



Ministry for the  
**Environment**  
*Manatū Mo Te Taiao*

# **Emissions pricing impact on innovation and competitiveness**

**A review of the international literature**

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## Acknowledgements

The Ministry for the Environment wishes to acknowledge the authors cited in this document, whose body of research has made this analysis possible.

This document may be cited as: Ministry for the Environment. 2018. *Emissions pricing impact on innovation and competitiveness*. Wellington: Ministry for the Environment.

Published in June 2018 by the  
Ministry for the Environment  
Manatū Mō Te Taiao  
PO Box 10362, Wellington 6143, New Zealand

ISBN: 978-1-98-852572-3 (online)

Publication number: ME 1372

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# Executive summary

This report reviews the international literature for the impacts of emissions pricing on innovation and competitiveness. It investigates extensively the literature on ex-post analysis and also considers ex-ante analysis.

This report concludes emissions pricing at current levels reduces emissions, but does not weaken the overall economic performance of most businesses.

Emissions pricing increases innovation activity in low-emission technologies, which may be of high economic value. Recent preliminary evidence suggests emissions pricing may also provide small positive economic impacts.

Some emissions-intensive and trade-exposed sectors show potential for emissions leakage and negative economic impacts with emissions pricing, although these negative impacts are small.

# Introduction

This report reviews the international literature for the impacts of emissions pricing on innovation and competitiveness with regards to climate mitigation goals. Emissions pricing refers to climate policies that put a price on emissions, typically by way of an emissions trading scheme or an emissions tax. This review supports detailed economic analysis by Sense Partners that aims to assess the impacts of emissions pricing on the innovation rates and competitiveness of New Zealand's emissions-intensive and trade-exposed (EITE) industries.

While the economic analysis on the impacts of emissions pricing on New Zealand businesses on innovation and competitiveness is limited, there is extensive international literature available. Hence this review, coupled with the detailed economic analysis, helps to understand impacts of emissions pricing on innovation and competitiveness of New Zealand industries.

## Theoretical background

Any government considering significant emissions reductions through emissions pricing recognises the importance of accounting for the impacts that stronger climate action might have on the economy, especially if the action is unilateral. Economic impacts, often referred to as competitiveness, are of particular interest, as these concerns stem from the differences in the strength of climate action between competing countries in the same marketplace (Jaffe et al, 1995). Various economic measures are applied to account for competitiveness including output, exports, trade intensity, profitability, revenue and employment levels of regulated businesses (Arlinghaus, 2015; Carbone & Rivers, 2017).

Innovation also needs to be accounted for, not only because it is the driver of economic growth, but because it is required across a whole range of existing and potential low-emissions technologies for countries to tackle climate change (IEA, 2008). Innovation broadly reflects all steps (ie, from invention to diffusion) in the process by which new ideas like low-emissions technologies become realities that generate value.

Understanding the impacts of emissions pricing on innovation and competitiveness is important. Innovation and competitiveness are not two disparate concepts with few overlapping messages. Rather they are interrelated concepts that emphasise contrasting hypothetical economic outcomes – the 'pollution haven' hypothesis and the 'Porter' hypothesis; to aggregate economic impacts of emissions pricing.

The 'pollution haven' hypothesis states higher emission prices under stronger climate action increases compliance costs, diverts scarce resources away from productive activities, and therefore reduces competitiveness of regulated businesses. These impacts may shift emissions-intensive production off shore toward countries with low abatement costs eventually and cause policy-induced emissions leakage. While there is significant costs from emissions pricing there is no certainty of reduction in overall emissions. It could lead to emissions leakage where emissions are just displaced rather than reduced, as economic activities shift to countries with weaker climate action (Levinson & Taylor, 2008).

In contrast, the 'Porter' hypothesis argues stronger climate action, especially higher emissions pricing that draws on the power of markets, can have a net positive economic impact on the competitiveness of regulated businesses. Such policies promote cost-cutting resource efficiency improvements and foster policy-induced innovation in new low-emissions technologies that may help businesses grasp first-mover advantages, which result in regulated businesses leading the development of high-value low-emissions technologies (Sauvage, 2014). Porter and van der Linde (1995) once described the basis of the hypothesis – if properly

designed, strong action can lead to ‘innovation offsets’ that will not only improve environmental performance (ie, reduce emissions), but can also offset the additional compliance costs of the pricing instrument.

