Sabotage as Industrial Policy

Jin Liu
NYU

Martin Rotemberg
NYU

Sharon Traiberman
NYU & NBER

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Abstract

We characterize sabotage, exemplified by recent U.S. policies concerning China's semiconductor industry, as trade policy. For some (but not all) goods, completely destroying foreigners' productivity increases domestic real income by shifting the location of production and improving the terms of trade. The gross benefit of sabotage can be summarized by a few sufficient statistics: trade and demand elasticities and import and production shares. The cost of sabotage is determined by countries' relative unit labor costs for the sabotaged goods. We find important non-monotinicities: for semiconductors, partially sabotaging foreign production would lower US real income, while comprehensive sabotage would raise it.

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I Introduction

By the summer of 2022, China had a thriving and growing semi-conductor industry, with rapidly increasing exports (Thomas, 2021). That fall, the United States undermined Chinese technology capabilities by restricting China's access to essential equipment and staff, and the US has continued to expand on those efforts into 2024 (Bloomberg News, 2022; Hawkins, Koc and Furukawa, 2024). While these actions have been partly motivated by national defense interests, the Biden administration also explicitly described the actions as an industrial policy: to "maintain as large of a lead as possible" in these technologies (Sullivan, 2022). In particular, the administration noted that the destruction of foreign capacity must be "comprehensive," and that these measures represented a "new strategic asset."

In this paper, we study the economic implications of sabotage—by which we mean measures designed to lower foreign productivity. For example, the strategy underlying many of the provisions of the CHIPS Act were to lower foreign semiconductor productivity by limiting the expansion of semiconductor manufacturing and research in what the administration called "foreign countries of concern." These actions included banning American firms from producing certain chips in China or exporting them to China (Becko and O'Connor, 2024).[1]

While the industrial policy motivation for sabotage may be mere rhetoric, it seemingly contradicts a long-standing understanding in economics that *foreign* productivity improvements in goods that the foreign country is already exporting must increase *domestic* welfare (Hicks, 1953; Matsuyama, 2000; Bhagwati, Panagariya and Srinivasan, 2002). Indeed, countries have often transferred technology abroad (Giorcelli, 2019; Li and Giorcelli, 2023), potentially raising both foreign and domestic welfare (Jones and Ruffin, 2008; Blalock and Gertler, 2008). We resolve this apparent contradiction by demonstrating, both theoretically

[1] In our paper we are interested in understanding the economic effects of sabotage, without explicitly modeling what specific actions affect foreign productivity, or their other normative implications. In practice, the policies that motivate our approach are those where a global hegemon uses diplomatic instruments (Clayton, Maggiori and Schreger, 2024*a*; Liu and Yang, 2024). Physical destruction could be another approach to cause industrial sabotage. For instance, the Russian government may be actively attacking factories in Europe (The Economist, 2024). However, acts of war are likely incompatible with maintaining broader ties.

and quantitatively, conditions under which seemingly contrasting policies—either lowering or raising foreign productivity for a given good—can both increase domestic real national income.

Our starting point is the standard Ricardian model of trade with two countries, Home and Foreign (Dornbusch, Fischer and Samuelson, 1977). There is one factor of production, labor, and a unit continuum of goods. For each good, we allow the Home planner to either raise or lower foreign productivity, corresponding to technology transfer and sabotage, respectively.[2] We show that there are goods for which *either* increases or (large) decreases in Foreign productivity can raise domestic real income.

The logic is as follows: improving Foreign productivity for goods that Foreign is already exporting *always* raises domestic real income, as it lowers the price index while leaving the terms of trade unaffected. Correspondingly, minor sabotage—which does not lower Foreign productivity enough to reshore production—*always* lowers real income, by raising prices without changing the terms of trade. Indeed, the consequences of changing foreign productivity are continuous around doing nothing.

However, there is a discontinuity around the initial relative wage. If, as the Biden administration intended, sabotage is "comprehensive" enough to render Foreign producers unable to compete on prices, then Home's real income can be improved, as the terms of trade gains can outweigh the loss to the global production possibility frontier.[3]

Dornbusch, Fischer and Samuelson (1977) models are typically difficult to map to data, as it is not straightforward to literally rank goods according to comparative advantage for one country relative to the rest of the world. Nevertheless, we show in our baseline model that the gains from a given amount of sabotage are fully captured by a handful of simple quantifiable parameters: the trade elasticity and import shares. Thus, the gains from sabotage can be

[2]For descriptive purposes, we refer to an increase in foreign productivity as a "technology transfer," regardless of initial differences in absolute advantages.

