Tariffs and Technological Hegemony

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Motivation

- Sharp turn toward trade protectionism by the United States
  - Hope that import tariffs will revive competitiveness of US firms and reduce the trade deficit (Miran, 2024)
  - Heated debate about macroeconomic implications for US and rest of the world (Obstfeld, 2025)
- Impact of tariffs on innovation and technological hegemony?
  - Rising importance of innovation-oriented firms for national output and international trade
  - Medium-run outlook (5/10 years horizon)

This paper

- Endogenous growth model of the global economy
  - High-tech clusters: innovation-oriented firms selling to global markets, geographically-localized knowledge spillovers (Silicon Valley's Big Tech, EU pharmaceutical industry,...)
  - Innovation inputs: scarce global supply and internationally mobile (skilled labor, venture capital,...)
- Countries compete for technological hegemony
  - Technological hegemon: earns technological rents by importing innovation inputs and exporting high-tech goods
  - Technological rents: social return to innovation $>$ cost of innovation inputs $=$ private return to innovation

Preview of the results

- Import tariffs on foreign high-tech goods
  - Foreign high-tech firms: lower profits $\rightarrow$ less innovation
  - Home high-tech firms: increase innovation $\rightarrow$ higher profits
- Trade-off: efficiency losses vs. technological rents
  - Lower imports reduce productivity and output (short run), but higher innovation boosts high-tech profits (medium run)
  - Taxing imports of high-tech goods may lead to welfare gains, at the expenses of larger welfare losses in rest of the world
- Tariffs may backfire even for the country imposing them
  - Retaliation may lead to full-blown trade wars
  - Taxing imports of innovation inputs depresses innovation and welfare

Sketch of the model: households

- Two countries: home (h) and foreign (f)
- Representative household in country i with expected lifetime utility

$$\sum_{t=0}^{\infty} \beta^t C_{i,t}$$

- One unit of labor supplied inelastically, own all domestic firms

$$C_{i,t} + \frac{B_{i,t+1}}{R_t} = W_{i,t} + B_{i,t} + \Pi_{i,t}$$

- Linear utility from consumption
  - Optimal saving implies that $R_t = 1/\beta$
  - Welfare determined by present value of households' income

Firms and production

- Final good produced combining labor and high-tech goods

$$Y_{i,t} = (ZL_{i,t})^{1-\alpha} \int_0^2 \left(A_t^j\right)^{1-\alpha} \left(x_{i,t}^j\right)^{\alpha} dj$$

- High-tech firms $j \in [0,1]$ located in the home country, high-tech firms $j \in [1,2]$ in the foreign country. Constant tariff τ_i on imports of high-tech goods

$$p_{i,t}^j = \begin{cases} \frac{1}{\alpha} & \text{if good } j \text{ is sold domestically} \\ \frac{1}{\alpha(1-\tau_{-i})} & \text{if good } j \text{ is exported} \end{cases}$$

- Profits earned by high-tech firm j located in country i

$$\varpi A_t^j \left(1 + \xi_{-i}\right)$$

where $\xi_i \equiv (1-\tau_i)^{\frac{1}{1-\alpha}} \leq 1$ is a measure of openness of country i

The innovation process

- High-tech firms invest to increase the quality of their products

$$A_{t+1}^{j} = \rho A_t^{j} + A_t^{*} I_t^{j}$$

- Each household endowed with $\bar{I}$ units of innovation good

$$I_{h,t} + I_{f,t} = 2\bar{I}$$

- Local knowledge spillovers: each firm has survival probability η, technology of dying firm taken over by new domestic firm

$$\frac{P_t^I}{A_t^*} \geq \sum_{\zeta=1}^{+\infty} \frac{\eta^{\zeta} \rho^{\zeta-1}}{R^{\zeta}} \varpi \left(1 + \xi_{-i}\right), \qquad I_t^j \geq 0,$$

- Tariff depresses return to innovation and demand for innovation goods by firms in the rest of the world

Static impact of tariffs on GDP

- $A_{i,t}$ = average quality of high-tech goods produced by country i
- GDP in country i given by

$$\underbrace{(1-\varpi)\left(A_{i,t}+\frac{\xi_i^{\alpha}-\alpha\xi_i}{1-\alpha}A_{-i,t}\right)}_{\text{labor income}}+\underbrace{\varpi\left(1+\xi_{-i}\right)A_{i,t}}_{\text{high-tech profits}}+\underbrace{P_t^I\bar{I}}_{\text{in. good}}$$