The debate as to which hypothesis holds sway has been ongoing for a number of decades. Jaffe et al (1995, p. 159), in the first significant empirical review of these hypotheses, concluded that “just as we have found little consistent [...] evidence for the conventional hypothesis regarding environmental regulation and competitiveness, there is also little or no evidence supporting revisionist hypothesis that environmental regulation stimulates innovation and improved international competitiveness.”

However, the international literature has developed considerably since Jaffe’s first conclusions and has developed analysis that specifically addresses emissions pricing with the ongoing experiment and development of emissions trading schemes and carbon taxes worldwide. Despite these developments, evidence is crucial, otherwise conventional wisdom may hold sway.

The belief in conventional wisdom is apparent in the work of Rassier and Earnhart (2015). These researchers examined the impact of environmental regulations on actual versus expected profitability from the implementation of these regulations. They found actual profitability consistent with the Porter hypothesis. However, expected profitability indicated a negative relationship between the implementation of environmental regulations and profitability in keeping with conventional wisdom.

# Evidence of emissions pricing impacts

This review of the impacts of emissions pricing on innovation and competitiveness differentiates evidence gathered from ex-post analysis (ie, backward-looking) and from ex-ante analysis (ie, forward-looking). First the ex-post analysis is reviewed, where evidence is compiled regarding innovation and competitiveness including emissions leakage, as well as evidence on the impacts of emissions pricing on reducing emissions. Then the ex-ante analysis is reviewed, before relevant conclusions from the review are developed.

## Ex-post analysis

Ex-post analysis of emissions pricing impacts on innovation and competitiveness has progressed significantly in recent years with better data available and more sophisticated methods to undertake such analysis. Earlier ex-post analysis was limited by data restrictions and methods applied (Arlinghaus, 2015). By far the most available ex-post analysis on the impacts of emissions pricing on innovation and competitiveness comes from the European Union emission trading scheme (EU ETS) (see box below), the world's largest trading scheme accounting for over three-quarters of international carbon trading. Other emissions pricing instruments, especially British Columbia's (BC) carbon tax (see box below), are also analysed in this review where ex-post analysis is available. Both these emissions pricing instruments are well-established and have been implemented for at least 10 years, which provides enough time for sufficient ex-post analysis.

These pricing instruments, while different from the New Zealand Emissions Trading Scheme (NZ ETS) in a number of respects, provide the basis for critical insight, both generally and also specifically to the New Zealand context for a number of reasons.

- The EU ETS has a defined cap on emissions, which the NZ ETS is moving towards to ensure the delivery of emissions reduction targets.
- The BC carbon tax, while a tax, provides an indication of the impacts a relatively stable emissions price (ie, Can\$30/tCO<sub>2</sub>-e) can have on environmental and economic performance.

### 1. EUROPEAN UNION EMISSIONS TRADING SCHEME

The key provisions of the EU ETS are listed below.

- **Coverage:** As of 2013, the EU ETS covers more than 11,000 factories, power stations, and other installations in 31 countries (28 European Union member countries and Iceland, Norway and Liechtenstein). The EU ETS covers the power and heat generation sector and energy-intensive industry sectors (eg, oil refineries, steel works, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, acids and bulk organic chemicals). Overall, the EU ETS covers around 45 per cent of the EU's emissions.
- **Exemptions and free allowances:** Businesses can be exempt from participating in some sectors for businesses under a certain size. For manufacturing industries, the share of free allowances will decrease annually to reach 30 per cent of their baseline in 2020. For the aviation sector, the share of free allowances amounts to 82 per cent of their allocation.

## 2. BRITISH COLUMBIA CARBON TAX

The key provisions of the BC carbon tax are listed below.

