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Evaluating the EU Emissions Trading System: Take it or leave it? An assessment of the data after ten years

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Headlines

- Since 2005, the European Union (EU) has been running a carbon market to govern the greenhouse gas emissions from 12,000 power and manufacturing plants in 31 countries.
- This has led to a reduction in industrial carbon emissions.
- It has had no detrimental effects on economic performance.
- The scheme has been partly responsible for the increase in low-carbon 'cleantech' innovation since 2005.
- The detailed design of a carbon market affects its impact on the risk of carbon leakage and the incentives it creates for cleantech innovation.
- While there are opportunities for further improving the EU Emissions Trading System (ETS), evidence suggests that it is worthwhile maintaining and developing this landmark policy.
- As an alternative policy, a carbon tax would provide more certainty and visibility for low-carbon business, therefore it should remain a potential tool for policymakers.

Introduction

Since its inception in 2005, the EU ETS has changed the way that business is conducted in Europe by establishing a monetary value for the right to emit greenhouse gases that cause climate change.

The scheme aims to limit and reduce greenhouse gas emissions from more than 12,000 power and manufacturing plants in 31 countries, which together account for around 45% of the EU's greenhouse gas emissions (5% of global emissions). It is administrated by the European Commission (EC).

Critics argue that stringent climate change policies in EU countries, without similar action in other countries, can only lead to a loss of competitiveness in global markets, with no real impact on global emissions (see box 2).

Carbon- or emissions-trading is a market-based policy instrument that is designed to reduce emissions with minimal cost to society, while stimulating technological innovation to further reduce this cost in the future.

Contents

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Box 1: Evaluating the EU ETS: A primer

Ever since the EU first considered implementing emissions trading, policymakers and leaders have been concerned about possible adverse economic impacts on regulated companies. In evaluating the impact of the EU ETS, researchers have faced three key difficulties:

1. Availability of data pre-2005
There is a limited availability of precise data on emissions prior to 2005, making it difficult to compare emissions after the introduction of the policy to emissions before its introduction. The challenge remains to establish that any measured change in the performance of regulated firms can be ascribed to the policy itself, and not to other factors.

2. How to define 'business as usual'?
The most challenging element of evaluating the impact of any policy is building a counterfactual picture – the hypothetical 'control' case, of what would have happened if the policy hadn't existed. This is sometimes called the 'business as usual' scenario.

Since we are not able to directly observe how firms under the EU Emissions Trading Scheme (ETS) would have behaved if they were outside it, and *vice versa,* researchers question whether there is a causal connection between a policy and a measured outcome.

To answer this fundamental problem of so-called, causal inference: researchers must make certain assumptions to fill the gaps.

For example, researchers assume that, on average, regulated and unregulated firms were identical in terms of their greenhouse gas emissions, employment, etc. when the policy was introduced. In a controlled experiment, this could have been true if membership of the ETS were randomly assigned to firms. However, this wasn't the case, and for good reason, thus violating the assumption.

3. Correlation versus causation
Any evaluation of the EU ETS could draw a correlation between being part of the EU ETS and changes in emissions, employment or innovation. However, correlation is not causation.

Emissions in Europe have been declining for some time, as a result of structural economic change, since well before the introduction of the ETS in 2005. Around 2007-08 the Great Recession caused economic activity to drop significantly, which in turn led to a further drop in greenhouse gas emissions in the EU and around the world. It is difficult for researchers to disentangle those attributable to the EU ETS from these other correlated downward trends.

Evaluating the evidence
In light of this, the effect of the EU ETS on an individual firm can be expressed as the sum of:

'The causal effect of EU ETS' + 'any other differences between regulated and unregulated firms' + 'other macroeconomic changes that may have occurred at the same time as the policy'.

This formula highlights the fact that it is very difficult to separate the causal effect from other correlated factors – the so-called 'identification problem'.

Table 1: compares the strengths and weaknesses of research addressing the effect of the EU ETS.

