Effective Protection with Global Value Chains

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Big Picture

Question: How do tariffs affect resource allocation across sectors?

Challenge: Tariffs are often applied to inputs and outputs → competing effects.

Example: US tariffs on autos and steel have increased.

- ▶ Auto tariffs boost demand for cars assembled in the United States.
- ▶ Steel tariffs raise the cost of US-assembled cars.
- ⇒ ambiguous net effect on demand for US workers and capital in car industry.

Max Corden (1966): The Effective Rate of Protection

Classic formula: $\frac{1}{1-s}\left[t_{output} - s \times t_{inputs}\right]$, where s is the input share.

▶ seeks to measure net protection offered by output and input tariffs;

▶ push/pull forces on resource allocation across sectors.

Good idea, lingering problems of implementation.

▶ Strong assumptions!
  ▶ Corden's ERP assumes Home and Foreign goods are perfect substitutes, so *all* goods prices are essentially exogenous.
  ⇒ Shuts off key transmission channels; runs afoul of modern quantitative models.

▶ What about the global value chain?
  ▶ The *entire* ERP literature predates the rise of GVCs.
  ▶ We seek to update ERP theory and practice for the GVC age.

What We Do

1. Update theory for ERP measurement.
   - ▶ Leverage a "value-added approach."
   - ▶ Define ERP $\equiv$ shift in demand for sectoral value added induced by tariffs.
   - ▶ Or, the effective subsidy to (or tax on) buyers of sectoral value added.

2. Build the GVC-ERP using world input-output data.
   - ▶ First-order (log-linear) approximation to gravity trade model.
   - ▶ OECD ICIO data + calibrated elasticities + tariff data.
   - ▶ Two versions: one country (SOE) vs. many countries.

3. Compute changes in effective protection due to US tariffs in 2025.
   - ▶ Even uniform tariffs $\rightarrow$ uneven effects; US ERP increases most in upstream sectors.
   - ▶ GVC linkages shape effective protection in complex ways:
     - ▶ upstream sectors are protected by downstream tariffs;
     - ▶ downstream sectors are taxed by upstream tariffs.

Demand for Value Added

Real value added $\rightarrow$ real net output; quantity index of primary factors.

Derived demand for real value added from sector s:

$$v_s = D_s(p_s^v; \mathbf{p}_{s'}^v, \boldsymbol{\tau}, D)$$

v_s is quantity, p_s^v is price, $\boldsymbol{\tau}$ are tariffs, and $\{\mathbf{p}_{s'}^v, D\}$ are demand shifters.

Inverse demand curve: $p_s^v = P_s^D(v_s; \mathbf{p}_{s'}^v, \boldsymbol{\tau}, D)$

Effective Protection

Tariffs change from τ_0 to τ_1.

$$ERP_s = \frac{P_s^D(v_{s0}; \mathbf{p}_{s'1}^v, \tau_1, D_1)}{P_s^D(v_{s0}; \mathbf{p}_{s'0}^v, \tau_0, D_0)} - 1$$

ERP_s is the %-change in willingness to pay, induced by tariff changes.

This aligns with Corden's original objective: to measure "the proportional increase in the effective price [of real value added] made possible by tariffs." [Corden (2016)]

Tariff-Induced Shift in Demand for Value Added
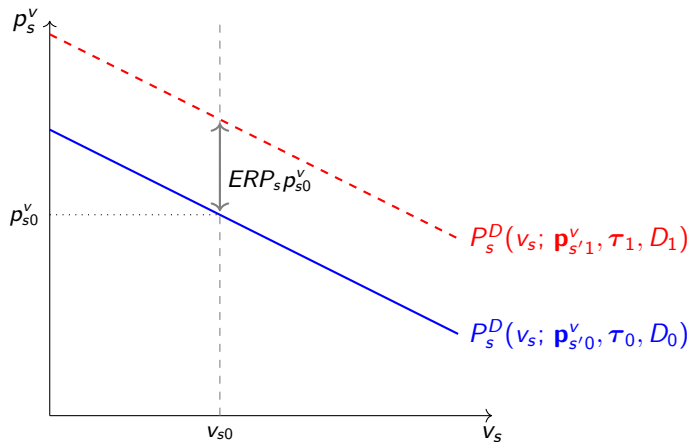
ERP measures the vertical shift in inverse demand for value added.

Public finance interpretation: $ERP_s > 0$ is 'as if' purchases are subsidized.