- **Coverage:** Fossil fuels used within the province, accounting for approximately 75 per cent of all emissions in the province.
- **Exemptions:** Fossil fuels exported from BC, fuel used by planes and ships travelling to or from the province and all non-fossil fuel emissions including those in industrial processes, landfills, forestry and agriculture.
- **Tax rate and revenue use:** It started at 10 Canadian dollars per tonne of CO<sub>2</sub> equivalent at its first implementation in 2008, and rose to \$30 in 2012. Tax is revenue-neutrality, where all revenues are redistributed back to households in the form of tax reductions.

### Impact on emissions

Emissions pricing is theoretically the most cost-effective and efficient means of reducing emissions compared with less 'flexible' instruments. While in a number of sectors and countries emissions have been declining (eg, in the United Kingdom emissions have decreased by nearly 30 per cent between 1990 and 2013), it has been difficult to infer whether these reductions can be attributed to pricing emissions. However, relatively recent evidence now confirms what is expected – emissions pricing does reduce emissions.

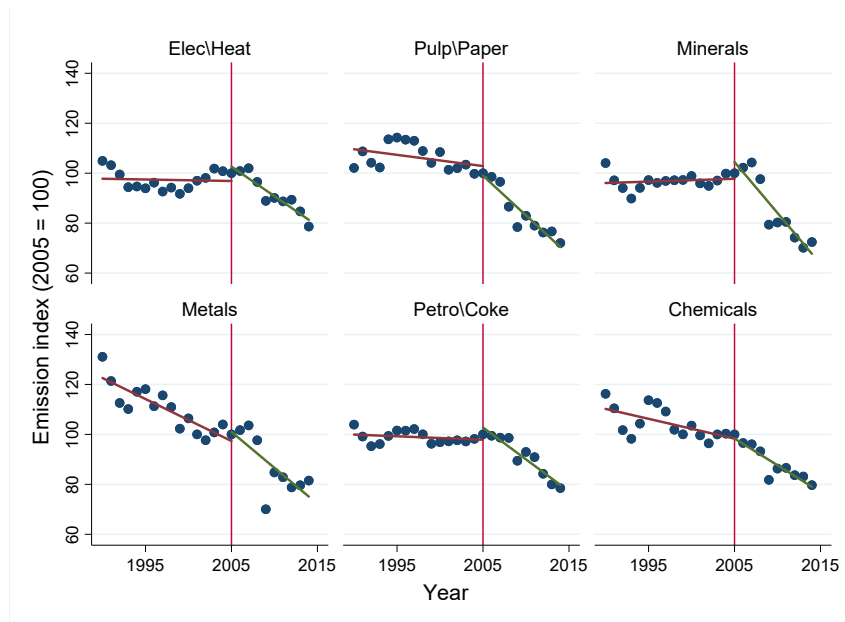
For example, Rivers and Schaufele (2012) estimate the impact of the BC carbon tax on petrol sales and find that at \$30 per tonne of CO<sub>2</sub> equivalent, the tax caused a reduction of 11 to 17 per cent in petrol sales. Similarly, Bernard et al (2014) undertook research on petrol sales and estimated a reduction in petrol sales because of the tax of around seven per cent. Murray and Rivers (2015), in reviewing all available studies on this tax, stated it is possible to infer that the impact of the tax was to reduce fuel consumption and emissions by around 5 to 15 per cent in the Canadian province.

With regard to the EU ETS, Martin et al (2016) reviewed several quantitative sector-level studies (eg, Ellerman et al, 2010; Anderson & Di Maria, 2011). They found that emissions across all regulated sectors under this ETS reduced by around three per cent in phase one (ie, 2005–2007) and during the first two years of phase two (ie, 2008-2009).

Dechezlepretre (2018) in the first comprehensive, European-wide analysis of the EU ETS analysed the emission trends of six key emission-intensive sectors since the scheme's first implementation in 2005. The author found that the EU ETS can be causally attributed to have reduced emissions between 10 to 14 per cent. Finding a causal link was significant as correlative findings could be explained via the Global Financial Crisis and other economic downturns.

