Tariffs, Manufacturing Employment, and Supply Chains

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Motivation

- Stated goal of Trump tariffs: “reindustrialize” U.S. economy
  - $\rightarrow$ Can it work?
  - $\rightarrow$ Best way to do it?
  - $\rightarrow$ How long will it take?
- Problem 1: Tariffs raise costs for downstream industries
  - $\rightarrow$ Steel tariffs during 1st Trump admin increased steel employment but…
  - $\rightarrow$ Destroyed $\sim$10x more jobs in other mfg sectors (Cox and Russ, 2020; Flaaen and Pierce 2024)
  - $\rightarrow$ Reduced export growth in other mfg sectors (Handley et al. 2020)
- Problem 2: Frictions slow adjustment & cause short-term pain
  - $\rightarrow$ Factors: Need to build new factories, get workers to switch occupations
  - $\rightarrow$ Supply chains: Transitory shocks in upstream sectors cause persistent disruptions in downstream sectors (Tsyvinski and Liu 2024)
- This paper: short vs. long-run effects of tariffs on mfg employment in general equilibrium

What I do

- Build multi-sector, multi-country dynamic GE model of US economy
  - → Starting point: Kehoe et al. (2018)
  - → Manufacturing split into 4 subsectors that differ by trade elasticity and upstreamness:
    - "Oil:" upstream, high elasticity
    - "Steel:" upstream, low elasticity
    - "Toys:" downstream, high elasticity
    - "Cars:" downstream, low elasticity
  - → Supply-chain adjustment frictions as in Tsyvinski and Liu (2024)
- Simulate effects of tariffs on sectoral employment dynamics
  - → Target specific sectors vs. across the board
  - → Baseline vs. frictionless model
  - → Target one country vs. entire world
  - → Passive trade partners vs. retaliation

What I find

- Tariffs can raise overall manufacturing employment
  - $\rightarrow$ Tariff on all mfg sectors: 1.75pct increase
  - $\rightarrow$ Best case: tariff on “toys” only, 3pct increase
  - $\rightarrow$ Worst case: tariff on “cars” only, 2pct decrease
- Net effect on overall mfg employment masks significant reallocation between mfg sectors
  - $\rightarrow$ Tariff on all mfg sectors: only “toys” grows, all other sectors shrink
  - $\rightarrow$ “Cars” tariff: employment in “cars” rises slightly, other 3 mfg sectors all shrink at least 2x more
- Employment may fall in short run before eventually rising
  - $\rightarrow$ Tariff on all mfg sectors: employment rises by 1.75pct in long run, but falls by 1.25pct in short run and remains depressed for 11 years
- If other countries retaliate, long-run gains disappear and short-run losses double

Model

Overview

- Discrete time, perfect foresight
- I countries indexed by i, j (subscripts)
- S sectors indexed by s, r (superscripts)
- Agents:
  - $\rightarrow$ Households: work, consume, invest, buy bonds
  - $\rightarrow$ Producers: gross output $= f$(labor, capital, intermediates)
  - $\rightarrow$ Distributors: sector-specific Armington composite $= g$(domestic products, foreign products)
  - $\rightarrow$ Retailers: consumption $+$ investment $= h$(sectoral composites)
  - $\rightarrow$ Governments: levy import tariffs

Producers

- Produce output using capital, labor, and intermediate inputs subject to labor adjustment costs

$$y^s_{i,t} = \left\{ \lambda_i^{s,v} \left[(k^s_{i,t})^{\alpha_i^s} (\ell^s_{i,t})^{1-\alpha_i^s} \right]^{\frac{\eta-1}{\eta}} + \left[\sum_{r=1}^{S} \lambda_i^{s,r} (m^{s,r}_{i,t})^{\frac{\xi-1}{\xi}} \right]^{\frac{\eta-1}{\eta} \frac{\xi}{\xi-1}} \right\}^{\frac{\eta}{\eta-1}} - \phi_\ell \left(\frac{\ell^s_{i,t}}{\ell^s_{i,t-1}} - 1 \right)^2 \ell^s_{i,t-1}$$

- Adjusting capital is also costly

$$k^s_{i,t+1} = (1-\delta) k^s_{i,t} + \delta^{1-\phi_k} (x^s_{i,t})^{\phi_k} (k^s_{i,t})^{1-\phi_k}$$

