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Burden or opportunity? How UK emissions reductions policies affect the competitiveness of businesses

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This policy paper is intended to inform decision-makers in the public, private and third sectors. It has been reviewed by at least two internal referees before publication. The views expressed in this paper represent those of the author(s) and do not necessarily represent those of the host institutions or funders.

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Executive Summary

The ongoing review of the UK's Fourth Carbon Budget is closely linked to the debate over the impact that domestic climate change policies can have on the competitiveness of businesses. Notably, there are concerns that, if the UK implements more ambitious climate policies than its trading partners, carbon-intensive producers might relocate.

This could mean that some affected sectors may have to reduce their production of goods and services below the optimum level that would be achieved if there were uniform international climate policies. In addition, the impact of climate change policies on emissions reductions could be limited if big emitters simply relocate, especially if they move to jurisdictions that have lower environmental standards.

This paper investigates to what extent these concerns are substantiated and whether they justify a change in the UK's ambitions for reducing its emissions, including the Fourth Carbon Budget. It does so by drawing on a range of 'ex-ante' and 'ex-post' studies.

'Ex-ante' studies aim to predict the outcome of intended policies. They use simulation or generalised economic models with explicitly chosen theoretical foundations (such as cost-minimising behaviour by profit-maximising producers, or average-cost pricing). Such models are informed by broad empirical evidence about the behaviour of firms. 'Ex-post' studies, on the other hand, estimate the impacts of existing policies on business behaviour, using actual evidence and data gathered after their implementation.

The paper also provides recommendations about how to 'create a level playing field' i.e. how to design policies that can mitigate the undesirable impacts of climate change policies so that UK businesses can compete on more equal terms with their international counterparts. It also highlights the complementary benefits associated with policies that increase a country's capacity to compete in a global race for low-carbon innovation over the coming century.

Competitiveness – impacts in theory and in practice

Economic theory generally suggests that if domestic climate change policies are introduced before other countries act, they can increase production costs and prompt the relocation of emissions-intensive activities – and the emissions they cause – abroad. This is often described as 'carbon leakage'. The results from ex-ante studies tend to vary greatly but, in general, they find that some carbon leakage can occur, especially in specific energy-intensive sectors.

By contrast, ex-post empirical studies suggest that the policies currently in place to meet the UK carbon budgets have had little or no impact on business competitiveness and carbon leakage. Similar results are obtained for studies applied to the European Union. In particular, there is no compelling evidence that investments in Europe have been cancelled, or production moved, because of the European Union Emissions Trading System (EU ETS) or, in the UK, because of the Climate Change Levy.

We suggest that the absence of evidence for impacts on competitiveness is not surprising given the relatively low carbon prices that have prevailed under current policies in the UK and Europe

and the existence of compensatory measures, such as the allocation of free permits within the EU ETS.

At present, variations in carbon costs are relatively minor drivers of investment and location decisions when compared with other factors, such as the prices of energy and raw materials, the cost of labour, market characteristics, institutional frameworks and demand shifts.

But carbon prices are likely to rise in order to meet constant or tightening emissions targets. Without targeted compensation for trade-exposed energy-intensive sectors, there could be some relocation of business activities, if the carbon prices become high enough. Analysis by the Committee on Climate Change (2008) suggests that the sectors which may be more exposed to higher carbon prices in the UK include iron and steel, refined petroleum products, aluminium, other inorganic chemicals, pulp and paper and rubber tyres.

Creating a level playing field

It seems unlikely that there will be a single global carbon price which affects all firms evenly, at least in the short to medium term, so it makes sense to implement measures that can help to 'create a level playing field' for businesses that are subject to domestic policies.

Ideally this could be achieved through multilateral or bilateral agreements in different sectors, or some form of carbon tax adjustment at the border. However, it will probably take time to reach effective agreements along these lines.

In the short term, while the UK fulfils the domestic commitments set out in the Fourth Carbon Budget and the Budgets to follow, other measures can be implemented at national level to reduce the impact of unilateral carbon pricing. Indeed, some measures have already been introduced. In some cases, compensation may also be justified to facilitate the transition within carbon-intensive sectors (to re-skill and re-tool production in order to reduce emissions, for example), or, from a 'political economy perspective', to attain buy-in from lobby groups representing carbon-intensive industries. But these efforts must be efficient in the allocation of scarce public funds.

There is evidence to suggest that the measures that are currently in place, such as free emission permits within the EU ETS and sector discounts or exemptions from national policies, are often too generous. In some cases they can provide firms with windfall profits and the only effect is to cause consumer prices to rise without preventing relocation of emissions abroad. Compensatory measures should therefore be carefully targeted, to avoid costly over-compensation and undesirable market distortion.

In terms of policy design, there is no rationale for discounts on carbon pricing as these would weaken the signal to reduce carbon emissions efficiently. Instead, compensation could be offered through reductions in corporate or labour taxes, for instance, and could be linked to support for low-carbon investment or research and development. However, such lump sum payments may still allow for some relocation, without reducing carbon leakage as producers opt to 'take the money and run'. To prevent this, the level of compensation should be proportional to the level of domestic output.

Economic competitiveness at state and regional levels

'Whole economy competitiveness', defined in terms of economic performance relative to other countries, is a different concept to 'business competitiveness'. Correspondingly, the analysis carried out in this paper covers not just vulnerable sectors, but also the impact of climate policies, such as the UK's carbon budgets, on the potential growth and productivity performance of the UK's economy as a whole relative to other trading partners.

Well-designed climate change policies could offer business opportunities in fast-growing global markets, as countries, such as the United States, China and the Member States of the European Union, implement ever more stringent carbon reduction and energy efficiency policies. The UK is well-positioned to benefit from a global transition to a more resource-efficient and renewable economy, provided flexible structural policies allow it to utilise its comparative advantages.

Policies that encourage the flow of resources from declining and less productive activities to growing and more productive activities are likely to increase the UK economy's capacity to adapt profitably to change.

Conclusions

Arguments in favour of revising the Fourth Carbon Budget, based on concerns about competitiveness, do not appear to be supported by the evidence. Existing data suggest that the impact of current policies is small or negligible, dwarfed by a range of other economic factors.

Domestic, as well as international, carbon prices are expected to increase, and with time this could have serious implications for a small group of energy-intensive businesses. Some businesses will naturally exit the market as demand for carbon-intensive goods and services is expected to gradually fall. But policy tools are available to ensure that strategic vulnerable sectors are not put out of business prematurely by the application of more ambitious domestic climate change policies.

At the macroeconomic level, climate change policies can increase competitiveness in the long term, making firms more innovative and productive in rapidly growing world markets. The right mix of policy tools can help businesses, and the UK economy as a whole, to realise the potential new market opportunities associated with the transition to low-carbon growth and the fulfilment of domestic climate change targets.

1 Introduction

The UK's emissions reduction targets, embedded in the Climate Change Act and in its five-year carbon budgets, have already required, and will require in the future, the implementation of a number of domestic climate change policies which generally impose a direct or indirect price on carbon. Concerns about these policies have been raised because of the risk of harming the competitiveness of British businesses, especially through potential increases in energy costs. This threat has led to the introduction of special treatments for businesses for which the risk of relocation is higher, such as tax reductions (as in the case of the Climate Change Agreement) or free emission allocations (as in the case of the European Union Emissions Trading System).