[3]We consider an active Home and a passive Foreign, abstracting from strategic considerations. From the perspective of Foreign, technology transfer on already-exported goods strictly raises Foreign real income, and sabotage always lowers it.

calculated without solving any counterfactuals, avoiding the need to specify productivity and demand. The losses are captured by the difference in unit costs for the sabotaged goods.

Having established that sabotage can improve domestic real income, we consider a natural follow-up: if and when sabotage is preferable to alternatives. We identify and characterize three regions in the comparative advantage space. For goods where comparative advantage differences are small, the productivity losses from sabotage are correspondingly small, and sabotage is preferable to technology transfer. For goods where comparative advantage differences are large, the productivity loss dominates and sabotage is worse than doing nothing at all. For goods in between, sabotage is better than nothing, but worse than technology transfer.

The size of the regions changes with the trade elasticity, which is determined by the *slope* of the comparative advantage schedule. A more elastic comparative advantage schedule magnifies both the gains and losses from sabotage. To parameterize the slope for comparative statics, we use a leading productivity distribution, Fréchet (Eaton and Kortum, 2002). Under Fréchet, we find that comprehensive sabotage becomes more attractive when trade is more elastic.

The baseline model is useful for demonstrating the relevant economic forces, but for quantification we extend the model to account for several important features of international trade. In particular, we allow for (a) unrestricted expenditure weights for all sectors, (b) intra-industry trade, with imperfect substitutability between Home and Foreign varieties, and (c) trade costs. Effectively, our quantitative approach adds a multi-sector Armington nest to a Dornbusch, Fischer and Samuelson (1977) model.

In this general environment, we find that the effects of sabotage can be measured with readily available summary statistics (import shares and production shares) and two commonly estimated parameters (the trade elasticity and the within-sector elasticity of substitution).[4] One contribution of our approach is providing a straightforward and transparent

[4]For studies measuring trade elasticities see, for instance, Baier and Bergstrand (2001); Head and Ries

quantification without relying on strong functional form assumptions on supply and demand, as is commonly done for research in the Eaton and Kortum (2002) tradition.[5]

Using the World Input Output Database (WIOD), we find that, across a range of two-digit tradable sectors, comprehensive sabotage would raise domestic real incomes, and the gains are specifically positive in the broad electronics sector. We then turn to the disaggregated semiconductor sector and find non-monotinicities to be quantitatively important. Partially sabotaging foreign productivity would lead to a decrease in U.S. real income, whereas fully sabotaging (or improving) it would result in an increase.

We contribute to a recent literature that has re-emphasized the importance of geopolitics for trade policy (Hirschman, 1945; Kleinman, Liu and Redding, 2023; Clayton, Maggiori and Schreger, 2024*a*), focusing on sanctions (Felbermayr et al., 2020; Morgan, Syropoulos and Yotov, 2023; Becko, 2024; De Souza et al., 2024; Javorcik et al., 2024; Johnson, Rachel and Wolfram, 2024) and the pandemic (Leibovici and Santacreu, 2021; Antràs, Redding and Rossi-Hansberg, 2023; Grossman, Helpman and Lhuillier, 2023; Traiberman and Rotemberg, 2023).[6] We complement this literature on the role of trade instruments for accomplishing non-trade-related objectives by studying the "new" policy tool of sabotage, which is at least partially motivated by non-trade-related objectives but has key implicates for trade.

Sabotage has implications that echo those of tariffs and subsidies, but our approach is distinct from that literature. Studies of tariffs and subsidies—and most research on trade policy—typically take productivity as given (Wilson, 1980; Opp, 2010; Costinot et al., 2015).[7]

Indeed, trade policy *regulation* has also not yet considered the implications of policies

(2001); Eaton and Kortum (2002); Simonovska and Waugh (2014) and Boehm, Levchenko and Pandalai-Nayar (2023). For studies measuring elasticities of of substitution see, for instance, Broda and Weinstein (2006); Gervais and Jensen (2019); Jones et al. (2023); Errico and Lashkari (2024) and Grant and Soderbery (2024).

