REPORT OF THE

HIGH-LEVEL COMMISSION ON CARBON PRICING AND COMPETITIVENESS

CARBON PRICING LEADERSHIP COALITION

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ACRONYMS

BC	British Columbia
BCA	Border carbon adjustment
CAD	Canadian Dollar
CDP	Formerly known as Carbon Disclosure Project
CEBDS	Brazilian Business Council for Sustainable Development
C2ES	Centre for Climate and Energy Solutions
CPLC	Carbon Pricing Leadership Coalition
EDF	Environmental Defense Fund
EITE	Emissions-intensive trade-exposed
ETS	Emissions Trading System
EU ETS	European Union Emissions Trading System
GHG	Greenhouse gas
ICAP	International Carbon Action Partnership
IETA	International Emissions Trading Association
IPCC	Intergovernmental Panel on Climate Change
NDC	Nationally determined contribution
PMR	Partnership for Market Readiness
WRI	World Resources Institute

THE COMMISSION

The potentially adverse impact of carbon pricing on the competitiveness of businesses and economies has been a matter of concern to industry and policymakers. It has also been a barrier to progress on carbon pricing. The Carbon Pricing Leadership Coalition launched the High-Level Commission on Carbon Pricing and Competitiveness at its 2018 High-Level Assembly to address the issue. The Commission is co-chaired by Feike Sijbesma, Chairman and CEO of Royal DSM, and Anand Mahindra, Chairman of Mahindra Group.

OBJECTIVE

The Commission serves as a platform for dialogue among business leaders to explore the evidence base, the concerns of business, and the lessons learned in the design and implementation of carbon pricing policies in the context of competitiveness.

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I. KEY FINDINGS

1. Climate change poses a real threat to our industries and economies and needs to be addressed as a matter of urgency. The cost-effective transition to a net zero-carbon economy by the middle of the century is important to avoid the most severe impacts on our climate and to maintain the productivity of our economies.

2. Carbon pricing is an effective, flexible, and low-cost approach to reducing greenhouse gases (GHGs). Combined with other policies, carbon pricing can help accelerate and ensure a smooth transition to a low-carbon economy.

3. Carbon pricing is intended to drive a shift away from high-emissions products to low-emissions products and processes. Some firms that compete against these low-emissions substitutes may experience a loss of market share and reduced profits even as others adapt, increase their profitability and develop new business models.

4. Concerns exist that, due to differential carbon prices between jurisdictions, there is the potential risk that high-carbon economic activity may move to regions without a carbon price or with a lower price. This could result in decreased profits and job losses. It could also exacerbate political push-back and undermine the intended environmental outcome of reduced GHG emissions. If this "carbon leakage" occurs, it would be a lose-lose: a loss of competitiveness or economic activity without an environmental gain.

5. There is little evidence to date that carbon pricing has resulted in the relocation of the production of goods and services or investment in these products to other countries. This outcome is consistent with the economic literature assessing the competitive impact of environmental regulation more broadly. There may be several reasons for this, including the observation that carbon price levels have generally been moderate and existing programs include protection for at-risk sectors. In addition, tax rates, labor availability, and infrastructure may be more significant to investment decisions regarding location of production than environmental regulations.

6. While competitiveness remains a key concern for policymakers considering a price on carbon, these concerns should not be overstated. Competitive risks exist primarily for highly emissions-intensive and trade-exposed (EITE) sectors and jurisdictions that depend on such sectors. These risks can and should be addressed through a suite of locally tailored policy design choices intended to protect industry from unfair international competition even as they ensure that the incentive and support for low-carbon innovation remains.

7. There are a variety of options to address competitiveness risks, including free allocation of emission rights and border measures. However, these should be based on a location-specific, data-driven evaluation of impacts. Once implemented, these measures should be periodically reevaluated to ensure their effectiveness and usefulness. To that end, data transparency from industry, at least with government officials, is particularly important for assessing how and when intervention is necessary.

8. As ambition levels increase to meet the goals of the Paris Agreement, two countervailing effects may be relevant for competitiveness impacts. On the one hand, greater ambition will generally mean higher carbon price levels leading to the potential for more significant competitiveness impacts for EITE industries. On the other hand, as more countries adopt climate policies and develop linkages between carbon markets, differences in carbon prices among countries and regions should become smaller, alleviating competitiveness concerns.

9. Concerns about competitiveness implications should not preclude carbon pricing or keep regions from increasing carbon prices or emission targets over time to levels needed to implement the Paris Agreement, for example as set out in the Stern-Stiglitz report (CPLC 2017), namely \$40–\$80/tCO_2e by 2020 and \$50–\$100/tCO_2e by 2030.

10. Carbon pricing, along with complementary measures, can also drive innovation, investment and substantial growth in some sectors. The investment opportunities that arise from decarbonization are considerable, as is the potential for the development of new industries and innovation within existing ones. Carbon pricing can also generate revenues to further program or national objectives and to support those who might be negatively impacted.

11. Innovation and investment, as well as stable and predictable policies, are crucial to the transition to a low-carbon economy. Policy clarity, with strong governmental commitment to meaningful policy which increases in stringency over time, can help ensure that companies and regions remain competitive in global markets. Furthermore, large mainstream investors are increasingly factoring in the development and implementation of low-carbon strategies when evaluating their portfolios.

II. PURPOSE, SCOPE AND METHODOLOGY

Industry and policymakers considering the introduction of carbon pricing are often concerned that putting a price on carbon in the form of a tax or an emissions trading system may have adverse effects on the competitiveness of a carbon-intensive firm, sector, or country. For industry the concern is partially about the low-carbon transition challenge, and partially about the potential for international competitors to have an unfair advantage if they do not face a similar carbon price. While both factors may be significant to the overall competitiveness of a firm, the primary policy focus of most carbon pricing competitiveness discussions is on international competitiveness. This is primarily because of the potential to shift production, investment, and jobs, resulting in non-achievement of the environmental objective. This does not mean that the transition challenge is not significant for some industries, sectors, or regions, but rather that it is not typically thought of as "unfair" or unintentional. Providing an incentive that lowers emissions is the goal of carbon pricing; if emissions are simply moved elsewhere, or "leaked" to a region without similarly stringent climate regulations, that goal is not achieved.

An increasingly large body of literature (both peer-reviewed and from industry) has examined the international competitiveness issue, both from a potential, ex-ante perspective and from an empirical, ex-post analysis of actual experience. In general, those studies seeking to understand future impacts tend to suggest more potential competitiveness impacts than have actually been experienced to date—at either the sector or country level. This may be due to several reasons, including that carbon costs tend to be only one of the many factors that influence investment decisions and competitiveness; that carbon price levels in general have been moderate; and that existing carbon pricing programs include protection for at-risk sectors, which tend to account for only a small proportion of the overall economy.

This report is based on the Commission's assessment of the available evidence and literature, a series of consultations with industry from a range of countries and advice from an expert advisory group.[1] (See Annex A for a summary of the consultations. See Annex B for a summary of the literature on impacts of carbon pricing on competitiveness.)

The primary focus of the report is on the competitiveness issues that may arise from carbon pricing. The report does not evaluate the merits of the two primary options for establishing a carbon price: cap and trade, or carbon tax. The report also does not provide an overview of the internal carbon pricing used by some entities to prepare for carbon pricing policies and to assess the viability of their investment decisions under different policy scenarios.[2] Instead, it highlights key insights and significant considerations relevant to mandatory pricing of GHG emissions and its effect on competitiveness.

The report is organized as follows: first, it provides background on the rationale for carbon pricing policy and offers a short explanation of the general nature of competitiveness impacts. Next, it examines international competitiveness, specifically the concerns of EITE industries. It then identifies policies that can remediate competitiveness impacts and describes the benefits associated with pricing. Finally, key takeaways conclude the report.

1 - Other summaries of carbon pricing competitiveness literature can be found at PMR 2015; Arlinghaus 2015; and Dechezleprêtre and Sato 2017.

2 - A review of corporate use of internal pricing practices can be found at Ahluwalia 2017.

III. CONTEXT AND BACKGROUND

The scientific evidence for climate change is well-established and the consequences of climate change are already being felt through sea-level rise and extreme weather events. Recent estimates by the Intergovernmental Panel on Climate Change (IPCC) stated that impacts on health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and to increase further with a rise of 2°C above pre-industrial levels. To reduce these impacts and give adaptation efforts a better chance of success, global economies must transition to carbon-free and low-carbon technologies. The IPCC report also found that limiting global warming to 1.5°C would require “rapid and far-reaching” transitions in land, energy, industry, buildings, transport and cities, with emissions needing to fall by about 45% from 2010 levels by 2030, reaching net zero around 2050 (IPCC 2018).

Achieving this level of emissions reductions will require dramatic changes throughout every economy in terms of how we use energy, grow food, manage our lands and forests, and transport ourselves. Economists, overwhelmingly, point to carbon pricing as a policy tool that can stimulate innovation and minimize the cost of this transition. Rather than government requiring specific technologies or dictating when emissions need to be reduced, a carbon price puts a value on carbon pollution that provides an economic signal that reducing emissions is valuable. Companies exposed to this price each decide how and where to reduce GHG emissions and when to adopt lower-carbon technology options. In this way, the overall environmental goal is achieved in the most flexible and least-cost manner.

“Bold and immediate commitment is needed to respond to the challenge of climate change. Carbon pricing is an effective response especially when coupled with other policies. It can result in remarkable opportunities for corporations, countries, and for mankind as a whole.”

—Anand Mahindra, Chairman, Mahindra Group

The primary goal of carbon pricing is to reduce emissions. This is achieved by changing the relative costs of low-emissions and high-emissions products, services and production methods. Depending on the structure of the sector, this price may or may not be passed along to consumers but where it is, it can provide an incentive for both firms and consumers to reduce their costs by reducing their use of carbon-intensive goods and lowering their emissions.

Carbon pricing policies continue to expand around the globe because of their flexibility and effectiveness for addressing climate change. As of April 2019, there are 57 carbon pricing initiatives implemented or scheduled for implementation, consisting of 28 emission trading systems (ETSs) in regional, national, and subnational jurisdictions, and 29 carbon taxes, primarily applied on a national level. In total, these carbon pricing initiatives cover 11 gigatons of carbon dioxide equivalent ($GtCO_2e$), or about 20% of global GHG emissions, compared to 15% in 2017 (World Bank 2019). And pricing programs continue to be

explored and introduced. Of the Nationally Determined Contributions (NDCs) submitted for the Paris Agreement, 52% intend to use or are considering the use of carbon pricing or market mechanisms. Of particular note is the official announcement by China to launch their national ETS in December 2017, and trading is expected to begin next year (2020). Singapore implemented its carbon tax in January 2019, and South Africa in June 2019. Senegal is exploring carbon pricing as part of the policy options to reach the objectives of its NDC.[3] While a national carbon price does not exist in the U.S., 10 states have carbon pricing programs which cover about 6% of national emissions (Rhodium Group 2018).