- Higher tariffs on imports of high-tech goods ($\downarrow \xi_i$)
  - Lower labor productivity and labor income (net of tariff revenue)
- Higher tariffs imposed by r.o.w. ($\downarrow \xi_{-i}$)
  - Lower high-tech profits

Import tariffs and innovation

- Home country imposes a tariff ($\xi_h < 1$), foreign country keeps free trade ($\xi_f = 1$)
- Lower return to innovation for foreign high-tech firms

$$p_t^I = \underbrace{2\frac{\varpi\eta}{R-\eta\rho}}_{\text{return to inn. home firms}} > \underbrace{(1+\xi_h)\frac{\varpi\eta}{R-\eta\rho}}_{\text{return to inn. foreign firms}}$$

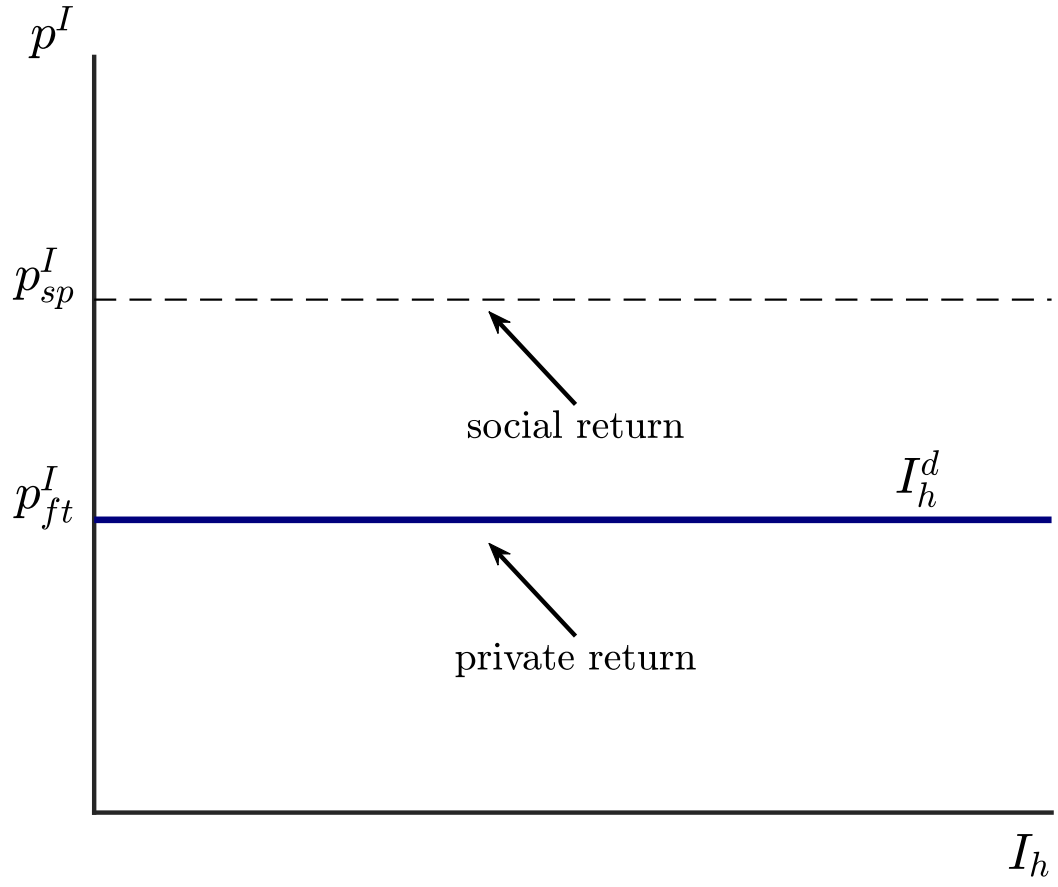
- Innovation inputs flow toward home economy