- Choose $\{\ell^s_{i,t}, k^s_{i,t}, m^{s,1}_{i,t}, \ldots, m^{s,S}_{i,t}\}_{t=0}^{\infty}$ to maximize PDV of dividends

$$\sum_{t=0}^{\infty} \Lambda_{i,t} \left[p^s_{i,t} y^s_{i,t} - w_{i,t} \ell^s_{i,t} - p^x_{i,t} x^s_{i,t} - \sum_{r=1}^{S} p^{m,r}_{i,t} m^{s,r}_{i,t} \right]$$

Distributors

- Combine domestic and foreign products into use-specific (final or intermediate) Armington composites subject to cost of substituting between suppliers

$$q_{i,t}^{u,s} = \left[\sum_{j=1}^{I} \mu_{i,j}^{u,s} (z_{i,j,t}^{u,s})^{\frac{\zeta^s - 1}{\zeta^s}}\right]^{\frac{\zeta^s}{\zeta^s - 1}} - \sum_{j=1}^{I} \phi_u \left(\frac{z_{i,j,t}^{u,s}}{z_{i,j,t-1}^{u,s}} - 1\right)^2 z_{i,j,t-1}^{u,s}, \; u \in \{m, f\}$$

  → Long-run trade elasticities, ζ^s, vary by sector

  → Adjustment frictions modeled as in Tsyvinski and Liu (2024)

  → Lower short-run elasticities as in Krugman (1986)

- Choose $\{z_{i,1,t}^{u,s}, \ldots, z_{i,I,t}^{u,s}\}_{t=0}^{\infty}$ to maximize PDV of dividends

$$\sum_{t=0}^{\infty} \Lambda_{i,t} \left[p_{i,t}^{u,s} q_{i,t}^{u,s} - \sum_{j=1}^{I} (1 + \tau_{i,j,t}^{s}) z_{i,j,t}^{u,s}\right]$$

Retailers, households, and government

- Retailers: combine final-use sectoral composites into aggregate consumption and investment:

$$c_{i,t} = \left[\sum_{s=1}^{S} \varepsilon_i^{c,s} \left(z_{i,t}^{c,s} \right)^{\frac{\rho^c - 1}{\rho_c}} \right]^{\frac{\rho_c}{\rho^c - 1}}, \quad x_{i,t} = \left[\sum_{s=1}^{S} \varepsilon_i^{x,s} \left(z_{i,t}^{x,s} \right)^{\frac{\rho^x - 1}{\rho_x}} \right]^{\frac{\rho_x}{\rho^x - 1}}$$

- Households: work, consume, and save

$$\max_{\{c_{i,t}, \ell_{i,t}, b_{i,t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} u_i(c_{i,t}, \bar{\ell}_i - \ell_{i,t}) \quad \text{s.t.} \quad p_{i,t}^c c_{i,t} + Q_t b_{i,t+1} = w_{i,t} \ell_{i,t} + \bar{p}_t b_{i,t} + \Pi_{i,t} + T_{i,t}$$

- Government:
  - $\rightarrow$ Set tariffs $\tau_{i,j,t}^s$ on goods from country j's sector s
  - $\rightarrow$ Today: Rebate tariff revenue lump-sum to households
  - $\rightarrow$ Future: Reduce other distortionary taxes or subsidize investment as in Alessandria et al. (2025)

Equilibrium

- Sequence of prices and quantities that satisfy (i) household, retailer, distributor, and producer problems, and (ii) market clearing conditions
- Steady-state equilibrium: if tariffs are constant, equilibrium converges in long run to situation where all p's and q's are constant
- But no unique steady state! Continuum of steady states indexed by vector $b_{i,\infty}$ as in Kehoe et al. (2018) and Steinberg (2019, 2020)
  - $\rightarrow$ Long-run trade imbalances are endogenous
  - $\rightarrow$ Steady state determined by initial conditions and policy trajectory
  - $\rightarrow$ Adjustment costs $\phi^m, \phi^f, \phi^k, \phi^\ell$ don't enter steady-state versions of equilibrium conditions, but still affect which steady state you go to

Calibration

Overview

- Assign elasticities of substitution externally
  - $\rightarrow$ Between sectors in consumption and investment: Kehoe et al. (2018)
    - $\rho_c = 0.65$
    - $\rho_x = 1$
  - $\rightarrow$ Between value added and intermediates: Kehoe et al. (2018)
    - $\eta = 0.05$
    - $\xi = 0.03$
  - $\rightarrow$ Between different source countries (“trade elasticity”): Caliendo and Parro (2015)
    - ζ^s range from 2 to 18
- Calibrate expenditure shares so that input-output table constitutes pre-tariff steady state
  - $\rightarrow$ Next 4 slides
- Calibrate adjustment costs to short-run trade elasticity = 1
  - $\rightarrow$ Done during tariff experiment stage