Study Type	Strengths	Weaknesses
Country- or industry-level	• Provides an estimate of the economy-wide effect on emissions. • Easy to communicate to academics and practitioners.	• Results do not provide a causal interpretation. • Aggregate data is the sum of both regulated and unregulated installations and so the estimated effects cannot be disentangled from macroeconomic trends, such as recession.
Firm- or plant-level	• Provides a more credible estimation of the EUETS. • Macroeconomic trends can be accounted for. • Regulated firms can be compared to unregulated firms. • Other differences between regulated and unregulated firms can be measured and controlled for to identify the effect of the EUETS.	• There may still be differences between regulated firms and unregulated firms that are unobservable. • It can be difficult and costly to get access to this type of data, although it is often collected by governments for other purposes. • It can sometimes be more difficult to communicate the results to academics and practitioners because it requires more advanced econometric techniques.

Now, as new carbon markets emerge around the world, evidence about the impact of the EU ETS and a thorough understanding of how it affects companies' behaviour, will be essential to policymakers.

This is a summary of the impact of the EU ETS on environmental and economic outcomes such as carbon dioxide (CO_2) emissions, economic performance, international competitiveness and innovation.

Economic and environmental values

Globally, 39 national and 23 sub-national jurisdictions have either implemented or are scheduled to implement carbon pricing instruments, including cap-and-trade systems and carbon taxes. Emissions trading schemes are now valued just under $50 billion worldwide and account for 12% of global greenhouse gas emissions.

Of particular interest, China – the country with the highest carbon emissions – now houses a carbon market covering the equivalent of 1,115 tonnes of CO_2, which is second only to the EU ETS. The Chinese scheme covers seven separate pilot trading schemes in Chongqing, Shenzhen, Shanghai, Beijing, Guangdong, Hubei, and Tianjin. Yet, with the introduction of a national ETS during China's 13th Five Year Plan (2016-2020), the share of global emissions covered by carbon markets will rise substantially.

At the same time the United States, the world's second largest emitter, has implemented a significant change of direction in its climate policy, following several milestone amendments to the Clean Air Act since 2013. In addition, the recently announced Clean Power Plan introduces the prospect of US states using emissions trading systems, with the first compliance period set to start in 2020.

Given the rising importance of climate policy, and its adoption globally, it is necessary that policy design is based on well-grounded evidence. By reviewing the evidence gained from the European experience, this paper provides policy makers and stakeholders with an overview of what might be expected in other countries and, also, the opportunity to learn from difficulties faced by the EU ETS over the last decade.

In addition to reviewing the literature we highlight gaps in the body of evidence gathered so far, creating opportunities for future research, and identify the key challenges that stakeholders will face.