However, there have also been calls to reduce the ambition of domestic climate change policies altogether. Indeed, the review of the Fourth Carbon Budget has re-opened the debate about whether domestic objectives should be revised if there is sufficient evidence that they damage business competitiveness.

In providing its advice about the review of the Budget, the UK Committee on Climate Change (CCC, 2013a) found no evidence of significant industry relocation due to low-carbon policies. More generally, the Committee did not find any significant change to the circumstances which prevailed at the time at which the budget was initially agreed, and concluded that there is no legal or economic case for reducing its ambition[1].

This paper aims to contribute to the debate about the possible revision of the Fourth Carbon Budget due to the impact on competitiveness. It discusses the available evidence about the effect of climate change policies on competitiveness, and suggests options for creating a level playing field, while also highlighting possible business opportunities associated with changes in comparative advantages.

'Competitiveness' is a relative term. The world cannot become more 'competitive' but countries, businesses and sectors can. However, the precise meaning of the term varies depending on the level at which it is defined.

For businesses and sectors, improvements in competitiveness essentially depend on the ability to produce either cheap or innovative products that the world wants to buy, and that allow market shares, sales and profits to expand. This may be a 'zero sum' game in terms of the fortunes of companies, in so far as one firm's gain in competitiveness might be a rival's loss, or it might help to create new markets for both businesses.

Measuring national competitiveness requires a very different framework. An economy cannot go out of business, though it may build up foreign debt. Depending on factor endowments, a country will always have a comparative advantage in trading something in an open market. Competitiveness at the national level, therefore, tends to refer to performance-related outcomes, such as productivity and output per head, or the underlying conditions necessary to generate higher productivity and sustainable wealth for a country's citizens, through, for

[1] The Climate Change Act states that a carbon budget can only be changed if 'there have been significant changes affecting the circumstances on which the previous decision was made'.

example, improved educational standards, investment in infrastructure, scientific prowess and political and legal stability.

In order to try to capture these multifaceted aspects of competitiveness, the first part of the paper explores the impact of policy on businesses, while the final part discusses the effects at national and regional level.

The paper is structured as follows: after this introductory section, Section 2 provides an overview of the relative contributions of current energy and policies to overall business costs, and Section 3 illustrates the key findings from a selection of 'ex-ante' studies of the theoretical impacts of climate change policies on carbon leakage and competitiveness. Section 4 provides insights from 'ex-post' studies on the actual effects of existing policies, and Section 5 discusses possible ways to create a level playing field for businesses that are subject to different climate change policy regimes. Section 6 broadens the discussion to cover economic competitiveness at the state and regional level, and Section 7 summarises the paper's main conclusions.

This paper is part of a broader series of policy papers which explore issues associated with the review of the Fourth Carbon Budget. A companion paper by Bassi *et al.* (2014) focuses on what the UK's trading partners are doing in terms of climate change policy and legislation, exploring whether or not the UK is truly acting alone. Another paper by Grover and Zenghelis (2014) uses the latest National Accounts Supply Use tables to determine what impact a hypothetical carbon price above current levels would have on UK industries, identifying which sectors would be most acutely affected.

2 Businesses, energy and competitiveness: the big picture

Energy costs are often regarded as a significant burden for the business sector. The recent debate in the UK over energy bills, both for businesses and households, has put climate change policies under the spotlight, as some of them result in a carbon price that raises energy costs.

However, when compared with other drivers of performance, energy costs appear to be relatively small for most sectors. In 2011, UK businesses spent in total around £158 billion on energy[2] (ONS, 2013) which, on average, accounted for less than 6 per cent of total variable cost[3], or 12 per cent of gross value added (GVA). By comparison, labour costs were £820 billion, almost 30 per cent of variable costs (60 per cent of GVA).

But while energy costs are, on average, much lower than labour costs, high energy prices are often regarded as a significant threat to the UK economy. This is a common feature of industrial

[2] Total energy costs include coal, lignite, coke, natural gas, crude and refined petroleum, and electricity.

[3] The term 'variable costs' used here refers to the UK Office for National Statistics's Total Output at Basic prices and includes: total wage costs, gross operating surplus, and taxes minus subsidies, as well as total intermediary consumption at purchasers' prices. By contrast, Gross Value Added (which corresponds closely to GDP) nets off intermediary consumption because these are inputs into production and not final outputs. GVA is therefore the appropriate measure of final net output at the 'whole economy level', and has been used extensively in the literature. However, from a sectoral point of view, input costs (intermediate consumption) are just as relevant as a constituent of the sector's total costs as labour and capital, so it is the relevant metric to use here.

economics as, in general, it is easier to lobby for lower energy prices, which are seen as strongly influenced by government policy, than lower wages, which are seen as determined by the markets and are unlikely to be the basis for a politically popular case.

Typically, labour costs also change in a more predictable manner while energy costs can fluctuate significantly, along with energy wholesale prices. For instance, Brent crude oil prices increased in real terms by around 74 per cent between 2000 and 2013 (EIA, 2014). By comparison, average salaries increased by only 10 per cent over the same period (ONS, 2014).

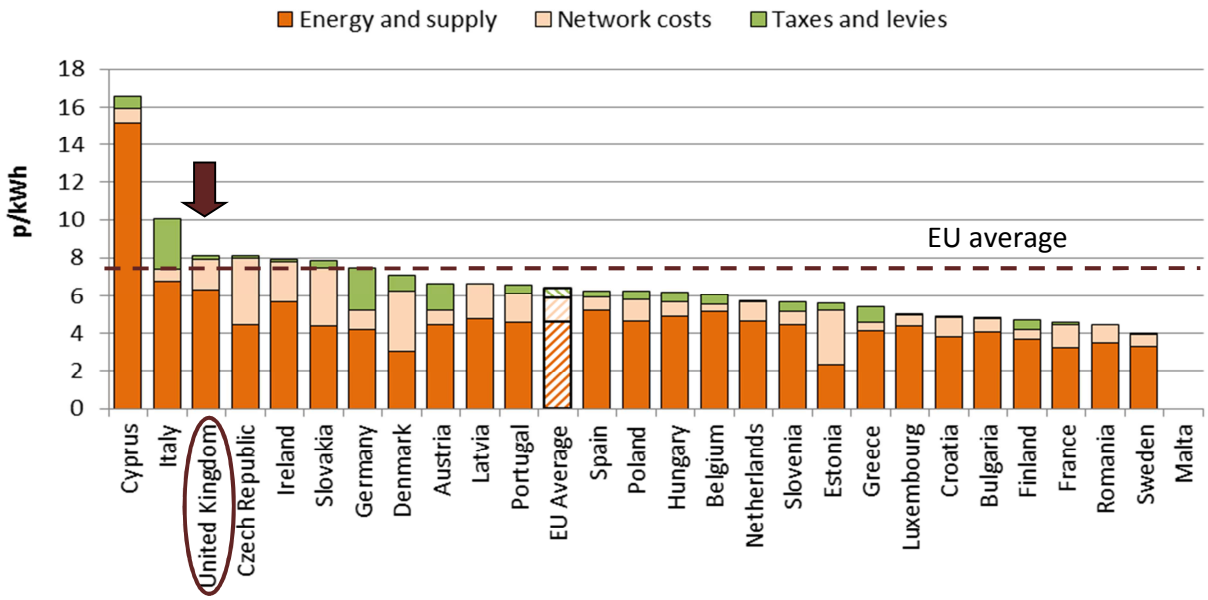
And when energy prices rise, they tend to erode profits at the margin. Businesses with low profit margins can be affected even by relatively small changes (see, for example, Webster and Ayatakshi, 2013).