As more governments adopt carbon pricing and complementary policies that become more stringent over time, new technologies will be developed, knowledge about climate innovation will be transferred among regions, and demand for new low-and zero-carbon industries will increase. Existing firms with higher carbon footprints, however, fear that they could face competitive challenges from two directions: first, from lower-carbon competitors with products easily substituted, and second, from foreign competitors with comparable products without similar constraints. For example, domestic steel producers subject to a carbon price fear that they could see reduced demand in the domestic building sector where wood products, which will likely not face the same level of carbon cost, can be used as a substitute. In addition, if foreign steel producers do not face the same carbon constraints, domestic producers may see their market share reduced if domestic demand can be met by lower-cost foreign steel.

These examples highlight an important distinction, however. In the case of substitution from more carbon-intensive products (steel and cement) to less carbon-intensive products (wood), the difference in carbon costs as a result of a carbon price is an accurate reflection of the difference in underlying emissions. Thus, from a climate policy perspective, such substitution is desirable—although policymakers may still want to ensure a just transition for workers and firms in carbon-intensive industries. On the other hand, a difference in carbon costs between domestic and foreign steel that results from differential climate policies does not reflect underlying emissions. As explained in more detail below, leakage may even worsen the problem.

"We know that carbon pricing works. If more governments put a price on carbon, business will follow suit and quickly."

—Eldar Sætre, Chief Executive Officer, Equinor

Competitive pressures, however, are not always one-sided. Steel producers, who can rapidly adapt, innovate, and lower their emissions, may find domestic or international market opportunities if they can make these changes more cost-effectively than others. A key goal of carbon pricing policy is to incentivize industry to invest in low- or zero-carbon technologies and consumers to buy lower-carbon products. In fact, market-oriented policies can create a healthy dynamic where firms compete to make the transition, aiming to perform better than peers so as to create a valuable form of competitive advantage. To that end, low-carbon companies may highlight their environmental track-record as part of their branding to attract customers.

3 - For a summary of carbon pricing programs around the world, see World Bank 2019.

A JUST TRANSITION

Shifting from higher to lower-carbon technologies will likely cause industry disruption; some sectors in an economy could shrink, as others grow. Some corporates may plan their transition well and attract market rewards, but others may lag behind. Pricing may also cause financial and societal shocks to a region as jobs are lost in one sector—even if they are gained in another. As discussed at regional consultations held for this report, negative impacts for certain sectors and in certain regions could be significant, and should be acknowledged and addressed to ensure a just and equitable transition. Governments can support low-carbon transitions, through research and development programs that help with technology innovation, and tax incentives that lower technology adoption costs. To alleviate the negative impact on sectors or regions less able to transition to a lower-carbon economy, a range of policies can be used. Such policies can help workers transition to other employment or seek to boost local economies and therefore job opportunities. A notable positive outcome of carbon pricing is that it can generate significant funds that can be used to pay for transition-assistance programs like those listed above.

"A just transition brings together workers, communities, employers, and government in social dialogue to drive the concrete plans, policies, and investments needed for a fast and fair transformation. It focuses on jobs, livelihoods, and ensuring that no one is left behind as we race to reduce emissions, protect the climate, and advance social and economic justice (World Bank 2018a)."

Box 1 - The International Trade Union Confederation's definition of a "Just Transition"

No single low-carbon transition policy package, however, will create equal benefits and opportunities for every region.[4] National policy objectives, sectors at risk, and existing policies and constraints will influence the appropriate mix of policies to include with carbon pricing.[5]

INTERNATIONAL TRADE COMPETITIVENESS

Sector and employee assistance aimed at an equitable low-carbon transition may not, however, be enough to eliminate the concern that arises from international competitiveness for emissions-intensive firms with products traded globally. For these, an additional cost on their GHG emissions could create concern about their ability to compete with foreign firms who do not face a similar carbon constraint. It is this combination of emissions intensity and trade exposure that gives rise to the fear that these firms may unfairly lose market share as foreign competitors, not subject to similar policy, increase their presence in that market. The fear extends to a potential reduction of jobs, if that industrial activity relocates to countries that do not have domestic climate regulations. The result may be a shift of industrial activity to another country without any environmental benefit. This is a lose-lose scenario and one likely to exacerbate the political push-back on carbon pricing, unless effectively addressed. This type of competitiveness impact is therefore the primary focus of the remainder of this report.

4 - Regions in this context refers to geographic areas defined by a political boundary and could include one or more provinces, states, territories, cities or even countries.

5 - For a recent review of energy transition policies, see IEA 2017.

If a significant carbon price differential exists between competitors in the same industrial sector, firms and sectors facing a higher price could be disadvantaged (Aldy 2016). Eliminating this differential with a more consistently stringent global policy (including border adjustment measures like a carbon tariff on imports to level the playing field), would solve that issue. Yet, to date, this type of border measure is rarely used because of its complexity and fear of creating political issues involving trade and the World Trade Organization. Instead, as regions consider and implement carbon pricing policies, they must assess how carbon price differentials—and other carbon constraints—could potentially result in the relocation of investment or emissions-intensive manufacturing activity, both of which could reduce jobs and undermine the environmental objective of the policy.

The decision to locate, relocate, or decrease production or investment in any company, is rarely based on just one factor, however. Researchers who have examined the degree to which carbon pricing has an impact on these decisions have consistently found it to be one among many factors, and not the most important. Many studies conclude that other variables—corporate tax rates, energy prices, wage rates, labor availability, infrastructure, geographic location, cost of capital, exchange rates, prices for commodities and materials—exert a stronger influence on most industry decisions to locate or invest. The same is true of other forms of environmental taxation.[6] Nevertheless, different carbon prices will impact specific sectors and firms differently depending on the relative significance of the price to its overall marginal cost and profit margin. Consequently, the concern about competitiveness remains and poses political challenges. The vast majority of carbon pricing programs therefore include provisions to protect EITE industries. (See Box 2 for an example of the mix of policies used in Canada.)

Like many regions, Canada and Canadian Provinces use a mix of carbon pricing and other policies to reduce emissions and manage the potential negative impact on international competitiveness of EITE industries. Alberta and Quebec use an output-based system for allocating their emission allowances. British Columbia uses its carbon tax revenue to lower other corporate taxes and provide technology innovation assistance for specific sectors.

All provinces and the federal government provide direct support for R&D technology that can help reduce the financial cost for firms as they transition to lower-carbon technology. As an example, the federal government provides funding to an organization called Sustainable Development Technology Canada, which supports low-carbon technology R&D and deployment across the country. Alberta uses revenues from the carbon price paid by large emitters to fund and demonstrate technologies that reduce emissions and British Columbia provided a CAD14 million grant ($10.7 million)[7] to help LafargeHolcim transition to lower-carbon fuel used in cement production (Rantanen 2019).

Box 2 - A mix of policies protect Canadian industry from international competitiveness

6 - Studies including Jaffe et al 1995; Reinaud 2008; Ekins and Speck 2010; Rogge et al 2011; Vivid Economics 2014; Rivers and Schaufele 2014; and Arlinghaus 2015 (to name just a few) have examined the factors that influence firm decisions about where to locate

7 - Currency conversion rates as of June 28, 2019. U.S. Federal Reserve. https://www.federalreserve.gov/releases/h10/current/ Accessed July 3, 2019.

IV. INTERNATIONAL TRADE COMPETITIVENESS: WHAT ARE THE CONCERNS AND WHO IS IMPACTED?

Identifying which firms or sectors are EITE is not a simple task and can vary between regions and over time. In general, sectors considered emissions-intensive produce significant GHG emissions during their production process and/or use a significant quantity of products (e.g. electricity) with embedded carbon as part of their production process. The greater the emissions intensity, the greater the potential cost impact from carbon pricing. When firms are able to pass along these costs to consumers in the form of higher prices, the impact on them should be significantly reduced, even as the impact on consumers could increase.[8]

COST PASS-THROUGH

While most manufacturers can pass along additional production costs to consumers, they may find it more difficult to do so for internationally traded products. This is because they may be competing with firms that do not face similar carbon costs and so would be at a relative cost disadvantage. The complexity of determining which industries can passthrough carbon costs, and what percentage, is exemplified by the vast number of studies that have considered this topic. Many have sought to calculate the level of free allocation that allows firms to maintain profit and shareholder value in the European Union Emissions Trading System (EU ETS).[9] Others have focused on whether firms and emissions will relocate because they cannot pass along a carbon price.[10] Still others have looked primarily at cost pass-through in just one sector, like power generation or agriculture.[11] In all of these studies, the overarching conclusion is that the competitiveness impact is less for firms when the extra cost can be passed along to consumers. But, when this is not the case, how significant is this issue? Furthermore, how do we know which firms or sectors are able to pass along the added cost of carbon pricing?

Evidence suggests that, where carbon pricing programs have been implemented, the number of firms that have truly faced this EITE competitiveness pressure is limited to a small number of sectors and specific regions (Morgenstern et al 2007).[12] For example, Beale et al (2015) found that in Canada only 5% of the economy faced carbon pricing trade-exposure because of a much larger number of service-focused industries and a reliance on local markets (see Figure 1). However, in some Canadian provinces, such as Alberta and Saskatchewan, this number was significantly higher (18%). This is because oil and gas make up a much larger share of the local economy and, with greater reliance on fossil energy, electricity is more carbon-intensive.

8 - Whether or not a firm can passthrough the additional costs associated with a carbon price may be a function of regulations that allow or preclude this cost pass-through. From an economic perspective, the ability to pass through this additional cost is fundamentally tied to the relative responsiveness of both supply and demand to the carbon price. The general factors that influence this relationship include: the time for adjustment, number of substitutes available, and the relative importance of the carbon cost in the final product.

9 - See, for example, Carbon Trust 2004; McKinsey and Ecofys 2006; and Hourcade et al 2007.

10 - Gielen and Moriguchi 2002 and Demailly and Quirion 2006 examine competitiveness and relocation.

11 - As illustration, see Demailly and Quirion 2008; Boston Consulting Group 2008; and Vieth et al 2009.

12 - Morgenstern suggests that for EITE industries, energy often accounted for more than 3% of total costs (whereas for most manufacturing industries it accounts for less than 2%).