Comments

1. What about $\mathbf{p}_{s'}^v$ and D?
   - ▶ In baseline analysis, we hold $\mathbf{p}_{s'}^v$ and D constant.
   - ▶ Extensions allow $\mathbf{p}_{s'}^v$ to adjust when tariffs change.
   - ▶ D includes macro-effects: changes in real final expenditure and real exchange rates. We hold these constant throughout, so ERP is measured in partial equilibrium.

2. What about the supply side?
   - ▶ Derived demand embeds supply-side features (production functions, input linkages).
   - ▶ We do not specify supply functions for value added: ERP is a 'demand-side' concept.

Clarifying Interpretation

To head off mis-interpretation, the analysis does not tell us about:

- ▶ general equilibrium effects of tariffs.
- ▶ the welfare effects of tariffs.

It does tell us about the push/pull of resources across sectors.

- ▶ Primary factors should flow toward sectors with higher ERPs.
- ▶ Bhagwati and Srinivasan (1973): the ERP should rank sectors to predict changes in primary factor allocation and real value added.
- ▶ With specific factors, the ERP predicts changes in rents [Anderson (1998)].

Nuts and Bolts

Start with "small open economy."

- ▶ Take import prices and export demand schedule as given.
- ▶ Isolate the roles of imported inputs and domestic production network.

Standard multisector-CES structure:

- ▶ Production takes place under perfect competition.
  - ▶ Gross output combines real value added (primary factors) and intermediate inputs.
  - ▶ Composite input: CES across upstream sectors, CES between H/F within sectors.
  - ▶ Output price = marginal cost, which depends on input tariffs.
- ▶ Output allocated to consumption, input use, and exports.
- ▶ Consumption: CES across sectors, CES between H/F within sectors.

Manipulate log-linear approximation to form the ERP index.

Defining the ERP

Inverse Demand: $\hat{p}_V(s) = \mathbf{\Omega}(s) + \frac{1}{\sigma(s,s)}[\mathbf{R}_{V1}(s)\hat{\boldsymbol{\tau}}_C + \mathbf{R}_{V2}(s)\hat{\boldsymbol{\tau}}_M] - \frac{1}{\sigma(s,s)}\hat{v}(s)$,

- ▶ $\mathbf{\Omega}(s)$ collects non-tariff determinants of the demand intercept.
- ▶ $\mathbf{R}_{V1}(s)$ and $\mathbf{R}_{V2}(s)$ are matrices that depend on:
  - (a) substitution elasticities;
  - (b) input-output data for the initial equilibrium.
- ▶ $\sigma(s,s) = |\ln \hat{v}(s)/\ln \hat{p}_V(s)|$ is the own-price elasticity of demand.

Approximate ERP: $ERP(s) = \mathbf{\Omega}(s) + \underbrace{\frac{1}{\sigma(s,s)}[\mathbf{R}_{V1}(s)\hat{\boldsymbol{\tau}}_C + \mathbf{R}_{V2}(s)\hat{\boldsymbol{\tau}}_M]}_{\text{direct effect of tariffs}}$.

Many Countries with GVCs

Multi-sector, multi-country gravity model with full global input-output structure.

Messy matrix math, but the gist is the same.

Approximate GVC-ERP: $ERP_i(s) = \mathbf{\Omega}_i(s) + \frac{1}{\sigma_i(s,s)} \left[\mathbf{R}_{V1(i,s)} \left(\hat{\boldsymbol{\tau}}_C \right) + \mathbf{R}_{V2(i,s)} \left(\hat{\boldsymbol{\tau}}_M \right) \right]$.

- ▶ $\hat{\boldsymbol{\tau}}_C$ and $\hat{\boldsymbol{\tau}}_M$ include tariff changes in *all* countries.
    - ▶ $ERP_i(s)$ depends on both country i's own tariffs and foreign tariffs.

- ▶ $\mathbf{R}_{V1(i,s)} \left(\hat{\boldsymbol{\tau}}_C \right)$ and $\mathbf{R}_{V2(i,s)} \left(\hat{\boldsymbol{\tau}}_M \right)$ are matrix operations to feed tariffs through GVCs.
    - ▶ Final goods tariffs propagate backward, via upstream input demand.
    - ▶ Input tariffs propagate both backward (via demand for inputs to inputs)
      and forward (via downstream price changes, which trigger substitution).

Numbers

OECD Inter-Country Input-Output tables (2025 edition).