Furthermore, energy intensity varies significantly across sectors. While an increase in energy costs may have a limited impact on most businesses, it can have significant implications for those industrial activities characterised by a relatively high share of energy costs. In the UK, energy costs represent about 15 per cent of variable costs for the cement, ceramic and fertiliser manufacturers sector, 21 per cent for iron and steel, 17 per cent for other basic metal and casting, 22 per cent for pulp and paper, 28 per cent for fishing, and 33 per cent for dyestuff and agrochemical production (ONS, 2013). For industries directly involved in energy production or transformation, such as electricity generators, gas suppliers and petroleum refineries, the share of energy costs is even higher, above 70 per cent. While these energy-intensive sectors are only a subset of all UK industries, they remain an important contributor to the UK economy. In 2011 they accounted for about 9 per cent of the total UK output (ONS, 2013).

Among the different components of energy costs, it is policies that typically attract most criticism from the business sector. However, analysis by the European Commission shows that the cost of current climate change policies is a relatively small component of the overall energy costs paid by firms (Eurostat, 2014).

For instance, Figure 1 shows the electricity costs incurred by moderately high energy-using businesses in the European Union. The data indicate that total electricity costs for UK businesses are slightly higher than the European average, but policy costs are smaller. Similar conclusions can be drawn for other energy-user categories.

Figure 1. Retail price of electricity by component, industrial consumers of between 70,000 and 150,000 MWh/year in 2012 (p/kWh[4])



Note: Lithuania is not included due to lack of data
Source: Eurostat (2014)

The cost of climate change policies is likely to increase further in the future, as the UK complies with its carbon budgets and its longer term emission reduction targets that are set out in the 2008 Climate Change Act. The impact of climate change policies, however, may still be smaller than expected.

In the UK, applying a US$30/tonne (around £19[5]) price on carbon dioxide, on top of current costs, would have the effect of raising the oil price by the equivalent of US$14 a barrel. The comparison with oil prices is not perfect, since these are set internationally and in principle affect all firms equally, while carbon prices, if set unilaterally, affect only domestic firms. Nevertheless, it is interesting to compare the effect of such a carbon price with the wide energy price fluctuations experienced in the past 15 years. For instance, oil prices were around US$20/barrel in 1998 (EIA, 2014) and are now about US$108/barrel[6] (Bloomberg, 2014).

There is also evidence that higher energy prices tend to be associated with more efficient use of energy. In the OECD, despite significant differences between domestic energy prices, the share of energy costs per unit of GDP stays almost constant across countries (Neuhoff *et al.*, 2014). We return to this issue in Section 6 of this paper.

It would therefore be misleading to claim that climate change policies are a very strong determinant of international competitiveness. In reality, other factors mitigate or dominate the contribution of environmental regulatory costs to the determination of business location and trade decisions (Aldy and Pizer, 2011; Neuhoff *et al.*, 2014). These include variations in the prices of energy and raw materials, transport costs, access to markets and labour, reliance on

[4] Using an average exchange rate of €1 = £0.811 in 2012.
[5] Using an average exchange rate of $1 = £0.640 in 2013.
[6] On 1 April 2014. Data refer to crude oil Brent Price for May 2014 contracts.

integrated production processes, customer relationships and the investment environment (see for example Dröge, 2013; Hourcade *et al.*, 2007; Antweiler *et al.*,2011; Ederington *et al.*, 2005).

This means that capital-intensive businesses tend to locate in capital-abundant countries. Businesses that manufacture goods with high transportation costs choose locations near to their customers and some businesses co-locate with others carrying out similar activities to exchange intermediate inputs. Those with significant investments in large fixed physical structures generally tend to move less.

Investors also need to assess the potential evolution of climate policies in alternative locations. One cannot assume that China or Malaysia will not implement comparably tough energy efficiency and carbon emissions policies over the lifespan of a new plant.

Shifts in demand are also powerful drivers affecting decisions about business location. The financial crisis of 2007-08, combined with the sustained growth trend in Asia and Latin America, led to a phase of over-capacity among European energy-intensive industries, while demand for goods like steel, cement and aluminium kept shifting towards emerging countries (Dröge, 2013). This opened up new opportunities to choose locations nearer to, for example, a growing demand, an increasingly skilled workforce or cheaper resources.

A natural implication of this observation is that it does not matter whether a carbon price is enforced or not: investments in new energy-intensive plants are going to shift from mature to emerging markets. But as the outcome of having no climate policies at all is unknown, it is sometimes easy to hold environmental regulation responsible for what is actually a structural change (Branger *et al.*, 2013).

Sometimes trade openness can also shift emissions-intensive production to richer countries, even if they have tighter pollution regulations because other offsetting factors, such as income gains and technological progress, more than compensate for the cost of regulation (Antweiler *et al.*, 2011). Therefore, it is perhaps not surprising that the 2013-14 annual Global Competitiveness Report by the World Economic Forum (Schwab and Sala-i-Martín, 2013)[7] lists Switzerland, Germany and Sweden among the top five countries in terms of global competitiveness, despite their high energy costs. The UK appears in a respectable 10th place.

A recent study by the European Commission (2013) concluded that European comparative advantage increasingly depends on high-value-added goods, with a high degree of sophistication or knowledge intensity. It added that manufacturers in the European Union should gradually shift away from the current portfolio of predominantly mature products, over which firms compete more on price than quality, to more innovative and complex products. This makes sense as, for all but the most energy-intensive sectors, small changes in demand for products and key costs, such as labour or capital, have a far greater potential impact on profit margins than a change in energy costs.

For instance, some specialised high-productivity energy-intensive producers in the UK have benefited from climate policies through the additional demand on them to supply materials to

[7] The Global Competitiveness Report considers competitiveness to be affected primarily by institutions, infrastructures, the macroeconomic environment, health, education and training, goods and labour markets efficiency, financial market development, technological readiness, market size, business sophistication and innovation. Energy prices are not among the key drivers.

the renewables sector, which has been growing strongly in the UK and continues to be a net exporter. The overall effect on these producers' profits has been positive despite the fact that energy costs have increased. This is reflected in the presence of a number of providers of UK materials (including glass and steel producers) among the memberships of business lobby groups seeking support for the renewables sector.

Nevertheless, for some energy-intensive sectors, energy costs remain an important factor affecting business performance. The aim of a successful climate policy must therefore be to reduce global emissions in a way that is cost-effective, while also limiting the regional loss to output in vulnerable sectors.