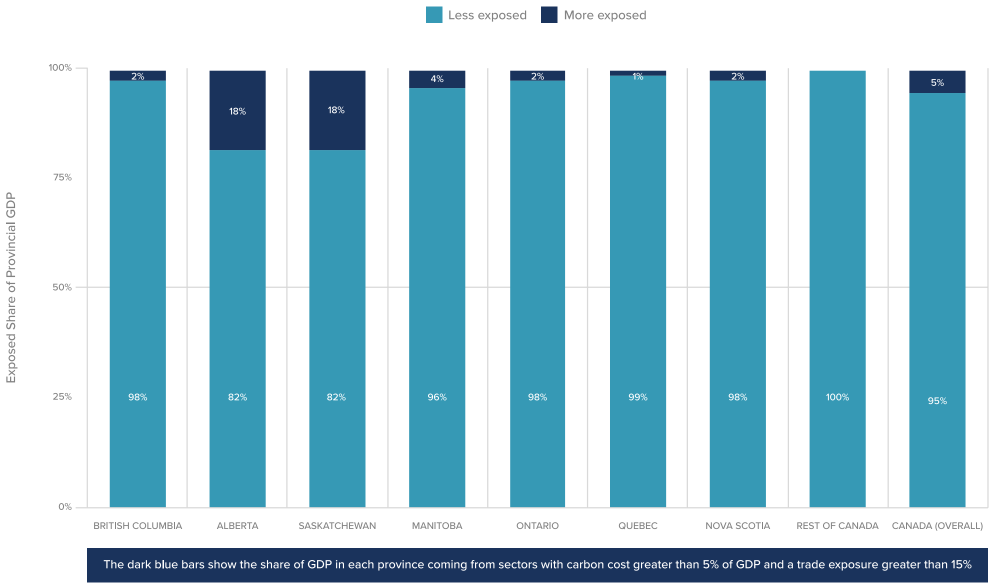

Figure 1 - Relative competitiveness pressures across Canadian provinces, 2015
Source - Canada's Ecofiscal Commission (2015), "Provincial carbon pricing and competitiveness pressures"

Many industries beyond oil and gas, however, are typically considered EITE. Glass, steel, metal casting, pulp and paper, chemicals, aluminum, cement, in addition to refining, are commonly considered EITE.[13] In these sectors, energy costs tend to make up a larger portion of costs, or production fundamentally involves the release of GHGs, and because they face global competitors, their ability to recover the cost of the carbon policy is assumed to be limited. Even for EITE industries, however, studies have suggested that many have an ability to pass through at least some portion of the cost of carbon. For example, Arlinghaus (2015) summarized the empirical findings in the EU and concluded that, while cost pass-through in wholesale electricity markets ranged from 60% to over 100%, studies had found pass-through rates for manufacturing sectors between 0% and 100%. She also concluded that some iron, steel and refineries could pass along all of the carbon cost to consumers.[14]

While empirical studies provide insights into the general nature of cost pass-through and competitiveness, results can differ by researcher, firm, region, and price level, and the conclusions of any one study should not be taken as absolutely definitive. (See Annex B for a summary of empirical analyses reviewed for this report.) This suggests that the impact of carbon prices on EITE sectors and the degree of cost pass-through need to take into account local conditions and should perhaps be analyzed on a regional basis. Smaller firms, for example, tend to operate in more localized markets and can differentiate themselves through offerings like community engagement. Regions also differ in multiple ways, including the age of their industries, their policies, and infrastructure—including their transportation options.

Understanding sector fundamentals and the operating environment are important for understanding whether costs can be passed through. Using firm-level and publicly available data, Beale et al (2015) examined the issue of competitiveness in EITE sectors across Canada and found that the competitiveness of sectors differed in each province. For example, steel production in Nova Scotia faced significantly more competitive pressure in relationship to its overall economy than Ontario, whereas fertilizer producers faced less pressure in Ontario than Alberta. As partial explanation for this, the researchers pointed to the electricity generation mix in each province and the relative size of the industry.

13 - According to Demailly and Quirion 2008 and Veith et al 2009, while electricity generators tend to receive policy assistance to reduce the carbon price cost impacts, they are not materially exposed to international competition and are not generally considered to be trade-exposed.

14 - See also Obendorfer et al 2010; and Alexeeva-Talebi 2011 for empirical findings about cost pass-through in the EU.

Related to this, capacity utilization and vertical integration are also important determinants of whether companies can pass through an additional cost to consumers (Droege et al 2009 and RBB Economics 2014). The more vertically integrated, the greater the likelihood that costs will be passed through to consumers. Pass-through capability is fundamentally dynamic in nature and can change as the fundamentals of a sector or pricing level change over time (Reinaud 2008). Industry structure and stage of country development likewise change over time and have implications for policy design.

EVIDENCE OF PRODUCTION AND INVESTMENT LEAKAGE

The potential risk of production and investment leakage for EITE sectors falls into two main categories: 1) short term, where companies lose market share to competitors operating in regions without similar carbon constraints, and trade flow patterns change; and 2) longer term, where rates of return on capital are impacted and investors/firms choose to relocate their investments and their capital to countries with less stringent climate policies and/or lower carbon prices.

Dechezleprêtre and Sato (2017) examined a wide variety of studies to ascertain if environmental regulations, in general, have resulted in measurable changes in either short-term trade patterns, or longer-term decisions about production and investment. They concluded that, while increasing the cost of environmental regulation has had an impact on trade flows, these impacts were small and concentrated in only a few sectors. Similar results were found for longer-term production and investment decisions. More stringent environmental policy has resulted in small changes to production and investment decisions for energy-intensive industries, but the researchers concluded that environmental policy was only a relatively small factor compared to other location considerations like raw materials and transportation costs.

Evaluating investment implications over the long run, however, can be a particularly challenging empirical problem. Since EITE sectors tend to be capital-intensive, the impact of investment decisions on capacity and output can take several years to become apparent. Partly owing to this difficulty, and the challenge of getting firm-level data, fewer studies have considered the impact of environmental regulation on investment decisions or location. The majority focuses on short-term competitiveness impacts associated with trade flows.[15] In addition, while profit margins influence investment decisions, a number of factors have an impact on a firm's profits and competitiveness. These include access to raw materials, workforce productivity, other regulations, tax rates, labor and infrastructure availability, prices for commodities and materials, exchange rates, and transport costs. As previously noted, most studies conclude that these factors have played a more significant role than carbon pricing to date.[16]

One factor often highlighted in the literature as particularly important for EITE sectors is transportation costs. Because of the bulky, low-value, high-volume nature of most emissions-intensive products, transportation costs are exceptionally important. Transport costs for cement, for example, can account for up to 10% of the variable costs and can limit the distance that it is profitably shipped—especially if it is shipped by truck or rail.[17] Because high transport costs tend to discourage trade, products that are costly to transport relative to their value are less likely to experience competitiveness concerns. For example, Allevi et al (2013) concluded that, since ocean shipping is considerably cheaper than overland

15 - See Vivid Economics 2013, Beale et al 2015, and Branger et al 2016

16 - See, for example, Reinaud 2008, Droege et al 2009, Ekins and Speck 2012, in addition to Dechezleprêtre and Sato 2017.

17 - https://marketrealist.com/2014/08/must-know-cost-elements-cement Accessed August 11, 2018.

transport, the sector along the coast of Italy was particularly vulnerable to international competition associated with carbon pricing differentials between regions.

A similar concern about ease of shipping and the competitiveness implications for the cement industry was raised by British Columbia's (BC's) cement industry. BC has one of the only carbon pricing programs that began with no direct protection for EITE industries. (BC opted for a revenue-neutral carbon tax that provided benefits from corporate and income tax cuts.) In 2018, BC revised their program and now includes specific policy aimed at EITE industries. BC has also committed CAD27 million ($20.6 million)[18] over five years to help the sector transition away from fossil fuels to low-carbon fuels, which will have the effect of lowering their carbon tax liability and reducing competitiveness impacts.[19] In a letter to BC's Minister of Environment and Climate Change Strategy, the Cement Association claimed that provincial cement imports relative to consumption have increased from roughly 5% before the introduction of the BC carbon tax to between 30% and 50% since implementation of the carbon tax (CAC 2018). Like Allevi et al (2013), they point to the proximity of shipping ports—and proximity to Washington State, which has no carbon price—as a major factor, increasing their short-term competitiveness impacts. They further identify that these issues could have longer-term implications for investment and jobs.

In assessing these concerns and designing appropriate measures to address them, however, it is important for policymakers to understand the data. The increase in BC cement imports, for example, could be the result not of the carbon price differential, but a number of non-carbon-related factors such as a temporary increase in demand for cement that could not have been filled locally. For policymakers this difference can be difficult to determine without specific data. Data transparency can help make the case for sector-specific policy intervention and assist policymakers in targeting assistance to those that need it the most. Beale et al (2015) reinforced the need for good data as part of policy decisions, as did stakeholders at the regional consultations. Firm-level data, however, is not always publicly available, precisely because of corporate concerns about competitiveness. While data confidentiality is a valid concern, without data transparency—at least with government officials—assessing when intervention is necessary can be challenging.

18 - Currency conversion rates as of June 28, 2019. U.S. Federal Reserve. Accessed July 3, 2019. https://www.federalreserve.gov/releases/h10/current/

19 - BC Carbon tax applies to the purchase or use of fuels such as gasoline, diesel, natural gas, heating fuel, propane and coal, unless a specific exemption applies. Initially revenues from the carbon tax were returned to families and used to reduce taxes, including industry taxes, which can help with overall competitiveness pressure. In April 2018, BC government initiated an incentive program for industry that meets certain performance goals, and a Clean Industry Fund, both of which are designed to keep industries competitive. https://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action/carbon-tax

INTERNATIONAL TRADE COMPETITIVENESS IMPACTS IN THE LONG RUN

"Carbon pricing is an inevitable opportunity to mitigate climate change. It has been proven to be one of the most effective tools unlocking the potential from the private sector, companies as well as investors. From a competitiveness perspective, carbon pricing is only one of many factors determining global competitiveness and plays a smaller role than differences for instance in labor and infrastructure. At DSM we are already using an internal carbon price of 50€/tCO_2e to redirect resources, scale up investments and innovations towards low-carbon technologies and driving operational efficiencies, and we feel more secure in future-proofing our business also in regions we expect carbon pricing regulation to emerge in the future."

—Feike Sijbesma, Chairman and Chief Executive Officer, Royal DSM

The general empirical conclusion from the literature is that economies as a whole have experienced minimal impact on competitiveness arising from carbon pricing at current pricing levels, though a few sectors have faced some impacts.[20] Given that every carbon pricing program includes protections for EITE industries, the general inference must be that existing policy protections have succeeded, at today's relatively low-carbon price levels. But it is important to recognize that studies of existing programs are primarily focused on more developed economies, where EITE industries may represent a smaller proportion of the overall economic activity. In regions where these sectors make up a larger proportion of the economy, the impact can be larger. Furthermore, while the relative impact on the economy may be small, for those sectors or those regions that lose market share, the impact can be significant.