The chemical sector was found to experience the highest emissions reductions, though reductions were observed in all analysed sectors, especially those with high coverage rates (see figure 1). In recognising the importance of coverage, Dechezlepretre (2018) found that allocating free allowances significantly limits the EU ETS's abatement potential, and that emissions could have declined an additional 25 per cent if only half of the allowances were freely allocated.

**Figure 1: Emission trends over time pre- and post-implementation of the EU ETS in different sectors**



Source: Dechezlepretre, 2018.

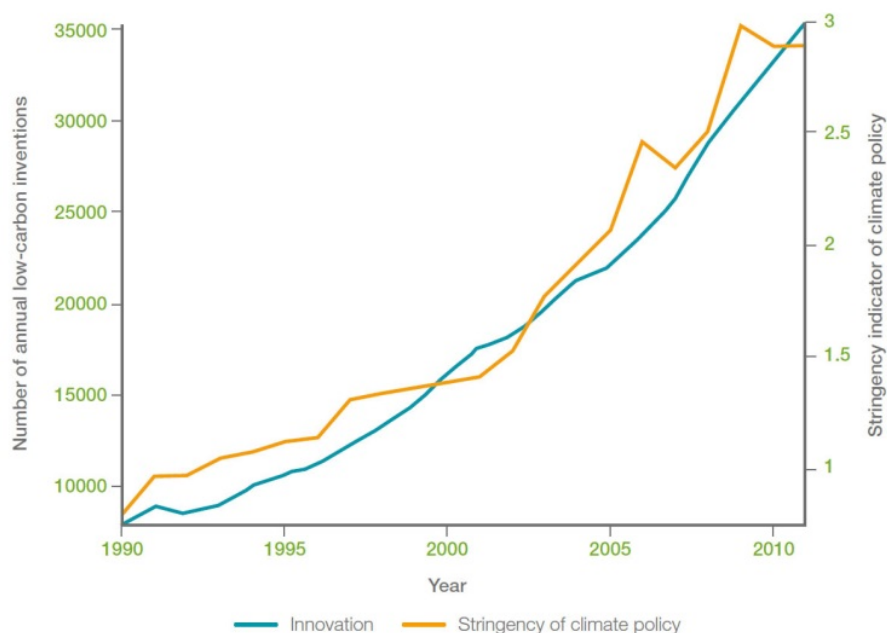
## Impacts on innovation

Evidence suggests emissions pricing reduces emissions as intended and expected. Many qualitative surveys of business managers have been conducted to understand the factors behind these emissions reductions. For example, Loschel et al (2010) surveyed 120 German businesses, and only six per cent indicated that the explicit objective of emissions abatement was the key factor for reducing emissions. This survey indicated that emissions reductions were driven largely by factors that led to resource efficiency improvements, including switching to less emissions-intensive production processes (eg, switching from coal to gas). Another similar survey found 94 per cent of Swedish businesses regulated under the EU ETS indicated they would not reduce their production volume to abate emissions, instead they placed greater emphasis on improvements in resource efficiency (Sandoff & Schadd, 2009).

If resource efficiency improvements occur as a result of emissions pricing, it is reasonable to conclude that the improvements are likely to be the result of policy-induced innovation. Rexhauser and Rammer (2014) support this view and have argued that regulated businesses are likely to find innovations to reduce costs and improve efficiency in terms of input material and energy consumption.

However, there is direct evidence of emissions pricing stimulating innovation in low-emissions technologies, which is consistent with findings about environmental policies more generally (Ambec et al, 2013). For example, Dechezlepretre et al (2016) found evidence of policy-induced innovation using patent data. Figure 2 shows a strong correlation between innovation, as measured by patent filings for low-emission technologies, and the strength of climate action.

**Figure 2: Innovation in low-emissions technologies and strength of climate action**



Source: Dechezlepretre et al, 2016.

This approach of investigating patent filings has also been applied to specifically assess innovation activity under the EU ETS. Calel and Dechezlepretre (2016) investigated regulated businesses and their patent filings under this scheme, and found that while innovation activity was similar before the implementation of the EU ETS between regulated and non-regulated businesses, this activity diverged notably with the scheme's implementation. This increased innovation activity was most significant during phase two of the EU ETS when emission prices were relatively high at approximately €30 per tonne of CO<sub>2</sub> equivalent.