The Fourth Carbon Budget is intended to be consistent with the most feasible and cost-effective emissions reduction path for the UK economy, and compensatory measures for vulnerable sectors are already in place alongside climate change policies. As targets for future dates are more ambitious, it is important that policy impacts are monitored and mitigation measures are accurately designed or revised. This is discussed further in Section 5.

Policies that stimulate energy efficiency can also help to compensate for residual energy price differentials due to differences in natural resource endowments (Neuhoff *et al.*, 2014), such as the availability of cheap shale gas in the United States.

3 The risk of competitiveness loss and carbon leakage: what the theory suggests

When environmental policies increase costs, businesses can react to them in three ways. First, they can decrease costs by improving the energy and/or resource efficiency of their operations. Second, they can absorb the policy costs, for example by reducing their profit margin or, in the long run, wages. Third, they can pass on the additional costs to consumers by increasing the price of their output which can have limited impact on profit margins, but in the long run can lead to decreasing market share (Dechezleprêtre and Sato, 2014).

While the first effect is the most desirable policy outcome, the second and third can to some extent be unavoidable counter effects which can reduce business competitiveness. In some cases, if there are no opportunities for input or technology substitution to reduce the damage caused by production, then some substitution by consumers away from damaging products is to be encouraged and expected as a result of effective policies to regulate carbon.

Governments ultimately worry about the prospect of polluting firms simply relocating to countries with looser environmental policy, so-called 'pollution havens', which can damage national competitiveness and create the risk of increasing global emissions. However, the view that environmental regulation can lead to negative economic performance by pollution-intensive businesses has long been challenged. Notably, Porter (1991) claims environmental policies can lead to technological change that has a positive effect on competitiveness.

In reality, the effects of policy on businesses are often mixed.

Several ex-ante studies have attempted to explore the hypothetical impact of climate change policies, such as the effect of future carbon prices, to estimate whether they would drive up relative costs and affect competitiveness. They do so by predicting the outcome of intended policies, using simulation or generalised economic models based on given theories, such as cost-minimising behaviour by profit-maximising producers and average-cost pricing informed by broad empirical evidence about the behaviour of firms. They differ from ex-post studies (discussed in Section 4), which estimate the impacts of existing policies using actual evidence and data gathered after their implementation.

Both ex-ante and ex-post studies often use rates of 'carbon leakage' as a proxy for loss of competitiveness. While the two terms are related, they are not identical. The latter refers to the profitability, output and location decisions of a business or sector, whereas carbon leakage refers specifically to the amount of reduction in domestic emissions that is offset by an increase in emissions abroad[8]. For example, 100 per cent leakage means that the entire amount of emissions saved as a result of carbon pricing is emitted elsewhere, typically when a plant relocates to a country with no equivalent legislation. This implies no net saving in global emissions. If production relocates to parts of the world where industrial activities are more carbon-intensive, leakage can even exceed 100 per cent.

Ex-ante analyses point to positive but limited leakage at the aggregate level, typically from 10 to 20 per cent for carbon prices between £10 and £40 per tonne of carbon dioxide. The OECD (2009) estimated that, if the European Union cut its emissions by half unilaterally in 2050 (over 2005 emission levels), only about 12 per cent of this abatement would be wasted through carbon leakage.

However, for some carbon-intensive sectors, especially steel and cement, higher leakage rates are often forecasted (see Table 1[9]).

In the UK, analysis by the Committee on Climate Change (2008, 2013b) suggests the sectors that may be more exposed to carbon prices because of their higher marginal compliance cost relative to their GVA, and because they are more exposed to trade outside the UK[10], include iron and steel, refined petroleum products, aluminium, other inorganic chemicals, pulp and paper and rubber tyres. A few other sectors are also considered to be significantly exposed, although they play a smaller role in the UK economy, including, malt, coke oven product, non-wovens, other textile weaving, copper, and silk and filament yarn.

[8] So, for example: if domestic carbon policies lead to a 5 per cent reduction in emissions, due in part to improved efficiency and less carbon-intensive inputs as well as a transfer of emissions to plants abroad, then, assuming that the transfer accounted for 1 per cent of the reduction, the leakage rate would be 20 per cent.
[9] Several studies discuss sector-specific carbon leakage. Examples include: Carbon Trust (2008); Carbon Trust (2004); Demailly and Quirion (2006); Hourcade *et al.* (2007); Houser *et al.* (2008); Graichen *et al.* (2008); de Bruyn *et al.* (2008); Dröge and Cooper (2010); Branger *et al.* (2013). A good summary of the available literature can be found in Dröge (2013).
[10] These are sectors with a non-EU trade intensity of more than 15 per cent.

Table 1 Overview of selected ex-ante studies on carbon leakage

Carbon price (£/tCO_2)	Sectors			Source
	All	Cement	Iron & Steel	
10	11-15%			(Kuik & Gerlagh, 2003)
12	10%	20%	39%	(Monjon & Quirion, 2009)
12		20%		(Demailly & Quirion, 2008b)
14		9-50%		(Demailly & Quirion, 2006)
16			0.5-25%	(Demailly & Quirion, 2008a)
16		56-70%		(Ponssard & Walker, 2008)
16		3-22%		(Quirion *et al.*, 2012)
16		80-100%	~70%	(Linares & Santamaria, 2012)
17	11%	19%	35%	(Kuik & Hofkes, 2010)
18			9-75%	(Ritz, 2009)
27	5-19%			(Böhringer *et al.*, 2012)
27		29%		(Szabo *et al.*, 2006)
27-85		17-100%		(Allevi *et al.*, 2013)
28		88-100%	~100%	(Linares & Santamaria, 2012)
28-29	15-17%			(Caron, 2012)
34		0-50%		(Demailly & Quirion, 2006)
40		67-73%		(Ponssard & Walker, 2008)

Note: Results generally refer to industrial countries, such as those listed in Annex I of the United Nations Framework Convention on Climate Change (United Nations, 1992), or the European Union specifically, where studies included different scenarios. Wherever possible, we selected those that did not include cost-mitigation measures, such as free allocation of allowances within the EU ETS or border tax adjustment. Carbon prices have been converted into £s using average yearly exchange rates for the year of publication (http://www.oanda.com/currency/average).

Source: Authors, based on mentioned studies.

Results from ex-ante studies vary greatly, especially those for specific sectors. Notably, leakage rates tend to vary significantly with the assumptions made about carbon and energy prices, energy- or carbon-intensity, market openness, plant location, the ability to apply abatement technologies, transport costs and product substitutability.

The models used also tend to have a number of limitations. For instance, several studies rely on static models, which do not allow for substitution by lower carbon technologies, inputs or processes, resulting in lower mitigation potential and higher leakage rates. Others may not be able to capture factors that improve, rather than deter, competitiveness, such as technology spillovers (Bosetti *et al.*, 2009), the crowding out of dirty capital stock (Carbone, 2013) or induced fuel substitution in third countries (Bauer *et al.*, 2013).

Despite these limitations, ex-ante theories generally concur that the lack of uniformity of climate change policies can raise concerns about competitiveness and carbon leakage. However, these impacts are limited to specific industry sectors and sub-sectors. A common feature of these sectors is that they are both exposed to international competition as well as relatively sensitive to carbon pricing – either because they are large emitters of carbon dioxide, such as the steel industry, or because they are large users of electricity, as in the case of aluminium producers (or both).