Input-output data

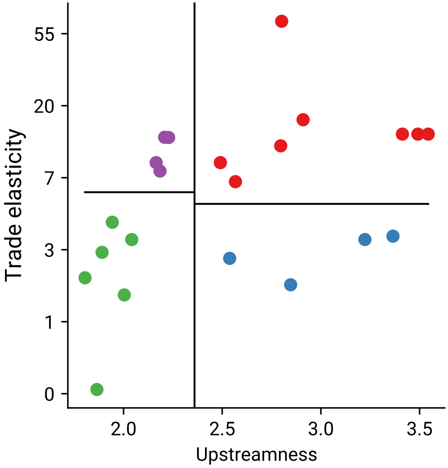
- Source: 2020 OECD inter-country input-output table
- Aggregate countries into 3 regions: USA, China, rest of world
  $\rightarrow$ Not crucial. Could use just USA and rest of world, but wanted to allow for trade diversion.
- Aggregate industries into 6 sectors
  $\rightarrow$ Cluster goods industries (ISIC codes A-C) into 4 sectors by clustering on two characteristics
    - Trade elasticity from Caliendo and Parro (2015)
    - Upstreamness from Antras et al. (2012)

  $\rightarrow$ Aggregate services industries (ISIC codes D, E, G-T) into one sector

  $\rightarrow$ Keep construction (ISIC code F) separate. Completely non-traded, only used for investment.

Clustering goods industries

Industry-level characteristics

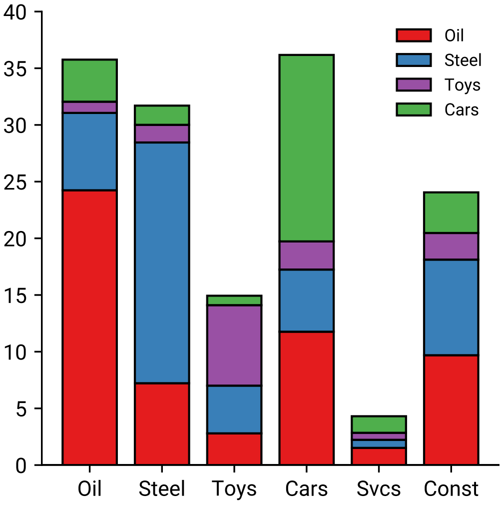


Sectoral aggregation

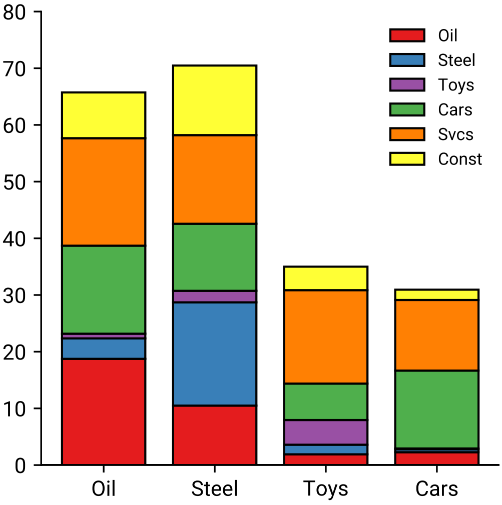
Sector	Industries	Upstreamness	Trade elasticity	Share of goods emp.
"Oil"	Agriculture, Mining (energy), Mining (non-energy), Mining support, Wood products, Paper products, Refined petroleum, Fabricated metals	3.0	17.6	28.4
"Steel"	Chemicals, Rubber + plastics, Minerals, Basic metals	3.0	2.8	18.1
"Toys"	Fishing, Textiles, Electronics, Electrical equipment	2.2	11.9	17.7
"Cars"	Food + beverages, Pharmaceuticals, Machinery + equipment, Motor vehicles, Other trans. equip., Other mfg	1.9	2.2	35.7