Martin et al (2013) found regulated businesses in sectors below the thresholds for free allocation undertake higher levels of innovation activities than those above the thresholds. They concluded the amount of free allowances provided for strongly influenced innovation decisions for regulated businesses, and need to be considered with the emissions pricing level when accounting for policy-induced innovation.

Patent filings, while a useful measure of innovation, are not a perfect and complete measure of economic value. Dechezlepretre et al (2013) also focused work on the stock market value of regulated businesses under the EU ETS to address this issue. They observed the value of businesses increase more when they apply for a patent that cites a low-emissions patent compared to an emissions-intensive patent.

The findings suggest strongly that emissions pricing, especially high prices, increases innovation in low-emission technologies. This overall picture of policy-induced innovation is corroborated by interviews with business managers. For example, Rogge and Hoffman (2010) found managers in German electricity-generating industries considered the EU ETS supported innovation activities and accelerated research on resource efficiency improvements in emissions-intensive technologies. Furthermore, Anderson et al (2011) found that the EU ETS stimulated a shift toward low-emissions technologies and raised awareness about emissions reduction possibilities in Ireland.

Aghion et al (2016) show innovations in low-emissions technologies occur for regulated businesses under the EU ETS at the expense of innovation in emissions-intensive technologies. Calel and Dechezlepretre (2016), on the other hand, find no evidence of these effects of substitution, and indicate the EU ETS increased innovation activity in low-emissions

technologies for regulated businesses by as much as 30 per cent, while also raising the overall rate of innovation rather than redirecting innovation from emissions-intensive technologies to low-emissions technologies. While increases in overall innovation activity can occur in the shorter term, in the longer term some crowding out would be expected to inevitably occur, given the scarce availability of resources including researchers and developers themselves.

Emissions pricing encourages innovation in low-emission technologies. Dechezlepretre et al (2013), after measuring knowledge spillovers from low-emissions and emissions-intensive patents, found that knowledge spillovers are higher for lower-emission technologies. The authors also found the level of these knowledge spillovers were similar to those in high-end emerging technologies, like nanotechnology, robotics and information technology. On the other hand, knowledge spillovers in emissions-intensive technologies were much fewer.

Dechezlepretre et al (2013) also found innovations with lower-emission technology generate knowledge spillovers locally and overseas, but with most of the benefits being found locally. Dechezlepretre et al (2016, p. 15) interpreted this finding as a “[...] potential channel for positive home country effects from unilateral emissions pricing”. They also emphasised that the local benefits from policy-induced innovation provides greater local benefits than emissions reductions alone. This makes sense because with emission reductions the benefits of mitigating climate change are shared across all countries.

Overall, there is sufficient evidence to be confident that emissions pricing can increase innovation activity in lower-emission technologies. Despite the evidence of innovation activity and knowledge spillovers with emissions pricing, this does not reduce concerns about the economic impacts of emissions pricing on the competitiveness of regulated businesses.

## **Impact on competitiveness**

The analysis of emissions pricing impacts on competitiveness and the wider economy have been investigated across measures including revenues, assets, profits and employment levels. Until more recently, research has generally concluded that emissions pricing has no significant impact on competitiveness. Arlinghaus (2015, p. 23), in reviewing a wide set of papers concluded that “most studies reviewed [...] fail to measure any economically meaningful competitiveness effects as a consequence of these [emissions pricing] policies.”

Specific emissions pricing examples include the work of Petrick and Wagner (2014) who analysed the economic impacts of the EU ETS on German manufacturing businesses. They found small, but statistically significant increases in turnover, but no statistically significant impacts on employment. Wagner et al (2012) analysing French manufacturing businesses found no statistically significant impact on domestic employment of regulated businesses compared to non-regulated ones. Abrell et al (2011) also, when estimating the economic impact of the scheme between 2004 and 2008, found no statistically significant impact on regulated businesses’ value-added or profit margins. However, they did find a statistically significant, albeit very small (ie, 0.9 per cent) decrease in employment, which they found was driven largely by the non-metallic minerals sector.