$$I_{h,t} = 2\bar{I}, \qquad I_{f,t} = 0$$

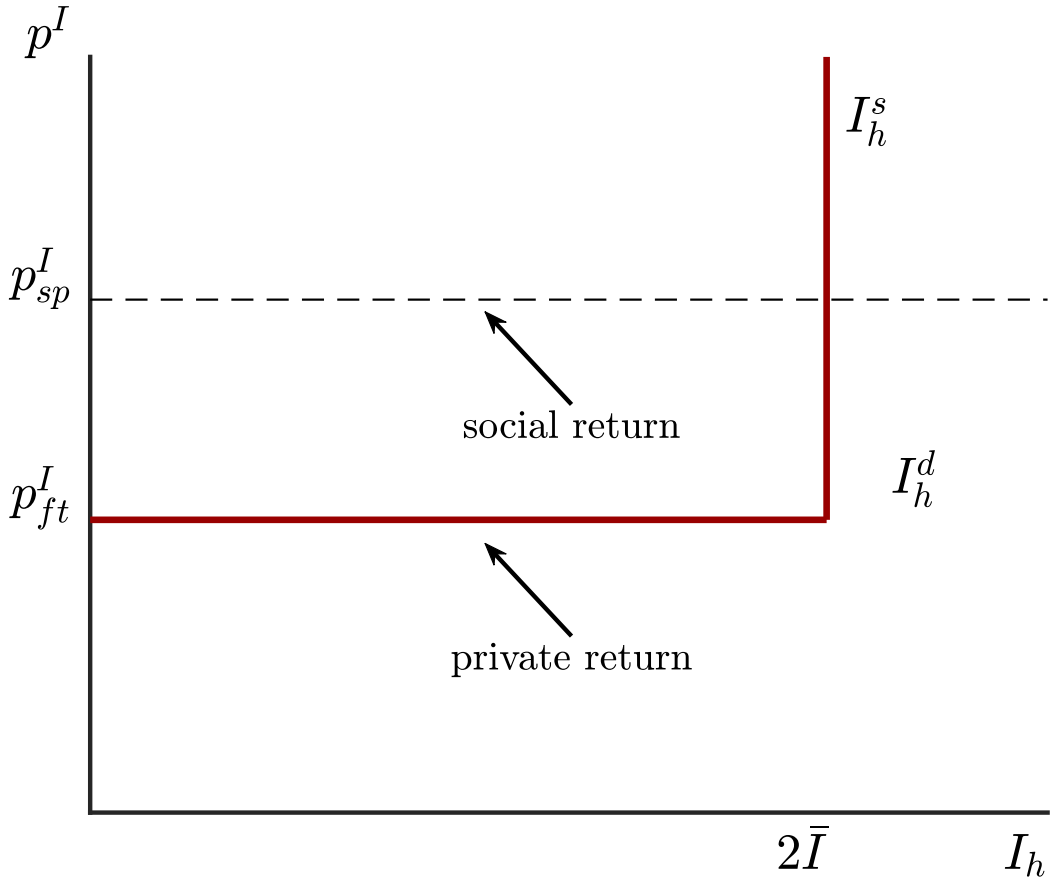
- Home country becomes the technological hegemon

$$\Delta\text{tech. rents} = \Delta I_h(p_{sp}^I - p^I) = (2\bar{I} - I_{h,ft})\frac{R(1-\eta)}{(R-\rho)(R-\rho\eta)}$$