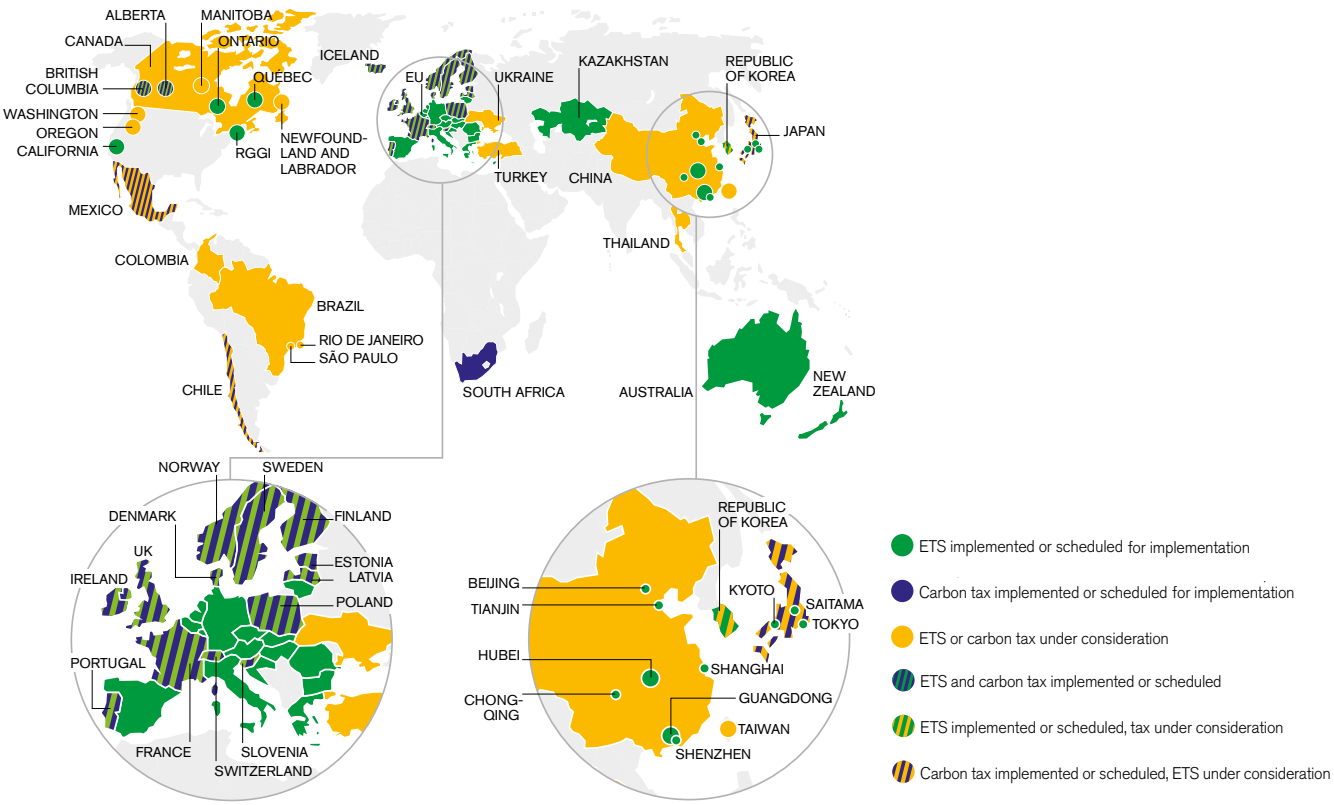
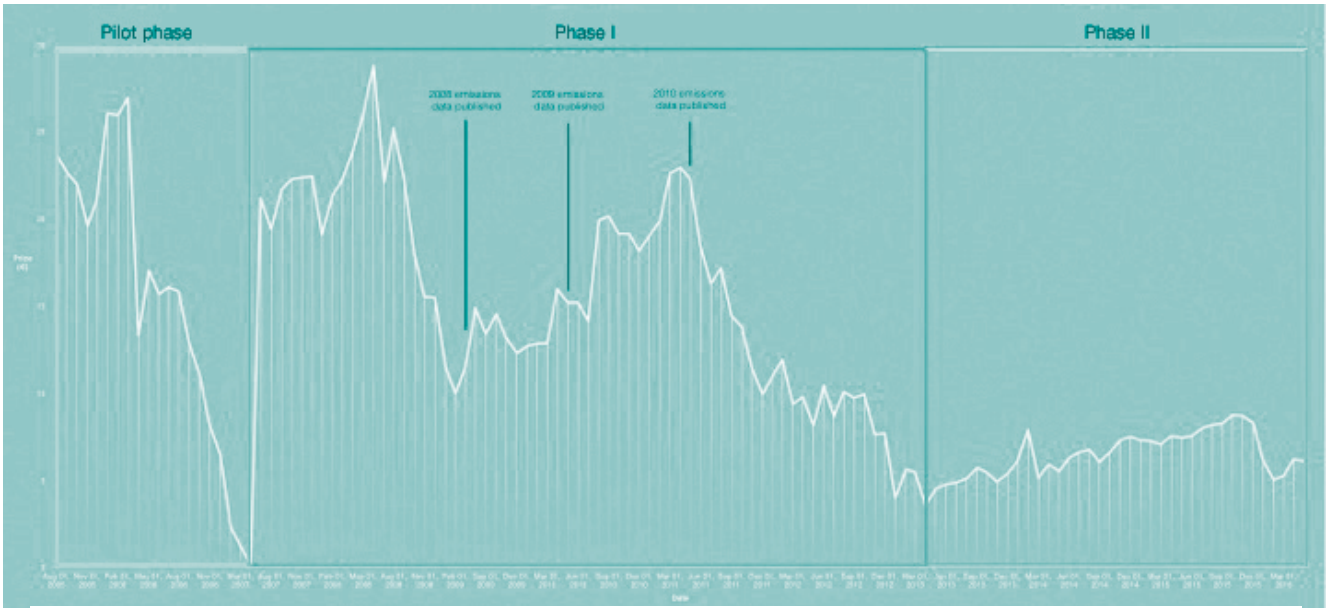


Figure 1: Overview of existing, emerging and potential regional, national, and sub-national carbon pricing instruments (ETS and tax).
Source: World Bank, Ecofys, and Vivid Economics, 2016. State and Trends of Carbon Pricing 2016. Washington, DC: World Bank.