Supply-chain linkages

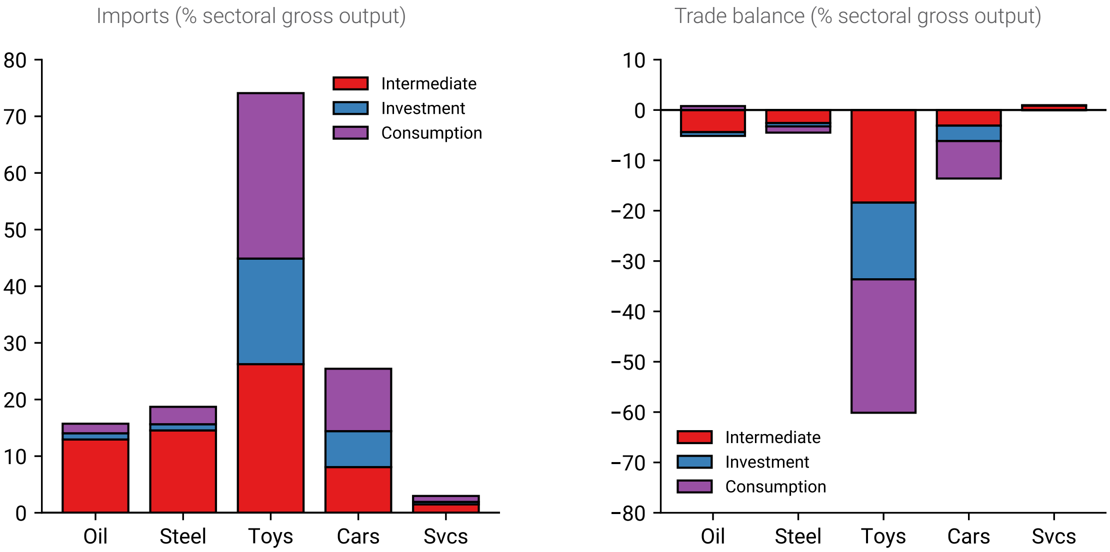
Downstream: intermediate purchases (% gross output)
'If it gets more expensive, how much does it affect me?'



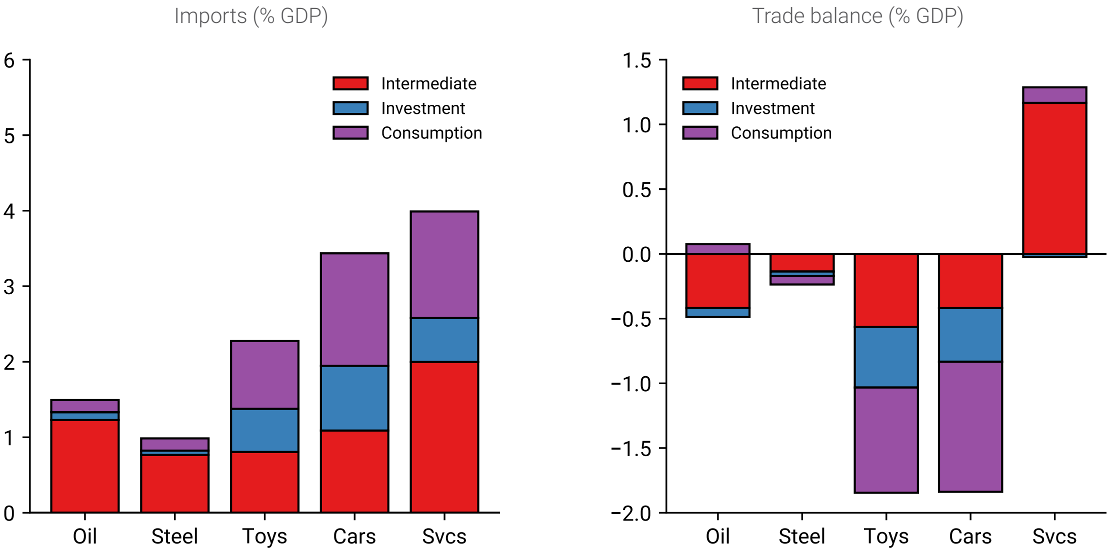
Upstream: intermediate sales (% gross output)
"If they stop buying, how much does it affect me?"