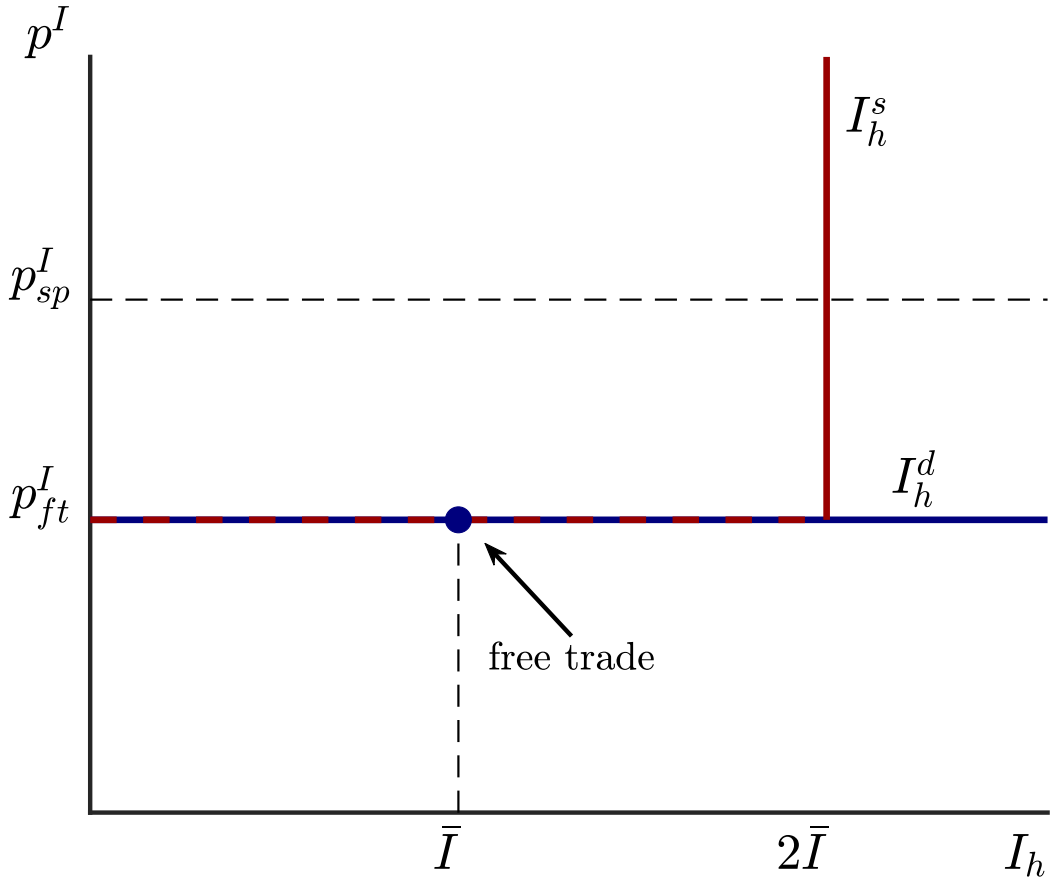
Demand for innovation inputs by home country



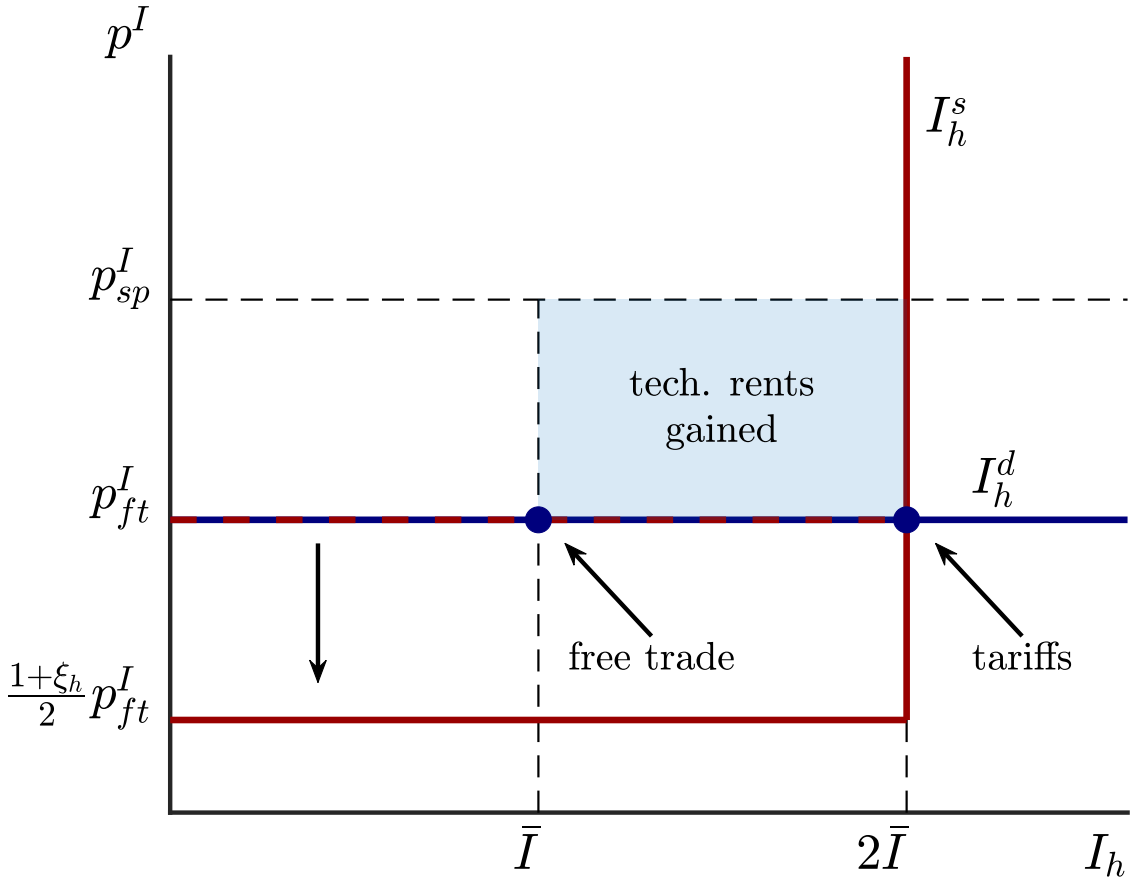
Supply of innovation inputs from foreign country



