



## Carbon leakage: theory and evidence

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# Overview

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- ◆ **Definition**
- ◆ Theory
- ◆ Evidence

# The aims of carbon regulation

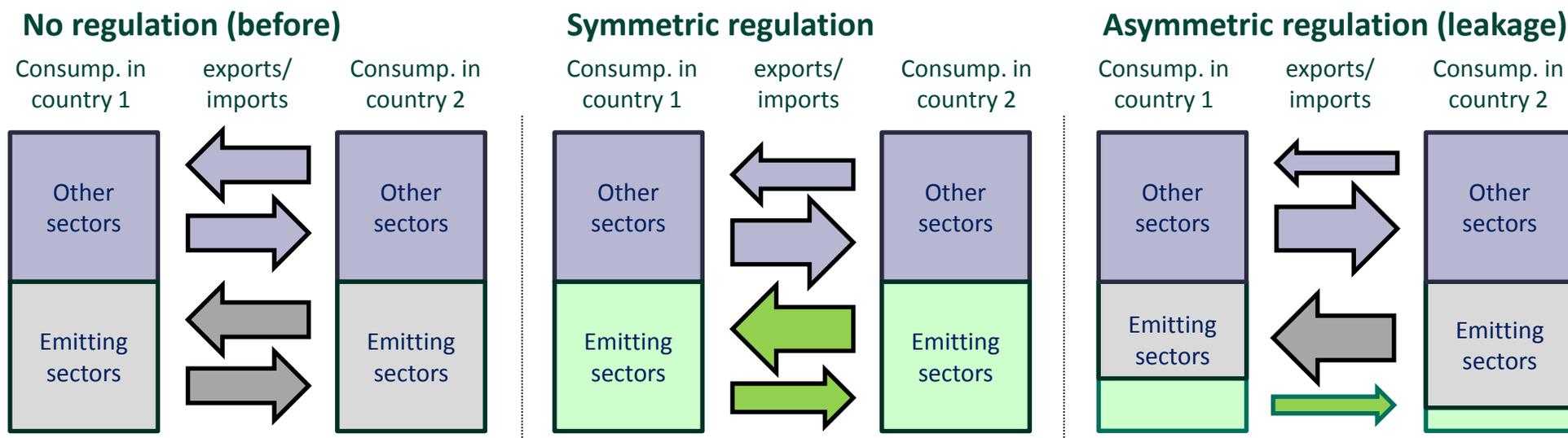
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- ◆ There are various forms of carbon regulation including,
  - cap and trade schemes
  - carbon taxes
  - mandatory technology standards
- ◆ Carbon regulation aims to eliminate the “externality cost” of carbon emissions, and hence to reduce climate change
- ◆ It does this by “internalizing” the externality cost of carbon emissions, and ensuring the consumer of that carbon pays for the full damages to others (e.g. owing to climate change) caused by those GHGs
- ◆ Carbon regulation should promote substitution from high to low-carbon products, increase the competitiveness of more carbon efficient producers, and encourage firms to reduce their emissions intensity
- ◆ Owing to the complexity of a low-carbon transition, carbon regulation should be as flexible as possible to facilitate various potential decarbonization pathways – hence the importance of globally harmonized carbon prices

# A definition of carbon leakage

## – competing firms facing different carbon emissions costs

- ◆ Carbon leakage is the transfer of production (and hence emissions) owing to differences in carbon emissions costs from one jurisdiction to another as a result of differences ('asymmetries') in the stringency of carbon regulation