Note: The surplus in permits at the end of Phase I that had led to a zero price was relatively small, 83 million permits, roughly 4% of the annual limit. By contrast, at the end of Phase 2 in 2012, the accumulated surplus of permits was 1.8 billion; more than 20 times the size of Phase I surplus and roughly equal to one year of total emissions during Phase 2. Importantly, the price did not fall to zero. The fact that Phase 2 permits can be banked for use in later years when the cap will have contracted further is a clear explanation for this.

Figure 2: Evolution of the EU ETS prices between 2005 and 2016.

The road so far

The EU ETS was designed in three phases, with policies governing the operation of each phase informed by the one that came before. Phase 1 came into effect in 2005 as a three-year pilot period. Phase 2 ran from 2008-2012 and saw an expansion in the coverage of both countries and sectors. Currently in Phase 3 more than 12,000 power and industrial plants in 31 countries are taking part in the scheme. While the third phase is scheduled to end in 2020, some policies are now set that extend beyond the end of the scheme. At the start of Phase 3, the upper limit on total emissions was set to decline at a rate of 1.74% per year up until 2020 and 2.2% per year until 2030. By this time, EU emissions will be 43% less than they were in 2005.

Phase 1 of the EU ETS covered CO_2 emissions and focussed mainly on power generation and energy-intensive manufacturing industries. Participation was mandatory for all plants that exceed 20MWh of energy use, including conventional power plants. Moreover, the scheme covered large emissions-intensive plants such as mineral oil refineries, coke ovens, iron and steel, and factories producing cement, glass, lime, bricks, ceramics, and pulp and paper. Recent years have seen an expansion to include airlines, aluminium and ammonia manufacturing plants, as well as covering other greenhouse gas emissions, nitrous oxide and perfluorocarbons.

Participating plants are required to surrender one pollution permit, known as an EU allowance (EUA), for each metric ton of CO_2 (tCO_2e) emitted. These permits are distributed to companies either for free or through an auctioning system.

The total maximum number of permits available – the 'cap' – is designed to limit emissions below the levels that would otherwise be produced – this is referred to (perhaps erroneously) as the 'business-as-usual' emissions (see Box 1).

The ETS established an EU-wide carbon price that signals the opportunity-cost of emitting CO_2 to all carbon market participants. By design, a scarcity of permits pushes up their price, which companies buy or sell on the market. There is also an incentive for participants to reduce their emissions up until the point at which there is no difference between buying one permit at the market price and paying the cost of reducing emissions by one additional ton of carbon.

Over the life cycle of the EU ETS, the price has varied considerably (Figure 2). Initially, the price of EUAs was expected to be between €5-10/tCO_2e, and the first quotes in early 2005 on the newly-formed markets reflected this expectation. While the EUA price rose quickly in the first year, several member states reported their emissions in April 2006 and all were lower than expected. As it became increasingly clear that Phase 1 emissions would be below the cap, the price fell to a few euro-cents.

This price collapse was due to the fact that participants were not allowed to bank their permits from Phase 1 for use in Phase 2 and that there was no demand to buy extra permits since all plants had plenty to carry out their desired activities.

With the start of Phase 2 and the modified rules, the price recovered to over €20 and reached almost €30 before the great recession in 2008 reduced the EUA price by around 50%.

This time, however, the price drop was not due to the system's design; it was the consequence of reduced economic activity and, hence, emissions. After some recovery in price in early 2009, the EUA price experienced a two-year period of stability with a price around €15. This lasted until the summer of 2011 when it fell to a new low level of €7-8 in 2012 before falling further to around €4 at the start of Phase 3.

Despite concerns that the price would fall to zero, it has stayed positive since the start of Phase 3. The comparison between the price of EUAs, and the numbers of surplus permits at the ends of Phases 1 and 2 testifies to the importance of companies being able to bank allowances, as implied in Figure 2. The question of interest is whether the prices observed were substantial enough to incentivise participants to actively reduce emissions, which is the focus of the next section.

Effectiveness of the EU ETS in driving emission reductions

Measuring the impact of the EU ETS on emissions is crucial given the objectives of the policy. Importantly, studies including in Germany and France show that it has caused reduced greenhouse gas emissions in the participating companies.

