Sabotage as Industrial Policy

Jin Liu (Princeton University)
Martin Rotemberg (NYU)
Sharon Traiberman (NYU & NBER)

New Policies, Same Old Terms of Trade

> *...[T]echnology export controls can be more than just a preventative tool. If implemented in a way that is robust, durable, and comprehensive, they can be a new strategic asset in the U.S. and allied toolkit to impose costs on adversaries, and even over time degrade their battlefield capabilities.*
>
> — Jake Sullivan

- Non-economic interests (e.g., National Security) are being run through trade policy
- **We develop trade tools to understand the economic consequences of these actions.**

Policy Evaluation

- There is a policy debate about whether or not foreign productivity has been disrupted (Crosignani et al., 2024; Hsieh, 2024)

- **This Paper:** For real income, what matters is not whether the program "works" but whether the destruction is comprehensive
  - Classic debate: are foreign productivity *improvements* good (Hicks, 1953; Jones & Ruffin, 2008) or bad (Gomory & Baumol, 2001; Samuelson, 2004) for real income?
  - Contrast with tariffs: for a large open economy, small tariffs are better than no tariffs

Set-up (Dornbusch et al., 1977)

- **Environment:**
  - 2 countries: Home and Foreign (asterisked)
  - Continuum of goods indexed by i
  - Competitive firms/ mobile workers
- **Demand:**
  - Cobb-Douglas with expenditure share: β_{it}
- **Supply:**
  - Unit labor requirements: a_i
- **Trade Policy:**
  - We do not consider tariffs
  - Planner can engage in targeted sabotage of Foreign TFP

Preferences

- Utility is Cobb-Douglas over goods:

$$U = \int_0^1 \beta_i \log(c_i)$$

- Implies constant expenditure shares:

$$p_i c_i = \beta_i w L$$

Technology

- Labor is the only factor of production
- Linear unit input requirements: a_i
- Define *comparative advantage schedule* to be,

$$A(i) = a_i^* / a_i$$

  - A large $\Rightarrow$ Foreign productivity is low relative to Home's
  - Rank goods so that $A(i)$ is decreasing

Consumers source from the lowest cost producer:

$$m_i = \mathbf{1}\left(w^* a_i^* \leq w a_i\right)$$

- No additional trade costs (relaxed in quantification)
- Specialization is *complete*
  - All adjustments occur on the extensive margin
  - We relax this for quantification

1. Optimal sourcing: there is a cutoff good that determines production,

$$wa_\iota = w^* a_\iota^* \Rightarrow \underbrace{\frac{a_\iota^*}{a_\iota}}_{A(\iota)} = \underbrace{\frac{w}{w^*}}_{\equiv\omega}$$

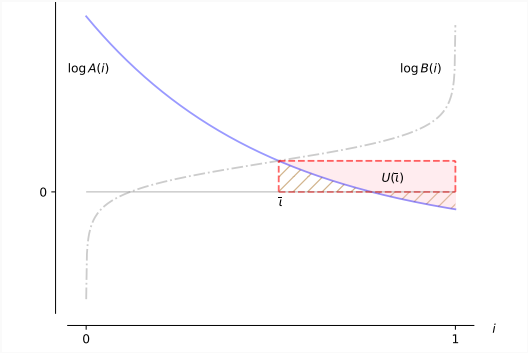
2. Trade Balance:

$$wL \times \int_\iota^1 \beta_i di = w^* L^* \times \int_0^\iota \beta_i di \Rightarrow \omega = \underbrace{\frac{L^* \times \int_0^\iota \beta_i di}{L \times \int_\iota^1 \beta_i di}}_{\equiv B(\iota)}$$

$\Rightarrow$ **Equilibrium is when** $A(\iota) = B(\iota)$

Graphical Illustration of Welfare Gains

Figure 1: Equilibrium and Welfare Gains

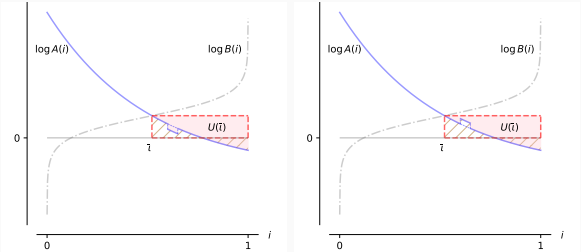


- Equilibrium is where $\log A = \log B$
- Rectangle between 0 and ω is the *Terms of Trade Effect*: change in relative wages
- Area under $\log A$ is the *Price Index Effect*: change in prices due to specialization
- Difference is the gains from trade

