1 The economic impacts of environmental policies: Key findings and policy implications

This chapter summarises the conclusions from the report and presents the main policy implications of these findings. It shows that environmental policies have become more stringent in OECD countries over the past decades, but at a different pace across countries. The empirical evidence in this volume shows that climate policies have been effective at reducing emissions from industry. At the same time, the policies had relatively small effects on economic outcomes such as employment, investment and productivity. The evidence suggests that well-designed environmental policies do not have large negative effects on the economy. The policies can however generate winners and losers. Policy packaging can help compensate workers and industries that may lose and strengthen public support for more ambitious environmental policies.

Introduction

The world is facing increasing environmental pressures in numerous domains. These include rising air and water pollution, climate change, biodiversity loss and waste generation. At the same time the COVID-19 pandemic has triggered an unprecedented health crisis resulting in a sudden economic downturn. Post-crisis economic recovery programmes provide an opportunity to "build back better", and to align economic recovery with climate objectives (Box 1.1) and (OECD, 2020[1]; OECD, 2020[2]). The growing awareness of the urgency of a structural transformation of the global economy has brought environmental policies to the forefront of national and international politics in the past decade. This is illustrated by numerous initiatives such as the Sustainable Development Goals (SDGs), the Paris Agreement on Climate Change, or the European Union's Green Deal. Between 1995 and 2015 – the period which studies summarised in this book focus on – the stringency of environmental policies related to air pollution, energy and carbon emissions, as measured by a composite indicator developed by the OECD,[1] increased significantly across OECD countries (Figure 1.1). Average industry energy prices[2] – which are affected by energy taxes, carbon pricing and other environmental policy instruments to reduce pollution associated with fossil fuel energy consumption – also increased substantially (+50%).[3] What has been the impact of these increasingly stricter policies on the environmental and economic performance of firms in the manufacturing sector? This book offers an overview of empirical OECD work from the past decade on this question.[4]

Box 1.1. Environmental policies and the COVID-19 pandemic.

The COVID-19 pandemic poses a major challenge to economies and societies across the world and it might weigh on economic policies over several years (OECD, 2020[3]).

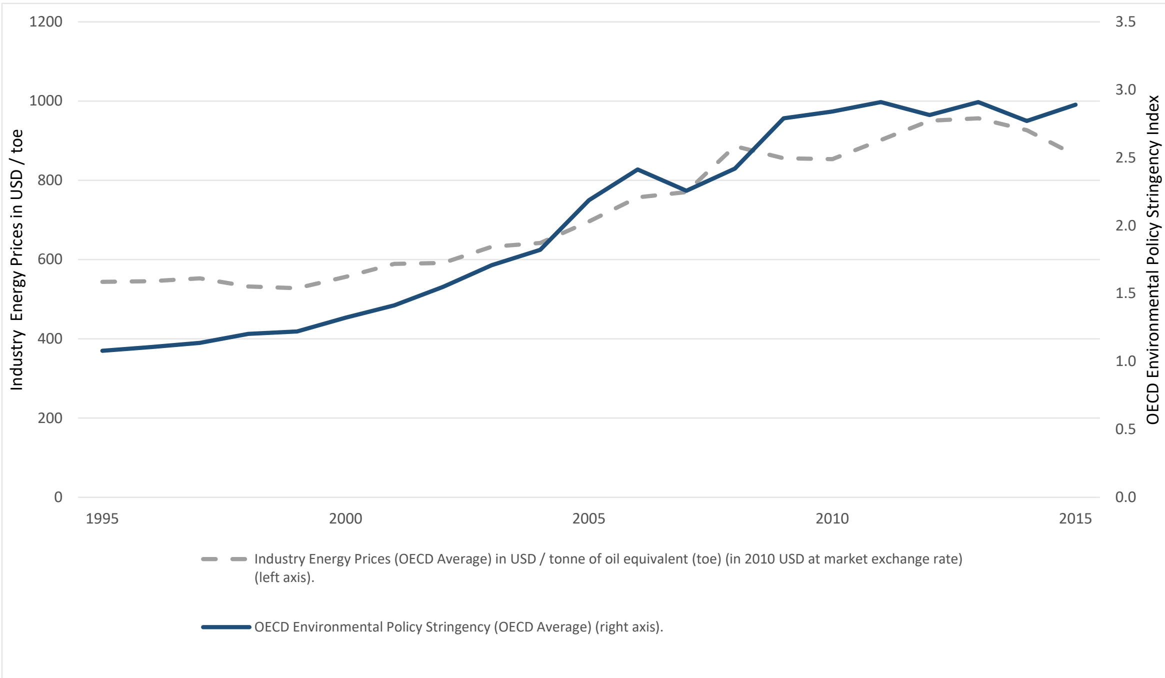
Economic recovery programmes present an opportunity for governments to 'build back better' and to warrant that efforts of meeting climate objectives are not derailed by the pandemic. Well-designed environmental policies can play an important role in aligning the recovery with climate objectives to limit warming to well below 2°C, in line with the Paris Agreement. Learning from previous crises when designing green recovery packages can help ensure more effective policy design (Agrawala, Dussaux and Monti, 2020[4]; OECD, 2020[1]; OECD, 2020[2]).

To meet the targets of the Paris Agreement, a first priority is to avoid the weakening of environmental policies. Investments in energy technologies require long-term planning and policy certainty. Weakening environmental policies increases uncertainty that can delay or discourage investments (OECD, 2020[1]).

Green stimulus packages can help strengthen economic growth and support investments in green technologies (e.g. renewable energy, battery technologies, etc.). Nevertheless, green stimulus packages and investment support for green technologies are not sufficient to deliver continued investment in low-carbon technologies. Longer-term signals are necessary. The removal of fossil fuel subsidies and clear commitment to carbon pricing trajectories can help align price signals, and make investments into climate mitigation technologies more viable.

The studies reviewed in this book provide support for the effectiveness of environmental policies in reducing emissions. Moreover, they show that environmental policies have little aggregate effect on economic outcomes of firms. Well-designed environmental policies – specifically market-based approaches – are suitable and required to help governments align the economic recovery with climate objectives to limit global warming to well below 2°C.

Figure 1.1. Environmental Policy Stringency and energy prices, 1995-2015

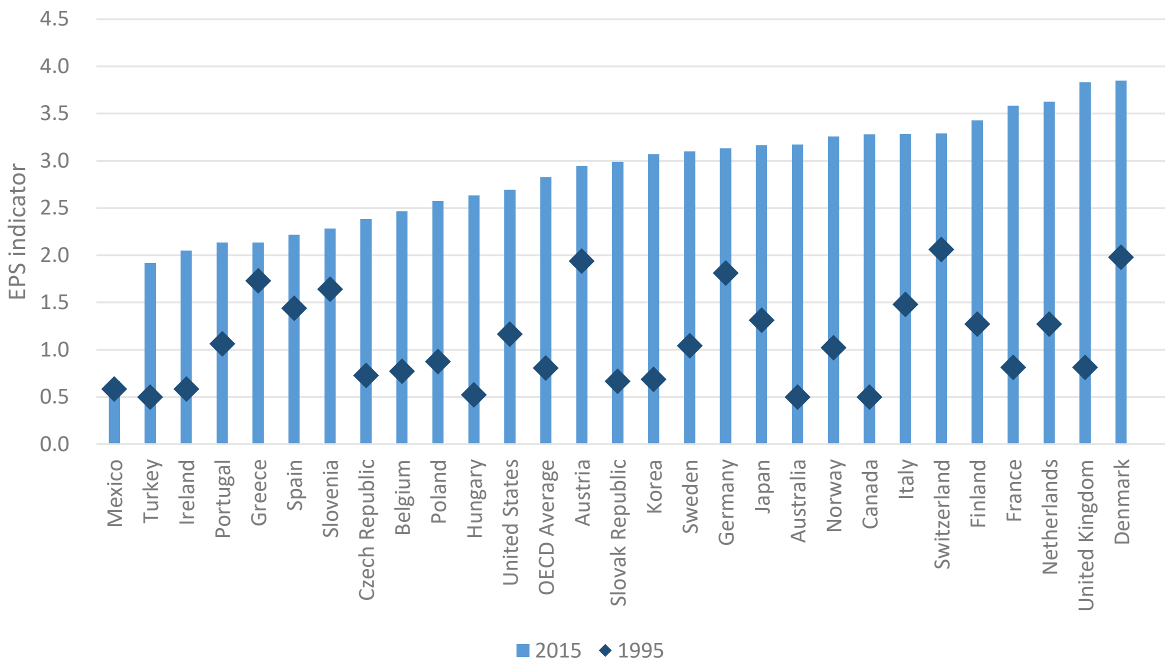


Note: The figure shows the OECD Environmental Policy Stringency (EPS) indicator for the OECD average (solid line, right axis) and industrial energy prices (dashed line, left axis). The OECD EPS average is an unweighted average across 28 OECD countries for which data are available. The industry energy price data are taken from Sato et al. (2019[5]). The values are computed from their VEPL_MER variable (Variable weights Energy Price Level at Market Exchange Rate). It is based on a weighted average of fuel consumption by fuel mix. The graph is based on their industry-level prices which covers 12 industrial sectors across 25 OECD countries.
Source: OECD; Sato et al. (2019[5]).

Environmental policies and competitiveness concerns

Over the two decades that preceded the Paris Agreement, environmental policy has become more stringent at a different pace across countries. Figure 1.2 presents the level of environmental policy stringency across OECD countries in the years 2015 and 1995. It shows significant heterogeneity in the environmental policy stringency across countries, including between countries of similar level of economic development. Some countries also ramped up ambition stronger than others.

Figure 1.2. Environmental Policy Stringency Indicator across countries



Note: The figure shows the evolution of environmental policy stringency from 1995 (squares) to 2015 (bars). Where no data were available for 2015, the data for 2012 are used. Slovenia's starting value is from the year 2008. See Box 1.3. for more details on the measurement of the environmental policy stringency indicator.
Source: OECD Stats.

These regulatory differences affect relative production costs of firms across countries and sectors, for example, by increasing the price of inputs for firms located in the most stringent jurisdictions. This raises the concern that cross-country differences in environmental policy stringency could impact the competitiveness of affected businesses, particularly in a world characterised by the rise in global value chains and the fragmentation and interdependence of production across multiple jurisdictions.

Due to fears of hurting economic growth and shedding jobs, tightening of environmental policies, in particular policies to mitigate climate change, has been politically difficult. While adapting to new environmental regulations unquestionably requires firms to change parts of their production processes and their business models, it might also lead to efficiency gains through restructuring, and induce new resource- and pollution-saving innovations that could enhance productivity. In spite of these potential positive effects of environmental policies, concerns about their potential negative impacts on firms' economic performance often dominate the public and policy debates. This is reinforced by the slowdown of productivity, the reduction of employment in the manufacturing sector in most advanced economies, the 2008 Global Financial Crisis and the modest rates of economic growth experienced by many OECD countries since then (OECD, 2019[6]; OECD, 2019[7]). Concerns about a loss of competitiveness of local industries have also led to multiple exemptions for particular sectors, jeopardising the environmental ambitions.

Evidence from OECD studies

Empirical evidence about the economic effects of environmental policies is needed to implement better-informed policies. This publication summarises eight recent OECD studies investigating the link between environmental policies and economic outcomes, based on cross-country firm-level, sectoral and macro datasets (see Box 1.2 for a brief description of these studies). A wide range of economic outcomes are considered: productivity, employment, domestic investment, foreign direct investment and international trade. In addition to the economic impacts, three of these studies also examine the effects of environmental policies on polluting emissions, making it possible to analyse these two dimensions jointly. This allows to juxtapose the economic impacts and environmental achievements.