If we are to meet the Paris goal of limiting global warming to well below 2°C and achieving net zero annual emissions by the second half of the century, however, most modeling analyses suggest prices will need to be much higher in the future than we have seen in programs to date (Edenhofer et al 2010; Piris-Cabezas et al 2018; Riahi et al 2015). While there are some notable exceptions in Europe, such as Sweden, Switzerland, and a few other countries, the majority of carbon prices are in the range of \$1–\$30/tCO_2e, with about half of the emissions covered by existing initiatives priced at below \$10/tCO_2e (World Bank 2019). To achieve the Paris temperature target, the High-Level Commission on Carbon Prices (2017) chaired by Nicholas Stern and Joseph Stiglitz suggested that prices would need to be in the \$40–\$80/tCO_2e range by 2020 and \$50–\$100/tCO_2e range by 2030. Many industries are aligned with the price levels suggested by Stern and Stiglitz and recognize that carbon prices may increase over time. Most companies participating in the Carbon Pricing Corridors Initiative (CDP 2018), for example, identified \$30–\$50/tCO_2e in the short-term as the carbon price corridor needed to catalyze emissions reductions, strategic planning, and investment, to decarbonize in line with the Paris Agreement. Currently less than 5% of global emissions covered under carbon pricing initiatives are

20 - Dechezleprêtre et al affirmed this conclusion in November 2018.

priced at this level.[21] The transformative impact of carbon pricing, by triggering climate action and innovation, is further explored in section VI.

If carbon prices increase significantly, there is broad agreement that potential impacts could be more significant (Fischer and Fox 2012; Droege et al 2009; Gray et al 2016). Potential negative implications could be offset in two ways. First, countries could continue to use direct and indirect EITE protections and second, as carbon pricing programs and other climate policies spread to more and more countries, the divergence between carbon prices could become less pronounced, in turn reducing competitive impacts. Examples from jurisdictions such as Sweden (see Box 3), with carbon prices already currently well above US$100/t$CO_2$e, show that, when combined with protections and other complementary policies, it is possible to avoid significant impacts on firms and regions.

Sweden introduced a carbon tax in 1991. Starting at the initial rate of €24/tCO_2e (~$27), it has gradually increased to €114/tCO_2e (~$129) in 2019. Industry covered by the EU ETS is exempt from the carbon tax. Introduction of the tax was accompanied by a significant reduction in the marginal tax rates on energy, capital and labor. While Sweden does not earmark carbon tax revenue, the national budget has been allocated to the deployment of climate-friendly options like mass transit and district heating. According the Ministry of Finance, during the 1990-2015 period, Sweden's GDP increased by 75%, while at the same time GHG emissions were reduced by 26% (Swedish Ministry of Finance 2018).

Box 3 - Carbon pricing in Sweden

V. POLICY SOLUTIONS

A wide variety of policy options exist to provide protection against competitiveness impacts. These range from direct protection measures, such as exempting sectors, to indirect protections designed to reduce costs, such as tax credits or transition assistance, to border adjustment measures. Fundamental to the policy, the compliance flexibilities in carbon pricing systems allow all companies, including those trade-exposed, to keep costs down and to manage their own transition. The flexibility and cost minimization of carbon pricing provide competitiveness benefits.

All existing carbon pricing programs include specific design elements directed at minimizing competitiveness pressure. These elements tend to fall into general categories: 1) allocation options, including grandfathering, fixed sector benchmark allocation, or output-based allocation;[22] 2) exempting sectors or companies; 3) rebating or reducing other taxes; and 4) border measures. A large body of research has gone into evaluating these options and most have been used to some extent.[23] Each can be modified with slight changes and variations, and all have their pros and cons.[24] A thorough description of the policy options often considered for directly addressing EITE competitiveness impacts can be found in the 2015 Partnership for Market Readiness (PMR) report on carbon leakage.

21 - According to the Stern-Stiglitz report, the appropriate carbon price levels will likely vary depending on the country. The appropriate price ranges in some developing countries, for example, may be lower, partly because complementary measures may be less costly and the distributional and social issues more complicated.

22 - Grandfathering is when allocations are directly based on a firm's historical emissions and do not vary as output changes, except between phases. Fixed sector benchmark allocation is when allocations are proportional to sector-wide benchmarks and firm-specific historical activity levels. Adjustments for changes in output only between phases. Output-based allocation is when allocations are proportional to sector-wide benchmarks and a firm's current output levels.

23 - While border measures are widely modeled and discussed, they have not been widely deployed, in part because of their complexity and in part because of the fear of creating border disputes.

24 - See Droege et al 2009; Edenhofer et al 2010; Bohringer et al 2012; Branger and Quirion 2014; Branger and Santo 2017; and Hecht and Peters 2018 for a review of policy options.

Criteria useful in assessing these approaches include their effectiveness in avoiding or mitigating competitiveness impacts; environmental integrity; economic efficiency; consistency with international trade rules; their influence on the actions of other countries; and their impact on international climate change cooperation. Of course, a key feature of successful policy is that it provides a strong incentive to reduce emissions. Policies that shield firms from competitiveness issues by blocking the pricing signal are less desirable. For example, exempting EITE firms from a cap-and-trade program removes the incentive for action. Providing free allocation or implementing a border measure, on the other hand, sends the signal that emissions reductions are valuable, while at the same time protecting industry from unfair international competition.

Table 1 highlights the main policy options for addressing international competitiveness concerns.

	Grandfathering	Fixed Sector Benchmarking	Output Based Allocation	Exemption	Rebates	Border Carbon Adjustments
Leakage Prevention	Weak, unless closure rules and updating included	Weak, unless closure rules and updating included	Strong	Strong	Depends on design	Strong
Incentives to improve emissions intensity	In principle, strong but diluted when updating included	Preserved	Preserved	Not preserved	Preserved	Preserved
Demand-side abatement incentives	Preserved	Preserved	Dulled, specially if applied to broadly	Removed	Depends on design	Preserved
Administrative complexity	Easy to implement	Some complexity in stablishing benchmarks	Some complexity in stablishing benchmarks and costs in collecting output data	Easy to implement	Some complexity	Very complex
Risk of windfall profits	Some risk	Some risk	No	No	No	No
Risk to environmental outcome	No	No	Some risk, depending on design	Yes, no incentive to reduce exempt emissions	Depends on design	No
Political and legal challenges	No	No	No	No	No	Some legal concerns in WTO

Table 1 - Policy options for addressing industrial competitiveness impacts
Source - PMR 2015 and Vivid Economics 2014

Market linkages can also guard against competitive distortions by giving firms in different jurisdictions access to a common market price (Bodansky et al 2015). For example, within Europe, industrial emitters in different countries face differing costs of control, but they all enjoy access to a common market. In large measure, this nullifies international trade competitiveness concerns because no firms have a cost advantage arising from different stringency in carbon pricing policy. A caveat to this, however, is that differences in support for industry—including to address leakage—between regions and how these indirect costs are handled, can have implications for competitiveness. Nevertheless, a linked market can create a valuable competitive dynamic among different sectors in the system, allowing a gradual transition to an optimal low- and zero-carbon mix for the sectors as a whole. Linkage can also facilitate knowledge sharing across jurisdictions and help ensure common policy and pricing stringency.

Overall carbon pricing policy design and coverage have important effects, not only on competitiveness, but on GHG mitigation, program cost, administration simplicity, and trade incentives. (See Annex C for a summary of the FASTER Principles for successful carbon pricing initiatives.) A carbon price applied only to the electricity sector, for example, may increase the price of electricity, but not the price of natural gas, thus providing an incentive for more on-site natural gas use. By contrast, an economy-wide carbon price that includes all fuels would not similarly incentivize more natural gas use. Likewise, in an interconnected electricity region, a carbon price applied in one community, but not in another, can give a cost advantage to electricity generators connected to the same system who do not face that same carbon price, unless other restrictions are applied. (See Box 4.)

Spain and Morocco are two regions that share a border and an electricity interconnection. Morocco does not have a carbon price, but Spain does. Historically, Morocco was a net importer of Spain's electricity until recently, when a coal-fired power plant came on-line in Morocco. Now Spain is the importer and claims of unfair competition have been raised (Carvajal 2019). Electricity interconnections are helpful to ensure adequate supply of electricity and backup power in case of regional outages but, in this case, the interconnected nature has also facilitated a larger market for dirtier electricity and additional interconnects are being discussed. EU commissioners are examining policy options for Spain to pursue.

Box 4 - Interconnected electricity markets

California, which has a carbon price and an electricity grid connected to several states without a carbon price, addressed this issue by requiring imported electricity to also obtain and surrender allowances.[25] This, and regulations on California's low-carbon fuel standard (where fuels are produced and imported into the state), are the only examples of a policy somewhat similar to the border carbon adjustment policy highlighted in the last column of Table 1. Notably, California has taken a sector-specific approach to addressing potential leakage that might arise from their carbon regulations on electricity and fuel rather than a single border measure to address all potential leakage that might arise from their economy-wide approach.[26] To address competitiveness implications in other sectors, California uses a hybrid approach of fixed-sector benchmarking and output-based allocation. This approach rewards firms with in-region production with free allowances, while at the same time sending a financial signal through its carbon price that GHG emissions should be reduced.

Consideration of border carbon adjustments (BCAs) has increased in recent years and analysts often point to their theoretical effectiveness in maintaining an incentive to reduce emissions while preventing leakage. An added benefit is that they may encourage other regions to adopt carbon pricing to avoid the additional cost on imports. However, administrative difficulties in determining the appropriate adjustment,[27] as well as policy or regulatory options that can avoid resource shuffling, may partially explain why this option has yet to be more widely used.

25 - California also has rules about "resource shuffling" to ensure that even as California gets lower-carbon electricity, other regions don't end up with higher carbon. Resource shuffling is the practice of swapping electricity contracts such that out-of-state entities hold the high-emitting contracts, and in-state entities hold the low-emitting contracts. The result is that emissions are not reduced, just "shuffled" from one region to another.

26 - See Droege et al 2010 and Helm et al 2012.

27 - The most administratively challenging approach would be to impose a border carbon adjustment on the basis of the carbon intensity of the imported goods, which would require information on carbon emissions in the exporting country. An alternative simpler approach would tie the border carbon adjustment to the carbon intensity of the importing country.

Concerns about adding to trade tensions, or whether a BCA would be compatible with World Trade Organization rules, may also be partially responsible. Nevertheless, advocates point to the use of import taxes on ozone-depleting substances as evidence that, while this policy design element maybe complicated, it can work.[28]

Related to this, carbon pricing rarely exists as a sole climate strategy. Often other policies aimed at reducing the cost of low-carbon technologies, increasing renewable energy generation, funding low-carbon technology development, and/or improving energy efficiency, are combined with carbon pricing to form a suite of climate policies. While these other policies may not be directly aimed at protecting against competitiveness impacts, they can help firms transition to lower-emitting technologies, reduce emissions, and indirectly reduce impacts by lowering the cost of compliance.

"We believe that the broad-based pricing of carbon is one of the most effective ways to incentivize real reductions in GHG emissions because it ensures that all emitters contribute to the solution. An appropriately developed output-based carbon pricing solution provides an effective incentive for big emitters to reduce emissions while also ensuring they stay competitive with jurisdictions that have less progressive climate policies. Climate change impacts every part of the world, every community and every person. The sheer scale of the challenges makes it too big and too complex to tackle alone."

—Marcia Smith, Senior Vice President, Sustainability and External Affairs, Teck Resources Ltd.

