

Comments on:
Measuring Leakage Risk
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What is emissions leakage? (*from Wikipedia*)

- “Carbon leakage occurs when there is **an increase in CO₂ emissions in one country as a result of an emissions reduction by a second country** with a strict climate policy.”
- Carbon leakage
= $\frac{\Delta\text{CO}_2 \text{ outside countries taking mitigation action}}{\Delta\text{CO}_2 \text{ in countries taking mitigation action}}$
- BEET: balance of emissions embodied in trade
- Here, leakage = $e_f dq_f$

Current policy approach to addressing leakage

- Production-based subsidies to mitigate higher costs
 - ▶ Output-based permit allocations or tax rebates
- Subsidies allocated based on industry-specific measures of
 - ▶ Domestic emissions intensity = $mmtCO_2/\$M VA$
 - ▶ Trade exposure = $(Imports + Exports)/(DomProd + Imports)$

New contributions of paper

- Current leakage risk measures omit:
 - ▶ Elasticity of foreign production to changes in domestic output
 - ▶ *Foreign* emissions content
- Estimate responsiveness of domestic and foreign sales to energy price changes
- Perform counterfactual analyses to assess leakage risk

Leakage in theory

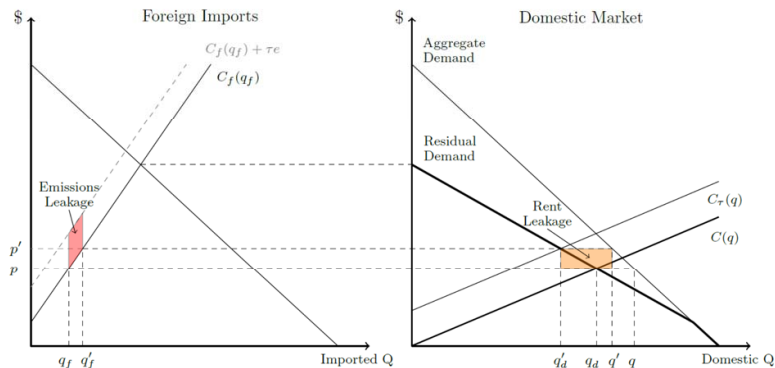


Figure 3: Leakage in Trade-Exposed Energy Intensive Industries

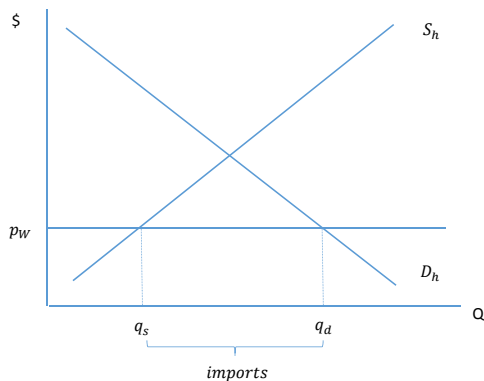
- Emphasize importance of foreign supply elasticity: $\frac{\partial q_f}{\partial q_d} \cdot \frac{q_d}{q_f}$

Understanding the theoretical framework

- Can recast as world price determined by

$$S_h(p) + S_f(p) = D_h(p) + D_f(p)$$

- If small country, home is just price-taker

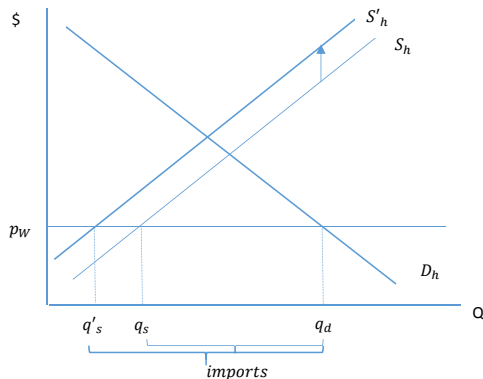


Small country world has full leakage with emission tax

- Can recast as world price determined by

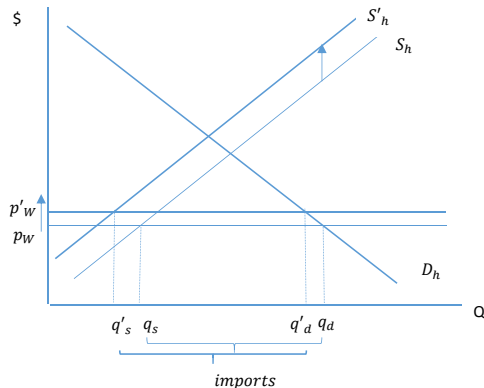
$$S_h(p) + S_f(p) = D_h(p) + D_f(p)$$

- If small country, home is just price-taker



If home is large, world price changes

- Extent of leakage depends on world price response
- Price response depends on
 - ▶ elasticity of world demand
 - ▶ importance of home supply in world