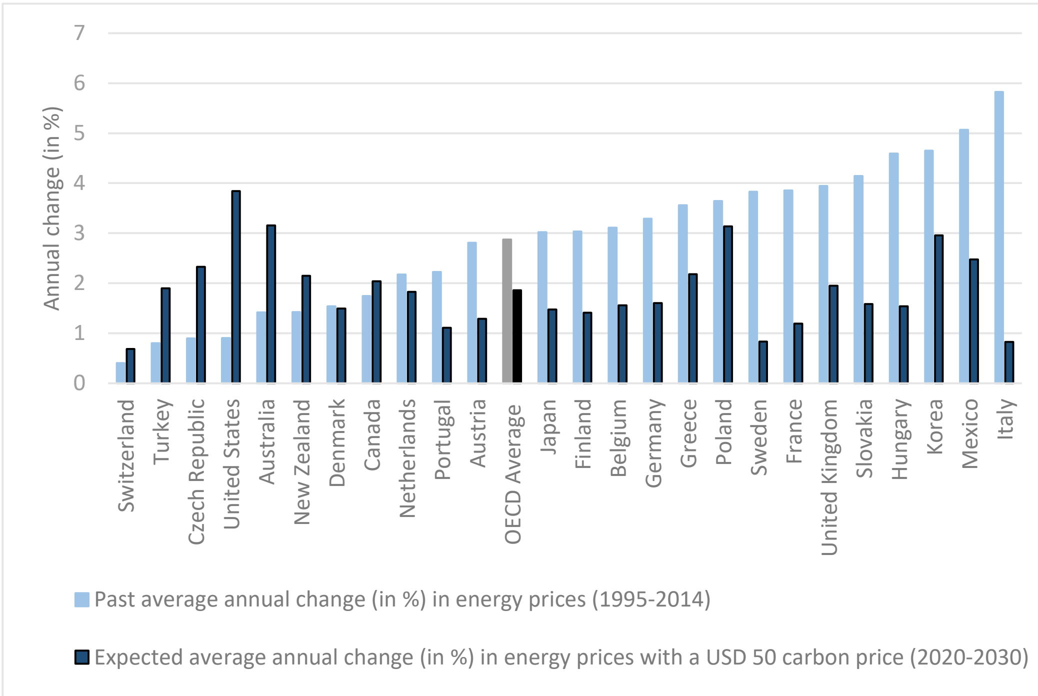
The papers presented in this publication make a common significant contribution to the existing empirical literature: they take a cross-country perspective of the effects of environmental policies, thanks to substantial data collection efforts and the use of comparable policy measures across countries in the analysis. Since firm-level environmental performance data are typically only available from government-owned country-specific datasets, the joint economic and environmental effects are explored instead through country-specific or EU-level case studies.

Is looking at past experience helpful with regard to future environmental policies?

The studies reviewed in this publication leverage on historical changes in the stringency of environmental policies, to analyse their effects on economic outcomes along various dimensions. As shown in Figure 1.2, while the stringency of environmental policy increased substantially over the period 1995-2015, allowing a backward-looking analysis of its effects, the future increases in stringency that are needed to address current challenges, such as climate change, might lie outside past changes. Potential non-linearities in both the economic and environmental effects could thus alter the conclusions drawn from the studies.

What, then, can be learned from past changes with regard to future policies, at a time when many countries around the world are implementing new environmental policies to reduce air pollution, carbon emissions, waste generation and other sources of environmental damage and health risk? In the climate change domain, reaching the ambitious goals of the Paris Agreement is challenging but possible, and does in fact not necessarily imply stronger increases in environmental policy stringency compared to what has been observed over the past decades. As an illustration, Figure 1.3 shows average past annual growth rates of industry energy prices across OECD countries for the period 1995-2014 and compares those with future increases implied by a USD 50/tonne of CO_2 carbon price.[5] It highlights that for the majority of countries, and for OECD countries on average, smaller increases in industry energy prices than those observed in the recent past would be sufficient to reach the targets of the Paris Agreement.[6] These calculations are rather conservative estimates, as they do not incorporate effects of technological break-throughs or consumer responses to higher energy prices. This simple example suggests that looking at past effects of environmental policies, as done by all studies reviewed in this publication, can bring valuable lessons for the future. Nevertheless, such increases are insufficient to achieve full decarbonisation of the economy by 2050.

Figure 1.3. Industry energy prices: Past versus future changes needed to reach a USD 50 per tonne of CO_2 carbon price



Note: The light blue bars indicate past average annual changes (in %) of industry energy prices over the period 1995-2014. The dark blue bars show expected annual changes of industry energy prices (in %) over the period 2020-30 to reach a USD 50 carbon price. The OECD average is an unweighted average of the 25 countries shown in the graph. Industry energy prices can differ from overall energy prices.[7]
Source: Authors' calculation based on data from Sato et al. (2019[5]).

Box 1.2. OECD studies summarised in this publication

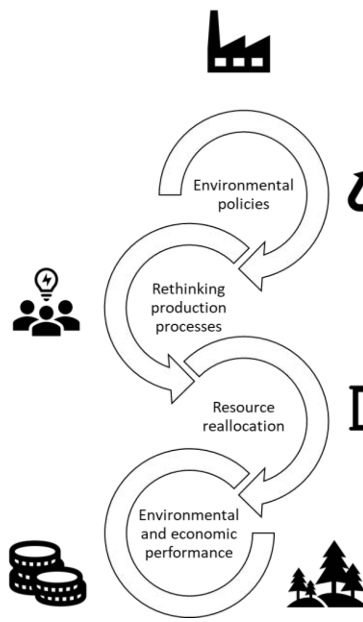
This publication summarises *ex-post* econometric work on the relationship between environmental policies and economic performance for manufacturing industries that has been conducted jointly by the OECD Economics Department and the Environment Directorate over the past years.

- *Productivity:* Albrizio, Koźluk and Zipperer (2017[8]) estimates the effects of environmental policy stringency (as measured by the OECD indicator) on country, industry, and firm-level multifactor productivity (MFP) in 17 OECD countries over the period 1995-2012.
- *Employment:* Dechezleprêtre, Nachtigall and Stadler (2020[9]) examines the effect of changes in energy prices (a proxy for policies aimed at curbing carbon emissions) on employment in the manufacturing sector based on industry-level and firm-level data from 23 OECD countries over the period 2000-14.
- *Investment:* Dlugosch and Koźluk (2017[10]) examines the effect of changes in energy prices on the investment ratio of listed firms over the period 1995-2011 in 30 OECD countries.
- *Foreign direct investment:* Garsous, Koźluk and Dlugosch, (2020[11]) looks at the energy price effect on FDI using data from mandatory balance sheets (share of foreign assets over total assets) of listed companies located in 75 countries over the period 1995-2008.
- *Trade:* Koźluk and Timiliotis (2016[12]) estimates the effect of changes in energy prices on international trade patterns over the period 1990-2009. They use a model of bilateral trade flows between the manufacturing sectors of 23 OECD and 6 BRIICS countries.
- *EU ETS and firm performance:* Dechezleprêtre, Nachtigall and Venmans (2018[13]) examines the effect of the European Union Emissions Trading System on the performance of affected companies in terms of carbon emissions and a range of economic outcomes, such as turnover, employment, investment and profits based on a combination of installation- and firm-level data, using data for 31 European countries over the period 2005-12.
- *Carbon tax and firm performance:* Dussaux (2020[14]) examines the effect of rising energy prices and carbon taxes on the environmental and economic performance of the French manufacturing industry based on firm- and industry-level data over the period 2001-16.
- *Energy prices and firm performance:* Brucal and Dechezleprêtre (2021[15]) analyses the effect of rising energy prices on the environmental and economic performance of the Indonesian manufacturing industry based on firm- and industry-level data over the period of 1980-2015.

The effects of environmental policies on firm behaviour

The effect of environmental policies on environmental and economic outcomes operates through a number of steps, as illustrated in Figure 1.4. When environmental policies are implemented (step 1), polluting facilities have to undertake pollution abatement activities, often imposing additional costs on businesses.[8] Depending on the design of the policy, firms can react with different types of responses. The policy might, for instance, simply require installing a filter on a chimney (so called end-of-pipe abatement). It may, however, also require more substantive adjustments, such as changes in the whole production process, or innovations in the product mix (step 2). The restructuring measures can also imply a reallocation of resources (step 3). This can imply additional investment, changes to the configuration of supply chains, adjusting the number of employees, or a combination of these responses. Once resources are reallocated, in the last step of Figure 1.4, the results of the changed processes will be seen in the environmental and economic performance of firms or industries, e.g. emission levels, productivity or profits.

Figure 1.4. How effects of environmental policies develop



The Pollution Haven and Porter hypotheses: the corner stones of predictions of the economic effects of environmental policies

The theoretical literature on the relationship between environmental policies and economic outcomes provides various predictions about the direction of the economic effects on firms, which are based on two main hypotheses. The so-called "Pollution Haven Hypothesis" (McGuire, 1982[16]) suggests that differences in the stringency of environmental policies across countries will shift pollution-intensive production capacity towards regions with less stringent regulation, where firms enjoy a newly acquired competitive advantage. Thus domestic reductions in pollution levels will be accompanied by increasing emissions in other regions, which is particularly troubling in the case of global pollutants such as carbon dioxide. On the other hand, the so-called "Porter Hypothesis" (Porter, 1991[17]; Porter and van der Linde, 1995[18]) suggests that stringent environmental policies could stimulate productivity growth via efficiency improvements and innovations aimed at avoiding these cost burdens and meeting the cleaner standards set by public policies. Porter argues that firms do not always make optimal decisions and that incomplete information, weak competition, organisational inertia and other behavioural biases may prevent firms from exploiting all profitable innovation opportunities. Environmental policies may thereby help firms to overcome such challenges. Induced innovations in environmentally-friendly technologies could thus lead to a better economic performance, offsetting the additional costs.

Different predictions for different aggregation levels

The validity of these theoretical predictions about the economic effects of environmental policies can differ depending on the level of aggregation, and a negative impact on facilities targeted by environmental policies need not translate into the same negative effect at the macro level. For example, an inefficient plant might need to close down, but the performance of the operating firm owning the plant overall might improve as a consequence. Resources of the inefficient plant may, for example, be used more productively in other plants of the firms. Similarly, sectoral outcomes can hide market dynamics and factor reallocation between individual firms. At the macroeconomic level, taking into account general equilibrium effects, a sectoral decline can be outweighed by another sector's improvement. Closure of inefficient plants might change the competition structure, which could lead to increased production and overall pollution (Qiu, Zhou and Wei, 2018[19]; Guarini, 2020[20]). It is therefore important to analyse the economic effects at different aggregation levels in order to obtain a complete picture of the effects.

Predictions for individual economic outcomes

Taking a closer look at the various economic outcomes discussed in the following chapters, theory typically does not provide a clear-cut prediction of the effect. This underlines the importance of providing empirical evidence.

Productivity, the first outcome studied in this publication, could be expected to increase according to the Porter Hypothesis. However, the additional investment in pollution-control technologies might crowd out more productive investment, potentially causing a productivity slowdown for these firms (Morgenstern, Pizer and Shih, 2002[21]).[9] This holds in particular within the conventional view that firms are perfectly rational and exhaust all profitable investment opportunities. Policy-induced investment in pollution-control technologies could then divert capital from more profitable investments. At the industry level, productivity might, however, still rise if the least productive firms are driven out of the market.

The second outcome studied in this volume is employment. While there might be adjustment costs in the short term, in the long run, there should be no sustained effects on employment as labour should simply shift from polluting to less polluting sectors (Chateau, Bibas and Lanzi, 2018[22]; Fankhauser, Sehhleier and Stern, 2008[23]). The short-term effects could be positive if non-polluting production is more labour-intensive than polluting activities, or negative in case a contraction of output leads to employment losses. For policy making, particular challenges occur, if such job losses are geographically clustered in areas dependent on pollution-intensive industries (Morgenstern, Pizer and Shih, 2002[21]; Kahn and Mansur, 2013[24]).