Climate change is the result of many market failures, in addition to the absence of a price on the environmental damage from GHG emissions. From this vantage point a variety of policies, in addition to a carbon price, is justified, including incentives for new technologies and regulations that address information asymmetries. Coherence of these policies towards a low- and zero-carbon goal is desirable, but not always possible. For example, import tariffs on certain low-carbon technologies or products (e.g., electric vehicles and solar panels) may be desirable to protect or develop local industries, but because the tariffs make the product more expensive, fewer may be deployed. Similarly, fossil fuel subsidies, often justified to support energy security objectives, can undermine the positive impacts of carbon pricing and the signal it sends to encourage the uptake of cleaner sources of energy.

As emphasized at global stakeholder consultations on carbon pricing competitiveness, it is important to review policies to ensure that they are not working at cross-purposes, or having unintended, indirect consequences. (For a summary of these meetings, see Annex A.) For example, some companies may not be covered by a direct carbon price, but may see the carbon price indirectly in their electricity prices. By design, this should induce them to use less electricity, or buy more from renewable sources. However, because of the way electricity is priced in some jurisdictions (using marginal cost), even the cost of renewable sources could be higher. If these firms with higher indirect costs are trade-exposed, this

28 - A more detailed review of policy options can be found in PMR 2015.

additional cost could impact their competitiveness. In addition, while complementary policies, like those aimed at efficiency improvements, are often necessary for addressing climate change, it should be recognized that these policies are not cost-free, and often their cost is less transparent.

The apparently limited negative impacts from carbon pricing may be the result of several factors: the fact that competitiveness protections are in place, that carbon costs are only one of the many factors that influence competition and investment, and that relatively low carbon prices have been observed to date. As mitigation programs identified under the Paris Agreement get more stringent, prices may rise. And as carbon pricing expands globally, the need for these protections will likely decline. Phasing out, or at least adjusting, these EITE protection policies over time may also be necessary to avoid trade restrictions or claims of unfair state aid. Program reviews and changes, however, should be planned in advance and based on actual data. If significant, they should be phased in over time to prevent any impact on policy certainty and investment.

VI. CARBON PRICING BENEFITS TO COMPETITIVENESS

As discussed previously, carbon pricing creates an advantage for low-emissions firms, sectors, and countries relative to high-emissions competitors. These positive impacts have been observed in many economic sectors, particularly in electricity generation where carbon pricing has helped to stimulate the growth of the renewable energy sector in many countries. This potential to foster investment and development and scale up low- and zero-carbon innovation exists across a wide range of sectors, including the industrial sector, where options for decarbonizing are often considered more limited. (See Boxes 5 and 6.)[29]

In 2016, SSAB, LKAB, and Vattenfall joined forces to create HYBRIT—an initiative that endeavours to revolutionize steel-making. HYBRIT aims to replace coking coal, traditionally needed for ore-based steel making, with hydrogen. The result will be the world's first fossil-free steel-making technology, with virtually no carbon footprint. Increasing carbon prices have also been an important factor for this initiative.

During 2018, work started on the construction of a pilot plant for fossil-free steel production in Luleå, Sweden. The goal is to start the ramp up to a larger scale industrial production by 2025, and the transformation of the existing production sites to be able to use the new technique has already commenced. If successful, HYBRIT means that together we can reduce Sweden's CO_2 emissions by 10% and Finland's by 7%. The steel industry as a total today is responsible for 7% of the world's CO_2 emissions.

Box 5 - Pricing and innovation: HYBRIT Technology

29 - While an assessment of the benefits of internal carbon pricing is beyond the scope of this report, the benefits this tool provides, including meeting consumer demand, branding and employee retention, maybe somewhat applicable to regions that also adopt this policy.

Investors are increasingly evaluating their opportunities in relation to low-carbon technologies and the need to consider and address climate change as part of their organizational strategy (Kantchev and Kent 2019). The management of climate risk is seen as a proxy for whether an entity is strategic and financially responsible, often good indicators of investment profitability. Use of an internal carbon price was mentioned at stakeholder consultations as an option for companies as they prepare for a low-carbon transition. This was specifically identified by the Task Force on Climate-related Financial Disclosure as a metric that companies should report to shareholders to demonstrate whether they are considering climate policy and impacts as part of their strategy.[30] Similarly, it seems reasonable to assume that regions that adopt policies aimed at addressing climate change may also be able to attract more capital, since they too may be seen as more strategic and providing better investment opportunities.

Two key reasons many economists support market-based policies over direct regulations are that they do so at a cost significantly lower than traditional regulation and they provide a continuous incentive to innovate in order to reduce emissions.[31] Innovation is a key objective of climate policy advocates because meeting the emission-reduction levels suggested by scientists requires cutting the link between emissions and economic activity (Anderson et al 2011, Frankhauser et al 2013). Innovation is also fundamental to improvements in productivity and, ultimately, determines the degree to which a firm or country is competitive. (See Box 6.)

"Unprecedented solutions are needed from businesses to tackle the climate crisis. Often in a crisis people become the most creative and innovative at finding solutions and forging partnerships. Carbon pricing is a policy tool that can help unlock this innovation so that sectors from across the economy can step up to make a more sustainable future."

—Mahendra Singhi, Managing Director and Chief Executive Officer, Dalmia Cement (Bharat) Ltd.

30 - At the request of G20 finance ministers and Central Bank governors, the Financial Stability Board created the industry-led Task Force on Climate Related Financial Disclosures to recommend how companies should report on climate risks and opportunities. For additional information on the Task Force on Climate Related Financial Disclosures, see Ahmad 2017.

31 - See Peace and Stavins 2010; Fischer, Parry and Pizer 2003; Fischer 2009; and Droege et al 2016 for an explanation of why economists prefer carbon pricing policies.

Elysis is a joint-venture created by Rio Tinto and Alcoa to scale up a breakthrough carbon-free aluminum smelting process. It aims to go to market in 2024. Instead of GHGs the production of aluminum emits pure oxygen. Key drivers for this project were productivity and reduction of costs (potentially by 15%), adjusting to future climate policy and pricing scenarios, and consumer expectations. The new process significantly increases the life expectancy of the electrode materials. It could eliminate the equivalent of 6.5 million metric tons of GHG emissions annually in Canada—the same impact as removing 1.8 million cars from the road.

This joint venture is supported by Apple. They are investing CAD13 million. The governments of Canada and Quebec are each contributing CAD60 million each, and Quebec has a 3.5% equity stake in the company. This groundbreaking technology is viewed by the industry as an opportunity to extend job opportunities for future generations as the world transitions to a low-carbon economy. Elysis is expected to create 100 direct jobs with the potential to create more than 1,000 jobs by 2030 and to secure more than 10,500 existing aluminum jobs in Canada. The project will also invest more than CAD40 million in the United States economy, including supply chain support for the proprietary anode and cathode materials.

Box 6 - Factoring in climate policy scenarios is driving innovative technologies in the aluminum industry

Porter and Van der Linde (1995) theorized that well-designed environmental policy would yield innovation, potentially "offset" the additional cost of that regulation, enhance profits/productivity and, over time, improve competitiveness. Many researchers have tested various environmental policies against what has become known as the Porter Hypothesis, and others have done meta-analyses of these multiple studies. The results have been mixed. Some of the initial studies found that environmental policy had a negative impact on productivity and competitiveness (Palmer et al 1995; Aldy and Pizer 2009). Later, others found that environmental policy could have a positive impact on productivity (Berman and Bui 2001; Lanoie et al 2011). Ambec et al (2013) reviewed these conflicting results and suggested that, over time, the research tended to find a more positive relationship. This may be attributable in part to the change in the type of environmental policy being implemented: over time, traditional technology-specific regulation has been supplanted by a trend toward more market-based policy (Wagner and Petrick 2014). More recently, Cohen and Tubb (2017) conducted a meta-analysis of 103 studies, many of which now include climate policies (which were not in place prior to the early 2000s). They concluded that there is a very small positive effect on competitiveness, but this effect is most noticeable at the country level rather than at the state or firm level.

Notably, these later two studies, which looked at the history of environmental regulations more generally, did not detect a negative effect: environmental regulations did not harm economic competitiveness for a region even if the benefits to productivity and competitiveness were small. While these studies do not prove that climate policy is beneficial to the economy, avoiding long-term and potentially irreversible damages due to climate change certainly is. Furthermore, a key insight is that well-designed environmental policy does not hurt the economy.

But what is well-designed policy? Porter and Van der Linde (1995) describe it as:

- Offering maximum opportunity for innovation by industry
- Fostering continuous improvement (rather than picking a particular technology)
- Minimizing policy uncertainty

Certainly, a long-term carbon pricing policy fits these characteristics and evidence exists that innovation from these policies has occurred (Calel and Dechezleprêtre 2016; Rogge 2016). Based on interviews with almost 800 firms from six EU countries, Martin et al (2011) found that more than 60% participating in the EU ETS were investing in energy and GHG-saving measures and 70% were investing in low-carbon R&D. Wagner and Petrick (2014) found that firms reduced the emissions primarily through improved energy efficiency and reduced use of natural gas and petroleum, but not electricity.

Rogge (2016) argues that, because of the low price in the EU ETS, the most significant innovation resulting from the EU ETS has been organizational innovation. Along the same lines, Burtraw (2000) notes that a market-based policy with respect to the sulphur dioxide program moved the conversation from the engineers or chemists to the financial vice-presidents, who think more about organizational finances than the technology. This is in line with Rogge's conclusion that the EU ETS made climate change a top management issue. Further, she argues that this change is a necessary precondition for future technological innovations. This beneficial effect of carbon pricing policy would not have arisen through technology-specific policy.

Research on this topic has been largely focused on experience with carbon prices in Europe and the United States. Significantly less research has focused on the implications for developing countries. Pigato (2019) suggests, however, that developing countries may see more innovation—and even productivity improvements associated with carbon pricing—than more developed countries. These benefits arise because carbon pricing can help correct some of the energy inefficiency that exists within those economies and because it can also help reduce other pollutants that negatively impact health and reduce labor productivity.

From industry's perspective, however, the long-term uncertainties surrounding the implementation of a carbon price and the "on again, off again" nature of policy in some jurisdictions may actually discourage low-carbon investment. If firms are concerned that carbon pricing policy will not endure, delayed investment may be the logical result. As stated in LafargeHolcim's 2019 Public Policy Frameworks (Key Messages and Priorities) document, "Tackling climate change and reaching the 2050 carbon neutrality ambition requires long-term, stable and reliable policy frameworks that incentivize investments in low-carbon solutions (LafargeHolcim 2019)." Strategic investment decisions for long-lived capital assets may consider the market environment 15 to 20 years in the future and policy clarity will play a part in those decisions. Dechezleprêtre et al (2016) came to a similar conclusion: policy stability is crucial for new technology development.

"In a relatively innovative and politically challenging area like carbon pricing, policy certainty is especially important. Without this certainty, potential investors face significant risk. It is essential that before significant low-carbon capital investments are committed, a jurisdiction has truly committed to a low-carbon future as a key pillar of their economic development. And transparent policies, like a price on carbon, certainly can provide that assurance."