[5] One notable exception is Adão, Costinot and Donaldson (2017).

[6] An older literature studies the national defense implications of industrial policy (Mayer, 1977; Arad and Hillman, 1979), see also Thoenig (2024).

[7] Our setting is static, abstracting from dynamic forces such as learning, although semiconductors are a natural sector where learning is an important economic force (Irwin and Klenow, 1994; Goldberg et al., 2024). Learning-by-doing would be a natural additional reason to sabotage a sector, just as it is a motivation for imposing tariffs (Bartelme et al., 2024).

that change foreign unit costs. The WTO has detailed rules on tariffs and subsidies, and in practice, partially due to those rules, tariffs are relatively low and export subsidies are small (relative to their model-implied optimal benchmarks, as in Costinot et al. 2015). Sabotage as a new tool of industrial policy may offer a way to promote production without running afoul of global trade rules. Juhász et al. (2023) discuss more broadly various tools that countries use to accomplish industrial policy goals beyond tariffs.[8]

A classic question in international trade is the effects of productivity improvements both domestically and abroad (Johnson, 1955; Jones, 1979), though the literature has not studied policy. Gomory and Baumol (2001) and Samuelson (2004) highlight the potential for domestic welfare losses following foreign productivity increases for goods that foreigners previously imported. In this sense, the benefits of sabotage follow naturally: if increasing foreign productivity by enough to lose comparative advantage can hurt domestic welfare, then reversing that process should correspondingly raise welfare. In addition to providing a framework for evaluating relevant policies, our primary contribution to this literature is therefore showing that both technology transfer *and* sabotage can raise domestic real income when targeted at the same goods, characterizing the set of goods for which sabotage may be useful, providing comparative statics with respect to the trade elasticity, and quantifying the effects on real income.

II Model

II.A Environment

We consider the standard Ricardian environment of Dornbusch, Fischer and Samuelson (1977). There are two countries, Home and Foreign, that can produce a continuum of goods indexed by $i \in [0, 1]$. Foreign variables are denoted by an asterisk. Home and Foreign are

[8]The CHIPS Act contrasts with the 1986 US-Japan semiconductor trade agreement, where Japan agreed to end the "dumping" of semiconductors abroad and opened up its domestic market to imports (Irwin, 1996), but Japanese productivity was not affected.

each endowed with a constant and inelastically supplied pool of labor, L and L^*. We define their ratio as $\ell \equiv L^*/L$.

II.B Production Technology

Labor is the only input. Both countries have a linear production technology with constant returns to scale:

$$y_i = l_i/a_i, \; y_i^* = l_i^*/a_i^*,$$

where a_i and a_i^* are the unit labor requirements for producing good i, and l_i and l_i^* are the amount of labor that Home and Foreign, respectively, use in the production of good i.

We define $A(i) = a_i^*/a_i$ as Home's comparative advantage in producing good i. Goods are ordered so that the comparative advantage schedule, A, is decreasing in i. For simplicity, we assume that A is smooth and strictly decreasing.

The policy instruments available to the domestic planner are ones that affect a_i^*. In this section, we describe the market equilibrium for *any* a_i and a_i^*. As a result, this captures the equilibria both in the absence of any policy as well as after sabotage and/or technology transfer.

II.C Preferences

Representative consumer-workers for both countries have the same preferences, using a Cobb-Douglas utility function to aggregate goods:

$$U = \exp\left\{\int_0^1 \beta_i \log(c_i)\mathrm{d}i\right\}, \tag{1}$$

where c_i is the quantity consumed of good i, β_i is the expenditure share on good i, and $\int_0^1 \beta_i \mathrm{d}i = 1$.

II.D Market Structure

Both labor and product markets are perfectly competitive. Workers are freely mobile between sectors within a country. We use w and w^* to denote the nominal wage paid to workers in Home and Foreign, respectively. Their ratio $\omega = w/w^*$ reflects the relative wage. The unit costs of producing i in Home and Foreign are therefore wa_i and $w^*a_i^*$.

Due to perfect competition in the product market, prices equal marginal costs, and firm profits are always zero. Let p_i and p_i^* denote the prices of good i for consumers in Home and Foreign.