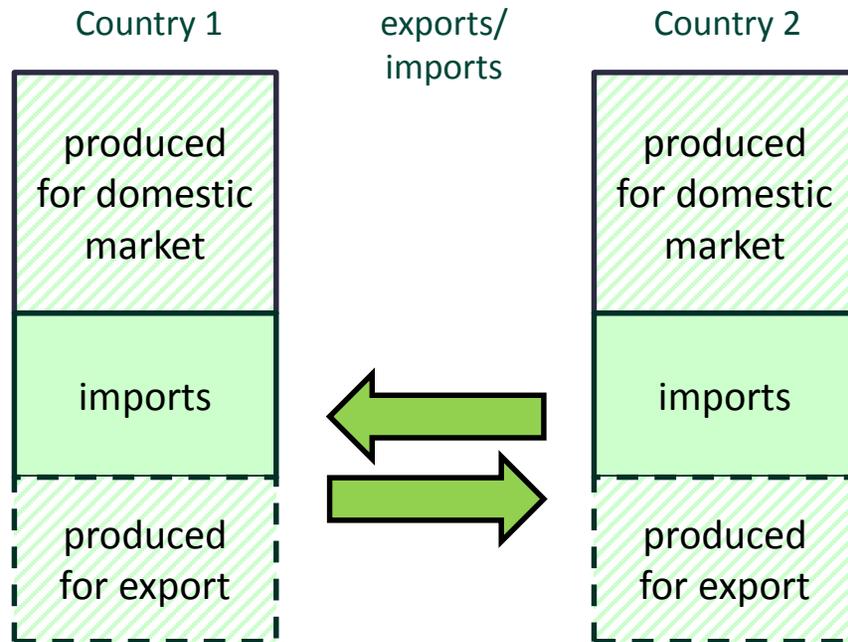


- ◆ **Before regulation:** trade occurs between the two countries based on various determinants of relative competitive advantage (not related to cost of carbon)
- ◆ **Symmetric regulation:** carbon emitting sectors in both countries become less carbon intensive, trade continues according to underlying determinants of relative advantage (with cost of carbon equal)
- ◆ **Asymmetric regulation:** less regulated country 2 will have lower cost of carbon, and hence export more in the emitting sector to the more regulated country 1 which will export less in the emitting sector

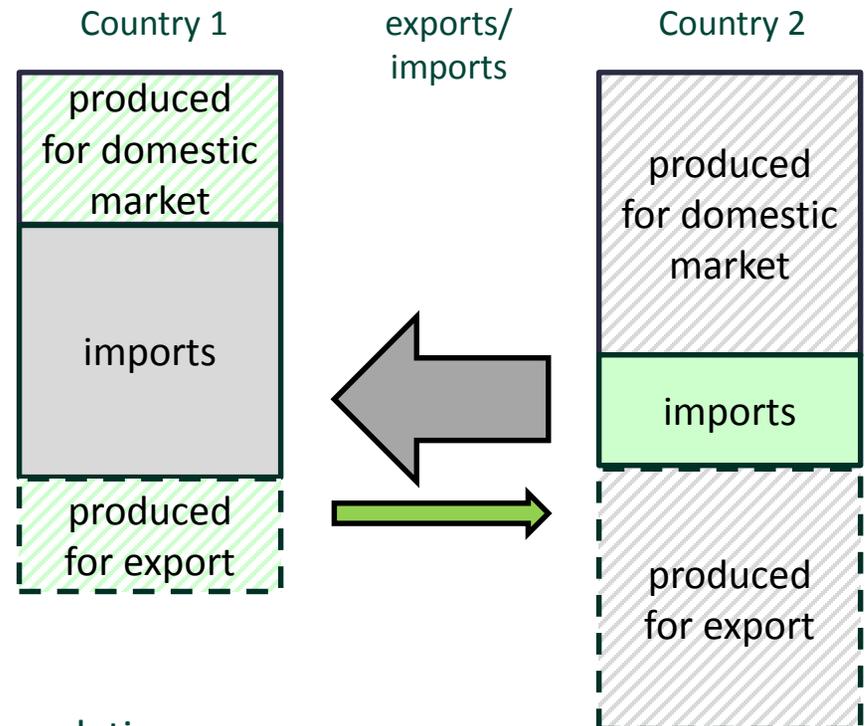
# If it occurs, carbon leakage can have undesirable environmental, economic and political consequences

## Dynamics in the emitting sectors

### Symmetric regulation



### Asymmetric regulation (leakage)



- ◆ Less competitive sector in country with carbon regulation
- ◆ Less production in country with carbon regulation
- ◆ Greater production in more emitting country (which may have even higher emissions intensity)
- ◆ Political pressure from companies and workers in the affected sector
- ◆ Less overall reductions in carbon emissions