While the EU ETS is widely considered to be successful with regard to reducing emissions, it is a significant challenge for researchers to evaluate its effect accurately (see box 1). Some findings stand out, however:

- EU ETS led to an estimated 100-200 million tonne reduction in CO_2 emissions across all ETS sectors and countries during the first two years of Phase 1[12,13]. This corresponds to total emission reductions of 2.4-4.7%.
- More recent studies using improved data and methodologies find similar effects[2,14].
- Most of the greenhouse gas emission reductions occurred in the EU15 (the first 15 member states to join the EU) rather than in the newer eastern European member states[14].
- Emission intensity reduced by 3.35% on average in Phase 2, or 0.45% when focussing on the industrial (non-power) sectors alone[11].

Recent studies comparing the effect of the ETS on individual plants, companies, countries or sectors, found with a greater certainty (see box 1) that reductions in total emissions and emission intensity are real, not merely the result of carbon leakage (discussed further in boxes 2 and 3).

French plants: An analysis of French businesses shows no effect of the EU ETS during Phase 1, and a 15% reduction in emissions during Phase 2 compared to unregulated plants26. Reductions in emissions were not driven by the reallocation of emissions within the company, nor by carbon leakage across space. The reduction in emissions appeared to be driven mostly by reductions in the carbon-intensity of production. The absence of carbon leakage was also confirmed when analysing this question using unique data on multinational companies' emissions[10].

The impact of the EU ETS on economic performance and competitiveness

Evidence on the pass-through of emis-sions costs

To comply with the ETS, companies must invest in changes to reduce their emissions profile or buy permits. Either of these increase their production costs, which the companies may choose to transfer onto consumers (known as 'pass-through') or shoulder by themselves.

Box 2: Competition and carbon leakage

Power plants account for a larger share of European regulated CO_2 emissions than industries. However, research has focussed predominantly on industry since it is widely considered that the economic consequences would be more damaging for the EU.

It is commonly supposed that companies participating in carbon trading put themselves at risk of losing market share to unregulated companies and global competitors, and that these pressures would eventually force them to shift their production chains or to leave Europe entirely.

Such consequences would lead to job losses in Europe, and jeopardize the environmental effectiveness of the ETS as carbon emissions 'leak' from Europe to unregulated countries. Sources of carbon leakage are discussed in box 3.

These concerns often take centre stage in the political debate about carbon trading, making empirical evidence all the more pertinent. Analysing this evidence contributes to improving the design of the EU ETS and can inform policymakers about further ways to reduce greenhouse gas emissions that cause climate change.

Power companies: Power companies are able to recoup the majority of the cost of EU permits by increasing electricity prices[5, 25], although not completely[16]. The extent of the pass-through depends on each generator's market power, on how sensitive the demand for the electricity they produce is to the price they charge - the so-called elasticity of electricity demand - and on the degree to which they choose to absorb the additional cost. Passed on costs also affect the industrial sector, as well as electricity consumers. A company's ability to pass-through emissions costs to the product market is widely regarded as an indicator of how the EU ETS affects competitiveness.

Manufacturing companies: Similar determinants of pass-through apply to industrial emitters. The fact that they are competing in international markets means they are more at risk of losing market-share, production and jobs if they pass-through the cost of carbon.

Energy-intensive industries such as iron and steel refining passed through a significant proportion of the permit price to their respective product markets between 2001 and 2009[9]. European refineries fully passed through the price of permits on petrol retail prices between 2005 and 2007[3]. In the UK, emissions cost pass-through of weekly petrol and diesel prices for 2005 and 2006 were in the region of 50-75%.

While this evidence suggests the presence of at least some cost pass-through in the manufacturing sector, it is based on fairly aggregated prices. There is a clear opportunity for researchers to estimate cost pass-through at the company-level, as has been done for the electricity sector[16], so that policymakers, practitioners, and academics alike can form a better understanding of how exactly the EU ETS affects pricing in these often imperfectly competitive markets. In addition, it is of interest to understand how the cost pass-through from electricity affects economic and environmental outcomes in manufacturing.

Evidence on employment, investment and productivity

So-called *ex-ante* studies took place before the introduction of the ETS, and modelled the impact the scheme would have on economic factors; predicting effects on revenues, employment, investment, and productivity.