Sectoral exposure to trade

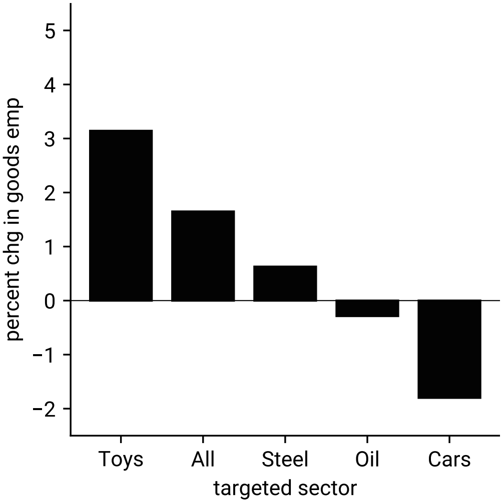


Macroeconomic importance of trade



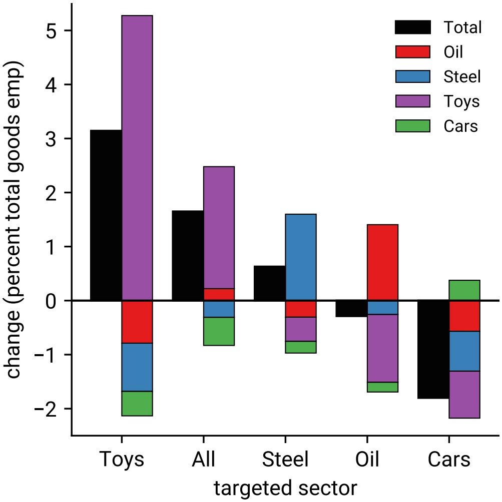
Experiments

Which tariffs would be most effective at reindustrialization?



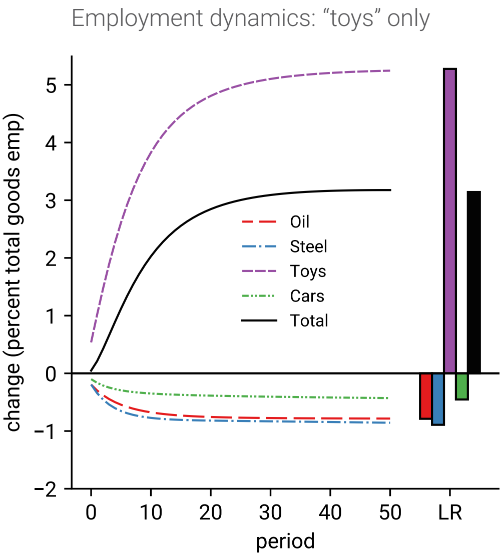
- Best: high-elasticity, downstream goods (“toys”)
- Worst: low-elasticity, downstream goods (“cars”)
- Broadest: Across-the-board (ATB) tariff on all goods. Still generates smaller employment gain than tariff on toys only.

Reindustrialization or reallocation?



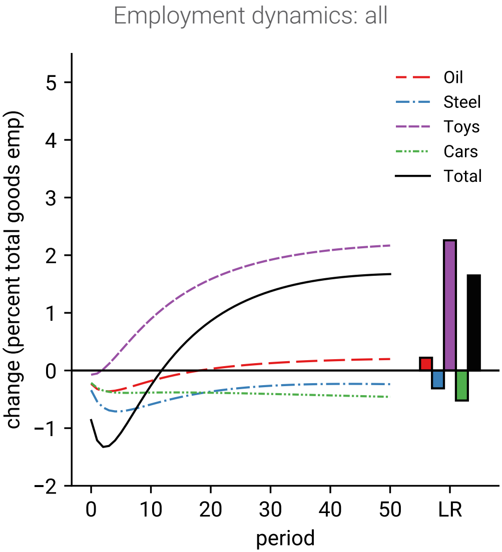
- Employment gains concentrated in one sector. All other sectors lose workers.
- ATB tariff hurts low-elasticity sectors. Barely helps "oil." Less growth in "toys" than under targeted tariff.
- Tariff on "cars" hurts all other sectors more than it helps protected sector

Short run vs. long run



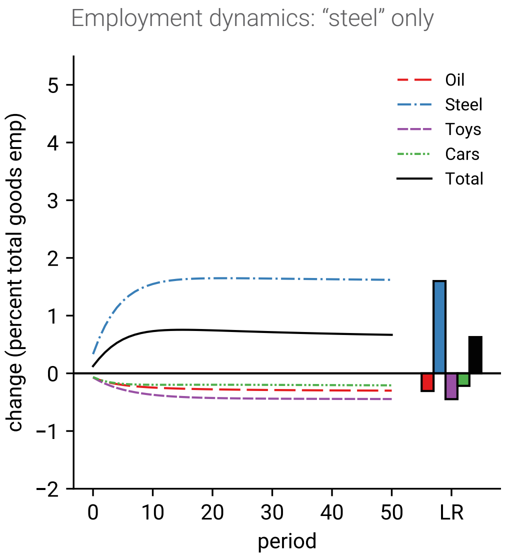
- "Toys:" Gradual net growth & reallocation

Short run vs. long run



- "Toys:" Gradual net growth & reallocation
- All: Overall employment falls in SR. "Toys" grows gradually, other sectors overshoot.