# A robust assessment of carbon leakage must take into account what would have happened under symmetric regulation

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## A counterfactual is key to establishing leakage rates

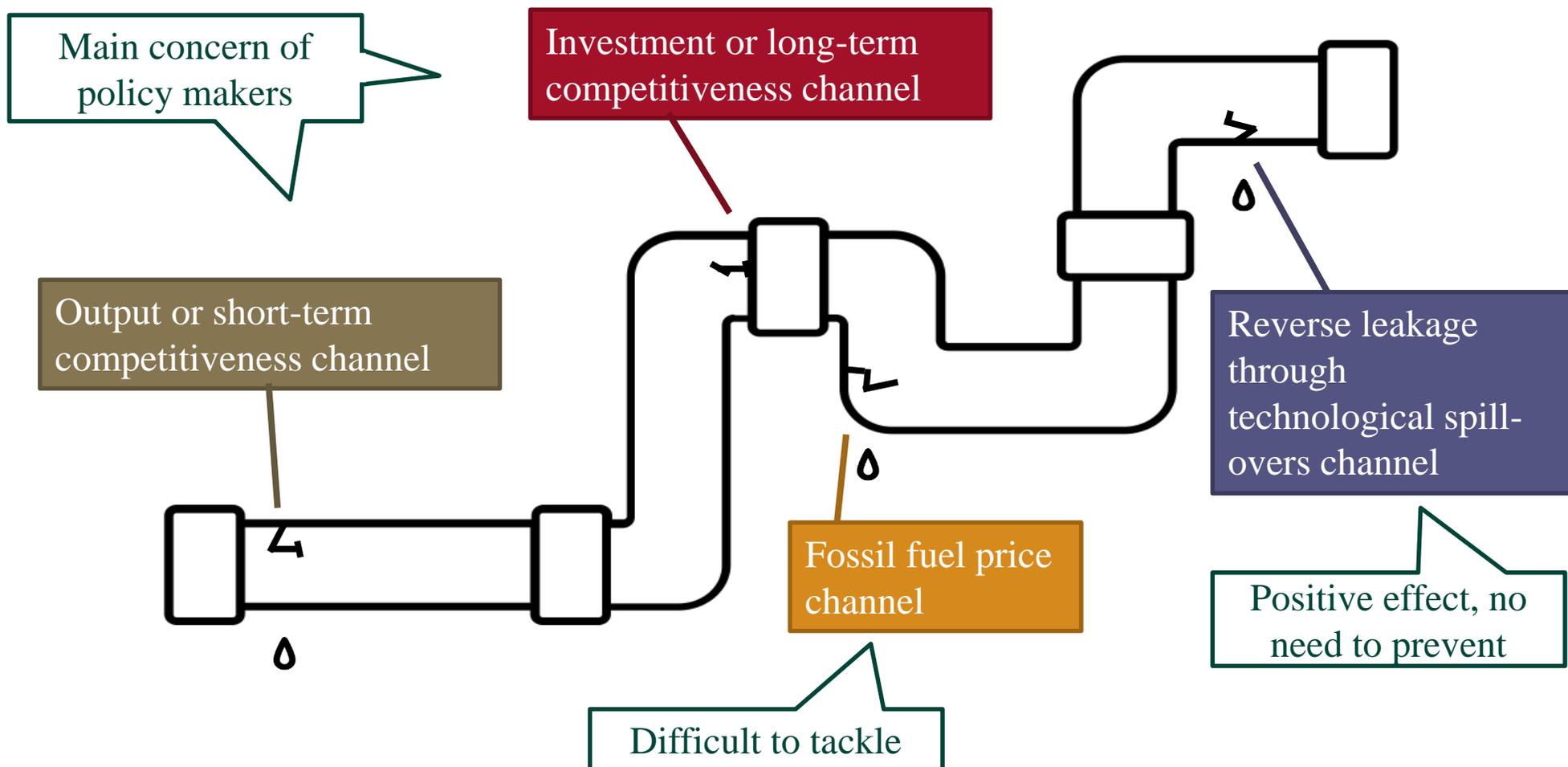
- ◆ leakage should be assessed by considering what happens as a result of differences in carbon regulation that would not have happened if regulation were equivalent across countries
- ◆ even under symmetric regulation, production (and remaining emissions) might shift from one country to another based on relative advantages in reducing carbon intensity
- ◆ more broadly, shifts in production and trade are due to a multitude of factors, including differences in labor costs, in innovation, in proximity to growing markets, in natural resource availability, etc.
- ◆ hence, observing declines in production and emissions in a regulated country, and increases in an unregulated country does not prove carbon leakage