The likely degree of relocation of output and emissions is ultimately an issue that needs to be addressed by empirical observations. We turn next to the question of whether the predictions of the models are matched by experience.

4 The impact of climate change policy on competitiveness: the evidence from observations

Although ex-ante studies suggest that carbon pricing can be a concern, at least for some sectors, ex-post analyses tend to indicate that existing climate change legislation has not led to any significant loss of competitiveness.

For instance, research carried out by Martin *et al.* (2011) compares the performance of UK businesses subject to the Climate Change Levy with similar businesses subject to the reduced tax rates granted by the Climate Change Agreements[11]. The study considers firms that operate in the same economic sectors and share similar characteristics, therefore facing the same international competition, regardless of the policy regime to which they are subject[12].

Its findings suggest that the Climate Change Levy did not cause businesses to lose competitiveness, in terms of employment, output and the likelihood to exit the market, relative to those which received a discount through the Climate Change Agreement. The research also suggests that those that paid the full levy reduced their emissions more and made larger improvements in energy efficiency, reducing energy costs. These findings are further confirmed by a more recent study by Bassi *et al.* (2013), which applies a similar method to a larger sample of data for the period from 1997 to 2010.

Several empirical studies also examine the performance of businesses participating in the EU ETS.

For instance, Bassi *et al.* (2013) analyse companies close to the EU ETS eligibility threshold, some of which are included in the scheme and some which are not. These are, therefore, companies that are subject to different policy regimes (inside or outside the EU ETS), but share similar characteristics, such as sector, size, turnover, etc. The analysis reveals no significant difference in turnover or employment between businesses inside and outside the EU ETS which belong to the same sector. In other words, there is little evidence that the EU ETS has affected the competitiveness of firms to which it applies.

Several other economy-wide or sector-specific studies on the EU ETS reach similar conclusions, including Martin *et al.* (2013), Laing *et al.* (2014), Reinaud (2008), Petrick and Wagner (2014),

[11] The Climate Change Levy is a tax on energy consumption which was introduced in 2001. Since this was a unilateral measure adopted in the UK only (although some other Member States have similar policies in place), it created concerns about the competitiveness of UK businesses, especially those for which energy represents a relatively large share of their costs. This led to the creation of the Climate Change Agreements, which grant a discount against the Climate Change Levy for those energy-intensive industries which voluntarily sign up to them, in return for meeting targets for energy efficiency or carbon emissions savings. Currently the discount is 65 per cent for gas, coal and liquid petroleum gas (LPG), and 90 per cent for electricity.

[12] These could not be assessed, however, against a case where no climate policy applies, as most businesses in the UK are covered by either one policy or the other.

and Varma *et al.* (2012). Most analyses do not find any clear link between the EU ETS and a loss of competitiveness in most of the sectors analysed, including energy-intensive businesses such as steel and cement. Chan *et al.* (2013) find a slight increase in costs only in the power sector.

The effects on competitiveness may be small because of relatively low carbon prices. In 2013, the Climate Change Levy charged between £4 (for LPG) and £10 (for electricity) for each tonne of carbon dioxide emitted by regulated organisations. And the price of EU ETS allowances has oscillated between almost £0 and £24 (€30) per tonne of carbon dioxide since its introduction, and reached a plateau at around £3.50 (€4)[13] per tonne of carbon dioxide in 2013 (EEX, 2014).

A relatively wide range of sectors have also received substantial compensation in the form of free allowance allocations within the EU ETS and discounted levies for the Climate Change Agreements. Compensation within the EU ETS has been so generous that some businesses made windfall profits (see, for example, de Bruyn *et al.*, 2010), notably in those sectors with a higher propensity to pass through their costs to customers - especially the energy sector (Chan *et al.*, 2013; Anger and Oberndorfer, 2008; Sandbag, 2011; *Laing et al.,* 2014).

However, should the carbon price increase in the future as a result of the larger emissions reductions set out in the Fourth Carbon Budget and in the Budgets to follow, it is reasonable to expect the impact on the performance of some businesses to become more perceptible.

Ex-post studies in countries with more stringent climate change policy regimes can provide useful insights about the effects of higher carbon prices. For instance, OECD (2013b) estimates that electricity carbon prices in Norway, Sweden, the Netherlands and Denmark are respectively around £445, £134, £74 and £64 per tonne of carbon dioxide, compared with about £59/tCO_2 in the UK[14]. These carbon prices are typically accompanied by some form of revenue recycling and/or compensation for energy-intensive companies which mitigates the economic impact.

Overall, several studies have found that existing carbon and energy taxes only have small impacts on carbon leakage, economic growth, employment and consumer prices (e.g. Andersen *et al.*, 2007;Barker *et al.*, 2007; Vermeend and van der Vaart, 1998; Pwc, 2013).

5 Creating a level playing field

Although current policies have not affected business competitiveness so far, the impact of higher carbon prices in the future is more uncertain and ex-ante models warn that some amount of carbon leakage may happen in some sectors. With UK carbon prices due to increase to meet the UK's carbon budgets and European emissions targets, the design of policies that can prevent undesirable impacts on businesses will therefore be crucial.

Grover and Zenghelis (2014), for intance, explore the impact of an additional carbon price of up to US$30/$tCO_2$ (around £19/tCO_2[15]) on top of existing domestic policies. This is not too far from reality: the UK carbon price floor has been set at £18 until 2020 (HMT, 2014) and other policies could raise the implicit domestic carbon price further in the medium to long term. Their analysis

[13] Using an average exchange rate of €1 = £0.811 in 2012.
[14] Using an average exchange rate of €1 = £0.811 in 2012.
[15] Using an average exchange rate of $1 = £0.640 in 2013.

confirms earlier results from Stern (2006) that consumer prices may rise by only a negligible amount, but that the impact on some carbon-intensive industries could be significant if no compensation is offered.

In an ideal world, the 'first best' option to minimise the risk of carbon leakage would be to reach agreement on a global carbon price. This would probably be accompanied by some form of support for developing countries. A 'second best' alternative would be to implement agreements in different sectors, applying the same carbon price to domestic and imported goods on a sector by sector basis, or some form of border adjustment[16] (e.g. a charge on imports). The implementation of the latter would require overcoming concerns about the measurement of carbon content in final goods, for instance by assuming 'best-in-class' carbon content, and any equity issues relating to who keeps the revenue (see, for example, Grubb, 2011). However, none of these options is likely to be feasible in the short term.

International negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) have not yet been able to agree on a common approach, let alone a single carbon price, that would apply evenly across all countries.

There is also controversy about the legitimacy of border adjustments under the rules of the World Trade Organization (WTO) (Horn and Mavroidis, 2011), as well as suspicion that such measures may lead to more general protectionism (Evenett and Whalley, 2009). And while several studies indicate that, with careful design, border adjustments have the potential to provide a credible long-term signal that could help to galvanise early action while complying with WTO requirements (see, for example, Helm *et al.*, 2012; Ismerand Neuhoff, 2007), these instruments still encounter some political opposition.