Ex-post evaluations based on economic data from the first two trading periods have looked for evidence of impacts. In seeking to understand the impact of the EU ETS on economic performance, researchers have drawn on a wide range of data sources including balance-sheet data, company-level surveys, administrative data, and stock market data, with varying methodologies and sometimes contrasting conclusions.

Several sector-level analyses show small or no impacts on a number of economic factors:

Sector-level analysis: Between 1996 and 2007 (the end of Phase 1), the EU ETS had a negative effect on the return-on-capital, but no effect on employment, productivity, or investment[8]. And 18 countries experienced an economically small but statistically significant 0.9% reduction in employment for regulated companies compared to unregulated companies between 2004 and 2008[1].

The sector-level analyses do not account for other sector-wide factors that may be causing these economic changes:

German firms: Administrative datasets analysed for the manufacturing sector in Germany show no significant impact of the EU ETS on employment in regulated companies, compared to unregulated companies in Phase 1[23]. By contrast, a positive impact on total revenues and export revenues during Phase 2 was identified. This increase could either be associated with an increase in productivity arising from the rationalisation of production, or with the possibility that German exporters face inelastic demand for their products and were able to pass emission costs on to international product markets.

Surveys with company managers provide a more in-depth analysis of their decision-making, however these results say less about causality:

Downsizing: In Europe, 761 managers from six countries were interviewed in 2009 about the concerns they might have about closure and downsizing resulting from climate change policies[20,21]. While most companies report that future carbon pricing has no impact on their location decision, the average risk of downsizing production or employment by a tenth is significantly higher for regulated companies compared to unregulated companies. Within the group of EU ETS companies, there is substantial variation in the level of downsizing risk.

Stock market prices can provide information on the economic impact of the EU ETS on publicly traded companies and the profits they expect to realise in the future:

Stock prices: During Phase 1, there was a positive correlation between carbon prices and the returns on stocks of major European power companies[25]. This correlation suggests that power companies profited from freely allocated permits and could pass-through a large enough share of the permit price. The precipitous fall of the permit price in April 2006 led to a drop in stock prices of companies in both carbon- and electricity-intensive industries, and particularly for companies selling primarily within the EU[5]. Evidence suggests investors gave a stronger weight to the positive impact of emissions trading on product prices (as companies passed-through the opportunity costs of EUAs obtained for free), rather than to the negative impacts, i.e. compliance costs.

Box 3: Sources of carbon leakage

The concept of carbon 'leakage' is used to describe the situation in which the responsibility for or cost of emissions are transferred from regulated to unregulated parties. Sources of carbon leakage are:

1. Carbon leakage is commonly seen as moving production to unregulated regions or countries that face less restrictive climate change policies.

   For example: Regulated companies could outsource the carbon-intensive parts of their production chain, or reduce their global market share and produce 'less'.