Paper uses rich sources of data from 1993 to 2013

- Census of Manufacturers and Annual Survey of Manufactures
- Longitudinal Trade Transactions Database
- Geographic energy prices in US (MECS and SED)
- Foreign energy prices
- Construct emission intensity measures

Amazing detail on energy use by establishment

- Price and quantity of electricity from CMF and ASM
- Price and quantity of primary fuels by state
- Establishment-level shares of energy use
 - ▶ Initial shares
 - ▶ Contemporaneous shares

Estimates of domestic sales and trade flows

$$\ln(y_{it}) = \alpha_0 + f(p_{it}^d, p_{it}^f, X_{it}; \beta) + \gamma \ln(w_{it}) + \phi_i + \eta_{st} + \varepsilon_{it},$$

where

i = 6-digit NAICS index,

t = year index,

y_{it} = aggregate outcome for industry i in year t ,

p_{it}^d = domestic energy price,

p_{it}^f = foreign energy price (a vector of foreign electricity and gas prices),

X_{it} = Industry characteristics other than energy intensity (e.g., capital inter

w_{it} = domestic wage,

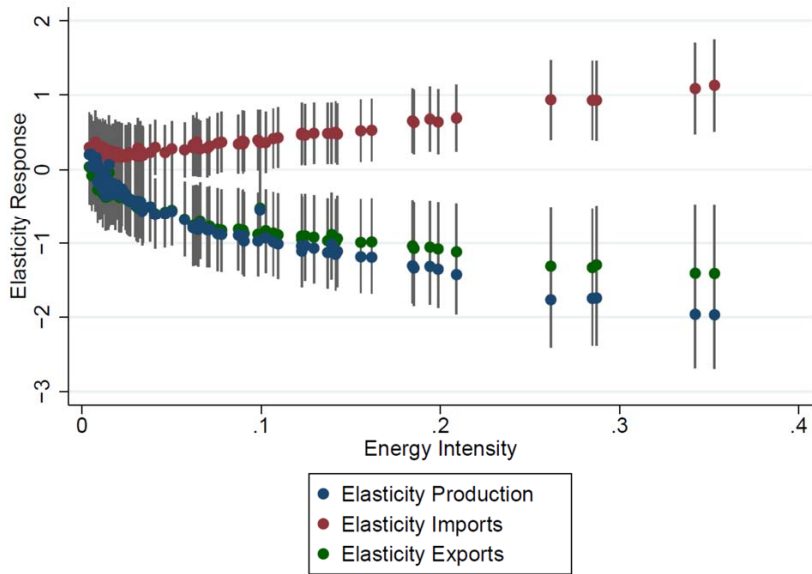
ϕ_i = 3-digit NAICS fixed effects,

η_{st} = year by sector (2-digit NAICS) fixed effects.

Limitations of the analysis (*noted by authors*)

- Domestic energy prices are potentially endogenous
- Do not observe climate change policy-induced variation
- Do not observe *quantity* changes, just revenue
- Do not observe foreign production, just US trade flows
- Theory does not provide structural guidance for estimation