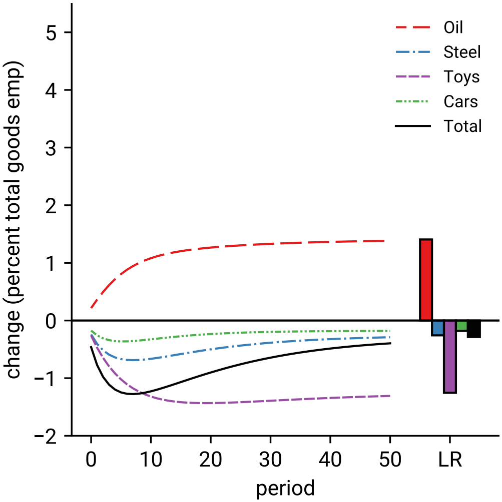
Short run vs. long run



- “Toys:” Gradual net growth & reallocation
- All: Overall employment falls in SR. “Toys” grows gradually, other sectors overshoot.
- “Steel:” Gradual growth & reallocation. Faster than “toys” tariff, but smaller effects.

Short run vs. long run

Employment dynamics: “oil” only



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- “Oil:” Pronounced overshooting in overall employment, steel & cars

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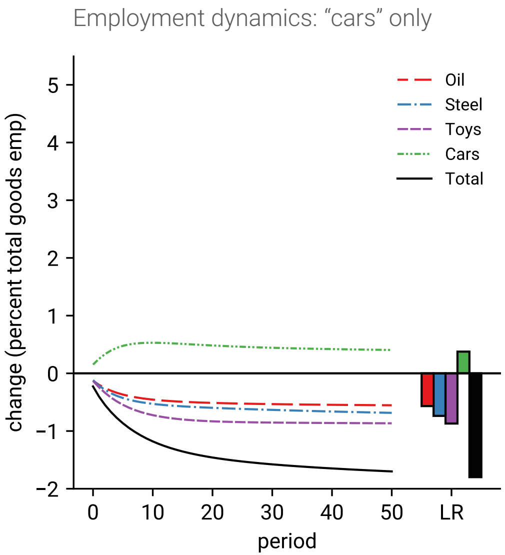

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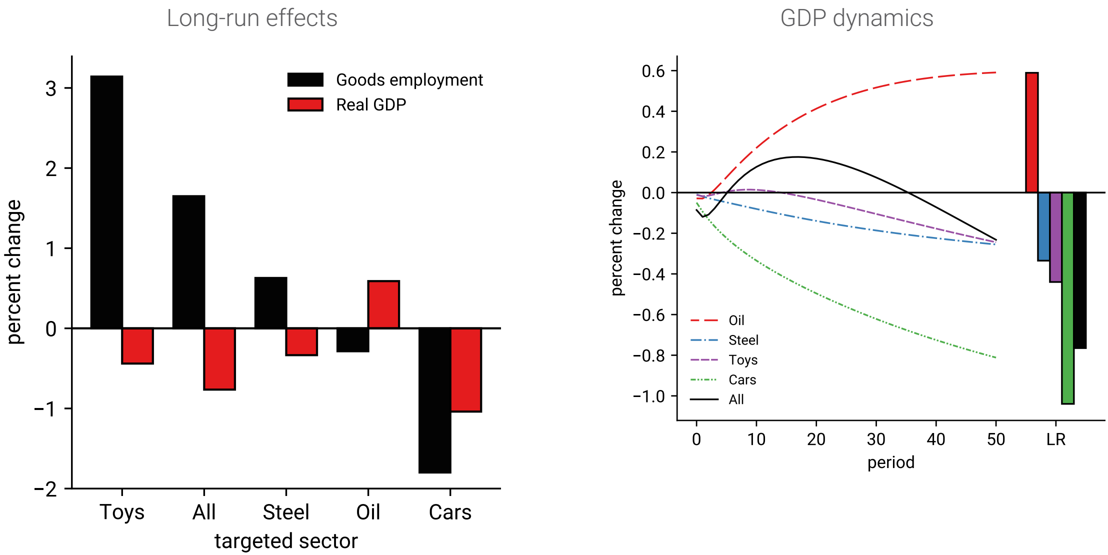
- “Oil:” Pronounced overshooting in overall employment, steel & cars
- “Cars:” Gradual net contraction & reallocation