Elasticity parameters:
- ▶ Trade elasticities by sector and end use from Fontagnè et al. (2022).
    - ▶ Long-run elasticities estimated using cross-sectional tariff variation.
    - ▶ Median elasticity ≈ 6.
- ▶ Cross-sector EOS for input use calibrated to 0.5, based on Atalay (2017).
- ▶ Cross-sector EOS in consumption also 0.5, as in structural change literature.

US tariff changes:
- ▶ Start with applied bilateral tariffs in 2022 from CEPII MAcMap database.
- ▶ Apply announced bilateral and sector-specific changes from executive orders. Good summary by Congressional Research Service (2025).

Effective Protection in the US
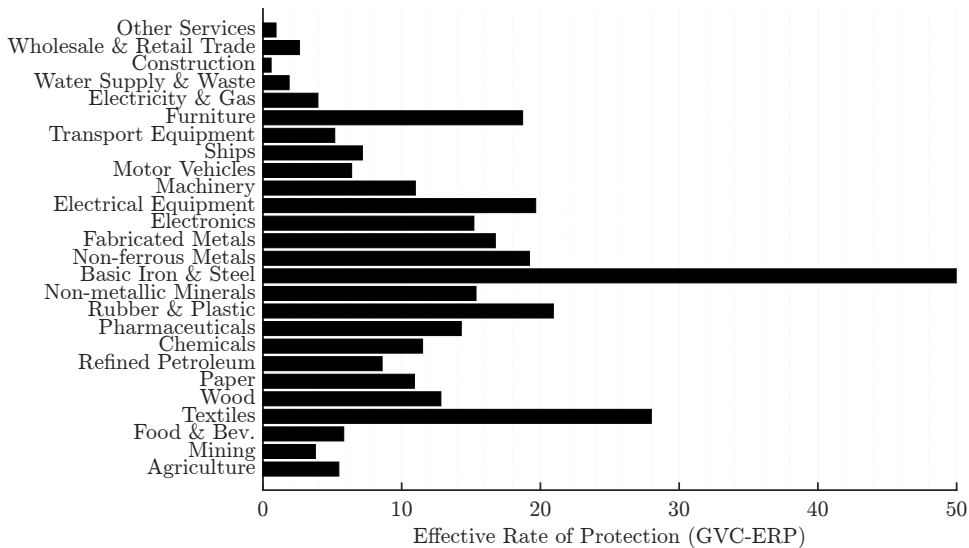
Effective Rate of Protection (GVC-ERP)

Under the Hood: Final Goods Tariffs

1. Final goods tariffs raise demand for domestic final goods: $\hat{\mathbf{c}}_{HH} > 0$.

   ▶ Direct impacts on demand for value added from Home sectors with increased tariffs.

   ▶ Plus indirect impacts via backward propagation.

      ▶ US auto tariffs raise demand for US steel.

      ▶ US auto tariffs raise demand for Foreign auto parts.
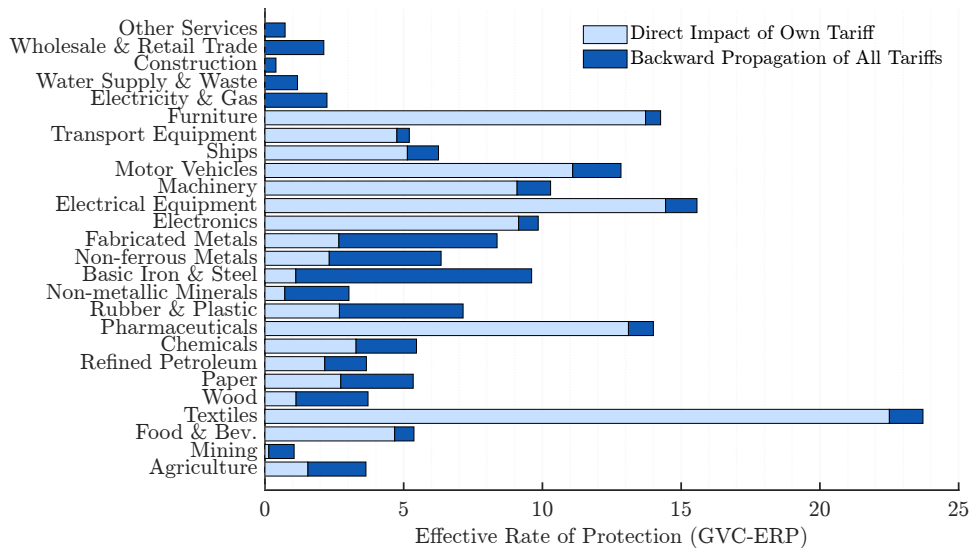
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3. USMCA Twist: Mexico & Canada still receive preferences on most goods.
   - ▶ US tariffs on ROW switch expenditure toward Mexico & Canada: $\hat{\mathbf{c}}_{MEX/CAN,US} > 0$.
   - ▶ Effective protection in Mexico & Canada increases.