Equilibrium under free trade



Home country taxes imports of high-tech goods



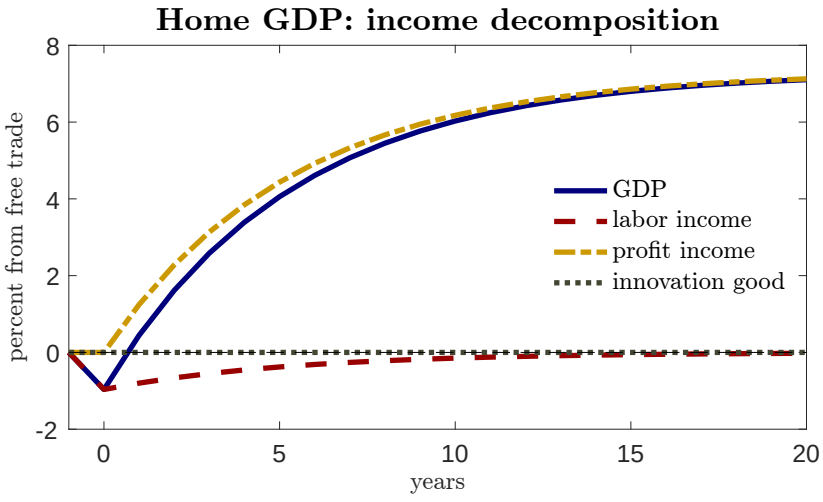
Unilateral import tariffs on high-tech goods

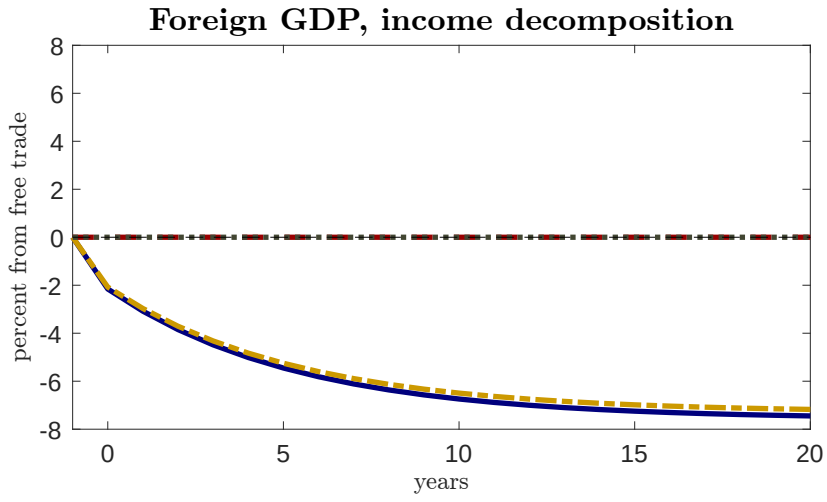
$$GDP_{h,t} = \underbrace{(1-\varpi)\left(A_{h,t} + \frac{\xi_h^{\alpha} - \alpha\xi_h}{1-\alpha} A_{f,t}\right)}_{\text{labor income}} + \underbrace{\varpi 2 A_{h,t}}_{\text{high-tech profits}} + \underbrace{P_t^I \bar{I}}_{\text{in. good}}$$

- Lower imports of foreign high-tech goods $\rightarrow$ efficiency losses
  - $\downarrow \xi_h$: drop in labor productivity and output (short run)
- Higher innovation $\rightarrow$ rise in quality of domestic high-tech goods
  - $\uparrow A_{h,t}$: higher technological rents and national income (medium run)
- Ambiguous impact on national welfare

$$\frac{R}{R-\rho}\left(2\varpi\left(\frac{R-\eta g}{R-\eta\rho}\frac{R-\rho}{R-g} - 1\right) - (1-\varpi)\left(1 - \frac{\xi_h^{\alpha} - \alpha\xi_h}{1-\alpha}\right)\right) a_{f,0}$$