Because of these challenges, a range of 'third best' options may be required in the short term. A starting point would be to set the same domestic carbon price across the economy, rather than allowing different prices for different sectors (see, for example, Bowen and Rydge, 2011; Advani *et al.*, 2013), so as not to negate the behavioural impact of carbon pricing. Any measure that attenuates the carbon price signal would significantly undermine the effectiveness of climate policy (Reinaud, 2008; Aldy and Pizer, 2011).

The sectors at risk of carbon leakage should then be compensated in a way that is unrelated to their emissions. For example, some firms could receive rebates or other transfers that are proportionate to their size or average energy use for their sector. Another option would be to reduce non-carbon taxes, such as corporation taxes, so that overall aggregate business costs do not increase.

Researchers have highlighted the need to develop political economy positive 'feedbacks' as a means of making the low-carbon transition politically viable (see, for example, Lockwood, 2013, 2014). This is because policy signals affect the costs of deploying low-carbon investment, and their credibility is key to investment and expectations. A corollary of this is that, in some instances, compensation for affected incumbents may not necessarily be justified for reasons of competitiveness or efficiency, but may be a prerequisite for political acceptance (Fay *et al.*,

[16] The literature about the economic merits of border tax adjustments is vast. Relevant readings include Helm *et al.* (2012), Cosbey (2008), Wooders *et al.* (2009), Kuik and Hofkes (2010), Caron (2012), and others.

2013). This was the justification, for instance, for allocating free emissions allowances in the first phase of the EU ETS.

Assuming significant levels of pass-through of the carbon price, profit neutrality actually does not require many allowances to be allocated for free in most sectors (Hepburn *et al.*, 2013). Goulder (2013), for instance, finds that only 13.7 per cent of the total allowance would need to be given out free in order to preserve the profits of the most carbon-intensive industries. Nevertheless, without initial large compensations, the EU ETS would probably never have been politically viable in the first place.

However, an excessive focus on political consequences may have the perverse effect of encouraging so-called 'rent-seeking' by incumbent industries which have an incentive to exaggerate the impact of policies in order to receive compensation. The misallocation of compensation can generate windfall profits (notably in the power sector) and the only effect of this is to raise consumer prices (see, for example, de Bruyn *et al.*, 2010; Hourcade *et al.*, 2007; Reinaud, 2008).

Over-compensation also waters down the actual purpose of carbon pricing, which is to reduce emissions. In Norway, for example, extensive tax exemptions and relatively inelastic demand within the sectors where the tax is actually implemented have led to only small effects on emissions reductions, despite relatively high carbon taxes (Bruvoll and Larsen, 2004).

In order to avoid undesirable market distortions, compensation measures are best targeted at only those businesses which are effectively at risk of carbon leakage, but this is complicated by asymmetric information about compliance costs (Martin *et al.*, 2013).

As noted in Section 4, the compensation mechanisms for current policies are arguably far too generous. For instance, the discount on the Climate Change Levy granted by the Climate Change Agreement is made available to firms which are either energy-intensive or highly trade-exposed[17]. This implies that sectors which are heavy energy users but are not exposed to competition outside the UK, such as large retailers or industrial-scale bakeries, qualify for a tax discount even if, in effect, they face little risk of carbon leakage (Advani *et al.*, 2013).

Within the EU ETS, currently 164 sectors have been identified as being at 'significant risk of carbon leakage', and are exempted from the auctioning process. These sectors account for almost 90 per cent of the emissions from all sectors covered by the EU ETS, and include businesses that are either very carbon-intensive, very trade-exposed, or both[18].

An econometric analysis by Martin *et al.* (2013) found that the criteria used by the European Commission to measure trade intensity are not a good proxy for business vulnerability to carbon

[17] From 2006, eligible sectors are those that have an energy intensity (the ratio of energy costs to the production value of the sector) of at least 10 per cent. Alternatively, the eligible sectors must have an energy intensity of 3 per cent or more and the industry import penetration ratio (the total value of sector imports, divided by the sum of UK sector sales and net imports) must be at least 50 per cent or more (DECC, 2014).

[18] According to the ETS Directive (2009/29/EC), Article 10a, a sector or sub-sector is deemed to be exposed to a significant risk of carbon leakage if participation in the EU ETS would lead to an increase in its production costs (calculated as a proportion of their Gross Value Added) of at least 30 per cent, or if the trade intensity of the sector with countries outside the EU is above 30 per cent. Alternatively, a sector is considered to be exposed to risk of carbon leakage if the increase in its production costs is at least 5 per cent and the trade intensity of the sector with countries outside the EU is above 10 per cent.

pricing. This is a reason for concern, because the trade-intensity criteria represent the route by which most sectors currently qualify for EU ETS exemptions.

Therefore, it is important that the right parameters are devised and that careful assessment is carried out to identify the correct sub-categories of sectors which need compensation.

The Green Growth Platform (2014) advised EU Ministers that freezing the list of EU ETS sectors at risk of carbon leakage would increase policy stability, but pointed out that a thorough analysis of the evidence for leakage needs to take place. It recommended: "Europe needs to ensure that the list is focused on those sectors genuinely at risk of carbon leakage to ensure that the level of support needed is available. Moreover, the risk of 'investment leakage' and regional differentiation thereof need to be taken into account to ensure that energy-intensive industries can compete during the transition to a green economy."

The design of compensation is also crucial. Lump-sum compensation, for instance, may not reduce carbon leakage, as firms may receive the full compensation while moving their production abroad so that they can also avoid paying some of the carbon costs. In order to limit leakage, this implies that the level of compensation must be proportional to the level of domestic output of the carbon-intensive commodity. Only if a business does not reduce its domestic output will it be eligible for full compensation (Neuhoff *et al.*, 2014). This constraint has, to date, hampered any attempts to remove the link between leakage protection and the incentive for emissions reductions.

Several studies also point out that a sector-specific approach is likely to be more effective than a 'one size fits all' compensation scheme (Carbon Trust, 2010; Dröge and Cooper, 2010; Reinaud, 2008; Sato *et al.,* 2014). Carbon Trust (2010) provides some insights into possible compensatory measures tailored for the aluminium, steel and cement sectors. The study finds that free allocations under the EU ETS regime appear to be more suitable for capital-intensive sectors that have high 'direct' carbon dioxide emissions, such as cement and steel. These measures should be temporary, and border levelling that is compatible with WTO rules should be explored in the longer run. Capital and electricity-intensive sectors, such as aluminium, would instead be better incentivised through direct investment support for low-carbon electricity.

Finally, it is also important to recognise that some businesses will unavoidably exit the market as demand for carbon-intensive goods and services falls and emissions regulations tighten. If an activity creates harmful by-products, some reduction in domestic output from this sector may be optimal and would probably have resulted from a uniform global application of carbon policies as part of the substitution away from carbon-intensive activities. The size of any such reduction depends on the opportunities available to substitute in lower carbon alternatives, and compensation should not interfere with this process.

6 National competitiveness, growth and economic performance

The previous sections focused on the impacts of domestic climate change policies on sector competitiveness and, specifically, on the risk of carbon leakage for carbon-intensive industries that are open to international competition. This section broadens the discussion to cover economic competitiveness at the state or regional level, defined as relative economic performance in terms of growth in output, output per capita and productivity.