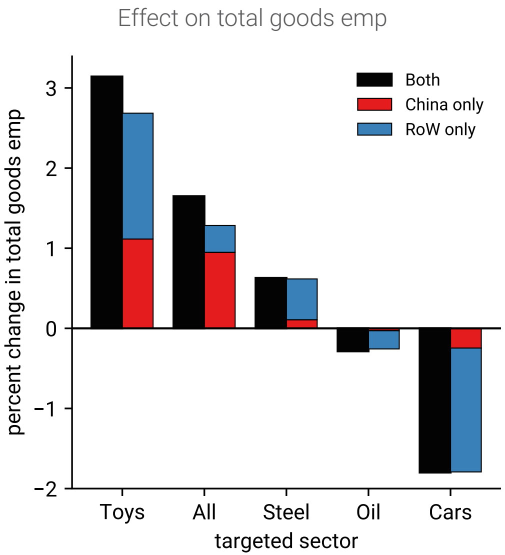
Other considerations

- What about macroeconomic consequences?
- Target all countries or just China?
- What if other countries retaliate?
- What if there were no adjustment frictions?
- What if the tariffs end after Trump's term in office?
- For simplicity, focus on across-the-board tariffs on all goods sectors

Goods employment vs. aggregate GDP

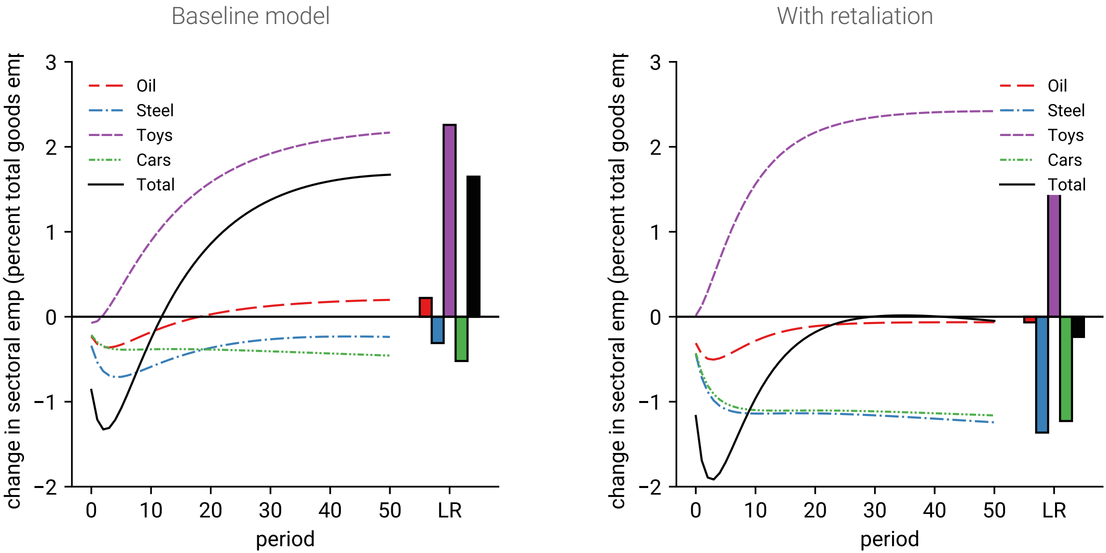


Target all countries or just China?