More recent studies appear to suggest even stronger findings than no significant impact on the economy from emissions pricing. These papers, indeed, provide evidence that counters conventional wisdom and indicates some support for the Porter hypothesis, where innovation not only softens competitiveness impacts, but may provide net positive economic impacts.

For example, Klemetson et al (2016) examine the economic impacts of the EU ETS of Norwegian businesses for the period of 2001 to 2013. In particular, these authors measured the economic impacts of labour productivity and value-added at factor prices, which represents the businesses’ gross production value minus the cost of intermediates plus

subsidies and minus taxes. They found that both measures were positive and statistically significant, and suggest increases of around 25 per cent. Dechezlepretre (2018) speculated in reviewing this work that the economic impacts observed could be the result of free allowances or the ability of regulated businesses to pass-through costs. However, Klemetson et al (2016) also referred to the Porter hypothesis in an effort to explain their results.

Evidence potentially supporting the Porter hypothesis is also observed in the recent work of Dechezlepretre (2018), who investigated the economic impact of the EU ETS on regulated businesses regarding the measures of revenue, assets, profits and employment. From his analysis, Dechezlepretre (2018) concludes that the EU ETS not only had no negative impact on economic performance of regulated businesses, but also led to a statistically significant increase in revenues of between 7 to 18 per cent, and fixed assets by 6 to 10 per cent (see table 1). Employment and profits also showed positive increases though these results were not statistically significant. Further analysis needs to be undertaken to understand the mechanisms behind the results, but free allowances and the pass-through of costs are likely to explain only a small percentage of these positive findings.

**Table 1: Impact of the EU ETS on economic performance measures**

Economic performance measure	Change	Statistical significance
Employment	+ 2%	Not significant
Profits	+ €280k	Not significant
Revenue	+ 7-to-18%	Significant
Fixed assets	+ 6-to-10%	Significant

Source: Dechezlepretre, 2018

Dechezlepretre (2018) also found that no single sector analysed experienced, on average, a negative economic impact. Furthermore, the author found the positive economic impact from the EU ETS on revenue is observed within four sectors: minerals, metals, electricity and heat, with the largest positive economic impact in the metals sector. The author found the electricity and heat sectors were positively impacted the most with statistically significant increases in revenue, assets and employment.

Finally, Yamazaki (2017) also finds positive economic impacts where the revenue-neutral BC carbon tax generated a statistically significant two per cent increase in aggregate employment in the Canadian province. This suggests double dividends are achievable in the sense that the carbon tax can reduce emissions, the first dividend, and the revenues can be used to reduce the effects of more distorting effects in the tax system, the second dividend.

Yamazaki (2017) also noted that the magnitude of the impact differed depending on the level of emissions intensity and trade exposure of the sector. Due to carbon tax of \$10 per tonne of CO<sub>2</sub> equivalent, the chemical sector, as a highly EITE sector, experienced a large employment decline of 30 per cent. On the other hand, the health care sector, which is neither emissions-intensive nor trade-exposed, experienced a 16 per cent increase in employment.

**Impacts on emissions leakage**

There is some evidence to potentially support the Porter hypothesis that policy-induced innovation in low-emission technologies can occur, which provides economic value that may offset competitiveness impacts. While evidence at the aggregate level suggests negligible positive economic impacts with emissions pricing, sectors that are emissions-intensive and trade-exposed may be at a competitive disadvantage. The result is businesses within these sectors may take their production off-shore and cause policy-induced emissions leakage

impacts in line with the pollution haven hypothesis. The results by Yamazaki (2017) may suggest this occurrence.

Earlier studies specifically investigating sector-level analysis regarding trade, relocation and emissions leakage found little evidence to support the pollution haven hypothesis. For example, Sijm et al (2004) compared results of various empirical studies regarding the relocation of energy-intensive businesses and concluded that if a relationship existed between relocation and emissions pricing, then it is a relationship that is too weak to infer for policy-making purposes. In another early study, Reinaud (2008) analysed the impact of the EU ETS on aluminium, refining, iron/steel, and cement sectors between 1999 and 2008. The results did not indicate any statistically significant changes in trade flows and production patterns during the phase one (2005–2007) of the scheme. The author suggested the findings were partly a result of the free allocation of allowances to emission-intensive and trade-exposed sectors.