At the whole economy level, carbon pricing will provide additional revenues for governments that can be used, or 'recycled', to increase the efficiency of the tax system and the broader economy, for example by reducing taxes on things we want to encourage - like work and intellectual activity. This can help increase efficiency and competitiveness across a range of carbon-efficient sectors[19].

As this section focuses on opportunities, many of which have yet to be realised or are by their nature speculative, the evidence base to support arguments about the deployment of specific technologies and about future trends can appear to be rather thin. This does not make the discussion less relevant and, where necessary, we draw on historical examples which provide relevant insights.

As Krugman (1994) pointed out, national economies, unlike companies, cannot go bankrupt on account of relative price changes (even if state and local governments can). In the long run, changing relative prices lead to changes in comparative advantage and factor resources are employed to most effectively exploit these changes.

There are continual changes in relative prices, the pattern of consumption and the structure of production. There are also changes due to the advance of technology, increasing per capita income and wealth, and the emergence of new global suppliers.

Economies with flexible institutions are better able to cope with structural adjustment associated with change, including those with open trade markets, effectively-regulated competition policy, low corruption, a strong rule of law and flexible labour markets.

Policies that encourage or at least do not inhibit, the flow of resources from declining and less productive activities to growing and more productive activities, and leave economies better able to absorb shocks, are most likely to exploit such global transitions. In short, these policies increase the capacity of economies and societies to adapt to change (Llewellyn Consulting, 2013).

Many reforms which increase an economy's productivity in the long term can be initially unpopular and blocked by vested interests. Labour market reform, competition policy or trade openness are considered good drivers for long-term growth but are often either costly to impose or subject to opposition by special interests in the short term.

There may be strategic reasons to support low-carbon investment. The green economy covers several sectors, including transport, energy, buildings, industry and land use. The Confederation of British Industry (CBI, 2012a) estimates an investment of £150 billion is required in the energy sector over the next 20 years in the UK. The UK Department for Business Innovation & Skills (2013) values the green market at £3.4 trillion annually worldwide.

The UK carbon budgets, and the policies that aim to implement them by encouraging low-carbon investment, provide new business opportunities and generate income for investors in the UK precisely because they address growing global resource challenges.

[19] For a rich discussion of the evidence see material presented by Larry Goulder, Ian Parry and others at the MCC Carbon pricing conference in Berlin on 22-23 May 2014 http://www.mcc-berlin.net/en/events/event-detail/article/public-finance-workshop.html

As Asia and other parts of the world industrialise, allowing billions of people to adopt consumption patterns that previously were limited to a minority of the world's population, the global economy will have to increasingly shift to low-carbon resource-efficient production, either as a result of policy or because of market pressures on the prices of resources.

A recent study by Globe International showed that almost 500 climate laws have been passed in the 66 countries covered by the analysis, including all of the world's major economies (Nachmany *et al.*, 2014).

Two of the world's fastest-growing economies, South Korea and China, moved decisively to champion high-technology low-carbon growth in stimulus packages in 2008 and 2009, investing in efficiency measures and developing fast-growing export markets. China's 12th Five-Year Plan also sets strong 'green' targets. These countries recognise that investment flows to the pioneers in industrial revolutions (Perez, 2002).

The exploitation of shale gas has prompted a sharp reduction in energy costs in the United States relative to Europe and Asia (IEA, 2013). According to some claims, this has served to attract key energy-intensive businesses, for instance in the chemicals sector, away from more expensive European locations to the United States. This 're-industrialisation' is often referred to as a clear win for the economy of the United States. However, the actual effect of low gas prices on business competitiveness in the United States is still under scrutiny. The International Energy Agency (IEA, 2013) notes that, except for the petrochemical sector, there is no evidence that low energy prices have led to a resurgence in investment or production.

Furthermore, it is possible to question whether this is in the long-term interests of the United States. Firms in the United States may hope to adjust efficiency when they have to after a period when they reap the profits from cheap gas. But reducing the incentive for companies to be more efficient in their energy use may lead these firms to miss out on developing and deploying those productivity gains necessary to compete in an increasingly resource-constrained global economy in the 21st century.

The history of the car industry in the United States provides a useful comparison. In response to strong pressure from consumers and the car industry itself, the Federal and state authorities in the United States have kept gasoline taxation fairly light. As a result, cars built in the United States became heavier and less efficient than their European and Japanese counterparts, just when energy efficient vehicles were in greater demand globally. However, sport utility vehicles (SUVs) and pick-up trucks, which have low fuel economy, were hard to market once energy prices rose in response to the rapid industrialisation of China and other economies. Chrysler filed for Chapter 11 bankruptcy protections on 1 May 2009, and was followed by General Motors a month later. The United States government stepped in to rescue both, while Ford secured a special line of credit.

Investing in a low-carbon and resource-efficient economy has a price, but it is important to differentiate an 'investment' cost from a 'resource' cost.

The cost of installing an alternative energy infrastructure is higher than continuing with conventional fossil-fuel-based infrastructure, when carbon prices are low or not in place. Indeed, levelised costs, taking into account amortised capital costs, are still higher for

renewables than for most of the cheapest fossil fuel options (EIA, 2013). But this margin is beginning to narrow for most renewable technologies (Kost et al, 2013). Many such energy systems are likely to be cheaper to run in the future, with lower operating costs than fossil fuels, which require costly excavation and transportation. The relative cost of fossil fuels is also expected to increase as carbon prices rise.

Solar photovoltaic and onshore wind technologies are already competitive with gas and coal in a number of global locations, even without a strong carbon price. The likelihood is that the costs of new energy systems, especially for a variety of solar technologies, will fall further, and close the gaps with conventional energy sources, even without the application of a strong carbon price – especially as energy storage and energy distribution technologies improve (see, for example, Bloomberg NEF, 2011; EPIA, 2011). Supporting these sectors will accelerate cost reductions, and in doing so will increase cost-effective opportunities to substitute out of carbon-intensive activities. This will reduce the revenue raised from carbon pricing, but lower whole economy costs.

The extent to which the costs of new energy systems will fall depends on the purchase, installation and running costs of the capital equipment, which is, in part, a function of learning and experience. Future reductions also depend on the evolution of fossil fuel costs. Although technological developments, such as 'fracking', will allow the exploitation of unconventional reserves and may alleviate pressures on fossil fuel costs and/or imports in some European regions, it remains likely that fossil fuel prices will generally rise under pressure from growing demand from industrialising countries in Asia and elsewhere (Dobbs *et al.*, 2011).

Furthermore, there is a large and untapped potential for investment in efficiency technologies and processes in the European Union. Sectoral studies show there is still significant potential for additional energy efficiency gains, including in the most energy-intensive sectors - see for example Neuhoff *et al.* (2014) on the cement sector, and ECF (2014) on the chemical sector. According to the International Energy Agency (IEA, 2013), investments to improve energy efficiency are the most cost-effective way to protect industry against rising energy prices and, by lowering costs, it could improve business competitiveness.