2. The regulated economy can leak carbon if a company holds regulated and unregulated plants.

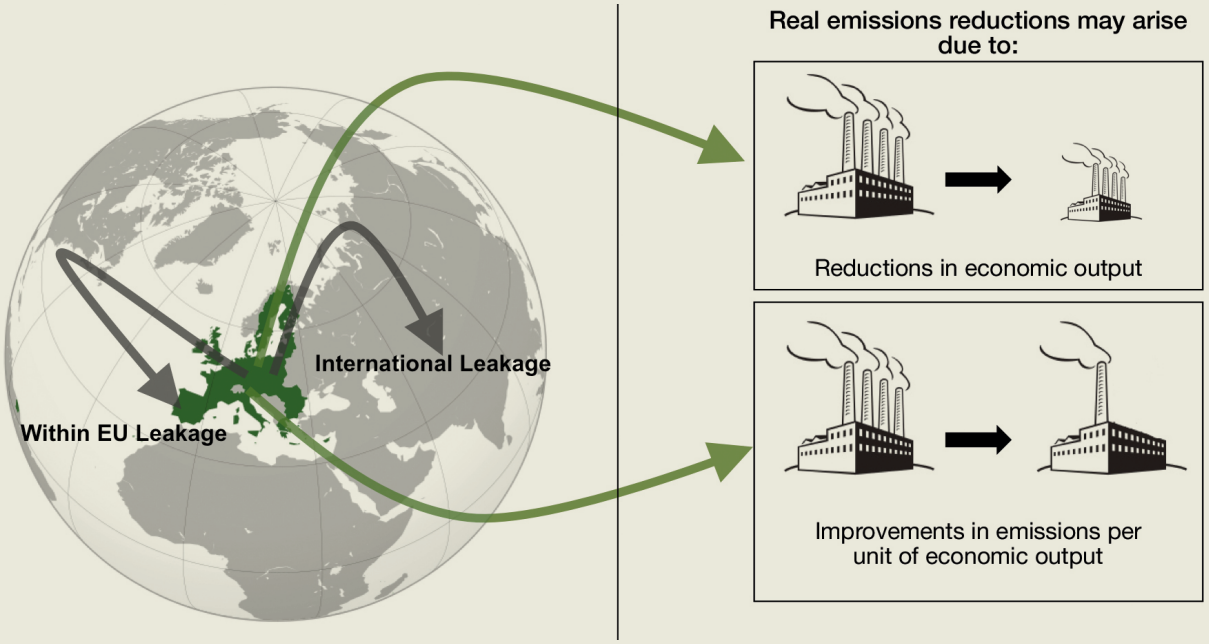
   For example: Consider a company with two plants: one that is regulated and one that is unregulated. If managers run more production through the unregulated plant this will appear to the ETS as a reduction in emissions and production; however, in practice the company has neither reduced emissions nor production in real terms.

3. Carbon leakage within the regulated economy may also occur through a loss of domestic market share to unregulated companies.

   For example: Consider two companies within the EU ETS region producing the same product. One is sufficiently large to be included in the EU ETS, whilst the other does not quality. Production may move from the regulated to unregulated entity.

Consequently, real emission reductions will only occur if:

- Regulated companies reduce levels of production without a corresponding increase in the emissions of the companies that take up the lost market share; or,
- Regulated companies maintain their levels of production and market share but reduce the emission of greenhouse gases per unit of output.



To summarize, the recent empirical literature finds, on average, very little evidence of adverse economic consequences from the EU ETS; carbon leakage may not be a problem as important as had been anticipated. However, this broad finding may mask variations in the ability of different participants to pass through the costs of regulation and, consequently, differences in the costs that regulated plants face within the system.

Mitigating against risks to companies in the EU ETS

Notwithstanding a lack of evidence that economic impacts are a real threat, the EU ETS seeks to mitigate the risk of companies choosing to relocate by granting free permits in sectors deemed to be at high risk of relocating. This risk is defined in terms of two measures:

1. A sector's carbon intensity in gross value added
2. Its trade exposure: the sum of a sector's imports and exports divided by the total market value.

Companies in manufacturing industries with sufficiently high carbon and/or trade intensities will continue to receive substantially more free permits than other companies until 2020.

However research has shown that this trade intensity criterion is ill-suited to identifying the companies in need of compensation to reduce the absolute risk of relocation[21]. And interviews with companies participating in the EU ETS indicated that there is variation in the degree to which downsizing risk can be mitigated through the free allocation of permits.

So to create a more efficient system, compensation should be given to companies to reduce the likelihood of relocation, weighted by the 'damage' caused by relocation, which can be measured in terms of jobs lost or tonnes of CO_2 'leaked'[20]. There is also significant potential for efficiency improvements in the design of policies that trade 'the polluter pays' principle off against carbon leakage and competitiveness concerns.

For many, the potential impact on economic performance might be too high a price for Europe to pay. These concerns are even greater if the reallocation of economic activity is combined with a relocation of greenhouse gas-emitting activities outside the EU; making the EU ETS less effective at reducing carbon emissions and less beneficial for the environment.

Innovation and the EU ETS

Cleantech (low-carbon or 'clean' technology) innovation aims to reduce the greenhouse gas emissions produced in manufacturing a product (process innovation) or minimise the energy the final product requires (product innovation). There is strong evidence the EU ETS has a positive effect on the amount of cleantech innovation.

Because this contributes to making clean technologies more competitive, the ETS can have the effect of reducing emissions in regulated, but also unregulated, companies and indeed in countries not part of the ETS.