Whether investment decreases or increases in response to environmental regulation depends on the downsizing and modernisation effects (Xepapadeas and de Zeeuw, 1998[25]). On the one hand, input costs might rise, leading to increased production costs and decreased output via a downsizing effect, eventually lowering investment. On the other hand, increased input costs might encourage firms to switch from old, often energy-intensive machines to new, more energy-efficient ones. Such a modernisation effect could increase overall investment.

Foreign direct investment is the fourth outcome examined here, and theoretical predictions are more univocal in this case. Following the Pollution Haven Hypothesis described above, theory predicts that tighter environmental policies should provide incentives for firms to relocate parts of their production to countries with laxer regulations (McGuire, 1982[16]; Xing and Kolstad, 2002[26]). This is especially relevant for pollution-intensive industries and can potentially lead to carbon leakage, whereby part of the emissions avoided through domestic environmental regulations are simply shifted to other locations.

Trade through global value chains (GVCs) is the fifth outcome studied in this publication. Similar to the predictions about foreign direct investment, off-shoring incentives for firms might lead to more trade through GVCs, e.g. importing pollution-intensive inputs from other countries. However, increased efficiency and productivity through a Porter effect might increase the competitiveness of firms, potentially providing them with a comparative advantage in cleaner production processes and increasing exports in "cleaner" goods.

Measuring environmental policy stringency

A challenge common to any analysis investigating the effects of environmental policies is to measure and quantify these policies accurately. Comparable cross-country measures are often not readily available, leading many studies to draw on country- or sector-specific policies, providing results that are not easily generalisable. Two measures are used in most of the studies presented in this publication, which are both relatively well comparable across countries and time, namely energy prices and an aggregate indicator for the stringency of environmental policies developed by the OECD.

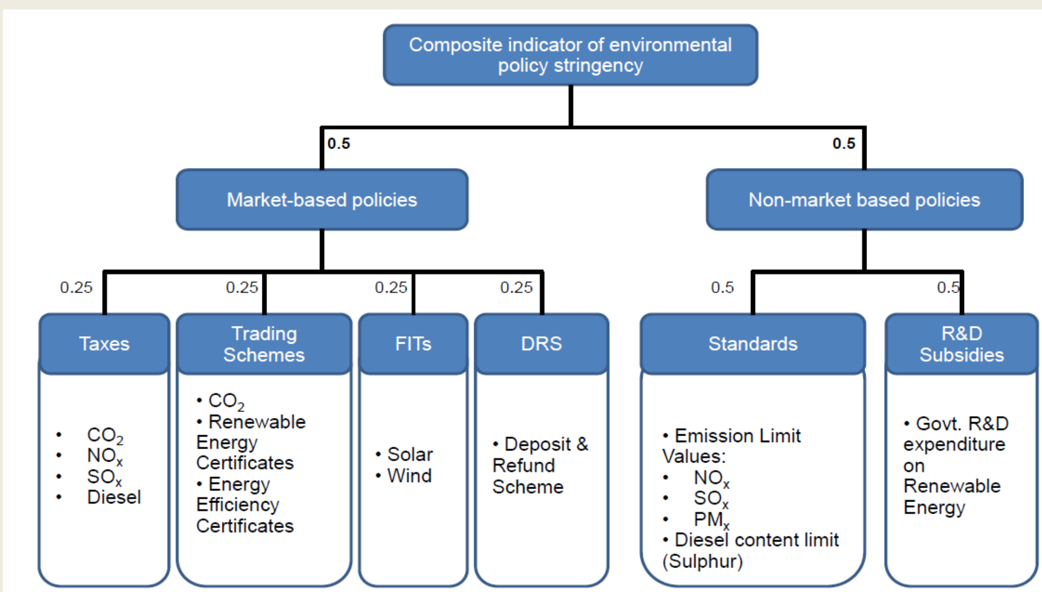
Since climate change policies such as carbon taxes or cap-and-trade mechanisms primarily affect firms through raising energy prices (Aldy and Pizer, 2015[27]), industrial energy prices have emerged as an oft-used proxy for climate policy stringency. While there are common factors that affect energy prices globally, such as crude oil and gas prices, there is considerable variation in energy prices across countries and sectors because of energy taxes or limited integration of energy markets due to transport costs or infrastructure bottlenecks. This variation can be exploited to determine the effect of energy prices on economic outcomes. A major advantage of using energy prices is that they are directly comparable across countries and time. They are also available for a large set of countries and are directly observed at the country-sector level.

However, energy prices offer only a partial measure of environmental policy stringency. In particular, they do not capture non-market-based environmental policies such as command-and-control instruments (e.g. emission standards, air pollutant maximum concentration levels) which do not impact the energy input prices directly. For this reason, the OECD has developed a composite indicator of environmental policy stringency (the EPS index) to provide a reasonably comparable cross-country measure of both market-based and non-market based policy instruments. The EPS index covers a broad set of climate and energy policies, including market-based instruments which assign an explicit price to environmental externalities, and non-market instruments such as standards (Box 1.3). The studies presented in this publication use either industry energy prices or the EPS index, depending on data availability at the time of the studies. Furthermore, the EPS index is available at the country-year level, whereas energy price data varies at country-sector-year level, allowing for more granular analysis.[10]

Box 1.3. The OECD Environmental Policy Stringency indicator

In order to assess the impact of environmental policy on economic outcomes, a first step is to quantify its stringency. The OECD Environmental Policy Stringency (EPS) index (Botta and Koźluk, 2014[28]) is a unique indicator, which allows for reasonably good comparisons both across countries and across time. The Environmental Policy Stringency index is based on the taxonomy developed by (De Serres, Murtin and Nicoletti, 2010[29]) and aggregated along a tree structure where the sub-components are all weighted equally. A market-based sub-component group of instruments, which assign an explicit price to environmental externalities (taxes on CO_2, SO_X, NO_X and diesel fuel; trading schemes for CO_2, renewable energy certificates, and energy efficiency certificates; feed-in-tariffs; and deposit-refund-schemes), while the non-market component clusters command-and-control instruments, such as standards (emission limit values for NO_X, SO_X and PM, limits on sulphur content in diesel), and technology-support policies, such as government R&D subsidies. The score assigns values from 0 (lowest) to 6 (highest) (see Figure 1.5 for the weighting scheme). A higher value indicates stronger or more stringent policies.

Figure 1.5. Structure of the Environmental Policy Stringency indicator (EPS)



Source: Botta and Koźluk (2014).

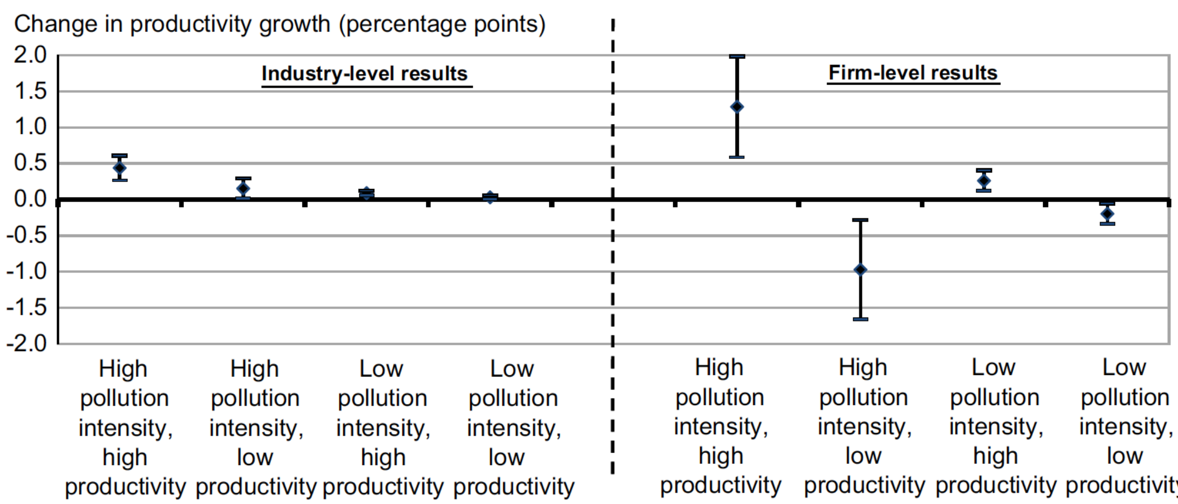
The EPS mainly measures the stringency of climate change and air pollution policies at the country-level, mainly upstream. While this has advantages (for example, the effects of upstream regulations flow downstream as well), the main limitation is that the indicator varies only at the country level. Albrizio, Koźluk and Zipperer (2017[8]) introduce the approach that firms are exposed to environmental policies to a different extent, which they term “environmental dependence”. This is either defined as pollution intensity (emissions over value added) or energy intensity (energy consumption over value added) of a sector. Interacting the environmental dependence with the EPS indicator yields a sector-specific measure of environmental policy stringency.

Economic impacts from environmental policies – empirical evidence from OECD studies

Technologically-advanced industries and firms benefit in the short-run from environmental policies in terms of productivity gains

Potential productivity gains as a result of tighter environmental policies have triggered much literature since the formulation of the Porter Hypothesis. However, empirical evidence has been rather country- or regulation-specific so far. Albrizio, Koźluk and Zipperer (2017[8]), summarised in Chapter 2, use a panel of OECD countries in their analysis and find that industry and firm productivity responses to environmental policies are heterogeneous, depending on the stage of technological advancement of sectors and firms. The study finds that, at the industry level, productivity growth increases in response to more stringent environmental policy, especially in countries where the industry is close to the global technological frontier (Figure 1.6, left hand side panel). The positive effect on industry productivity diminishes as the distance to the global technology frontier increases and vanishes far from the frontier. Thus, in each industry, the most productive countries benefit most in terms of productivity growth, perhaps because, in these countries, firms have access to the best technologies and are most capable to adapt to new regulations, for example, by improving production processes. They may also have the best access to financial markets, and hence be better able to react to the policy change.[11] Moreover, the productivity effect following an environmental policy change also differs depending on exposure to the policy, as measured by energy-and emissions-intensity. Energy-intensive industries (which are more exposed to environmental policies) and non-energy-intensive industries (which are less exposed) both experience productivity gains, but the effect is around twice as large for energy-intensive industries.

Figure 1.6. More stringent environmental policy is related to higher industry and firm productivity, but only close to the productivity frontier



Note: (1) One-year effect of a mean in-sample increase in environmental policy stringency, i.e. 0.12 change in the value of the EPS index in one single year. Effects on productivity growth are estimated to last for three years after the policy change and then fade away: (2) High (low) pollution intensity is defined as an industry with the highest (lowest) pollution intensity on seven selected key pollutants with respect to value added. (3) High productivity is defined as the country-industry pair (or firm) on or close to the estimated global industry (or firm) productivity frontier. Low productivity is defined as country-industry pair (or firm) at the 70th percentile of distance to the global industry (or firm) productivity frontier. (4) 90% confidence intervals are reported.
Source: Albrizio, Koźluk and Zipperer (2017[8]).

At the firm-level, the study finds only partially consistent results with the industry-level: A tightening of environmental policies leads to an increase in the productivity growth of firms close to the technology frontier, but to a decrease in productivity growth for those further away from the frontier (Figure 1.6, right panel). Only one-fifth of the firms are estimated to benefit from environmental policies, while the bottom 30% of firms are hurt in terms of productivity growth. Since smaller firms tend to be further away from the productivity frontier, they are more exposed to the negative effects, possibly because they have limited resources to adapt to the policy changes.