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# The four channels of carbon leakage



- ◆ Carbon leakage may be driven by both the direct and indirect costs of carbon regulation
  - **Direct** – The cost of carbon emitted directly by the production process
  - **Indirect** – The cost of carbon embedded in other inputs (e.g. energy, materials)

## ◆ The output or short-term competitiveness channel

- occurs if higher carbon costs for firms that are subject to policy leads to a **loss of market share** to firms that are not affected by policy
- note that if market share is lost to other firms that are subject to policy, this does not constitute carbon leakage
  - rather, this is the intended effect of the policy, as it may be due to differences in carbon intensity

## ◆ The investment or long-term competitiveness channel

- occurs if different carbon price **alters investment decisions** between countries in the medium-to-long term
  - in medium term, could occur through reduced investment in maintenance capital of covered firms
  - long term, plants in jurisdictions with carbon price may be closed and/or new plants may be built in regions without carbon price
  - challenging to establish cause-effect: other factors are usually more important than carbon price

## ◆ The fossil fuel price channel

- occurs if **global fossil fuel prices decrease** as a result of reduced demand in regions with carbon price
  - the fall in energy prices would increase demand in regions with less stringent carbon regulation
  - this in turn might increase emissions in these jurisdictions

## ◆ The technological spill-overs channel

- occurs if carbon prices **induce innovation that enhances competitiveness**, implying that more production occurs in regulated regions
- carbon price-induced innovation and ensuing competitiveness gains could improve international competitiveness of firms
- the increase in international market share of regulated firms constitutes negative leakage

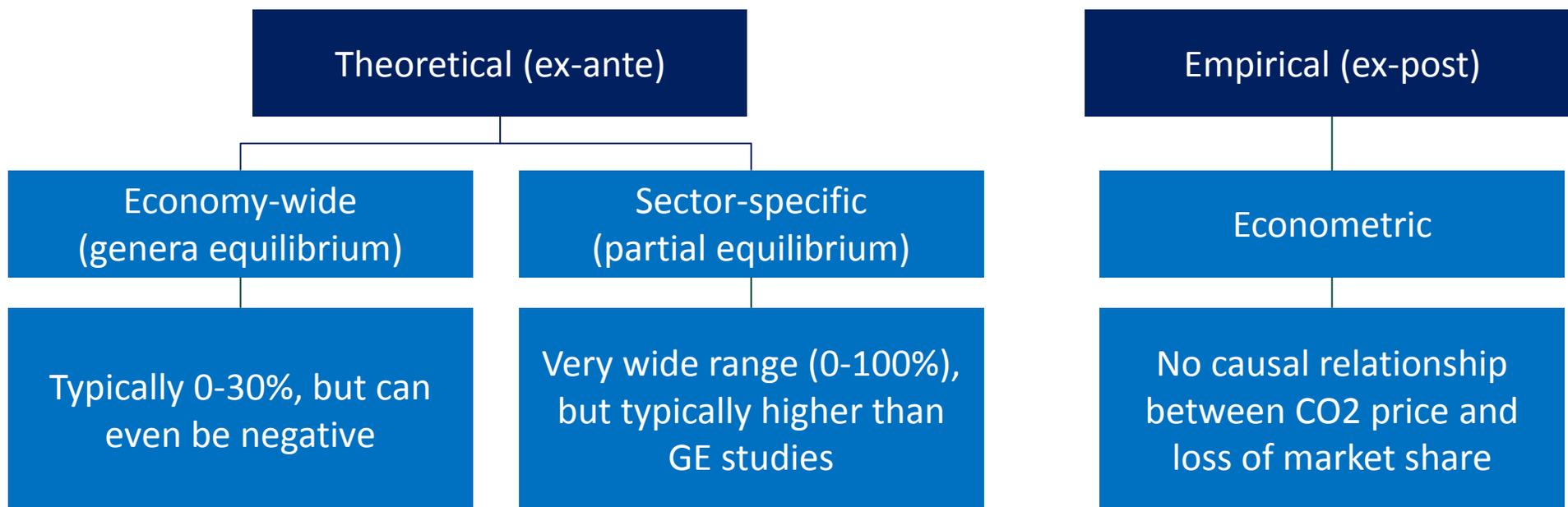
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# There are various approaches to assessing the existence and extent of carbon leakage