Further recent analysis found emissions leakage by investigating trade flows and energy prices, recognising that emissions pricing works to increase energy prices. Sato and Dechezlepretre (2015) analysed the impact of an energy price gap between two trading partners on bilateral trade flows for 62 manufacturing industries over 42 countries between 1996 and 2011. The authors found a 10 per cent increase in the energy price gap between trading partners increased bilateral imports by 0.2 per cent, and energy price differences between trading partners explained approximately 0.01 per cent of the variation in trade flows.

Kahn and Mansur (2013) also examined variations in energy prices and climate policies among adjacent United States counties between 1998 and 2009. They found evidence that energy-intensive sectors tend to locate in low electricity price areas, and that emission-intensive sectors seek out low-policy stringency areas; thus reducing employment in high-policy stringency areas. Similarly, Chan et al. (2013) compared EU ETS regulated and unregulated businesses between 2001 and 2009 across 10 countries in the energy-intensive power production, cement and iron/steel sectors. They found that in the power production sector, regulated businesses on average experienced an increase in 'fuel and material costs'. However, no negative economic impacts were found in the cement and iron/steel sectors, which was reasoned because of free allowances provided for these sectors.

Fowlie et al (2016) found emissions pricing has two negative effects in the Portland, United States cement industry. In particular, the authors found emissions pricing exacerbates 'market power' distortions, and emissions leakage offsets domestic emission reductions. On the other hand, Aldy and Pizer (2015) found statistical evidence that while higher energy prices led to small reductions in output in United States manufacturing businesses, they did not observe an increase in net imports. This highlighted that the production decline may be result of a decline in domestic consumption only. This result suggests consumers of energy-intensive manufactured products do not consume more imported products in response to higher energy prices, but instead economise their consumption of higher priced manufactured products.

Kozluk and Timiliotis (2016) using a model of trade flows for the manufacturing sector from 29 countries between 1990 and 2009 found the gap in emissions and energy pricing stringency between two trading countries does not have a significant effect on overall trade in the manufacturing sector. However, by changing the relative input prices in the production process, higher stringency in a country is linked to a comparative disadvantage for emissions-intensive manufacturing industries, and a comparative advantage for lower-emissions manufacturing industries. This result reaffirms the limited impact of emissions pricing at the level of the whole economy. Importantly, however, evidence indicates that emissions pricing may negatively impact energy-intensive and trade-exposed sectors.

The importance of appropriately identifying emission-intensive and trade-exposed sectors before providing such sectors with either exemptions or free allowances has been recognised

in work of Rivers and Schaufele (2014). These authors specifically investigated the impact of the BC carbon tax on the competitiveness of the agricultural sector. They found no statistically significant relationship between the agricultural trade and the tax. However in 2013, the BC budget returned 80 per cent of tax revenues to vegetable growers in the province and exempted fossil fuels used in agricultural operations.

These exemptions were implemented as the agricultural sector in BC was assumed to be exposed to competitiveness concerns because of the carbon tax. But, River and Schaufele (2014) found that agricultural commodities and products were neither trade-intensive nor fossil fuel intensive. Considering the tax did not change trade patterns in BC's agricultural sector, it is clearly difficult to justify the exemptions provided to this sector in the BC economic context (Murray & Rivers, 2015).

From the more recent evidence, emissions pricing is found to have small, but statistically significant effects on trade, employment, and business location, especially for emissions-intensive and trade-exposed sectors. Hence, emissions leakage, at a small scale, within these particular sectors has been observed to occur with emissions pricing in line with the pollution haven hypothesis.