Analysis by the OECD shows that the robust implementation of energy efficiency measures could raise profits in the European Union's iron and steel sector by 0.5 per cent by 2035, as production is expected to shift from the least developed countries to the European Union, the United States and India, where policies will lower production costs (Chateau and Magné, 2013). Opportunities for emissions reductions also appear consistent with the historical sources of competitive advantage in the chemicals sector, which centre around technological leadership, innovation and integration (ECF, 2014). Focussing solely on upfront costs is therefore not a good way to measure 'value for money'.

It has been suggested that the current economic environment in the UK means that it is not a good time to raise energy costs for businesses and households. However, from a macroeconomic perspective, now may be the appropriate time to pay for the changes needed to create jobs and growth.

Annual private sector surpluses (the difference between private saving and investment) increased to record levels over the past few years, amounting to more than 5 per cent of UK GDP (Zenghelis, 2012). However, there is a perceived lack of opportunity which is holding back

capital investment. The net returns achievable by leveraging this private saving now, to exploit investment opportunities, are uniquely high. Capital costs are historically low and the potential to 'crowd-out' alternative investment and employment is much smaller than when the economy is operating close to full capacity.

The UK economy is recovering but spare capacity is set to remain for many more years. In their latest projections, both the OECD (2013a) and the UK Office for Budget Responsibility (2013) project the official measure of spare capacity, the UK output gap, to remain negative. This means the economy will continue operating below its potential full capacity for several years to come.

Table 2 Output gap in the UK (per cent of potential output)

	2012	2013	2014	2015	2016	2017	2018
OBR	-2.6	-2.3	-1.8	-1.6	-1.2	-0.7	-0.2
OECD	-2.7	-2.5	-1.7	-1.2	-	-	-

Source: OECD (2013a) and OBR (2013)

The green sector is a vibrant part of the global economy at the moment. The UK Department for Business, Innovation and Skills (2013) valued sales in the UK low-carbon and environmental goods and services sector at £128.1 billion in 2011–12, 4.8 per cent higher than the previous year.

Overall, the UK is a substantial net exporter of green goods and services, including to Germany and China (Green Alliance, 2013). But the UK private sector is not investing as heavily as it could in green innovation and infrastructure because of a lack of confidence in future returns in this policy-driven sector.

Part of this lack of confidence is due to concerns about the impact on existing sectors. However, the business landscape is likely to continue to change in the coming decades. Industries in the UK that are competitive, relative to the rest of the world, belong to a mix of low-to-medium energy-intensive sectors such as financial services, business services, the creative industries, aerospace, specialist chemicals and pharmaceuticals (CBI, 2012b; Karecha and Meegan, 2013).

The evidence suggests that the UK's success in nurturing the innovative, high-technology low-carbon sector has been based on relatively strong domestic policies in the past, combined with global leadership and clear political commitments that have boosted investor confidence. However, more and more countries are now acting strongly to draw investment into this high-growth sector. There are 138 countries that now have renewable energy targets and 71 countries that apply feed-in tariffs for renewable generation (Green Alliance, 2013).

In economic terms, early action is required to resolve key market failures and prevent the lock-in of wasteful, resource-hungry infrastructure, as well as to drive innovation (Romani *et al.*, 2011). In turn, minimising the investment cost of such action depends on clear and strategic policy direction by the Government demonstrating its commitment to a sector. There are genuine risks associated with being over-prescriptive about technologies. For example, some people argue that offshore wind is too expensive and likely to be superseded by technologies such as solar (Helm, 2012). This is why broad policies such as carbon intensity targets may be

better placed to address non-price market failures than renewables targets or subsidies for particular technologies.

External factors associated with energy, communications and transport systems mean that the value of joining a network depends on how many others are on it. The private sector is highly unlikely to risk making changes to existing networks, even if the returns are viable for specific technologies, unless the long-term path of policy is credible, and policy risk is minimised to such an extent that it enables the hurdle of up-front costs to be overcome.

In addition, innovation requires an understanding of the unintended consequences that result from knowledge spill-overs from one sector to another. Market failures relating to information and ownership mean investors fear that they will fail to capture the full returns from risky long-term innovation where the knowledge spill-over to its competitors is free, and as a result will underinvest in its development.

In all these cases, private and public costs and benefits diverge, and coordination and information problems limit the degree of investment in energy efficiency and waste reduction. An innovative and competitive economic transition is unlikely to materialise without a strategic steer from the public sector that helps to induce an efficient level of private innovation.

A healthy debate about climate and energy issues is both welcome and democratic. However, a lack of clear political leadership, together with mixed or muddled policy signals about energy and climate policies, can weaken business confidence and undermine some of the most competitive and innovative business sectors.

For example, in the UK, the impact of the 2008 Climate Change Act in setting world-leading emissions reduction targets risks being undermined by political threats to weaken its carbon budgets. The Confederation of British Industry (CBI, 2012a) warned: ‘‘If the government continues with its current approach, there is a real risk that UK green business growth will not reach the government’s expectations [….] which could mean the UK losing almost £400 million in net exports in 2014-15”.

7 Conclusions

The UK emissions reduction target set in the Climate Change Act and embedded in the carbon budgets have led to the development of a number of policy instruments and regulations that expose UK business to a domestic carbon price.

As businesses face competition from countries applying different, and in some cases weaker, climate change policies, this has raised concerns over a possible loss of competitiveness due to higher business costs and the relocation of carbon-intensive activity to less ambitious jurisdictions abroad. Ex-ante theoretical studies have tended to give weight to this concern.

However, there is general agreement that only a few sectors and sub-sectors are truly at risk. There is also agreement that other factors affect investment and relocation decisions and, in most cases, these are stronger drivers than climate change policy.

Moreover, relocation of physical plants may make sense only if investors expect the asymmetric application of climate policies across competing countries to endure long enough to cover a sufficient part of the lifespan of the new capital. Otherwise, future policy changes might render investment decisions costly and unnecessary.

Ex-post studies based on actual evidence suggest that current policies have had no significant impact on business competitiveness in the UK and the European Union. But this can be partially explained by the fact that carbon prices have been low relative to movements in energy prices and also the fact that generous compensatory measures are already in place.

Current concerns over the impacts of climate change policies on competitiveness therefore appear to be overstated. But analysis suggests higher carbon prices necessary to meet the Fourth Carbon Budget could potentially distort production in, and prompt relocation of, some energy-intensive sectors.

In the absence of a global carbon price designed to 'create a level playing field', at least across carbon-intensive sectors, a compensatory border price adjustment might be required to limit distortions to production and enhance efficiency. However, at least in the short term, this appears unfeasible or undesirable. As a result, individual countries, including the UK, will have to rely on domestic measures to limit the threat of industry relocation. These measures can include support to compensate vulnerable sectors.

In order to cost-effectively achieve emissions reductions as well as avoid unnecessary relocation and limit undesirable distortions to trade and production, such measures need to be designed appropriately to target polluting activities in specific sectors.

However, the case for lowering the ambition of climate change efforts, as a weakening of the Fourth Carbon Budget would imply, is not justified by competitiveness concerns, not least because of the negative impacts this would have on some of the economy's fastest growing and most promising and innovative sectors. Uncertainty about the future climate policy framework could potentially cost jobs and affect growth, especially in the current macroeconomic environment.

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