There is also strong evidence that cleantech innovation creates more knowledge 'spillovers' than dirty technologies. A spillover occurs when research and development (R&D) by a company sparks further innovation in other companies that are not paying for the original R&D – sometimes in completely unrelated sectors. For example, research on ocean wave power has led to insights that have improved the encryption and storage of sound waves in the electronics industry.

Typically, private companies do not consider the value and positive effects of their innovation on other companies, so only invest in R&D according to their own needs. This implies that, from a social perspective, technology areas that are associated with more spillovers such as clean technologies – receive too little investment relative to dirty technologies, even if the negative effects of emissions associated with dirty technologies are ignored[18]. Consequently, a policy intervention that encourages clean technologies while discouraging dirty ones has the potential to increase the overall rate of innovation. As long term-growth is entirely driven by innovation and technological progress, it follows that such policies would also boost economic growth.

Evidence from patents and R&D spending

The innovative activity caused by the EU ETS is estimated to have resulted in 188 more cleantech patents than would otherwise have emerged. This corresponds to an 8.1% increase in patenting for regulated companies, or an 0.85% increase in total cleantech patents filed at the European Patent Office. Companies regulated under the EU ETS register significantly more low-carbon patent applications compared with unregulated companies[6]. There is no evidence that cleantech innovation displaces other forms of innovation.

As a proxy for research and innovation, patent data potentially understates the true scale of activity, and may also be noisy and/or incomplete due to strategic patenting decisions. The long time lag associated with patent applications (compared to the age of the EU ETS) may also be problematic in reporting activity.

As an alternative to patent data, the inputs to innovation, such as expenditures on R&D, are usually collected in tailored surveys conducted within a random sample of companies:

Italian firms: Using such data for Italian companies, for example, shows that EU ETS companies are more likely to be broadly involved with environmental innovation[4]. Given the cross-sectional nature of such data, however, one should be careful in attaching any causal interpretation to the results.

Interview data: Interviews revealed that companies in sectors just falling below the requirements for free allocations conduct significantly more innovation than those that just meet the requirements[19]. This suggests the ETS has a significant, albeit quite diverse, impact on innovation across Europe.

Moreover, the positive impact on innovation decreases with the number of permits obtained for free, which contradicts the "independence property" of cap-and-trade schemes, whereby permit market outcomes are independent of the initial allocation of permits[17]. This finding implies that innovation effects should become stronger in Phase 3 when companies will be required to pay for their permits rather than receiving them for free.

This finding suggests that rules being developed for Phase 4 and beyond should allocate free permits in such a way to jointly address the potential issues around carbon leakage and the currently weak incentives to encourage cleantech innovation.

The road ahead

As the world's first and largest international cap-and-trade system for carbon emissions, the EU ETS has been a poster child for market-based policies to tackle climate change.

While the development of the scheme has faced a number of challenges and has been the target of much criticism, the European Commission has made it clear that the EU ETS remains its flagship climate policy instrument and is here to stay. The available evidence also supports holding on to this landmark policy.

So far, it has reduced CO_2 emissions and increased low carbon innovation while, on average, having little effect on economic performance and international competitiveness. At the same time, it is clear that there is ample room for improving the policy. Any such improvements should be based on sound empirical evidence.

As a research endeavour, the impact evaluation of the EU ETS is still developing. On the one hand, this reflects the nature of the EU ETS as it continues and evolves as a policy instrument. On the other hand, many relevant studies have yet to be undertaken.

Micro-data at the company and plant levels is becoming more available, both in terms of outcomes of interest and geographic coverage. These data sets will prove an important stimulus for researching the impact of the EU ETS in the years to come. There should also be an emphasis on understanding the channels and mechanisms through which companies respond to the policy. The academic literature remains in its infancy for addressing cost-effectiveness credibly but, with time, such analysis should become possible.

Some important changes have recently been made to the EU ETS that will shape research and policy for years to come. Most recently, Members of the European Parliament have agreed to set up a market stability reserve in 2019 to reduce the number of permits on the market if there are too many, and introduce new ones onto the market in the case of a shortage. This amendment seeks to address the low carbon-price that is associated with an over-generous emissions cap, bringing it up closer to the expected €30 per tonne.

Following the Paris Agreement, carbon markets are likely to become more prevalent in the years to come. Learning from, and building on the EU's experience is therefore of paramount importance to ensure that these policies deliver the economic efficiency and environmental benefits they are designed to yield on the path to a low-carbon world.

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