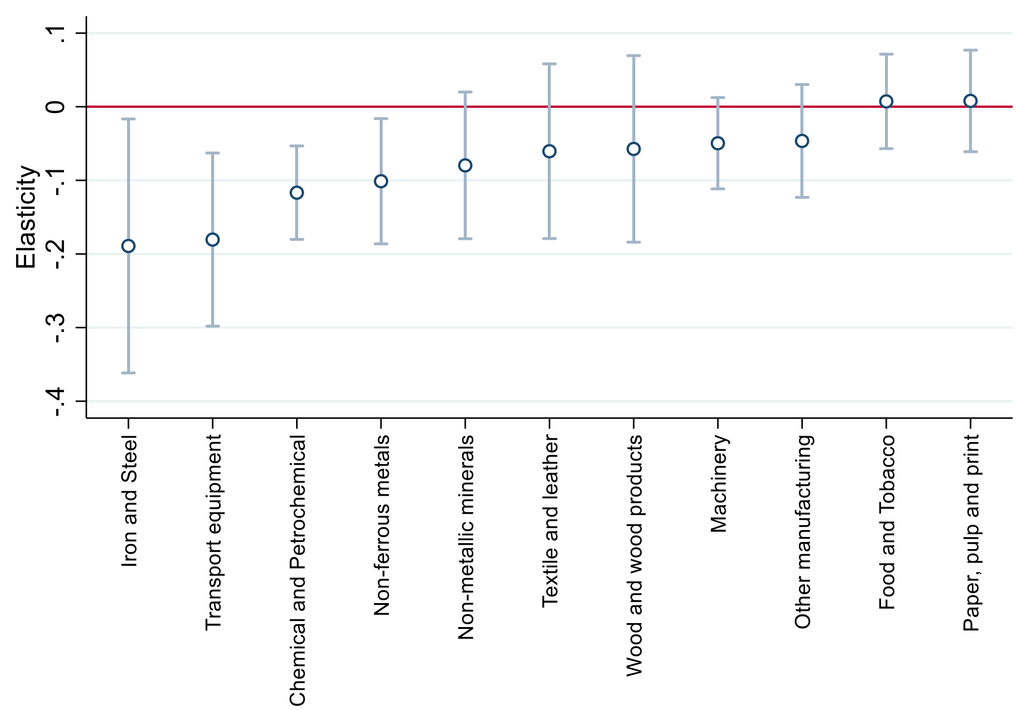
Comparing firm and industry-level results on the productivity effects of environmental policies suggests that part of the adjustment, particularly for less technologically advanced firms, may take the form of firm exit. The exit of the least efficient firms would raise overall industry productivity, cancelling out the negative productivity effects observed in surviving, less efficient firms. Indeed, one may consider the negative effect on the least productive firms as one way to reallocate resources previously locked in firms that were at the margin of exit (Andrews, McGowan and Millot, 2017[30]).

Similar to Albrizio, Koźluk and Zipperer (2017[8]), the broader literature finds heterogeneous effects of environmental policies on productivity. In the short run, environmental policies can have negative effects on productivity in some sectors, and positive impacts in others. The sign of the effects can also vary across pollutants, countries and time. The existing evidence is largely limited to the short run – typically for up to five years. Further work is needed in particular to better understand the long-run effects of environmental policies on productivity, and to understand the underlying reasons for the heterogeneity of results across sectors, pollutants, countries and time (Dechezleprêtre et al., 2019[31]).

Environmental policies have heterogeneous effects on employment, inducing job reallocation between energy-intensive and non-energy-intensive sectors

The effect of environmental policies on employment is a source of major concern, as even small but localised effects can generate strong resistance to policy implementation. The work by Dechezleprêtre, Nachtigall and Stadler (2020[9]), summarised in Chapter 3, shows that, at the sector level, increases in energy prices and in the stringency of environmental policies have a negative and statistically significant impact on total employment in the manufacturing sector. The overall magnitude is small, however: a 10% increase in energy prices leads to a reduction of manufacturing employment by 0.7%. To put things in perspective, job losses linked with increases in energy prices observed over the last two decades in OECD countries are estimated to be respectively 30% and 80% smaller than those due to automation and globalisation. Moreover, these job losses might be partially or completely offset by hires in non-manufacturing sectors, which are not considered in the study. Energy-intensive sectors (e.g. non-metallic minerals, iron and steel) are most affected, while the impact is not statistically significant for less energy-intensive sectors (Figure 1.7.). Even in energy-intensive sectors, however, the size of the effect is relatively small: in iron and steel production – the most affected sector – a 10% increase in the price of energy reduces manufacturing employment by 1.9% in the short run.

Figure 1.7. Short-term employment effect of a 10% increase in energy prices across sectors



Note: The figure shows the effect of a 10% increase in energy prices and 95% confidence intervals of the energy price variable on the log of employment. These underlying models are estimated with a one-year time lag. For the iron and steel sector, a 10% increase in energy prices leads to nearly 2% decline in employment.
Source: Dechezleprêtre, Nachtigall and Stadler (2020[9]).

At the micro level, the results show that higher energy prices have a statistically significant and small *positive* effect on the employment of surviving firms. However, these average effects at the firm level again hide important heterogeneity. In particular sub-sectors (e.g. basic chemicals), even surviving firms suffer and lay off workers because of higher energy prices and stricter environmental policies. The contrasting results of higher energy prices at the sector- and firm-level can be reconciled by looking at business dynamics. An analysis on the energy price effect on firm exit and entry shows that higher energy prices increase the probability of firm exit. Accelerated firm exit allows surviving firms to expand, boosting firm-level employment. Contrary to higher energy prices, stricter environmental policies (including both taxation and non-market regulations) reduce employment of surviving firms. Looking at business dynamics, stricter environmental policies do not affect entry or exit of firms, explaining why the negative effect on employment at the sector-level mirrors the negative effect at the firm-level.

Two country-specific studies summarised in this publication also find evidence of small aggregate effects on employment, with important heterogeneity in job reallocation across firms. Dussaux (2020[14]), summarised in Chapter 8, investigates the impact of energy prices on employment in the French manufacturing sector and finds that rising energy prices do not affect total manufacturing employment. However, employment in large and energy-inefficient surviving firms declines while employment increases in energy-efficient firms, notably SMEs. Similarly, Brucal and Dechezleprêtre (2021[15]), summarised in Chapter 9, looking at the Indonesian manufacturing sector, find small increases in employment among small plants and slight reductions in employment in larger firms, but no effect overall at the manufacturing level. Other empirical papers (Aldy and Pizer, 2015[27]; Dechenes, 2011[32]; Yamazaki, 2017[33]) and OECD modelling studies (Chateau, Bibas and Lanzi, 2018[22]) have similarly found small negative or statistically insignificant effects of environmental policies or energy prices on employment. Such aggregate effects mask significant heterogeneity across firms and sectors, underlining the importance of combining both sector- and firm-level analysis.

In summary, the OECD studies find that past environmental policies have not had large impacts on overall employment in manufacturing industries, despite heterogeneities across sectors. The most energy-intensive as well as the least productive firms tend to experience declines in employment. At the same time, less energy-intensive or more productive firms may benefit and increase employment. Relocation barriers tend to be higher across countries, for example, due to cross-country differences in industry laws. Hence, relocation effects tend to be larger within countries, rather than across countries (Dechezleprêtre et al., 2019[31]; Dechezleprêtre and Sato, 2017[34]). Importantly, the job reallocation rates potentially triggered by environmental policies that raise energy prices are relatively small compared to historical reallocation rates. OECD global simulations (Chateau, Bibas and Lanzi, 2018[22]) show that over the long run, a USD 50/tCO_2 carbon tax implemented in all regions of the world would trigger a reallocation of only around 0.3% of jobs for OECD countries (and 0.8% of jobs for non-OECD countries, because the heavily impacted sectors (energy-intensive sectors) represent only a small share of total employment (82% of the largest CO_2 emitting non-agricultural sectors account for only 8% of total jobs in the average OECD country). In comparison, job reallocation rates averaged 20% of the labour force over the period 1995-2005 in OECD Member countries.

The job reallocation rates triggered by environmental policies also appear small when compared with the potential effects of other major macroeconomic trends. One example of such a trend is the diffusion of new information and communication technologies, which are likely to radically change the type of jobs that will be needed in the future, and how, where and by whom they will be undertaken. For instance, an OECD study based on the OECD's Survey of Adult Skills (PIAAC), estimates that 9% of existing jobs are at a high risk of being automated (Arntz, Gregory and Zierahn, 2016[35]) and 25% of jobs will be changed fundamentally.

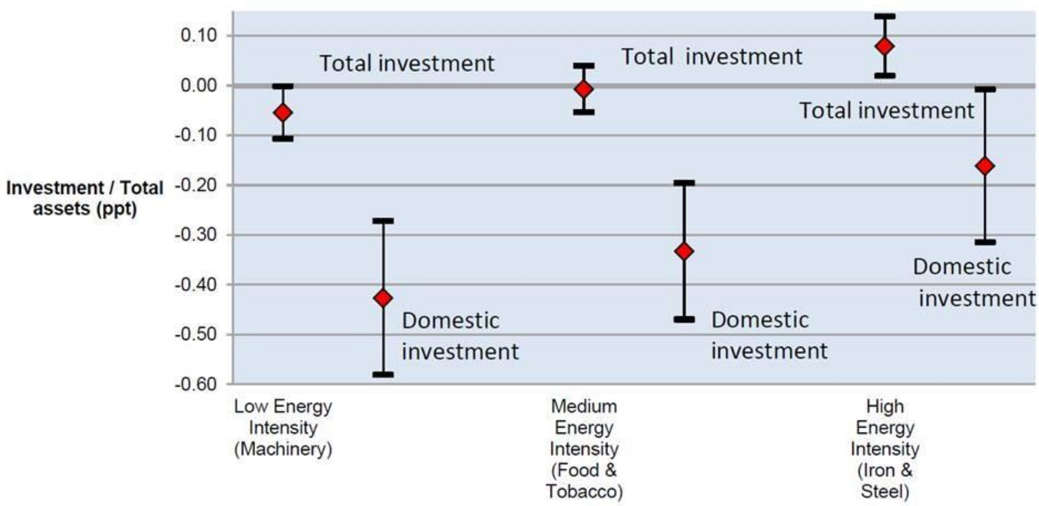
Domestic investment suffers, firms invest more abroad

By requiring polluting companies to make their production process less emission-intensive, environmental policies likely affect investment decisions. The overall effect could be neutral – simply reorienting investment toward less polluting production technologies – but investment in firms affected by environmental regulations could also be discouraged. Dlugosch and Koźluk (2017[10]), summarised in Chapter 4, point to a decline in domestic investment across all manufacturing sectors and to an increase in FDI by firms operating in energy-intensive sectors, possibly reflecting the search for "pollution havens". The analysis is based on balance sheets of listed companies in the manufacturing sector located in 75 countries and focuses on changes in the total investment ratio (i.e. the share of domestic and foreign investment in total assets) following an increase in relative energy prices.

On average, energy prices are associated with lower total investment, but there is significant heterogeneity across sectors. Dlugosch and Koźluk (2017[10]) find that a 10% increase in relative energy prices leads to a 1% decrease in investment on average in the manufacturing sector. However, this result masks significant heterogeneity across sectors: increasing energy prices, which decrease investment in low and medium energy-intensity industries, but increase it in high energy-intensity industries (Figure 1.8.). Their results suggest that in the sectors with a high energy-intensity the effect to modernise machines and equipment is strong and increases overall investment. In sectors with a low energy-intensity, investments are reduced as a response to the increase in energy input costs. Energy is a less important input for these firms, and incentives to modernise energy-consuming equipment are lower. In firms with a low energy intensity, it may also be more difficult to reduce the energy consumption further because energy may be consumed with low intensity across many different parts of the production process. The energy-consuming production may not be at the heart of the business model, making it more difficult to mobilise financial resources to invest in more energy efficient technologies. However, the fall in investment in low energy-intensity sectors, which suffer most, is still quite modest: for a large increase in energy prices (from median to the 75th percentile) of the price distribution across sectors and countries, their investment decreases by 0.12 percentage points (relative to an average investment ratio of 5.6%).