These impacts are small and have generated costs that are a small percentage of the total costs faced by emission-intensive and trade-exposed sectors. Businesses within these sectors will be influenced more by other factors (eg, transport costs, agglomeration effects, capability of available workers) as to their trade and location decisions than from the impacts of emissions pricing (Dechezlepretre & Sato, 2017). This conclusion is also borne out by two interview surveys of business managers by Martin et al (2014a; 2014b), who examined the likelihood of regulated businesses under the EU ETS relocating abroad. Both authors found that the relocation risk is low, at least with current emissions pricing levels, because most regulated businesses report that future emissions pricing is not a key determinant on their location decisions.

## Ex-ante analysis

Most ex-ante analyses of the impacts of emissions pricing have been done by computable general equilibrium (CGE) modelling frameworks. Within these frameworks, limited effort has been undertaken to adequately account for the stimulation of innovation promised with emissions pricing. Hence, the emphasis of the literature applying ex-ante analysis via CGE modelling has been on the issues of competitiveness and emissions leakage. The analysis is implicitly grounded in conventional wisdom that broadly follows the pollution haven hypothesis.

## Impacts on competitiveness and emissions leakage

Carbone and Rivers (2017) recently reviewed the ex-ante analysis literature on emissions pricing impacts. They found some consistency in the results across CGE modelling efforts. In particular, they found output in EITE sectors decreases as the regulating country abatement rate increases. These authors note that for a 20 per cent reduction in a regulating country's emission levels, the CGE models generally predict a reduction of around five per cent in EITE sector output in that country. The models also typically report a reduction of about seven per cent in exports at the 20 per cent abatement level. These conclusions regarding EITE sectors are broadly consistent with the direction of change found in the literature covering ex-post analysis.

# Conclusions

This report has reviewed the international literature on the impacts of emissions pricing on innovation and competitiveness. It has investigated extensively the literature regarding ex-post analysis and also considered ex-ante analysis. Given the ex-post analysis is less manipulated by underlying assumptions, conclusions formed are based primarily on this evidence.

Our conclusions are predominantly based on recent evidence, which applies improved methods and higher-quality data across longer time series.

Based on the review of the international literature, the report concludes that emissions pricing at current levels reduces emissions, while not weakening overall economic performance of most businesses. This conclusion is supported elsewhere when considering the impact of environmental policies more broadly (Dechezlepretre & Sato, 2017).

Recent preliminary evidence suggests stronger conclusions, where emissions pricing may also provide small positive economic impacts (eg, Klemetson et al 2016; Yamazaki, 2017; Dechezlepretre, 2018).

These conclusions as to the overall economic impact from emissions pricing need to be moderated. Findings also reveal some EITE sectors show potential for emissions leakage and negative economic impacts with emissions pricing, although these negative impacts are also small.

Some more conclusions can also be made on the impact of emissions pricing on innovation. Emissions pricing:

- reduces emissions in all sectors which are covered by the pricing instrument
- increases innovation activity in low-emission technologies, which may be of high economic value
- increases innovation activity in line with a higher emission price
- increases innovation in low-emission technologies, which provides knowledge spillovers for other local industries.

## New Zealand context

These conclusions draw insights from the international literature on the impacts of emissions pricing on innovation and competitiveness. While many of these insights can be applied to the New Zealand context, some reflection is appropriate.

Compared to the EU, some New Zealand sectors would be more trade-exposed. In the case of the EU ETS, businesses often trade within the EU only, making concerns regarding competitiveness less relevant as competing businesses will also be regulated under the EU ETS.

Unlike the EU and other overseas countries, New Zealand's EITE sectors are not always represented by multiple businesses within a sector. For example, Tiwai Point aluminium smelter is the only operating smelter in New Zealand.

The NZ ETS provides free allocation to EITE sectors to reduce the risk of policy-induced emissions leakage. Examples of highly EITE sectors' activities that qualify for free allocation include lime production, aluminium and iron/steel (MfE, 2015).

Finally, while the international evidence suggests emissions pricing can reduce emissions, while not weakening overall economic performance of most businesses, this is at current international prices. It remains speculative as to whether these trends will hold at much higher

emissions prices (eg, over \$200/tCO<sub>2</sub>-e) that may be needed for a transition to a low-emissions economy in New Zealand.

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