US ERP: Final Goods Tariffs Only

Legend: Direct Impact of Own Tariff; Backward Propagation of All Tariffs

Categories (top to bottom): Other Services, Wholesale & Retail Trade, Construction, Water Supply & Waste, Electricity & Gas, Furniture, Transport Equipment, Ships, Motor Vehicles, Machinery, Electrical Equipment, Electronics, Fabricated Metals, Non-ferrous Metals, Basic Iron & Steel, Non-metallic Minerals, Rubber & Plastic, Pharmaceuticals, Chemicals, Refined Petroleum, Paper, Wood, Textiles, Food & Bev., Mining, Agriculture

x-axis: Effective Rate of Protection (GVC-ERP)

GVC Spillovers: From US Final Goods Imports to US Input Suppliers

US final goods tariffs depress imports from ROW ($c_{ROW,US} < 0$), but raise imports from Mexico & Canada ($c_{MCA,US} > 0$). Backward spillovers to US input suppliers are weak.
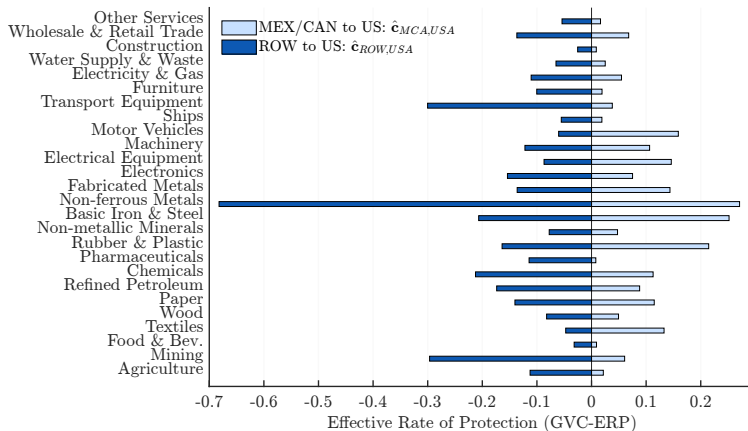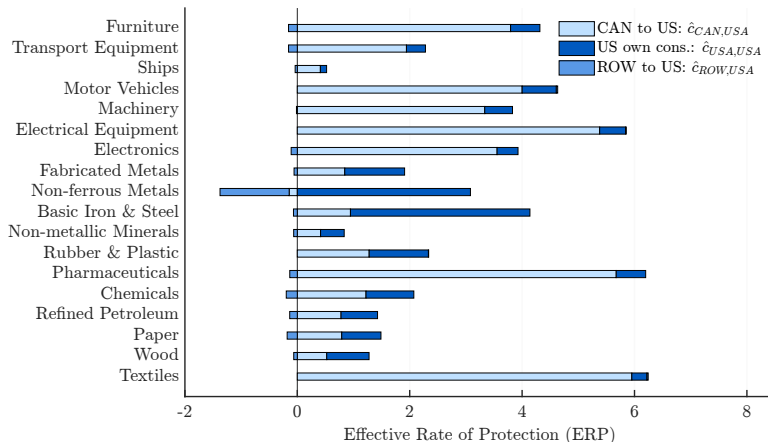
GVC Spillovers: Effective Protection in Canada

US tariffs switch expenditure toward CAN ($c_{CAN,US} > 0$), raising Canada's ERP.

US cons. of its own goods ($c_{US,US} > 0$) spills backward, also raising Canada's ERP.

Backward spillovers from US to Canada are strongest for metals.

Effective Rate of Protection (ERP)