Dechezleprêtre, Nachtigall and Venmans (2018[13]), summarised in Chapter 7, also find that energy-intensive firms regulated by the EU ETS increase their investments (likely in low-carbon technologies), and Brucal and Dechezleprêtre (2021[15]), summarised in Chapter 9, provide evidence that Indonesian firms invest in more energy-efficient machinery and vehicles in response to higher energy prices.

Figure 1.8. Increases in energy prices barely affect total investment but decrease domestic investment in all sectors



Note: The dots represent the estimated effects of a change of energy price growth from the median (Poland) to the 75th percentile (Germany) for different values of energy intensity. Values on the vertical axis are expressed in percentage points. For example, at low levels of energy intensity a change of energy price growth from the median to the 75th percentile is associated with a 0.42 percentage point decline in the investment ratio (investment / total assets). The black lines indicate the 90% confidence intervals.
Source: Dlugosch and Koźluk (2017[10]).

Overall, the size of these estimated effects is quite small, especially when compared with the effects of other structural policies that either deter or encourage investment. The econometric results show that changes in energy prices explain a very small part of changes in domestic investment. Other factors, included as control variables – such as macroeconomic trends or changes in employment protection legislation – had a much larger effect on investment between 1990 and 2012 than energy prices.

The positive effect on total investment for energy-intensive industries found by Dlugosch and Koźluk (2017[10]) in their global study appears to be driven by an increase in the amount of foreign investment, perhaps in countries where environmental policies are laxer (and energy prices lower). Indeed, Dlugosch and Koźluk (2017[10]) split investment into its domestic and its foreign components and find that environmental policy decreases domestic investment, regardless of energy intensity (Figure 1.8.). This discrepancy between the effect on total and on domestic investment points to an effect on foreign investment. This hypothesis is directly tested by Garsous, Koźluk and Dlugosch (2020[11]), summarised in Chapter 5, using changes in relative energy prices as the main explanatory variable. They show that a 10% increase in relative energy prices leads to an increase of 0.5 percentage points in the ratio between foreign and total assets, from a mean of 14% in the first year after the price increase. The effect increases over a longer time horizon to about 0.75 percentage points. This effect on FDI is more pronounced in energy-intensive sectors: a 10% increase in energy prices, which are affected by energy taxes, carbon pricing and other environmental policy instruments to reduce pollution associated with fossil fuel energy consumption, increases outward FDI by about 1.1 percentage points for these sectors. Based on their empirical model, Garsous, Koźluk and Dlugosch (2020[11]) simulate the effect on FDI of introducing a modest (USD 15/tCO_2) and a large (USD 55/tCO_2) carbon tax in the industry. Even a large carbon tax was found to have a small effect on FDI.

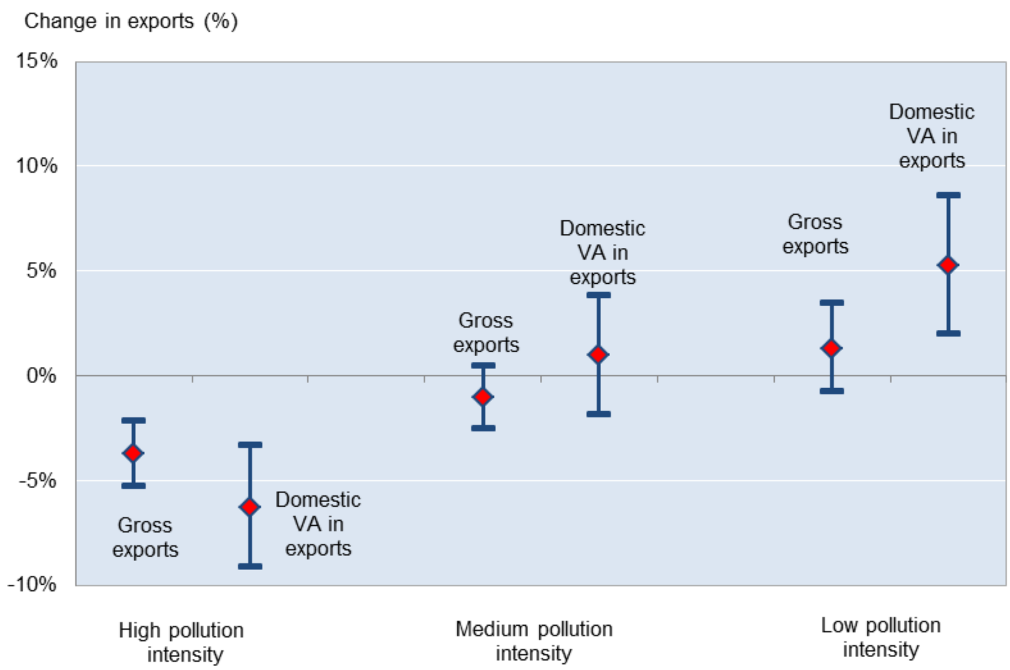
The broader literature on the effects of environmental regulation on FDI remains inconclusive. Most studies find that environmental policies either have no significant effect on FDI or lead at most to small increases in foreign assets, in line with Dlugosch and Koźluk (2017[10]) and Garsous, Koźluk and Dlugosch (2020[11]). In a review of the literature, Dechezleprêtre and Sato (2017[34]) show that the overall conclusions are sensitive to the geographic coverage, the type of environmental regulation, and the empirical specification, including the data and use of control variables. Thus, it seems that concerns regarding the adverse effects of environmental policies via this “pollution haven” channel are likely to be somewhat overstated.

Overall trade flows are barely affected, with rising exports of low-pollution sectors and declining exchanges of high-pollution ones

Another major source of policy concern is that stringent environmental policies may affect the competitiveness of regulated firms and thus their export market share. Yet, using trade data from 23 OECD countries and 10 manufacturing industries, Koźluk and Timiliotis (2016[12]), summarised in Chapter 6, find that, overall, environmental policies (as measured by the OECD EPS indicator described in Box 1.3) have had little effect on trade measured either in terms of gross exports or in terms of the domestic value added embedded in exports (which accounts for the rise in global value chains that increasingly decouple gross exports from trade in value added).[12] In line with priors, they also find that environmental policies affect more strongly the domestic value added export component than gross exports. This is expected because gross exports include to a large share imported intermediate components, which are not exposed to the domestic environmental policy.

As with other effects of environmental policies, this overall finding masks heterogeneous impacts on sectors depending on their pollution intensity. When environmental policies become more stringent in the exporting country, exports of high-pollution sectors decline, whereas exports of lower-pollution sectors increase, in line with basic trade theory. The latter finding echoes some earlier work suggesting that more stringent environmental policies may be associated with higher exports of so-called environmental goods (Sauvage, 2014[36]). Measured in terms of value added, the negative effect on pollution-intensive industries is counterbalanced by a positive effect on low-pollution industries of the same magnitude, both strongly significant (Figure 1.9).

Figure 1.9. Environmental policy decreases exports in high pollution industries and increases exports in low pollution industries

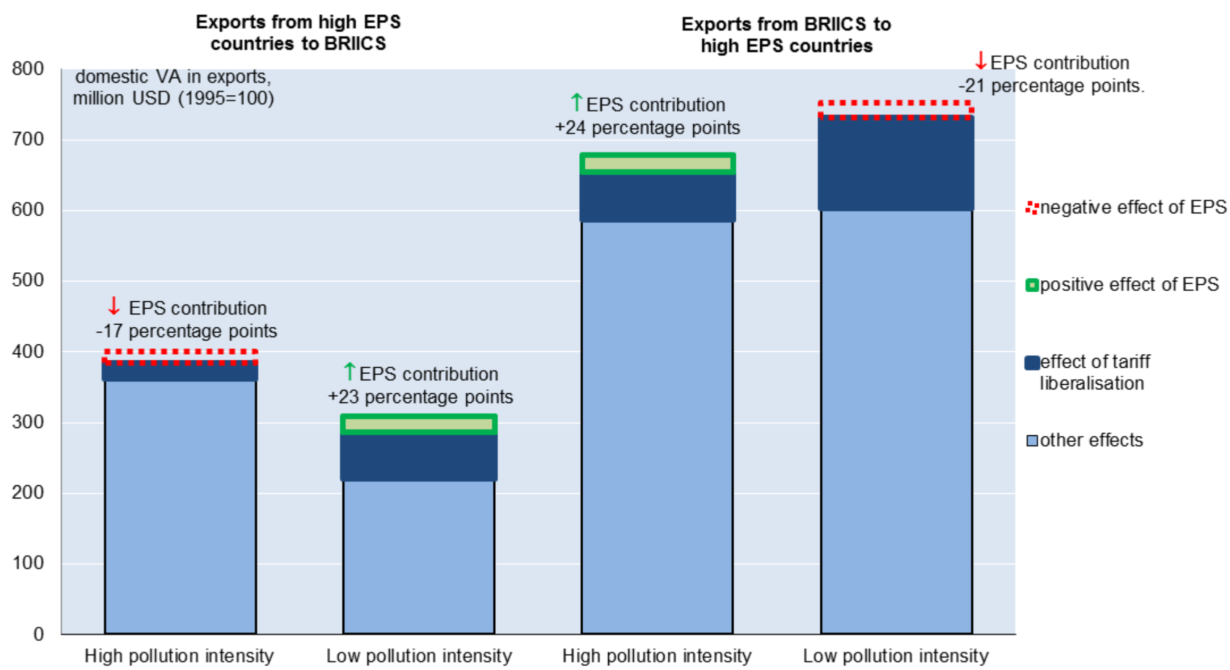


Note: The figure shows the effect on trade flows (exports from one country to another) associated with a change in the comparative environmental policy stringency between two countries. The dots represent the estimated effects of a change in the comparative environmental policy stringency on the trade performance. The change in environmental policy stringency compares two countries in which policies are equally stringent (median) to a situation in which the difference is large (75th percentile of distribution of difference). Effects are shown for three types of sectors with a high, medium or low pollution intensity. The blue lines indicate the 90% confidence intervals. The estimated coefficients are short-term effects (1 year lag).
Source: Koźluk and Timiliotis (2016[12]).

These findings suggest that, ceteris paribus, increased regulatory stringency in one country (for example, Denmark, Germany or Switzerland which tend to have a higher environmental policy stringency) leads foreign countries (e.g. the BRIICS countries - Brazil, Russia, India, Indonesia and China - which tend to have a lower environmental policy stringency) to specialise in the production of polluting goods which they can subsequently export back to "virtuous" countries (Levinson and Taylor, 2008[37]). This concern is particularly troubling for environmental policy aimed at addressing global environmental problems such as climate change, since pollution may simply be shifted to another region, with the same effects on global environmental degradation. However, the change in comparative advantage of polluting industries is estimated to be relatively small compared to other factors affecting trade. Focusing on trade between OECD and emerging countries over the 1995-2008 period, Figure 1.10 shows the size of the effect on exports from high-pollution industries in OECD countries toward emerging economies and compares this with the impact on low-pollution industries, accounting for differences in the stringency of environmental policies in these two groups of countries. The three colours show the effect of environmental policy (red: negative and green: positive), the effect of changing tariff structures (dark blue) and other effects, such as capital and labour endowment or institutional quality (light blue). The adverse effects of environmental policy on high-pollution sectors are not only compensated by positive effects on low-pollution industries, but also dwarfed by the effects of past tariff liberalisations and other factors.