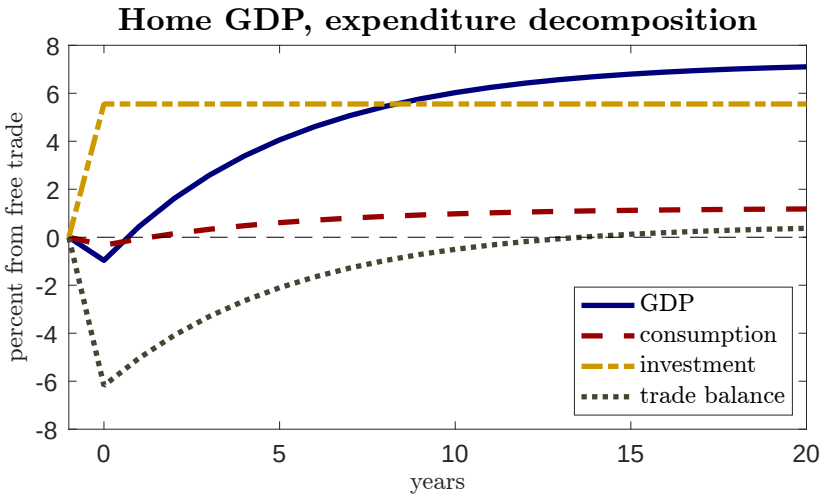
Unilateral import tariffs on high-tech goods

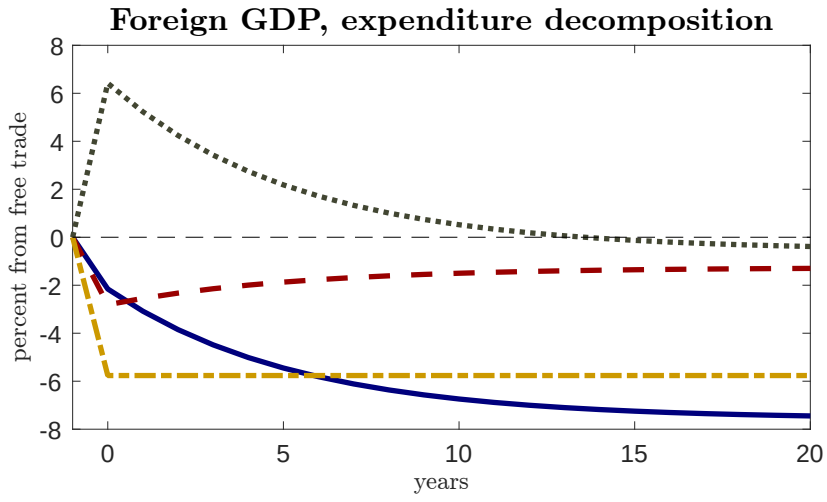




- Foreign country: gradual loss of high-tech profits and national income
- Global output drops on impact, but then recovers its initial value