—Anne Finucane, Vice Chairman, Bank of America; Chairman of the Board, Bank of America Merrill Lynch Europe

Related to this, stable and predictable policy is also important for the financial community, upon which many investments rely. In 2013 the World Economic Forum projected that, by 2020, about $5.7 trillion per year would need to be invested in climate-friendly infrastructure. However, it noted that climate-related (mitigation and adaptation) investments were closer to $364 billion annually.[32] Key elements highlighted by the World Economic Forum as holding back investment in green infrastructure were policy distortions and uncertainty. Policy uncertainty has been shown to have a negative impact on overall lending and credit growth, especially for larger financial institutions, which may have a lower risk tolerance than smaller, venture-capital type financial institutions (Bordo et al 2016).[33]

"With company planning cycles being more medium to longer term, the lack of policy clarity when designing carbon pricing mechanisms can result in companies deferring potential investments."

— Bongani Nqwababa, Joint President and Chief Executive Officer, Sasol

Carbon pricing can generate significant revenue. Global programs (including both ETSs and carbon taxes) generated approximately $44 billion in 2018 (World Bank 2019). How this revenue is used is program-specific. Some use it to fund programs that protect vulnerable populations; others use it to further their climate goals; and still others use it to help transition energy-intensive industrial sectors and protect competitiveness.[34] BC, for example, is using a portion of their carbon tax revenues as incentives to help large industrial firms transition to cleaner technologies with lower emissions.[35]

How the revenue is recycled back into the economy has significant implications for the overall economic cost of the program. In general, the more carbon revenues are used to replace other fees that hinder economic output, like taxes on employment or investments, the more beneficial they are to a region's economy (Morris and Mather 2013). In fact, because unskilled labor is more responsive to changes in price than skilled labor, substituting carbon revenue for employment taxes may benefit developing countries (with more unskilled labor) more than developed countries (Pigato 2019). Most programs, however, use the revenue in multiple ways related directly to their climate program, rather than to replace more distortionary fees or to augment general government revenue. According to the Institute for Climate Economics (PMR 2019), the majority of global carbon

32 - $364 billion refers to total climate specific investments in 2011.

33 - Less lending can also result in higher capital costs, both of which can, and have, hindered economic growth.

34 - Another use for carbon revenue could be contributions to help other countries meet their climate goals. Article 9 of the Paris Agreement specified that developed countries would provide financial resources to assist developing countries with both mitigation and adaptation; the minimum financial goal agreed to by the Parties was $100 billion per year.

35 - https://engage.gov.bc.ca/app/uploads/sites/391/2018/07/MoE-IntentionsPaper-Industry.pdf

revenues (excluding foregone revenues) in 2017/18 were allocated to either environmental or development objectives (53%). Other revenue allocations include assigning revenues to the general budget (37%), cuts to other taxes (6%) and direct transfers for households and businesses (3%).

As suggested at the regional consultations, for countries more heavily dependent on energy-intensive industries, a carbon price may be seen more as an "enabling" tool if revenues are used to address the climate problem and to ensure an equitable low-carbon transition. This means that socio-economic impacts are minimized and infrastructure is repurposed rather than abandoned. In addition, stakeholders noted that the level of transparency, accountability and governance of revenues can impact the effectiveness and acceptability of carbon pricing among industry. Investing in low-carbon job transition and creation may also help raise awareness and support for carbon pricing. Similarly, transparency and accountability about carbon revenues and support for the innovation spurred by carbon pricing can help with program trust and acceptance (Pigato 2019).

VII. CONCLUSIONS

Making the cost-effective transition to a low-carbon economy and achieving net zero emissions by mid-century is important if we are to avoid the worst outcomes associated with climate change. Carbon pricing is a policy that can enable this transition and provide firms with the flexibility to choose how and when to invest in low-carbon technologies. This flexibility reduces cost and provides a continuous incentive to innovate. With long-term clarity and credibility about program direction, a price on carbon sends a financial signal that low-carbon investments are valuable today and will be more so in the future. The investment and growth potential for low-carbon technologies and low-carbon industries is substantial. As trillions of dollars of investment are deployed in low-carbon infrastructure, new companies and new jobs will be created, while improvements in efficiency occur in others. Beyond reducing emissions and driving innovation, carbon pricing can generate revenues to further program or national objectives and help consumers and firms adjust and transition to lower-carbon technologies.

Carbon pricing could, however, have impacts on the competitiveness of firms and regions. Low-carbon technologies and activities will have a competitive edge over higher carbon technologies. Yet, while this is the policy objective, an unintended consequence—in the absence of measures to mitigate—could be that EITE firms relocate to other regions without similarly stringent climate regulations, which could result in job losses and, worse yet, a failure to reduce emissions. Carbon leakage would be a lose-lose outcome: a loss of competitiveness without an environmental gain. In most cases, though, the impacts of carbon pricing are less significant than other factors that influence where a firm will locate. Furthermore, because the concerns about industry relocation and carbon leakage are so prominent, all existing programs have features designed to manage this issue.

The significance of carbon pricing competitiveness has prompted numerous researchers to study this issue. Multiple meta-analyses that synthesize the evidence from a large number of studies have generally concluded that while concerns about short-term impacts (e.g., trade flows) on competitiveness are not entirely ungrounded, they are relatively minor and

concentrated in a few industries. Very little evidence has been found to support the longer-term concern about investment in energy-intensive industries moving locations due to differences in the stringency of carbon regulation. The majority of studies to date have focused on developed rather than developing economies, but the mix of policies aimed at protecting EITE firms on the whole seem to be working. However, programs should assess their individual circumstances and design their climate programs accordingly. Researchers also warn that higher prices in the future may have more significant impacts across all economies, particularly if the stringency of climate policy remains uneven across jurisdictions. Periodic reevaluation is therefore also important.

As more and more companies invest in low-carbon technologies and countries adopt more stringent climate and carbon pricing policies, competitiveness concerns will likely become less pressing and EITE protections could potentially be reevaluated. Assessments of impacts should be based on data and EITE protections periodically reevaluated to ensure their effectiveness and to establish whether they are still needed. Understanding the range of low-carbon technologies available within a given sector could help policymakers understand how to direct competitiveness support. The detailed data necessary to answer this question, however, may not be in the public domain and only be available from businesses themselves. Phasing out some EITE protections over time may stimulate additional innovation and maybe required to avoid trade disputes.

Finally, reevaluation should not inject unnecessary program uncertainty. Confidence in the policy objectives and program rules is important for both business and investment. The investment needed to address climate change is significant. Confidence that governments are committed to robust and increasingly stringent climate policy helps lower the cost of capital and ensures companies and regions remain competitive in global markets. Before large investors commit significant funding to a region or project, they often consider the issue of policy stability. Shifting policy, especially around carbon pricing, can strand capital and reduce payback. Mainstream investors are increasingly evaluating their options based on whether a firm or a region has a stable low-carbon strategy. A commitment to long-term carbon pricing can be a visible and effective component of that strategy.

Fear of competitiveness implications should not preclude carbon pricing or increasing prices or targets over time as part of a comprehensive approach to implement the Paris Agreement. Such concerns should be considered in designing a suite of locally tailored and complementary measures that protect industry from unfair competition while spurring innovation and an equitable transition to a low-carbon economy.

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ANNEXES

European regional consultation
Lisbon, Portugal
April 15, 2019

The following is a summary of the main messages from the European Regional Consultation, held on April 15, 2019, in Lisbon, Portugal alongside the margins of the European Climate Summit. This is not a full record of all comments made at the meeting, but rather a summary of the main points from this consultation.

KEY TAKEAWAYS

- The participants were in general agreement with the key messages and the content of the report.
- Carbon pricing plays a significant role in corporate innovation and investment.
  - Importance of having complementary policies to help spur innovation (e.g. on deployment or R&D) was emphasized, particularly as incremental vs. breakthrough innovation is considered. The role of higher carbon prices was also recognized as a driver.
  - The extent to which climate change is embedded in a company's culture and organizational structure, and the resources that it puts towards climate change, are crucial determinants of the company's response to carbon pricing, including investments made in new emission-reduction projects.
  - Consumer pressure on a company for lower-carbon products and services can also drive innovation and investment.
- Any assessment of competitiveness impacts should consider the total climate change regulatory burden on a firm or sector. Firms can be subject to multiple climate policies, (e.g., renewable procurement and energy efficiency policies), which may have higher compliance costs and a less transparent price per ton. There can also be indirect costs on the supply chain. The suite of climate policies facing a company should be taken into consideration as competitiveness impacts are assessed.
- Importance of broad coverage (or horizontal across multiple sectors) of carbon pricing within an economy to help prevent perverse incentives/competitiveness impacts across sectors. The example of covering all fossil fuels was highlighted to help place the right incentives for fuel switching and fuel use, including the role of carbon pricing on liquid fuels, in addition to power generation, for the electrification of transport.
- The report might want to expand the discussion about BCAs as a policy response to carbon leakage. Challenges to the broad-based implementation of BCAs were also acknowledged and discussed. The example of California's program to prevent higher-carbon electricity imports was highlighted as an example of a type of border adjustment. The point was made that it may be easier to use sector-specific border measures. For example, border measures on steel, aluminum, refined oil, etc. were suggested to be more feasible than broad-based BTA.

- The importance of getting evidence of cost pass-through was discussed. Firms that are at risk of carbon leakage can find it difficult to pass carbon costs through to consumers due to competition from firms that do not face the same carbon costs. The importance of transparent data was discussed and some companies committed to sharing reports on the extent of cost pass-through in their sector.

South Africa regional consultation Johannesburg, South Africa May 2019

The following is a summary of the main messages from the South African Regional Consultation held on May 29, 2019 in Johannesburg, alongside the Workshop on Carbon Markets: Matters relating to Article 6 of the Paris Agreement and Global Trends on Carbon Pricing and Competitiveness. The workshop was hosted by the Department of Environment, Fisheries and Forestry (formerly Department of Environmental Affairs), National Business Initiative, and the World Bank/CPLC, and held at Sasol, a large petrochemical company in South Africa. Following this consultation, on May 30, the Joint President and CEO of Sasol and Commissioner to the High-Level Commission on Competitiveness and Carbon Pricing, Mr. Bongani Nqwababa, hosted a CEO dinner on competitiveness. This document captures the main points and messages from both these consultations. It is not intended as a full record of all comments made at these consultations.

KEY TAKEAWAYS

- Carbon pricing in South Africa has been viewed mostly through the lens of a carbon tax.

- Carbon pricing in South Africa needs to be solutions-focused, taking a broader perspective that considers carbon pricing as a tool among a suite of climate policies.

- Several mentioned that it should be thought of as an enabling policy for a low-carbon transition rather than a penalty.