These results confirm previous research focusing on how imports and bilateral trade flows are affected by environmental policy, which finds no aggregate effect at the country level and only a limited effect on energy-intensive industries (Aldy and Pizer, 2015[27]; Branger, Quirion and Chevallier, 2017[38]). In related work, Sato and Dechezleprêtre (2015[39]) conclude that energy price differences between countries only explain 0.01 percent of the variation in trade flows. Thus, trade is barely affected by environmental policies. Dechezleprêtre and Sato (2017[34]) draw similar conclusions after a review of the "pollution haven" literature that analyses trade patterns. In response to stricter environmental regulation, imports of pollution-intensive goods tend to increase. The effect is, however, small and concentrated in a few sectors. Other determinants of trade flows tend to dominate the effect of environmental policy stringency. Levinson (2010[40]) for instance argues that any "pollution haven" effect is likely overwhelmed by factors such as the cost and availability of skilled workers, raw materials, transport costs and the overall market structure.

Figure 1.10. Environmental policy has small effects on trade patterns, even in pollution-intensive sectors



Note: The figure shows the export increase from 1995 to 2008, between high EPS countries and BRIICS countries (typically with low EPS scores) in high- and low- pollution-intensity sectors. The green rectangles indicate increase in exports caused by differences in environmental policy stringency. The red indicates lost export due to differences in environmental policies. The dark blue parts show the effect of tariff liberalisations and the light blue shows other effects.
Source: Koźluk and Timiliotis (2016[12]).

Are the economic effects small only because the effects on environmental outcomes are small? Joint analysis of economic and environmental impacts

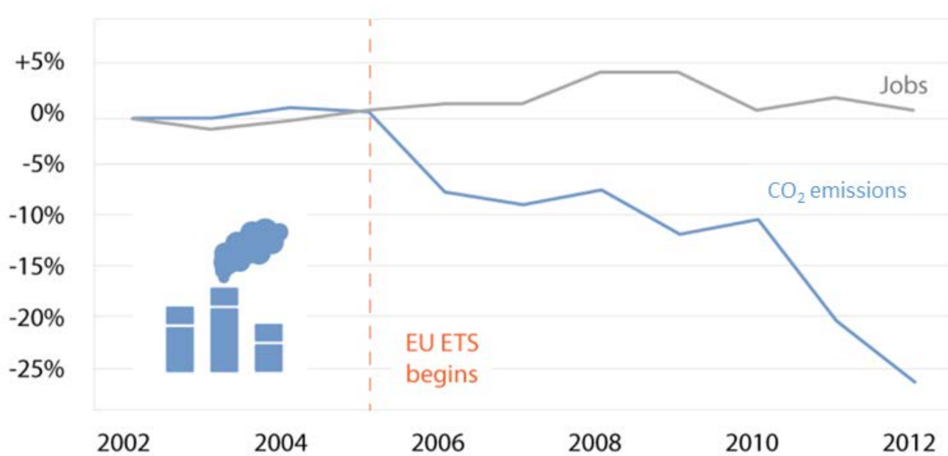
The results of the studies summarised in this publication show that environmental policies do not hurt economic performance significantly, but induce factor reallocations both within and across sectors, generating winners and losers. But are these small average effects – even if they hide important heterogeneity – a simple consequence of lax environmental policies? If this is the case, then more stringent policies in the future might have larger adverse consequences on the economy. To answer this question, empirical analyses of the effects of environmental policies need to look *jointly* at economic and environmental performance. Three studies summarised in this publication carry out such an empirical analysis of the joint environmental and economic effects of climate change policies and energy prices, providing insights into the full impact of environmental policies on environmental targets (their primary objective) and economic performance.

The European Union Emissions Trading System and its economic and environmental impacts

Dechezleprêtre, Nachtigall and Venmans (2018[13]), summarised in Chapter 7, provide a comprehensive firm-level impact evaluation of the effects of the EU's Emission Trading System (ETS) on carbon emissions and economic outcomes. The EU ETS is the European Union's flagship climate policy instrument and is the largest carbon market in the world, covering more than 12 000 plants in 31 countries (Laing et al., 2014[41]). Dechezleprêtre, Nachtigall and Venmans (2018[13]) recover the causal effect of the EU ETS on regulated companies by comparing them with unregulated, but similar firms and installations in terms of economic variables and emissions before the policy implementation (a "matching" method), examining effects on firms' emissions, revenues, employment, investment and profits.

The results of the study on the effects of the EU ETS show that the emissions trading system led to a substantial reduction of emissions. Figure 1.11 shows that, as a consequence of the EU ETS, carbon emissions were on average 10% lower between 2005 and 2012 than pre-2005, while employment remained unaffected. In addition, the study did not find any statistically significant effects on firms' profits, but a positive effect on revenues and fixed assets of regulated firms. One explanation for this finding could be that the EU ETS induced investment into low-carbon technologies, thereby increasing productivity and thus leading to higher revenues. Similar effects have also been found in country-level studies by Wagner et al. (2014[42]) for France, by Petrick and Wagner (2014[43]) for Germany, and by Klemetsen et al. (2020[44]) for Norway (see Dechezleprêtre et al. (2019[31]) for a detailed review).

Figure 1.11. Environmental and economic effects of the EU ETS



Note: The figure shows the causal year-specific impact of participation in the EU ETS on CO_2 emissions of regulated plants and number of employees of their mother companies by year. Over the period 2005-12, the average treatment effect is +2% for employment (not statistically significant) and -10% for CO_2 emissions.
Source: Based on Dechezleprêtre, Nachtigall and Venmans (2018[13]).

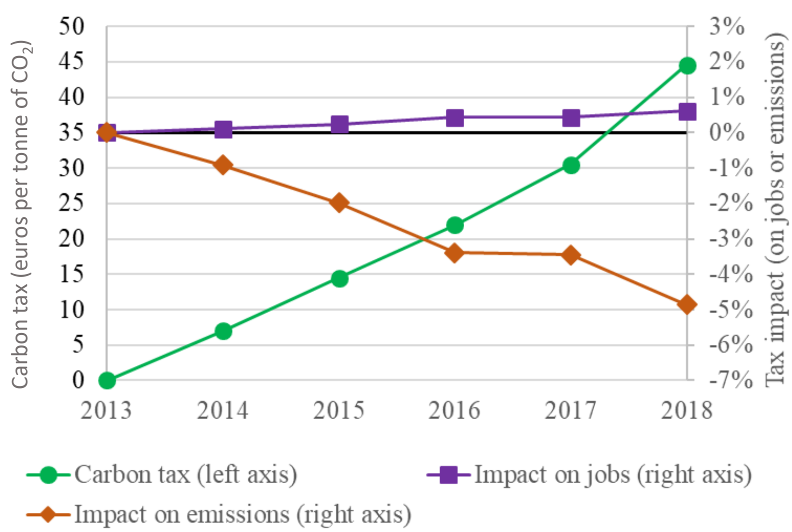
The joint effects of energy prices and carbon taxes in the French manufacturing sector

Dussaux (2020[14]), summarised in Chapter 8, investigates the effects of energy prices on energy use, carbon emissions, employment, output and investment in the French manufacturing sector. The study shows that, at the firm level, a 10% increase in energy costs results in a 6% decline in energy use, a 9% decrease in carbon emissions, and a 2% decrease in the number of full-time employees within one year.

However, these jobs are not lost, but are reallocated to other firms. At the industry level, the study finds no statistical link between energy prices and net job impacts, indicating that jobs lost at affected firms are compensated by increases in employment in other firms operating in the same sector during the same year. On average, large and energy-intensive firms experience a greater reduction in carbon emissions and greater job reallocation than smaller and energy-efficient firms.

The paper is able to measure the causal effect of the French carbon tax on the aggregate manufacturing sector since its introduction in 2014. Figure 1.12 plots the carbon tax on the left axis (green line) together with the impact of the carbon tax on the French manufacturing sector's jobs (purple line) and carbon emissions (red line) on the right axis. In five years, the carbon tax decreased carbon emissions by 5%. The net effect on employment is much smaller in magnitude and even slightly positive at 0.8%.

Figure 1.12. The impact of the French carbon tax on aggregate jobs and CO_2 emissions



Note: The figure shows the simulated impact of the carbon tax on the number of jobs and CO_2 emissions of the French manufacturing sector.
Source: Dussaux (2020[14]).

The joint effects of energy prices in the Indonesian manufacturing sector

Brucal and Dechezleprêtre (2021[15]), summarised in Chapter 9, look at the Indonesian manufacturing sector, analysing the effect of rising energy prices on energy use, carbon emissions, employment and output. In line with the finding of the French case study, Brucal and Dechezleprêtre (2021[15]) show that a 10% increase in energy prices leads to a decrease of 5.2% in energy use and a reduction of CO_2 emissions by 5.8%. The decrease in employment is much lower, at 0.2%. Rising energy prices also increase the probability of plant exit. However, at the aggregate sectoral level, the analysis shows no statistically significant effect on employment in response to rising energy prices, suggesting that job losses due to plant exit are compensated by job creation in new plants.

Therefore, the results of the case studies looking at the joint environmental and economic effects of environmental policies paint a reassuring picture, with environmental policies reducing emissions without hurting economic performance, in particular employment, at the aggregate level. This is without considering the significant benefits of environmental policies in terms of improved human health and increased welfare, which in cost-benefit analyses typically vastly dominate economic costs (Barde and Pearce, 2013[45]; Rehdanz and Maddison, 2008[46]; Pope and Dockery, 2006[47]; Pruss, 1998[48]). To give just one example, the 1990 Clean Air Act Amendments in the United States are estimated to have induced

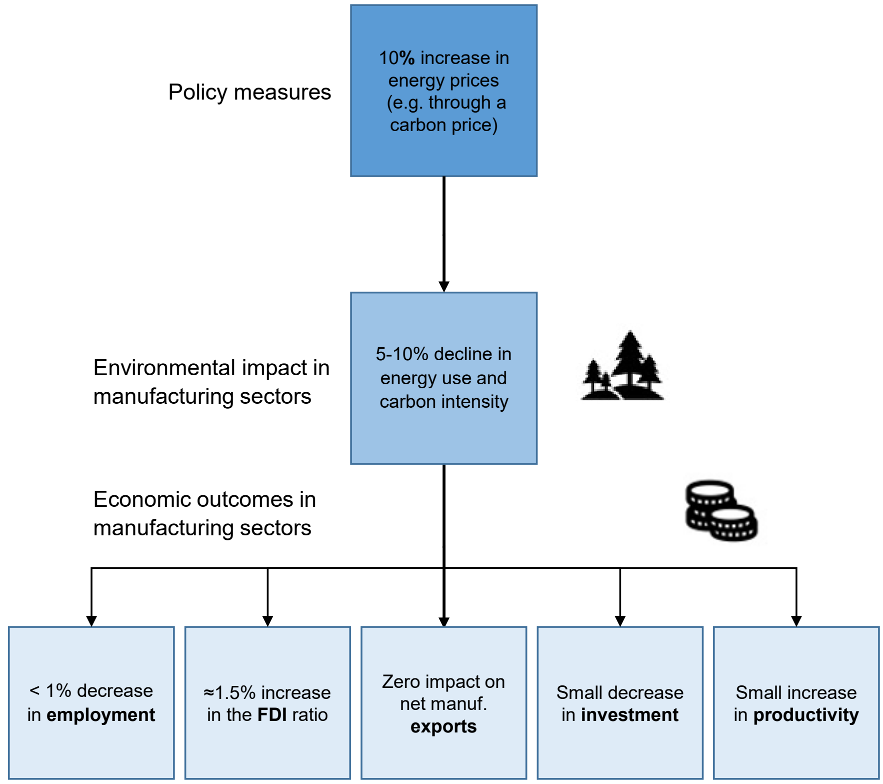
USD 100 billion benefits in terms of improved health and other environmental outcomes, for a total estimated compliance cost associated with the adoption of new pollution control technologies well over an order of magnitude smaller, between USD 3 and USD 6 billion (Chestnut and Mills, 2005[49]).