Unilateral import tariffs on high-tech goods



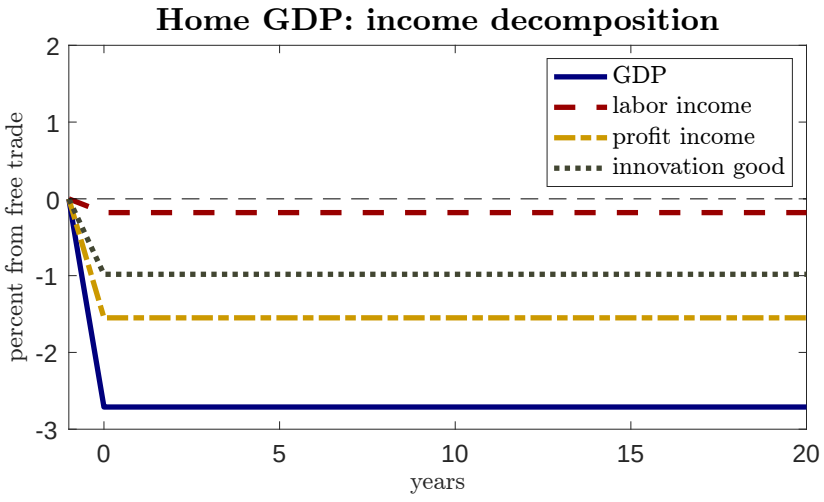


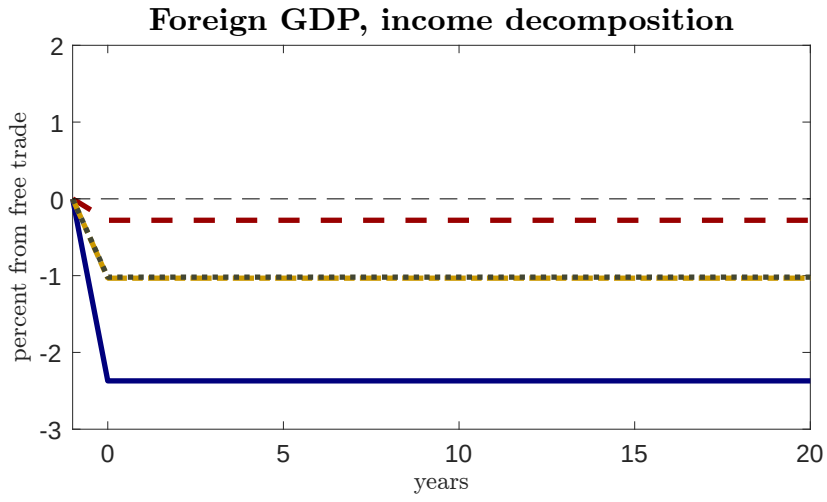
- Home country: consumption and investment boom $\rightarrow$ trade deficits
- Home country gains, foreign country loses, global welfare drops

Retaliation and trade wars

- We model trade wars as a Stackelberg game
  - Home country moves first and commits to a trade policy $\xi_h < 1$
  - Foreign country chooses whether to retaliate ($\xi_f < 1$) or not ($\xi_f = 1$)
- Both countries maximize their citizens' welfare (uncooperative eq.)
  - Trade off between productivity losses vs. higher technological rents
- Outcome depends on importance of technological rents
  - Strategic trade war: home country imposes a high tariff to prevent retaliation
  - Full-blown trade war: both countries impose high tariffs to protect domestic high-tech sector
- Lack of cooperation leads to global welfare losses

A full-blown trade war



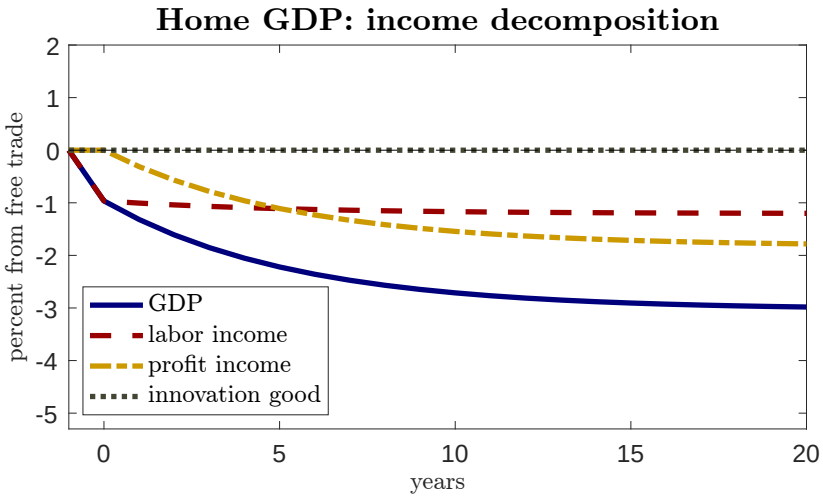


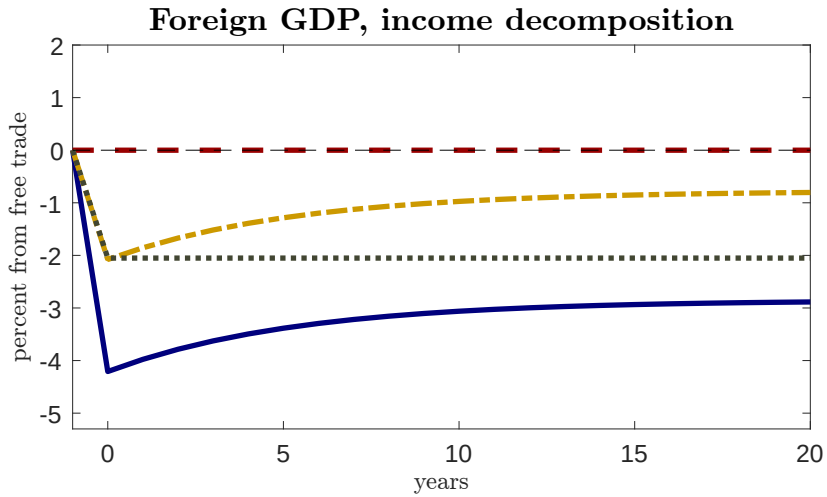
- Happens when technological rents have a large impact on welfare
- Global output drops permanently, every country loses

