regulations and the location of industry: an international perspective. Columbia Journal of World Business Summer, 52–68.

Light, M.K., Kolstad, C.D., Rutherford, Th.F., 1999. Coal Markets and the Kyoto Protocol. University of Colorado, Boulder, CO.

Low, P., Yeates, A., 1992. Do 'dirty' industries migrate? In: Low, P. (Ed.), International Trade and the Environment. World Bank Discussion Paper No. 159, New York.

Lucas, R., Wheeler, D., Hettige, H., 1992. Economic development, environmental regulation and the international migration of toxic industrial pollution: 1960–1988. In: Low, P. (Ed.), International Trade and the Environment. World Bank Discussion Paper No. 159, New York.

Maestad, O., 2000. International climate policy—consequences for shipping. SNF Report 82/2000, Centre for International Economics and Shipping.

Mani, M., Wheeler, D., 1999. In search of pollution havens? Dirty industry in the world economy: 1960–1995. Background Document OECD Conference on FDI and Environment, 1999. World Bank Discussion Paper No. 402.

Markusen, J.R., Morey, E.R., Olewiler, N., 1995. Competition in regional environmental policies when plant locations are endogenous. Journal of Public economics 56, 55–77.

Mathiesen, L., Moestad, O., 2002. Climate policy and the steel industry: achieving global emission reductions by an incomplete climate agreement. Discussion Paper 20-02, Norwegian School of Economics and Business Administration, Bergen, Norway.

Neumayer, E., 2001. Pollution havens: why be afraid of international capital mobility? Presentation at Environmental Economics, Org. by Jak Smulders and E. Bulte, Tilburg University, The Netherlands.

Oikonomou, V., Patel, M., Worrell, E., 2004. Does climate policy lead to relocation with adverse effects for GHG emissions or not? Report prepared within the project "carbon leakages and induced technological change: the negative and positive spill-over impacts of stringent climate change policy". Project commissioned by the Dutch National Research Programme on Global Change (Scientific assessments and policy analyses, NRP-CC-WAB), Department of Science, Technology and Society/Copernicus Institute at Utrecht University, Utrecht, Netherlands.

OECD, 1999. Action Against Climate Change: The Kyoto Protocol and Beyond. OECD, Paris, France.

OECD, 2002. Energy Balances for OECD countries. Organisation for Economic Cooperation and Development, Paris, France.

OECD, 2003. Pollution Abatement and Control Expenditure in OECD Countries. Organisation for Economic Cooperation and Development, Paris, France.

Patibandla, M., 2001. Pattern of foreign direct investment in emerging economies: an exploration. Working Papers from Copenhagen Business School, No. 1, Department of International Economics and Management, Denmark.

Pearson, C., 1982. Environment and international economic policy. In: Rubin, G. (Ed.), Environment and Trade, Allanheld. Osmun Publisher, Totowa, NJ.

Pellenbarg, P.H., Wissen, L.J.G., van Dijk, J., 2002. Firm relocation: state of the art and research prospects. Research Report 02D31, University of Groningen, The Netherlands.

Porter, M.E., van der Linde, C., 1995. Toward a new conception of the environmental competitiveness. Journal of Economic Perspectives 9 (4), 97–118.

Ramirez, C.A., Patel, M., Blok, K., 2004. The non-energy intensive manufacturing sector. An energy analysis relating to the Netherlands. Energy 30 (5), 749–767.

Rumbaugh, T., Blancher, N., 2004. China: international trade and WTO accession. IMF Working Paper 04/36.

Schmenner, R.W., 1982. Making Business Location Decisions. Prentice-Hall, Englewood Cliffs, NJ.

Scott, A.J., 2000. Economic geography: the great half century. Cambridge Journal of Economics 24/4, 483–504.

Sijm, J., 2004. Induced technological change and spillovers in climate policy modeling. An assessment report prepared in the project: carbon leakages and induced technological change: the negative and positive spill-over impacts of stringent climate change policy.

Singh, H., Jun, K.W., 1995. Some new evidence on determinants of foreign direct investment in developing countries. World Bank Policy Research Working Paper 1531, The World Bank, Washington, DC.

Smarzynska, B., Wei, S.-J., 2001. Pollution havens and foreign direct investment: dirty secret or popular myth? NBER Working Paper No. w8465.

Smarzynska, B.K., 2003. Does foreign direct investment increase the productivity of domestic firms? In Search of Spillovers through Backward Linkages. World Bank Policy Research Working Paper 2923, The World Bank, Washington, DC.

Tobey, J.A., 1990. The effect of domestic environmental policies on pattern of world trade: an empirical test. Kyklos 43 (2), 191–209.

UNCTAD, 2001. World Investment Report, Promoting Linkages. United Nations, New York, Geneva.

UNCTAD, 2003. World Investment Report. FDI policies for development: National and International Perspectives, United Nations, New York and Geneva.

Veenenbos, H., 2004. VNCI: public comment on the results of the SPILLOVER project. SPILLOVER Workshop, The Hague, The Netherlands.

Wang, T., 2004. China: sources of real exchange rate fluctuations. IMF Working Paper WP/04/18.

Wheeler, D., Mody, A., 1991. International investment location decisions: the case of US firms. Journal of International Economics 33, 57–76.

World Bank, 1998. Competitiveness Indicators. World Bank, Washington, DC.

World Economic Forum (WEF), 1999. Global competitiveness report. Geneva, Switzerland.

Worrell, E., Laitner, J.A., Ruth, M., Finman, H., 2003. Productivity benefits of industrial energy efficiency measures. Energy 11 (28), 1081–1098.

Xing, Y., Kolstad, C., 1998. Do lax environmental regulations attract foreign direct investment? Departmental Working Papers, Paper wp28-98pt1, Department of Economics, UCSB.

Yachir, F., 1988. Mining in Africa today. The United Nations University/Third World Forum studies in African political economy 5.

Further reading

FAO, multiple years, FAO statistical database (http://faostat.fao.org/)

IEA, 2003c. Experience curves: a tool for energy policy analysis and design. Joint Workshop Organized by the EU Project "Experience Curves: A Tool for Energy Policy Programme Assessment EXTOOL" and the International Network on "Experience Curves for Energy Technology Policy EXCEPT", 22–24 January 2003, Paris, France.

IPCC, 2000. Methodological and Technological Issues in Technology Transfer. Cambridge University Press, Cambridge, UK.

United Nations, 2001. Industrial Commodity Statistics Yearbook, Series P, No. 41, Sales number: E/F.03.XVII.10. United Nations, New York, Geneva.

UNCTAD, 1997. World Investment Report 1997. Transnational Corporations, Market Structure and Competition Policy. United Nations, New York, Geneva.