Summing up: What to expect from a 10% increase in relative energy prices?

The results of the studies on economic outcomes summarised in this publication show that more stringent environmental policies do not hurt economic performance significantly on average, with some heterogeneity across firms. Figure 1.13 summarises the magnitudes of the average effects – as estimated across the studies in this book – from a 10% increase in energy prices, which is typical of what most OECD countries have experienced over the 2005-15 decade. The results cover only the manufacturing sector, and are estimated for unilateral increases in energy prices relative to other countries and sectors. The increase in energy prices – which could stem from a price or tax imposed on carbon emissions, for instance – is expected to result in a decline in energy use and carbon intensity of 5% to 10% – a large effect. The effect on energy use and carbon intensity is expected to occur over a similar time horizon as the increase in energy prices, with a short delay of one or two years because firms require time to react to the change. In comparison, the effects on economic outcomes are much smaller, with employment expected to decrease by less than 1% on average. This effect is mostly being driven by energy-intensive firms with low productivity. A 10% increase in energy prices is likely to result in a small decrease of total firm investment and a small increase of around 1.5% of foreign investment by firms. The change in relative energy prices across countries can therefore result in a small shift of investment abroad. Total exports in manufacturing goods are not expected to change as a result of a 10% increase in energy prices. Finally, productivity should slightly increase on average, with highly productive firms expected to observe a small increase in productivity and low-productivity firms expected to experience a small decrease. These effects on economic outcomes are also expected to occur with a short delay of one or two years to the changes in energy prices because firms require time to react and adjust their production processes.

To summarise, a 10% increase in energy prices relative to other countries – recall that industry energy prices increased by 50% between 1995 and 2015 across OECD countries (Figure 1.1) – can deliver substantial environmental benefits through reductions of carbon intensity, while not causing a significant loss of jobs or decline in competitiveness of manufacturing firms. Note that these estimated effects are based on unilateral increases in energy prices, implying that effects on employment and competitiveness would be much smaller if prices were simultaneously raised in other countries. Statements suggesting that carbon pricing would result in substantial job losses and sizable harm to the economy seem to vastly overstate expected economic effects.

Figure 1.13. Expected effects from a 10% increase in energy prices on environmental and economic outcomes in manufacturing sectors



Note: This figure illustrates average expected effects from a 10% increase in industry energy prices on environmental and economic outcomes in manufacturing sectors. It shows effects from across several OECD studies, which cover different samples, time periods and methods. Effects may differ across countries depending on country-specific policy contexts, macro-economic effects and the time horizon.
Source: Authors.

Winners and losers

However, while more stringent environmental policies do not hurt economic performance significantly on average, the results of the studies summarised in this publication show that they also generate winners and losers (see Table 1.1 for a summary of the results). On the one hand, environmental policies entail costs, mainly on high-pollution industries and low-productivity firms: employment (Chapter 3), trade (Chapter 6) and investment outcomes (Chapters 4 and 5) are worsened for pollution-intensive companies, and the productivity of laggard firms is hurt by policy changes (Chapter 2). On the other hand, more stringent environmental policies also have positive effects like improving productivity of frontrunner industries and firms (Chapter 2) or increasing exports in non-pollution-intensive industries (Chapter 6). Overall, the small negative effects seem transitory and environmental policies mainly trigger a reallocation of factors from high- to low-emission industries. Therefore, the evidence summarised in this publication supports both the Porter Hypothesis (environmental policies can increase productivity) and the Pollution Haven hypothesis (environmental policies can increase outward FDI and imports of high-pollution products). It should, however, be kept in mind that the size of the estimated effects is small and that beneficial effects on the environment and human health are not even accounted for.

Table 1.1. Summary of empirical evidence showing the heterogeneity of economic outcomes from a tightening of environmental regulation in manufacturing sectors

Average economic outcomes from tightening of environmental regulation	Firm level		Industry level	
Productivity in manufacturing	High productivity firms	Low productivity firms	High productivity industries	Low productivity industries
	Increase	Decrease	Increase	No effect
Employment in manufacturing	Low productivity, energy-intensive	Others	Energy- intensive	Non-energy-intensive
	Decrease	Increase	Decrease	No effect
Total investment in manufacturing	Energy-intensive listed firms	Non-energy-intensive listed firms	Energy-intensive industries (listed firms)	Non-energy-intensive industries (listed firms)
	Increase	Decrease	Increase	Decrease
FDI in manufacturing	Domestic investment of listed firms	Foreign investment of listed firms	Domestic investment of industries (listed firms)	Foreign investment of industries (listed firms)
	Decrease	Increase	Decrease	Increase
Exports in manufactured goods	/		Pollution-intensive industries	Non-pollution intensive industries
			Decrease	Increase

Source: Authors.

Economy-friendly environmental policies

Implementation of stringent environmental policies remains politically difficult because small but highly localised economic harm (e.g. in terms of employment or competitiveness losses) can generate strong opposition to dealing with environmental issues. Therefore, from both efficiency and political standpoints, it is important to design environmental policies in a way that underpins their positive net effects on the economy without sacrificing their impact on the environment. While a complete treatment of these issues is beyond the scope of this publication, two areas deserve to be mentioned: the choice of environmental policy instrument and the packaging of environmental and other policies.

Appropriate policy design can underpin the economic benefits of environmental policies

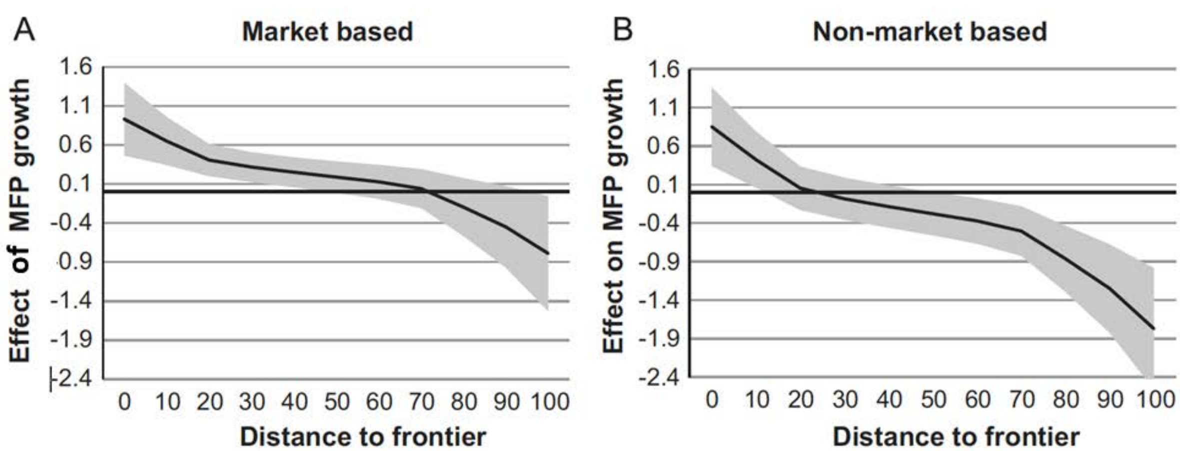
Market-based environmental policy instruments, which emit price signals (e.g. taxes, cap and trade systems), are generally considered to be more cost-effective than non-market instruments (e.g. bans, technology standards) (De Serres, Murtin and Nicoletti, 2010[29]). The use of these instruments can therefore be expected to boost the positive effects of environmental policies on firm performance and limit any detrimental impacts. This is mainly because, under a market-based mechanism, firms have more flexibility in choosing the technology and timing of adjustment, compared to technology standards, which tend to be more rigid. Indeed, policy flexibility is one of the key components for a competitiveness-enhancing environmental policy according to Porter and van der Linde (1995[18]).

The results of Albrizio, Koźluk and Zipperer (2017[8]) lend support for the cost-efficiency argument in favour of market-based instruments. They separately assess the impact of market and non-market based instruments on productivity. The firm-level analysis suggests that increases in environmental stringency obtained with market-based instruments may enhance productivity growth of the frontrunners and leave those at the bottom of the productivity distribution almost unaffected (Figure 1.14.), while some evidence suggests that non-market based instruments may slow down productivity growth of laggard firms and do not benefit the productivity of frontrunner firms. However, further empirical work on the differences between market-based and non-market based instruments is needed. Non-market based instruments have, for example, the benefit of being administratively easier and cheaper to implement. They can achieve emission reductions relatively quickly and may even encourage innovation if the technology standard prohibits the use of a specific technology rather than requiring firms to use a specific technology (Klemetsen, Bye and Raknerud, 2013[50]).

In short, compared with other instruments, market-based environmental policies are found to enhance positive effects on the economy, while lowering the negative ones. The case study of the effect of the largest market-based environmental policy in the world, the European Union Emissions Trading System, on economic outcomes (Dechezleprêtre, Nachtigall and Venmans (2018[13]), summarised in Chapter 7) provides additional evidence on the potential benefits of using a market-based policy approach.

Figure 1.14. Market-based policies enhance the positive effects and lower the negative ones

Effects of an increase in market and non-market based components of EPS on firm-level multifactor productivity growth



Note: The solid line shows the marginal effect of a one-point tightening of firm-level environmental policy stringency. The grey areas represent the 95% confidence intervals. The horizontal axis represents the distance from the productivity frontier, where 0 represents the firms that are on the frontier, 100 represents the firms furthest from the frontier. Panel A shows the effect of market-based environmental policies, Panel B shows the effect of non-market based policies.
Source: Albrizio, Koźluk and Zipperer (2017[8]).

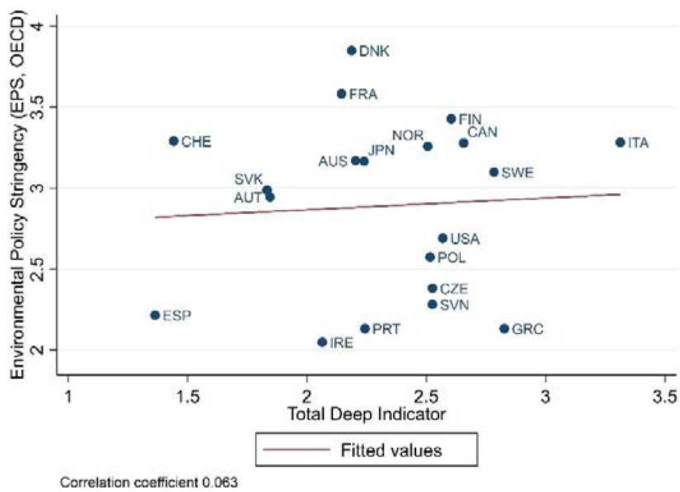
More stringent environmental policies do not have to come with an increased regulatory burden

Related evidence, based on the OECD indicator of Design and Evaluation of Environmental Policies (DEEP) (Box 1.4), suggests that more stringent environmental policies (as measured by the EPS indicator) need not be associated with heavier burdens on the economy. Plotting the DEEP indicator against the

OECD indicator of environmental policy stringency (EPS) suggests that, depending on the choice of policy instrument, highly stringent policies can be achieved without burdening the economy with restrictions on firm entry and competition (Figure 1.15). For example, countries such as the Netherlands, Switzerland and Austria were able to implement stringent environmental policies while putting relatively little burden on market dynamism.

Figure 1.15. Stringent environmental policies need not put a burden on the economy

EPS vs DEEP indicators



Note: The figure shows the lack of relationship between the stringency of policies and the restrictions they put on the economy in terms of entry and competition. The stringency is measured on the horizontal axis, by the EPS indicator, the burden is measured on the vertical axis, by the DEEP indicator (Box 1.4).