Introducing Sabotage

Figure 2: Technology Transfer v Minor Sabotage

(a) Case I: Improvement **(b)** Case II: Decline

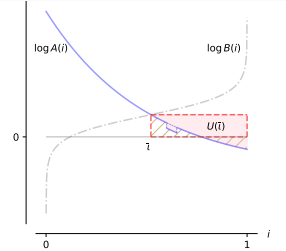


- **Sabotage:** For a small measure of goods, ε, the planner can shift Foreign productivity
- We do *not* consider optimal location of sabotage, and we only consider "small" sabotage
  - Approximates targeted policies on specific goods—e.g., export controls on chips

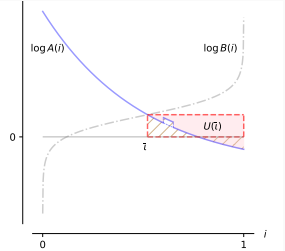
Introducing Sabotage

Figure 2: Technology Transfer v Minor Sabotage

(a) Case I: Improvement



(b) Case II: Decline

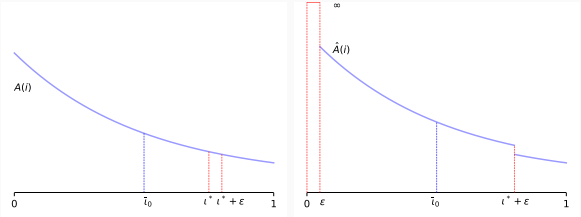


- **Sabotage:** For a small measure of goods, ε, the planner can shift Foreign productivity
- For small changes, sabotage is *bad*
- Compare to increases in productivity—which only lowers prices
- Key: for small changes, production patterns do not change

Comprehensive Sabotage

Figure 3: Comprehensive Sabotage

(a) Baseline **(b)** Sabotage

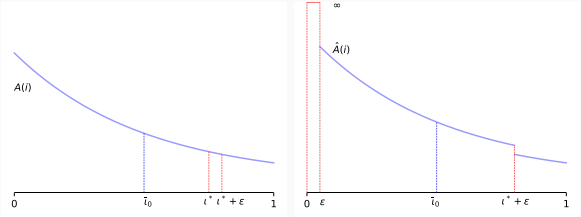


- If the reduction in foreign productivity is sufficiently large (e.g., $a^* \to \infty$) then production shifts

Comprehensive Sabotage

Figure 3: Comprehensive Sabotage

(a) Baseline **(b)** Sabotage

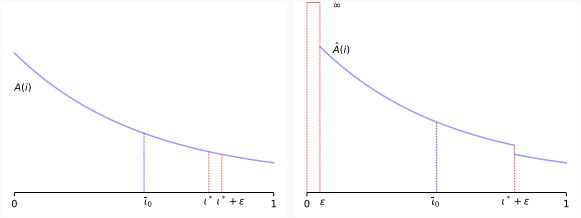


- If the reduction in foreign productivity is sufficiently large (e.g., $a^* \to \infty$) then production shifts
- $[\iota^*, \iota^* + \varepsilon)$ moves Home
- But some marginal goods shift to Foreign

Comprehensive Sabotage

Figure 3: Comprehensive Sabotage

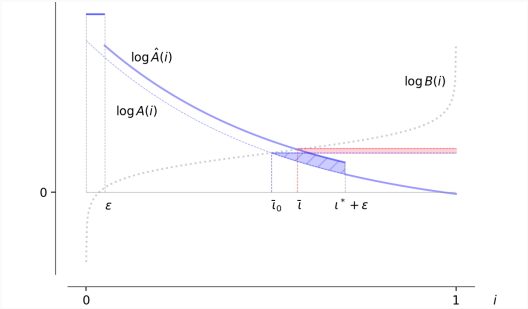
(a) Baseline **(b)** Sabotage



- If the reduction in foreign productivity is sufficiently large (e.g., $a^* \to \infty$) then production shifts
- $[\iota^*, \iota^* + \varepsilon)$ moves Home
- But some marginal goods shift to Foreign
- What happens to income?