For countries like South Africa, which are highly dependent on fossil fuels and a developing economy, carbon pricing needs to take the following into consideration:

CARBON PRICING TO FACILITATE A JUST TRANSITION

Stakeholders emphasized the importance of a managed, orderly, and just transition that takes into account the socioeconomic structure of the country; the need for a long-term vision for the economic transition of the country; the ways in which economic growth can be delinked from emissions growth in the South African context; and the options that might be considered for the transition to occur. In this regard the meeting underscored the following:

- The importance of understanding at what point a carbon price has competitiveness issues, and ways in which a carbon price can build “common but differentiated responsibilities” into the price.

- The need to address the unintended consequences of a transition to a lower-carbon future, for example, the importance of understanding the implications for jobs in fossil heavy industries, such as the mining sector, and the impacts that it has not just economically, but on social justice. Stakeholders highlighted the importance of a systemic, holistic approach to the low-carbon transition to ensure South Africa is not left behind.

- The need to ensure that the transition does not result in stranded assets or foregone investments when shifting production away from high carbon-intensive products. For example, existing infrastructure in the rail, ports, and pipelines could potentially be repurposed to transport hydrogen, as service stations for electric vehicles, or a large desalination facility.

- The importance of using revenues for socio-economic programs and national priorities, including job transition and creation. Several participants highlighted that revenues should be used to assist in the shift to a low-carbon economy.

- As the transition occurs, there is a need to take the macroeconomic context into consideration, especially on trade imbalance. The discussions also underscored the importance of understanding how competitiveness impacts change with different market structures, including where market share is concentrated in the hands of only a few players.

- The role of carbon pricing in investor decisions. There is a need to enhance the understanding of the role of the recommendations of the Task Force on Climate Related Financial Disclosures in the South African context, and the growing interest by companies to engage with their investors on carbon pricing.

- The need for policy coherence, regulatory environment, and long-term policy signals to drive investment and deliver on socioeconomic priorities. Stakeholders emphasized the importance of having policy alignment between decarbonization, industrial, and electricity policies; better coordination among different ministries; role of complementary vs. competing policies (e.g. for electric vehicles); minimizing regulatory hurdles for investment in clean technologies (e.g., for renewables); and importance of having policy certainty including on the timing and type of review of the policy.

- On relocation, stakeholders indicated that while companies may not necessarily relocate out of South Africa due to carbon pricing, South Africa may be less attractive for a company to begin operations, especially as investors start considering the carbon footprint of markets they invest in. That being said, stakeholders raised the point that ultimately every jurisdiction will need to adopt climate policies to adhere to the Paris Agreement, and to address climate risk early on, hence the importance of being proactive and gaining a competitive edge in a low-carbon economy vs. adopting a "wait and see" policy.

- Opportunities for innovation. Discussion focused on the potential opportunities that are incentivized by a price. This included how offsets can be used to provide finance (such as in capital markets where equity and venture capital sectors are underdeveloped) to leverage local technologies that could achieve domestic development priorities of industrialization and job creation.

- Role of South Africa in the region. Stakeholders highlighted the leadership role that South Africa has9 played in the climate change discourse, and the importance of continuing to play this role in the region. In this context, the question was raised on whether South Africa could help neighboring countries shift to lower-carbon transition.

Singapore regional consultation June 2019

On June 4, 2019, the Singapore Local Network of the United Nations Global Compact, GCNS, hosted a CEO Roundtable to seek feedback from key business leaders on carbon pricing mechanisms and their impacts on competitiveness. The roundtable consensus was that a price on carbon could foster innovation and serve as a robust risk management tool with the caveat that it was implemented conscientiously and in a coordinated manner; duly accounting for equity and socio-economic impact. The following captures the main points from the roundtable discussion.

KEY TAKEAWAYS

- Carbon pricing can spur low carbon innovations, incentivizing improvements to business models and operations including influences on the procurement choices of corporations. CEOs generally recognize that there are increasing awareness of the challenges of climate change and major stakeholders (investors, customers, employees) are keen to play a role in mitigating these challenges.

- Supporting infrastructure and international consistency are key, there are differing levels of data transparency, accountability, and governance between countries potentially impacting the effectiveness of carbon pricing, as well as the level of trust in the usage of carbon tax revenues. There was general consensus that any form of carbon policies should not be viewed in isolation, but rather in conjunction with other policies (e.g. revenue recycling, subsidies etc.). Climate policies also need to provide certainty over the long-term for businesses. With greater clarity about future carbon taxes, businesses can better plan and invest with more certainty. Implementation of standards and guiding principles for an industry approach to carbon pricing will help to create a more level playing field.

- A suggested framework for policymakers

    1. Consumerism—Consumer awareness and relatability can be substantive stumbling blocks in adoption of low-carbon initiatives in the region. Policies need to secure buy in from consumers, in addition to companies and governments.

    2. Transparency—Transparency in governance, measurement and allocation is important; it allows for greater awareness and reduces information asymmetry, which in turn allows for more calibrated responses.

    3. Materiality—Focusing efforts on activities that yield the greatest carbon reductions will ensure speedier results. Firms and governments can focus on areas that are sustainably expedient.

    4. Proportionality—Taxes or other carbon pricing mechanisms need to be priced at a meaningful level such that it incentivizes businesses to alter their investment

and operational decisions. Proportionality can address the competitiveness issues faced by developing countries, for instance a concerted ramp up over a longer time frame to adoption of carbon pricing policies while achieving similar emission reduction targets.

5. Incentivization—Incentivize behaviors that support the transition towards a low-carbon economy with the income generated from carbon pricing mechanisms.

6. Coordination—Carbon pricing policies will have to be coordinated and integrated across multiple socio-economic and environmental policy angles. Such policies should not exist in isolation with respect to other climate change mitigation policies.

ANNEX B | LITERATURE REVIEW OF THE IMPACT OF CARBON PRICING ON COMPETITIVENESS[36]

Table B1 - Impacts of carbon prices on indicators of competitiveness and innovation

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Aldy, J.E. 2016.	Competitiveness risks of a potential domestic carbon pricing policy for the U.S.	Economy wide.	Employment, production, carbon leakage.	Regression analysis and political analysis of implications.	Not investigated.	Small competitiveness-related economic impact of a $15/tCO2 pricing policy. Majority of impact for EITE is decline in domestic consumption rather than increase in net imports.
Beale, Beugin, Dahlby, Drummond, Olewiler, and Ragan. 2015.	Carbon leakage across provinces in Canada.	Economy wide.	Leakage.	Regionally disaggregated CGE modelling.	Not investigated.	Impacts only a few industries; varies across Provinces due to differences in cost structures, cost pass-through, the extent of firms' responses to carbon pricing, and the stringency of policies in other jurisdiction.
Cohen and Tubb. 2017.	The impact of environmental regulation on firm and country competitiveness.	Economy wide.	Firm and country level productivity.	Meta-analysis.	Not investigated.	Significant heterogeneity in both the impact and significance of environmental policy on productivity. Impact more likely at the state, region, or country level, compared to firm although most likely impact is small.
Dechezleprêtre, Martin, and Bassi. 2016.	Climate policy and innovation.	Economy wide.	Innovation.	Meta-analysis and synthesis.	Not investigated.	Policy is critical to innovation, and most effective when placed near market. Pricing should be augmented with additional R&D support. Knowledge spillovers have large local benefits.
Dechezleprêtre and Sato. 2017.	Environmental regulations on competitiveness.	Economy wide.	Trade, industry location, employment, productivity, and innovation.	Synthesis.	Not investigated.	Environmental policies can lead to small adverse effects on trade, employment, plant location, and productivity in the short run for EITE industries who cannot cost pass through. Size of impacts small compared to other determinants of trade and investment location choices (e.g. transport costs, proximity to demand, labor, raw materials, and capital costs). Leakage is a risk. Innovation is an outcome.

36 - Adapted from Arlinghaus, 2015, "Impacts of Carbon Prices on Indicators of Competitiveness: A Review of Empirical Findings", OECD.

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Ganapati, Shapiro, and Walker. 2018.	Cost pass through in manufacturing.	Manufacturing.	Cost pass through, incidence of input tax.	Meta-analysis using partial equilibrium model.	Not investigated.	Vast majority (70%) of energy price-driven changes input costs get passed through to consumers in short to medium time frame.
Gray, Linn, and Morgenstern. 2016.	Employment and output leakage CA ETS.	Manufacturing in CA economy.	Employment, output, leakage.	CGE using sub-national and national data.	Not investigated.	Short-run impacts on output, employment and value-add for manufacturers. Smaller impacts expected in the longer-run (5 year vs 1 year). In longer run, impacts might be positive.
Martin, De Preux, and Wagner. 2014.	Impact of the UK Climate Change Levy (CCL) on manufacturing plants (2001–2004).	Manufacturing.	Real gross output, employment, and total factor productivity (TFP).	Diff-in-diff design comparing outcomes between plants subject to full CCL and those with an 80%discount both over time and between plants receiving different treatment. Exploit exogenous variation ineligibility rules for discounts an instrumental variable to remedy self-selection into the treatment group.	Being subject to the full CCL decreased energy intensity and electricity use resulting in lower CO2 emissions.	No significant results for the effect of the full CCL on energy expenditure, employment and TFP.
Rivers and Schaufele. 2014.	Impact of carbon tax on international competitiveness of the agricultural sector in British Columbia (1990–2011).	Agriculture.	Gross exports.	Estimate whether introduction of the carbon tax has been associated with a measurable change in trade patterns (diff-in-diff design).	Not investigated.	Hardly any significant effects on gross exports or sector-specific effects. In the few cases where significant effects are found, results suggest that agricultural exports increased or imports decreases in conjunction with the carbon tax. Evidence does not support exempting sector from carbon tax.
Rogge. 2016.	Innovation impact from EU ETS.	Economy wide.	Technological innovation.	Synthesis.	Not investigated.	Small but positive impact of EU ETS on low carbon innovation. Organizational innovation more significant.

[Table B2] Impacts of the EU ETS on indicators of competitiveness

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Abrell, Ndoye Faye, and Zachmann. 2011.	Impact of EU ETS on firm competitiveness (2005–2008).	Non-metallic mineral products, electricity &heat, paper & paper products, basic metals, coke & refined petroleum products.	Added value, profit margin, employment.	Propensity score matching, exploiting the structural break between the first and the second phase of emissions (diff-in-diff approach).	EU ETS led to emissions reductions in its second phase. Non-metallic metals and basic metals contributed most to this reduction while electricity and heat sectors did not at all.	EU ETS is found not to have an impact on firm added value, profit margin or employment.
Ahamada and Kirat. 2012.	Impact of the EU ETS on wholesale electricity prices in France and Germany (2008–2012).	Power generation.	Cost pass-through.	Regression analysis.	Not investigated.	The impact of the carbon price on electricity prices tripled in France and was multiplied by 1.5 in Germany in Phase II with respect to Phase I.
Alexeeva-Talebi. 2010.	Impact of EU ETS on petrol retail prices in 14 EU member states (2005–2007).	Refineries.	Cost pass-through.	Vector Error Correction Model estimating the long- and short run dynamics of petrol prices. Variance decomposition allows uncovering heterogeneity of price dynamics between countries.	Not investigated.	In 10 out of 15 countries, the refineries are found to pass-through 50% or more of crude oil price increases to consumers within two weeks. Variance decomposition indicates that carbon costs play a large role in explaining the variance of differences petrol prices in Austria, Germany, France and Spain (between 10% and 20% of variance).
Allevi, Oggioni, Riccardi, and Rocco. 2013.	Carbon leakage effect on the Cement industry under the European Emissions Trading Scheme.	Cement.	Leakage.	Partial equilibrium model of Cournot oligopolistic frame.	Not investigated.	EU and Italian cement industry leakage especially where regulations stringent and near a seacoast. Transport costs a significant impact.
Anger and Oberndorfer. 2008.	Impact of allocation factor of EU ETS on competitiveness in Germany (2005).	Mining, electricity, energy, business, pulp & paper, coke & petroleum and other manufacturing.	Revenue and employment change in 2005.	Matching + Regression analysis using instrumental variables (2SLS).	Not investigated.	No significant impact of relative allocation of EU emissions allowances on firm revenue development and employment.