Estimates of output elasticity by energy intensity



Counterfactual for policy analysis of transfer rates

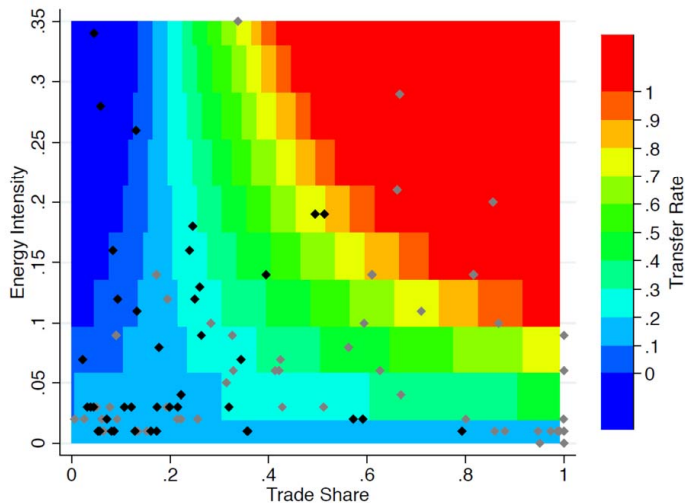


Figure 9: Heat Map of Transfer Rates

Leakage risk in model vs. policy

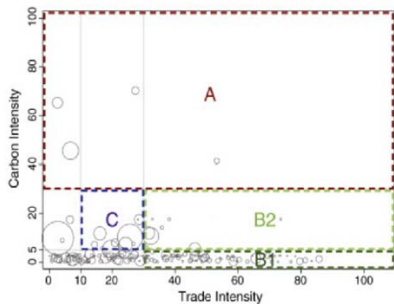


Figure: EU

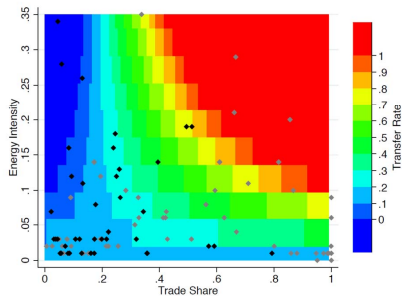


Figure 9: Heat Map of Transfer Rates

Figure: Model

Leakage risk in model vs. policy

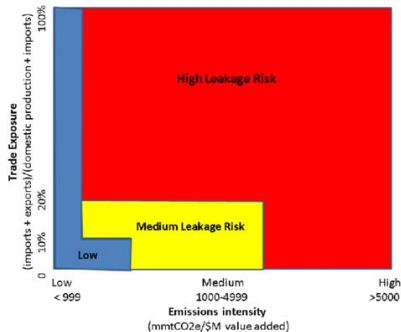


Figure: California GHG

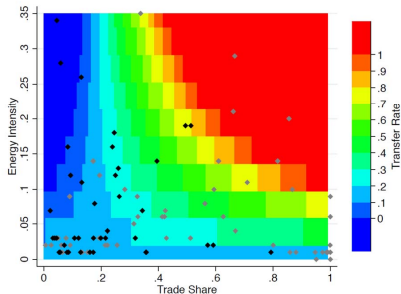


Figure 9: Heat Map of Transfer Rates

Figure: Model

Comment 1: Mapping the theory to the data

- Theory predicts imports *or* exports in an industry, but not both
- Authors acknowledge little guidance on structural relationships
- CES and monopolistic competition with hetero firms!
 - ▶ Imports and exports in same industry
 - ▶ More structure for estimating elasticities
 - ▶ Exploit the firm-level heterogeneity

Comment 2: Exploit establishment-level heterogeneity!

- How does establishment product composition change?
 - ▶ Bernard, Redding, and Schott (2010 & 2011) find major changes in response to trade
 - ▶ Do firms switch to more energy-intensive products?
- How does import and export composition change?
 - ▶ Do US imports from low energy cost countries increase?
 - ▶ Do US exports to high energy cost countries increase?
 - ▶ Does US comparative advantage change?
- Product adjustment margins could change leakage analysis

Comment 3: Exploit establishment-level heterogeneity!

- Authors control for changes in energy use
- How does establishment energy use change in response to price changes?
 - ▶ How much within vs. across estab variation is there?
- Is there evidence of (less) capital adjustment in response to price changes?
- Implications for policy metrics based on emission intensity
 - ▶ Incentives to produce emission-intensive products
 - ▶ Do not want to disincentivize abatement efforts

Comment 4: Exploit detailed geographic heterogeneity

- Plant-level details on production by geocode
- Geographic component in energy price variation
 - ▶ Some discoveries were unexpected
 - ▶ Time to develop infrastructure to transport newfound energy
- Does proximity to new energy sources lead to lower prices?
 - ▶ Potential source of exogenous variation
 - ▶ Varies by energy tradability

Geog interacts with policy heterogeneity within US

- California Global Warming Solutions Act and others
- Regional Greenhouse Gas Initiative
 - ▶ Market-based cap-and-trade approach
 - ▶ 2003-2017
 - ▶ CT, DE, ME, *MA*, *MD*, NH, *NJ*, NY, *RI*, VT
- Western Climate Initiative (AZ, CA, NM, OR, WA)
- Midwestern Greenhouse Gas Reduction Accord
- Agreement adoption often affected by political outcomes
- How does policy affect energy prices?
- Do we see similar production elasticities?

Comment 5: Exploit quantity information in trade data

- Possible to calculate unit values
- Can directly see how much prices change!
- Can control for country and product composition changes
 - ▶ Addresses quality change concerns somewhat
 - ▶ Evaluate within industry changes in product composition
- Speaks to mechanism underlying the basic theory
- Quantity-based measure of transfer rate

Comment 6: New implications for trade policy?

- Huge political obstacles to climate change policy
- Tariffs potentially easier to implement
- Extend theory to consider tariffs as a vehicle to prevent leakage
- Possibility of new BEET tariffs?

Additional comments and questions

- Are you using the product trailer files to classify establishments?
- How do you use NAICS prior to 1997?
- How do you use the ASM sampling weights?