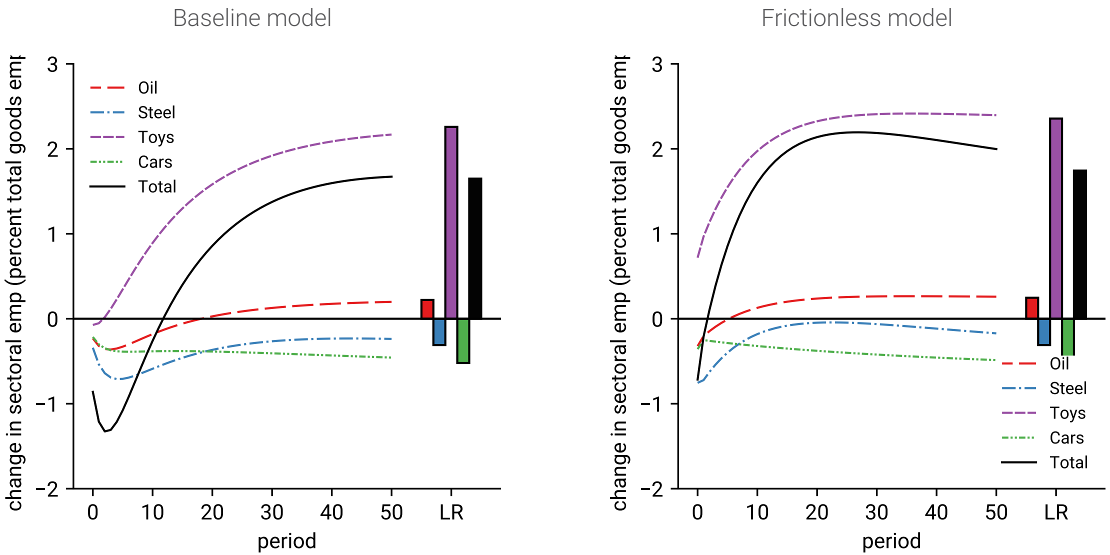


- Targeting only one country diverts trade to the other, reducing domestic production boost
- Especially in high-elasticity sectors where substituting between import sources is easy
  - → Most diversion in "toys", least in "cars" & "steel"
- Less diversion when one country is a minor supplier
  - → "Oil" has a high elasticity, but little potential for diversion because US buys barely any from China

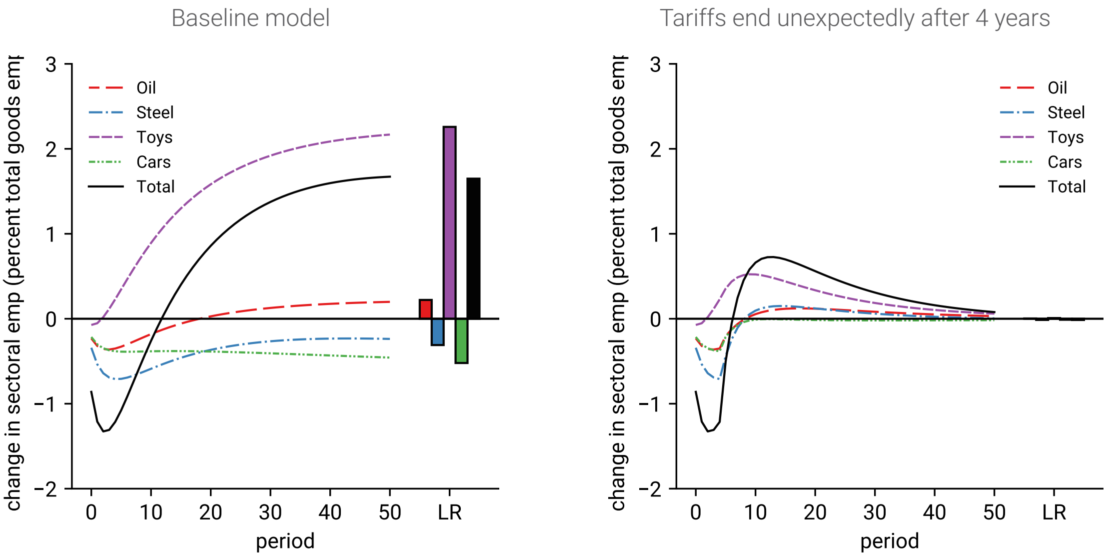
Effects of retaliation



Effects of adjustment frictions



Temporary vs. permanent



Conclusion

Summary

- Can tariffs increase mfg employment? Yes, but with some caveats.

- Long-run gain may require short-term pain
  - → Employment can fall for 10+ years before rising
  - → Supply-chain adjustment frictions play crucial role. W/o frictions, employment rises immediately.

- More reallocation across mfg industries than overall reindustrialization
  - → Broad tariffs only boost employment in consumer goods ("toys"). All other mfg industries shrink.
  - → Targeted tariffs can raise employment in industries with nat-sec concerns (cars, heavy machinery, etc.), but may shrink overall mfg sector

- Gains only possible if targeted countries don't retaliate
  - → With retaliation, no gain in long run and more pain in short run

Parting thoughts

- Positive analysis only. Don't draw normative conclusions.
- Manufacturing employment ! $=$ welfare
  $\rightarrow$ Welfare impact depends on what revenues are used for
  $\rightarrow$ Consumption can rise in LR with lump-sum tariffs even though output falls
  $\rightarrow$ But transition also matters! Next paper: optimal tariffs w/ vs. w/o supply-chain frictions.
- Hard to model and quantify nat-sec concerns
  $\rightarrow$ Maybe gov't is willing to boost "cars" even if rest of mfg sector shrinks
- $TFP = F$(tariffs)?
  $\rightarrow$ Protectionism often justified by scale/learning externality. But Baumol effect would attenuate effect on employment in equilibrium (Kehoe et al. 2018).
  $\rightarrow$ But trade may also raise productivity (Atkeson-Burstein 2010). Could go other way!