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Arlinghaus. 2015.	Competitiveness impacts of carbon pricing in the EU ETS, on sectors and countries (ex-post review).	Economy wide	Cost pass through, employment, production, and leakage	Meta-analysis	Most studies reviewed found carbon pricing significant reduced energy intensity and absolute emissions.	Cost pass-through for industry significantly varied in literature but often quite large. Impacts on competitiveness fairly small and primarily only relevant for EITE.
Branger, Quirion, and Chevallier. 2016.	Impact of EU ETS on cement and steel industry.	Cement and steel industry.	Leakage.	Econometric analysis broken into two data sets—from 1999–2005 and 2005–2012.	Not investigated.	Net imports of cement and steel driven by domestic and foreign demand but not by the CO2 allowance price.
Bushnell, Chong, and Mansur. 2013.	Impact of a sharp drop in CO2 prices on theshare price of affected firms (April 2006).	Firms traded on DowJones STOXX 600 index.	Expected profitability.	Event study.	Not investigated.	Share prices of dirtiest industries experience the largest abnormal declines. Within the power sector, firms with highest emissions experience declines which are less severe than cleaner firms.
Calel and Dechezleprêtre. 2016	Technological change and environmental policy.	Economy wide.	Innovation.	Econometric.	Not investigated.	EU ETS accounts for nearly a 1% increase in European low-carbon patenting compared to a counterfactual scenario.
Chan, Li, and Zhang. 2013.	Impact of EU ETS and initial allocation of allowances on competitiveness (2001–2009).	Power, cement, iron and steel.	Material costs, employment and revenue.	Matching + diff-in-diff.	Not investigated.	No effects found for cement, iron and steel sectors. EU ETS has no effect on power plant employment, but increases unit material costs for power plants. Phase II participation in the EU ETS is found to have a positive effect on powerplant turnover.
Commins, Lyons, Schiffbauer, and Tol. 2009.	Impact of energy taxes and the EU ETS on European firms (1996–2007).	Manufacturing.	TFP, employment, investment, return on capital.	Panel regression using fixed effects.	Not investigated.	Marginal tax change leads to a small improvement in TFP growth, lower employment, an average increase in profitability and no change in investment levels. Results vary strongly across industries.

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Costantini and Mazzanti. 2012.	Impact of environmental and energy taxation and the EU ETS on exports of 14 European countries (1996–2007).	Sectors are classified into high-medium-high, medium-low and low-technology industries.	Exports.	Two-stage estimation allows modelling the selection process of countries engaging in trade with each other to account for the large number of 0's (countries that do not trade), while estimating trade only for countries which actually engage in trade in the second stage.	Not investigated.	Environmental and energy taxes are found to increase exports in high- technology sectors. Energy taxes are also increase exports in medium-low tech sectors. The EU ETS in found to have significant negative effects on all sectors.
De Bruyn, Markowska, De Jong, and Bles. 2010.	Impact of EU ETS on prices of manufacturing products (2005–2009).	Key products from refineries, iron and steel, chemicals.	Cost pass-through.	Vector Error Correction Model estimating the long- and short run dynamics of price differences between EU and US prices.	Not investigated.	For €1 cost increase in emissions allowances, €2.2 price increase will be passed into prices of hot rolled and cold rolled coils (full cost pass-through for iron and steel). Refineries have likely been able to pass through the full costs of their freely allocated allowances in prices. Full cost pass-through is also found for chemicals.
Fabra and Reguant. 2013.	Pass-through of emissions costs to electricity prices (January 2005 to February 2006).	Spanish wholesale electricity markets (micro-level firm data)	Cost pass-through	Regression analysis using an instrumental variables approach and fixed effects	Not investigated.	Emissions costs are fully passed through to electricity prices. Average pass-through is found to be at 80%. Pass-through is at 100% in peak times.
Flues and Lutz. 2015.	Impact of the German electricity tax on firms in the manufacturing sector (1999–2004)	Manufacturing	Turnover, investments, value-added, turnover abroad, employment	Investigate the competitiveness outcomes of firms paying a reduced marginal tax rate, compared to firms paying the full tax rate, using a regression-discontinuity design.	Not investigated.	No robust negative or positive competitiveness effect of the electricity tax reduction on manufacturing firms could be identified.

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Jaraité and Di Maria. 2012.	Impact of the EU ETS on power generation sectors (1996–2007).	Power generation.	Productivity growth.	Panel regression with fixed effects.	CO_2 price improves environmental efficiency. Over-allocation of emissions permits reduces improvements.	No significant effects of EU ETS on productivity growth.
Kirat and Ahamada. 2011.	Impact of EU ETS on electricity prices in France and Germany (July 2005–June2007).	Power generation.	Cost pass-through.	Regression analysis (feasible least squares).	Not investigated.	Impact of carbon price is found to depend on the country's energy mix. The highest correlation between electricity prices in Germany and France coincided with the highest carbon prices, while the collapse of the carbon price led to divergence of carbon prices.
Oberndorfer, Alexeeva-Talebi, and Loschel. 2010.	Impact of EU ETS allowance prices on prices of UK manufacturing products (weekly data: 2005–2007, monthly data: 2001–2007).	Selected products within refineries, glass, chemicals and ceramics.	Cost pass-through.	Autoregressive distributed lag model.	Not investigated.	Pass-through rates of 50% and 75% for diesel and gasoline over a 5-week span. For chemicals, pass-through rates >100% are found for low density polyethylene film. Over 6 months, 20% to 25% pass-through is found for hollow glass, no pass-through is found for container glass, >100% pass-through for ceramic goods, 30–40% pass-through for ceramic bricks.
Reinaud. 2008.	Impact of EU ETS on net trade flows (1999– 2007).	Aluminium.	Net imports.	Regression analysis.	Not investigated.	Negative correlation between CO_2 price and net imports and no evidence of a structural break in imports after the introduction of the EU ETS.
Veith, Werner, and Zimmermann. 2009.	Impact of EU ETS allowance price changes on stock prices (25 April 2007–31 August 2007).	Power generation (22 publicly traded power firms of EU 25).	Expected profitability.	Apply asset pricing theory to capture the effect of the EU ETS on profitability using regression analysis.	Not investigated.	An increase in emission allowance price is correlated to an increase in the firm's share prices. Investors expect higher earnings in case of positive returns on carbon markets.

Paper	Causal effect of interest	Sectoral coverage	Competitiveness effects	Methodology	Findings	
					Environment	Competitiveness
Wagner and Petrick. 2014.	Impact of EU ETS on German manufacturing plants (1995–2010).	Manufacturing.	Employment, gross output and exports.	Semi-parametric nearest neighbor matching + diff-in-diff.	ETS firms abate 26- 28% more CO_2 emissions (2007–2010) relative to non-ETS firms. This is achieved improving energy efficiency, decreasing consumption of natural gas and petroleum products.	No evidence that emissions trading lowered employment, turnover or exports of treated firms.
Yu. 2011.	Impact of EU ETS on Swedish firms (2004–2006).	Manufacturing (pulp, paper, paper product, chemicals and chemical products, other non-metallic products) and electricity.	Profitability.	Diff-in-diff comparing firms that own regulated heating installations subject to EU ETS with non-participating firms.	Not investigated.	No significant impact of the EU ETS on profitability of Swedish firms in 2005, negative impacts on profitability in 2006.
Zachmann and Von Hirschausen. 2008.	Impact of EU ETS on German electricity prices (2005–2006).	Power generation.	Cost pass-through.	Error correction model and autoregressive distributed lag model.	Not investigated.	Asymmetric pass-through of EU emission allowance prices exist (i.e. rising prices have a stronger impact on wholesale electricity prices than falling prices).

ANNEX C | THE FASTER PRINCIPLES FOR SUCCESSFUL CARBON PRICING

In 2015, the World Bank Group and the Organization of Economic Co-operation and Development published a joint report on the essential principles behind successful carbon pricing initiatives. These were identified as: Fairness, alignment of policy and objectives, stability and predictability, transparency, efficiency and cost-effectiveness, and reliability and environmental Integrity. When integrated and taken together, these concepts lead to carbon pricing initiatives that succeed in developing and expanding sustainable energy, providing a consistent regulatory framework, and reflecting the public interest. Critically, they are designed around the notion that those who profit the most from carbon-intensive industries should contribute the most to mitigating its effects and building the transition to a low-carbon future. The principles are outlined below.

Fairness

Successful carbon pricing policies reflect the “polluter pays” principle and contribute to distributing costs and benefits equitably, avoiding disproportionate burdens on vulnerable groups.

Alignment of policy and objectives

Successful carbon pricing policies are part of a suite of measures that facilitate competition and openness, ensure equal opportunities for low-carbon alternatives, and interact with a broader set of climate and non-climate policies.

Stability and predictability

Successful carbon prices are part of a stable policy framework that gives a consistent, credible, and strong investment signal, the intensity of which should increase over time.

Transparency

Successful carbon pricing policies are clear in design and implementation.

Efficiency and cost-effectiveness

Successful carbon pricing improves economic efficiency and reduces the costs of emission reduction.

Reliability and environmental integrity

Successful carbon pricing schemes result in a measurable reduction in environmentally harmful behavior.

Source: http://documents.worldbank.org/curated/en/901041467995665361/The-FASTER-principles-for-successful-carbon-pricing-an-approach-based-on-initial-experience

The potentially adverse impact of carbon pricing on the competitiveness of businesses and economies has been a matter of concern to industry and policymakers. It has also been a barrier to progress on carbon pricing. The Carbon Pricing Leadership Coalition launched the High-Level Commission on Carbon Pricing and Competitiveness at its 2018 High-Level Assembly to address the issue. The Commission is co-chaired by Feike Sijbesma, Chairman and CEO of Royal DSM, and Anand Mahindra, Chairman of Mahindra Group.

www.carbonpricingleadership.org/competitiveness

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