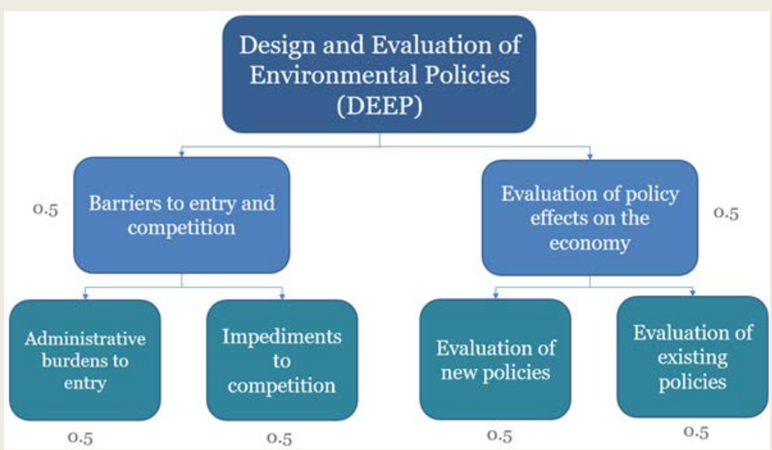
Source: Berestycki and Dechezleprêtre (2020[51]).

Box 1.4. The OECD indicator of Design and Evaluation of Environmental Policies (DEEP)

OECD experience shows that poorly-designed product market regulations can create barriers for entry and competition, which slows economic growth (Bourlès et al., 2013[52]). Similarly, some design and implementation features of environmental policies can burden entry and competition, which could hamper growth. Building upon Koźluk (2014[53]), Berestycki and Dechezleprêtre (2020[51]) construct an indicator of the "Design and Evaluation of Environmental Policies" (DEEP), [13] which is composed of two broad parts: the current administrative burdens and impediments to competition, and the evaluation of past and future environmental policy effects on the economy (Figure 1.16).

Specifically, the first half of the survey, which includes 25 questions, measures the first component: the additional administrative burdens and impediments to competition implied by environmental regulations. For example, the questions ask about the ease of finding information or making an application of new business, or whether the incumbents face different regulations than new entrants. The second half measures the second component: evaluation of new and existing policies. For example, whether an evaluation of new policies takes place involving stakeholders, and what economic effects are evaluated of a new or current policy. Each answer is assigned a score between 0 and 1. The DEEP indicator, similarl to the EPS, runs from 0 to 6, where 6 indicates the highest burdens on the economy. The information collected is primarily *de jure*, reflecting the legal and procedural requirements rather than the actual performance of the administration. The indicator is available for the years 2013 and 2018.

Figure 1.16. Structure of the Design and Evaluation of Environmental Policies (DEEP) indicator



Source: Berestycki and Dechezleprêtre (2020[51]).

Policy packaging could help increase public acceptance of tighter environmental policies

The empirical evidence in this volume shows that past environmental policies have had relatively small effects on economic outcomes. Extrapolating past evidence into the future would therefore suggest that concerns about well-designed policies having large negative impacts on the economy might be exaggerated. While this is encouraging for policy-making, achieving and sustaining public support for such measures can still be challenging. Public support is, however, particularly important for policies on issues such as climate change, which require stable and ambitious measures over multiple decades. Policy packaging to ease such concerns can play an important role and facilitate the political feasibility of environmental policies. Moreover, good packaging could help absorb localised but undesirable economic effects of the transition towards a greener growth path, e.g. in energy-intensive or dirty industries or for laggard firms.

The effect of environmental policies on employment is one of the most politically sensitive aspects. The empirical results suggest that total manufacturing employment is barely affected but some jobs are reallocated across sectors, from the more to the less polluting ones. Since easing reallocation is important to speed up job transitions, especially in the most vulnerable sectors, having effective active labour market policies in place (such as facilitating job search, enhancing skills, life-long training and education) could ease the transition to a cleaner economy, much in the same way as these policies are needed to support other kinds of structural adjustments (OECD, 2011[54]). If job losses are geographically highly clustered in particular regions – for instance in the proximity to fossil fuel reserves – additional specifically targeted labour market policies may be necessary in these regions. This is particularly important if a high share of the local labour force works in such pollution-intensive sectors or if local labour markets cannot absorb a large influx of workers in the short run (OECD, 2012[55]; OECD, 2017[56]).

The use of revenues from environmental policies is a crucial aspect in creating support from the public for ambitious environmental policies (The World Bank, 2018[57]; Carattini, Carvalho and Fankhauser, 2018[58]; Maestre-Andrés, Drews and van den Gergh, 2019[59]; Douenne and Fabre, 2020[60]). While both market-based and non-market based policies can achieve improvements in environmental outcomes, one advantage of market-based policies is that they generate additional public revenues, which can then be reallocated by governments. In order to increase public support, it is often envisaged to target such revenues to achieve the following three objectives, which are discussed in more detail below: first, addressing potential distributional impacts of environmental policies; second, further incentivising environmental innovation through subsidies; third, reducing distortive forms of taxation elsewhere in the economy. Policy makers can thereby design policy packages in a revenue-neutral way, meaning that they do not increase the overall tax burden, dispelling public scepticism that the government simply wants to increase its overall budget through tighter environmental policies.

One approach to recycling revenues, which has received increasing attention more recently, is to recycle parts of the revenues from environmental policies to firms or households through lump-sum payments. Such payments can cushion undesired distributional outcomes and thereby increase public acceptance. It also generates a directly visible benefit from the tax for all households, which can help to sustain public support (Maestre-Andrés, Drews and van den Gergh, 2019[59]; Carattini, Carvalho and Fankhauser, 2018[58]; The Wall Street Journal, 2019[61]). The British Columbia carbon tax provides a prominent example of such a policy design (Harrison, 2013[62]; Murray and Rivers, 2015[63]; Yamazaki, 2017[33]), as does the example of Switzerland's redistribution of parts of their carbon tax revenues.[14]

Another approach to recycle revenues is to fund additional innovation incentives, which can help accelerate the decrease in the costs of abatement technologies. From an economic perspective, it is crucial for environmental policies to provide incentives for technological change because new technologies may substantially reduce the long-run cost of pollution abatement (Harrison, 2013[64]), and innovation is a key component of productivity growth (Aghion and Howitt, 1992[65]). Even though market-based environmental policies already provide incentives for firms to innovate in environmentally-friendly technologies, the revenues from the policy instrument could be used to provide additional financial support for firms investing in such technologies. Innovation support policies, such as public R&D spending, direct grants, R&D tax credits and seed funding could help to provide a significant push for productivity and long-run economic growth, thereby also improving the political acceptability of environmental policies.[15]

Other options to recycle revenues include subsidising the adoption of clean alternatives (electric cars, more efficient appliances, etc.), repaying debt or reducing more distortive forms of taxations such as income taxes. Using the revenues from environmental policy to lower such distortive taxes can increase the efficiency of the economy, while being revenue-neutral. In practice this can be difficult to implement because the main purpose of environmental taxation is to reduce the tax base (i.e. pollution) over time. As the revenues from the tax will decline over time, the introduction of additional taxes may be necessary to balance government budgets. These policies may again be distortive. Moreover, it remains unclear if 'double-dividends' from a reduction of income taxes are actually obtained in practice due to "tax-interaction" effects with other forms of distortive taxation[16] (Aldy et al., 2010[66]). Lastly, using the tax revenue to lower other forms of taxation can reduce the visibility of the revenue use, which weakens the political acceptance compared to alternative approaches (see De Serres, Murtin and Nicoletti (2010[29]) and Maestre-Andrés, Drews and van den Gergh (2019[59]) for comprehensive discussions).

Notes

[1] The OECD's Environmental Policy Stringency (EPS) index aggregates market based and non-market based environmental policies at the country-level over time. The score assigns values from 0 (lowest) to 6 (highest). A higher value indicates more stringent policies. The EPS mainly measures the stringency of energy, air pollution and climate change policies on the country-level, mainly upstream.

[2] Energy prices in this book always refer to industry energy prices. These may be different from energy prices paid by households.

3 Increases in energy prices from taxation allow governments to raise revenue that can be used to compensate disproportionally affected firms. Cross-country information on the share of tax induced versus non-tax induced changes in energy prices do not exist.

4 A separate literature analyses the impacts of environmental policies on households (e.g. Oueslati et al. (2016[73])) which is not covered in this book. For an overview of the related literature on ex-ante modelling work see, for example, Chateau, Bibas and Lanzi (2018[22]) and Chateau, Dellink and Lanzi (2014[74]).

[5] A USD 50/tonne of CO_2 price on carbon emissions is the level generally agreed upon in order to limit further global warming and reach the objectives of the Paris Agreement (see for instance Nordhaus (2017[67]); Dietz et al. (2018[68]); Pindyck (2019[69])).

[6] Global trends in oil prices affect overall energy price levels. It is relevant to note that oil prices in 2020 are lower than in 2014. The latest available data for comprehensive cross-country energy prices that account for important sectoral variation is available for 2014.

[7] To obtain the expected energy price levels, the current country-specific carbon intensity of energy provision is multiplied by the respective carbon price (i.e. USD 50 per tonne of CO_2). To obtain percentage changes, the value of the expected energy price level is compared to the energy price levels in 2014. The overall percentage change is converted to annual percentage changes for the period 2020-30, based on the assumption that the carbon price is introduced gradually from 2020 until 2030 by annual incremental adjustments to reach the respective carbon price in 2030. Expected changes are calculated with respect to 2014 energy price levels using the variable VEPL_MER from the dataset of (Sato et al., 2019[5]). These data incorporate a country-specific fuel mix and therefore country-specific carbon intensities of the overall energy provision.

[8] This is assuming that firm cannot pass on the full costs of the policy.

[9] In the short-run it is also possible that investments lower productivity because firms may need to raise capital, which can mechanically reduce multifactor- or capital productivity.

[10] The analysis by (Albrizio, Koźluk and Zipperer, 2017[8]) (Chapter 2) uses an interaction of the EPS with sector-level pollution intensity, thereby making the EPS sector-specific.

[11] These results are in line with other research that provides direct (Yang, Tseng and Chen, 2012[70]) or indirect (Hamamoto, 2006[71]) evidence that environmental policy enhances industry productivity.

[12] International production, trade and investment are increasingly organised within so-called global value chains where the different stages of the production process are located across different countries. As a result, trade in intermediate goods is no longer proportional to trade in final goods. Trade in value added (TiVA) data can trace back the value added of each country and industry to a final product.

[13] The DEEP indicator was previously called the indicator of Burdens on the Economy due to Environmental Policies.

[14] Recycling revenues lump-sum can help increase the acceptance of policies. However, from an economic efficiency perspective reducing other distortive taxation may be preferable. The revenue recycling prevents that the revenues are used to make the overall tax system more efficient.

[15] Innovation support policies (also know as tax preferences) need to be designed in a way that avoid pitfalls such as technology lock-in into specific technologies that are decided upon by governments, rebound effects that may increase the overall harm to the environment from increased consumption, and windfall gains to firms that would have innovated in a technology also without a subsidy (Greene and Braathen, 2014[75]).

[16] Double-dividends may occur when using environmental tax revenue to lower distortive forms of taxation (e.g. income, payroll or sales tax). The underlying idea is that such an environmental tax design would reduce environmental pollution and at the same time improve economic efficiency. However, environmental taxation also raise costs to firms, which in combination with existing distortionary taxation may create additional inefficiencies and costs to society. This effect may reduce or offset potential double-dividend effects (for a detailed review see, for example, Goulder (2013[72]).

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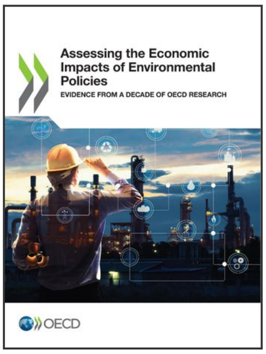

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