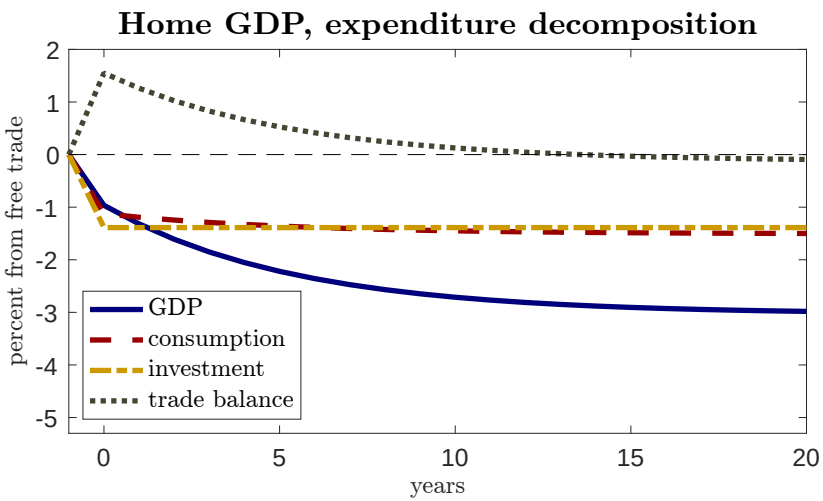
Tariffs on innovation goods

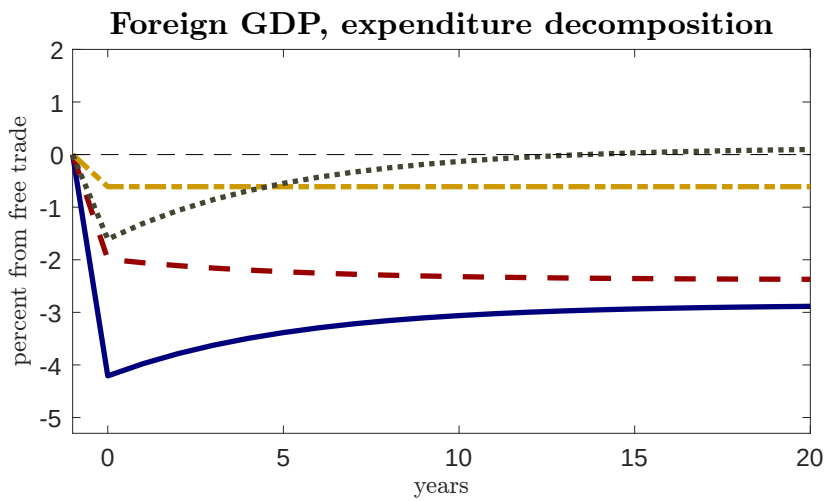
- What if the government taxes imports of innovation goods?
  - May be hard to discriminate between high-tech goods and innovation inputs (e.g. computers)
- Suppose that home government puts a tariff on high-tech and innovation goods
  - This trade policy fails to promote the domestic high-tech sector
  - It may even trigger outflows of innovation good, eroding the country's technological leadership
  - Every country suffers welfare losses

Tariffs on high-tech & innovation goods









- Home trade balance improves, but this is a sign of economic weakness

Conclusion

- Countries compete for technological hegemony
  - Exporting high-tech goods and importing innovation inputs gives technological rents
- Tariffs may be used to steal tech. rents from rest of the world
  - Hurt foreign high-tech firms to reduce their investments in innovation
  - Taxing imports of high-tech goods may lead to welfare gains, at the expenses of larger welfare losses in rest of the world
- Tariffs may backfire even for the country imposing them
  - Retaliation may lead to full-blown trade wars
  - Taxing imports of innovation inputs depresses innovation and welfare