Legend: CAN to US: $\hat{c}_{CAN,USA}$; US own cons.: $\hat{c}_{USA,USA}$; ROW to US: $\hat{c}_{ROW,USA}$
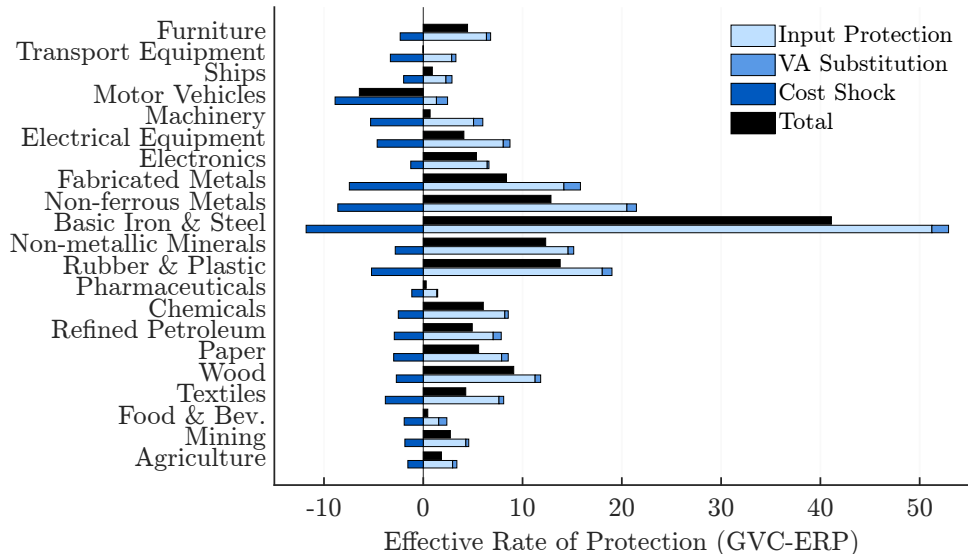
Under the Hood: Input Tariffs

Input tariffs work through three offsetting channels:

1. Input protection: τ_M raises demand for domestic inputs: $\hat{\mathbf{m}}_{HH} > 0$.
   - Input demand propagates backwards, like changes in final goods tariffs.
   - Analysis of GVC channels mimics previous results.

2. VA substitution: τ_M raises cost of composite input and demand for value added.
   - This channel is relatively weak, due to low EOS.

3. Cost shock: τ_M increases downstream costs, lowering demand for value added.
   - e.g., US metals (input) tariffs: $ERP_{metals}(s) \uparrow$ and $ERP_{autos}(s) \downarrow$.
   - The metals tariff is a net tax on auto production.

Effective Protection in the US: Input Tariffs

Chart showing Effective Rate of Protection (GVC-ERP) by industry, with bars for Input Protection, VA Substitution, Cost Shock, and Total.

Industries (top to bottom): Furniture, Transport Equipment, Ships, Motor Vehicles, Machinery, Electrical Equipment, Electronics, Fabricated Metals, Non-ferrous Metals, Basic Iron & Steel, Non-metallic Minerals, Rubber & Plastic, Pharmaceuticals, Chemicals, Refined Petroleum, Paper, Wood, Textiles, Food & Bev., Mining, Agriculture

X-axis: Effective Rate of Protection (GVC-ERP), ranging from -10 to 50

Legend:
- Input Protection
- VA Substitution
- Cost Shock
- Total

Conclusion

The ERP is alive and well, now up to date with gravity & GVCs.

Yet, more to do:

- ▶ Needed: applications of the toolkit.
    - ▶ Tariff changes in other countries: retaliation matters for the ERP too.
    - ▶ Tariff changes in other periods: analyzing historical reforms.
    - ▶ Export taxes and quantity restrictions.
- ▶ Additional theoretical concerns:
    - ▶ Endogenous markups & pro-competitive effects.
    - ▶ Increasing returns to scale (upstream or downstream?).
    - ▶ Adding the supply side to evaluate tariff incidence.

And much more to say about welfare...

References

Anderson, James E., "Effective Protection Redux," *Journal of International Economics*, 1998, *44*, 21–44.

Atalay, Enghin, "How Important Are Sectoral Shocks?," *American Economic Journal: Macroeconomics*, October 2017, *9* (4), 254–80.

Bhagwati, Jagdish N. and T.N. Srinivasan, "The General Equilibrium Theory of Effective Protection and Resource Allocation," *Journal of International Economics*, 1973, *3*, 259–282.

Congressional Research Service, "Presidential 2025 Tariff Actions: Timeline and Status," 2025. Updated September 16, 2025.

Corden, W. Max, "The Structure of a Tariff System and the Effective Protection Rate," *The Journal of Political Economy*, 1966, *LXXIV* (3), 221–237.

— , "Effective Protection," in "The New Palgrave Dictionary of Economics," London: Palgrave Macmillan UK, 2016, pp. 1–6.

Fontagnè, Lionel, Houssein Guimbard, and Gianluca Orefice, "Tariff-based Product-level Trade Elasticities," *Journal of International Economics*, 2022, *137*, 103593.