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- ◆ Fairly large differences exist both within and between modelling approaches
- ◆ All approaches make simplifying assumptions which affect their validity, in particular, models tend to divide the world in a binary fashion between jurisdictions with a carbon price, and those without a carbon price
- ◆ Results from one modelling exercise can not be applied to other localities or sectors – degree of leakage depends significantly on context!

# Theoretical “ex ante” approach

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- ◆ Economic models that develop scenarios with different carbon prices across multiple jurisdictions
  - can be general and partial equilibrium models
    - general (find 0-30 per cent leakage): focus on energy and factor market prices, by extension production and emissions
    - partial (find 0-100 per cent leakage): focus on detailed output and emissions patterns at sector level, ignoring interaction with wider economy but capturing more detail on market structure
  - differences may be due to:
    - CGE models will often look across both less and more exposed sectors, while PE models focus on later
    - CGE models assume less substitutability between domestic and imported products

# The differences in general equilibrium studies

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- ◆ The range of 0-30 per cent leakage rates in general equilibrium models is mainly due to underlying assumptions across sectors
  - The degree to which internationally traded goods are substitutable between economies
  - The degree to which factor inputs (especially energy vs. non-energy) are substitutable in the production process
  - The degree to which cleaner technologies can cost-effectively substitute for fossil fuels

# The large differences in partial equilibrium studies

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- ◆ The large range of 0-100 per cent leakage rates in partial equilibrium models is mainly due to varying exposure of assessed sectors
- ◆ Some of the variance is due to methodological differences
  - for example an important “off-model” assumption is the geographic span of competition
  - assuming national or regional competition results in lower leakage rates than assuming competition is global

# Empirical “ex post” approach

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- ◆ Empirical studies use observed outcomes
  - they rely on econometric techniques that can control for other influential factors, or company level assessment of investment and profitability
  - generally find that carbon pricing promotes abatement and has negligible negative impact on competitiveness
  - results are generally consistent with analysis of impacts of other environmental policies, and have sometimes shown evidence of “negative” leakage
  - but need to consider the technical difficulties to a conclusive empirical assessment
    - policies generally only in place for short periods
    - carbon prices have been modest to date
    - free allocation policies dampen the leakage effect

# Reconciling general and partial equilibrium

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- ◆ Respective strengths and weaknesses implies all approaches are best used in combination
  - empirical studies can inform the key assumptions in ex ante theoretical approaches
  - partial equilibrium analyses can elucidate sector-level effects, which can feed into general equilibrium analyses
  - general equilibrium captures fuel price changes and resource allocation across economy and can be used to calibrate partial equilibrium
  - if this is too time consuming, it is important to ensure studies are compared like-for-like basis
- ◆ *Moreover, it is generally not sufficient to base policy on evidence from other countries*

## Mixed evidence requires policy judgement, with pressure for action likely to remain

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- ◆ Significant evidence exists that carbon leakage is not as large a problem as some claim – general equilibrium and empirical studies find low to moderate leakage,
- ◆ there is evidence that some policies to prevent leakage lead to reducing the effectiveness of carbon regulation
- ◆ and as more countries adopt carbon prices, the relative asymmetries should diminish over time.
- ◆ **Yet**, partial equilibrium studies, anecdotal evidence and industry lobby suggest potential for higher leakage rates,
- ◆ and any carbon leakage would not only hurt local industry, but also diminish the effectiveness of carbon regulation
- ◆ **Typically, risk of leakage continues to lead to policy response**

# Thank You

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