Welfare Gains of Comprehensive Sabotage

Figure 4: Effects of Comprehensive Sabotage



- *Terms of Trade*: Red trapezoid is the **gain** in the relative wage coming from Home's increase in relative TFP
- *Price Effect*: Blue area is the **loss** in efficiency due to reallocating goods out of line with initial comparative advantage

$$\Delta U = \textbf{ToT Gain} - \textbf{Efficiency Cost}$$

- For small ε we can calculate these terms to a first order analytically
- In principle these depend on the shape of A and B jointly at ι_0, but it turns out that the first order terms have simple empirical counterparts

The Welfare Equation

$$\text{ToT Gain} = \underbrace{\epsilon}_{\text{Extent of Sabotage}} \times \underbrace{\frac{1}{1+\theta}\frac{1}{1-\Phi_H}}_{\text{Sufficient Statistic}}.$$

- The ToT Gain only depends on the size of sabotage and two sufficient statistics:
  1. The trade elasticity: θ
  2. Home's import share: Φ_H
- Why? Because the ToT Gain only depends on the movement near the cutoff, and not on the identity of the sabotaged good

The Welfare Equation

$$\text{Efficiency Cost} = \log \frac{A(\bar{\iota}_0)}{A(\iota^*)}$$

- Efficiency cost is summarized by difference between A at initial cutoff, $\bar{\iota}_0$, and at sabotaged goods, ι^*
- Captures change in prices from moving ι^* to Home and $\bar{\iota}_0$ to Foreign

The Welfare Equation

$$\Delta U^S \approx \beta_{\iota^*}\epsilon \times \left[\underbrace{\Delta \frac{\frac{1-s_H}{s_H}\frac{m^*_{\iota^*}(1-m^*_{\iota^*})}{m_{\iota^*}(1-m_{\iota^*})-\Delta(1-m_{\iota^*}-m^*_{\iota^*})}+1}{1+\theta(1-\Phi_H)+\theta(1-\Phi_H\frac{s_H}{1-s_H})}}_{\text{ToT Gain}} - \underbrace{\frac{1}{\sigma_{\iota^*}-1}\log\left(1+\frac{\Delta}{1-m_{\iota^*}}\right)}_{\text{Efficiency Cost}} \right]$$

- In the paper we expand our formula for three realistic features of the data:
  1. Variable expenditure shares $\Rightarrow$ need to know expenditure share on sabotaged goods, β_{ι^*}
  2. Trade Costs $\Rightarrow$ need to know Home's share of global output, s_H
  3. Incomplete specialization $\Rightarrow$ need to know the EoS, σ_{ι^*}, and good-level trade shares, $m_{\iota^*}, m^*_{\iota^*}$
- Δ is the fraction of production sent back home with incomplete specialization

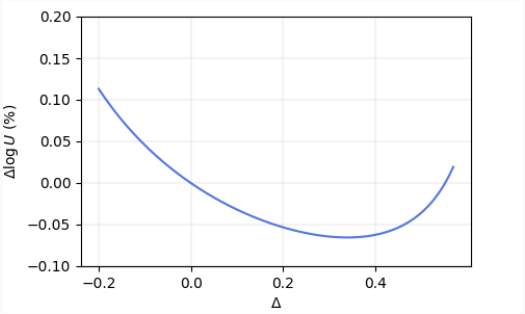
The Welfare Equation

$$\Delta U^S \approx \beta_{\iota^*}\epsilon \times \left[\underbrace{\Delta \frac{\frac{1-s_H}{s_H}\frac{m^*_{\iota^*}(1-m^*_{\iota^*})}{m_{\iota^*}(1-m_{\iota^*})-\Delta(1-m_{\iota^*}-m^*_{\iota^*})}+1}{1+\theta(1-\Phi_H)+\theta(1-\Phi_H\frac{s_H}{1-s_H})}}_{\text{ToT Gain}} - \underbrace{\frac{1}{\sigma_{\iota^*}-1}\log\left(1+\frac{\Delta}{1-m_{\iota^*}}\right)}_{\text{Efficiency Cost}} \right]$$

- Intuition for each term:
  - The ToT Gain depends only on aggregate sufficient statistics that describe the share of A and B near $\bar{\iota}_0$
  - The efficiency cost is measured by initial exports from Foreign and how many exports are reshored

Gains from Sabotaging Foreign Chips

Figure 5: Gains From Sabotaging Foreign Chips



- We calibrate based on standard measures of θ, s_H, Φ_H, and paper contains discussion of how we calibrate chips sector
- Sabotage is modeled as Δ: the shift in Home's imports back to Home
- Negative Δ is technology transfer—raises welfare
- Small sabotage *lowers* real income
- Comprehensive sabotage *raises* real income

Conclusion

1. Showed that non-standard trade policy can readily be adapted to standard trade models
2. The DFS framework is tractable and can accomodate several “realistic" features of the data: trade costs, variable demands, and intra-industry trade
3. Adding this realism does not come at the expense of empirical value and tractability: real income effects of sabotage can be calculated from readily available data on expenditures and two parameters: the trade elasticity and the EoS on Foreign and Domestic varieties of sabotaged goods
4. Plenty of room for the future: modeling the exact mechanisms of sabotage, adding “allied" trading partners, dynamics and economies of scale