II.E Trade

Consumers source goods from the lowest-cost producer. The import status of good i at Home is thus given by

$$m_i = \mathbf{1}\left(w^*a_i^* < wa_i\right), \tag{2}$$

where the right-hand side is an indicator function for whether Foreign produces good i more cheaply. Foreign's import status m_i^* is defined symmetrically.

II.F Equilibrium

An equilibrium in this model consists of a collection of wages, $\{w, w^*\}$, prices, $\{p_i, p_i^*\}_i$, labor allocations, $\{l_i, l_i^*\}_i$, consumption decisions, $\{c_i, c_i^*\}_i$, and import decisions, $\{m_i, m_i^*\}_i$, such that:

1. Households in Home maximize their utility in Equation (1) subject to the budget constraint:

$$\int_0^1 p_i c_i \mathrm{d}i \leq wL,$$

with a similar equation in Foreign.

2. Prices are set competitively,

$$p_i = \min\{wa_i, w^* a_i^*\},$$

with a similar equation for Foreign's prices.

3. Markets clear:

$$\begin{aligned}&\text{Goods: } c_i(1-m_i) + c_i^* m_i^* = l_i/a_i\\ &\text{Labor: } \int_i l_i \mathrm{d}i \leq L,\end{aligned}$$

with similar equations for Foreign markets.

4. Trade is balanced:

$$\underbrace{\int_i m_i^* c_i p_i \mathrm{d}i}_{\text{Export Value}} = \underbrace{\int_i m_i c_i^* p_i^* \mathrm{d}i}_{\text{Import Value}}.$$

with similar equations for Foreign trade balance.

The existence and uniqueness of the equilibrium follow from the argument in Dornbusch, Fischer and Samuelson (1977). Since A is monotonically decreasing with i, trade in equilibrium features a cutoff rule at the relative wage ω, where Home produces everything with $A(i) \geq \omega$ and imports everything else, while Foreign produces everything with $A(i) < \omega$ and imports everything else.

Let $\bar{\iota}$ denote the cutoff good. The equilibrium conditions are

$$\omega = A(\bar{\iota}), \tag{3}$$

$$\omega \times \int_{\bar{\iota}}^{1} \beta_i di = \ell \int_0^{\bar{\iota}} \beta_i di. \tag{4}$$

The first equation is implied by consumers' optimal sourcing decisions characterized in Equation (2). The second equation is a rearrangement of the trade balance condition, with the integrals on the left-hand side and the right-hand side representing the import shares for Home and Foreign, respectively.

II.G Characterizing Home Utility

In *any* equilibrium with *any* integrable comparative advantage schedule, we can solve for Home's indirect utility as a function of the aggregate relative wage and sourcing decisions. The ideal price index can be written as

$$\log P = \log w + \int_0^1 \beta_i m_i \log \left(A(i)/\omega\right) \mathrm{d}i + C, \tag{5}$$

where C is a constant that depends on β_i and a_i, which never change.

Combining Equation (5) with the fact that nominal income with free and balanced trade is wL and that the equilibrium relative wage is determined by Equations (3) and (4), we can write (the log of) indirect utility *solely* as a function of the cutoff product, $\bar{\imath}$:

$$U(\bar{\imath}) = \log A(\bar{\imath}) \int_{\bar{\imath}}^1 \beta_i di - \int_{\bar{\imath}}^1 \beta_i \log A_i di, \tag{6}$$

where $\bar{\imath}$ is endogenous and solves

$$A(\bar{\imath}) \times \int_{\bar{\imath}}^1 \beta_i di - \ell \int_0^{\bar{\imath}} \beta_i di = 0.$$

For ease of exposition, unless otherwise noted, we set $\beta_i = 1 \; \forall i$.[9] With $\beta_i = 1$, Home's utility is:

$$U(\bar{\imath}) = \log A(\bar{\imath}) \left(1 - \bar{\imath}\right) - \int_{\bar{\imath}}^1 \log A_i di. \tag{7}$$

Figure 1 visualizes the gains from trade in the economy. The first term on the right-hand side of Equation (7) is the log of relative wage multiplied by Home's import share, capturing

[9]While assuming a constant β is not without loss of generality, our main results are not qualitatively sensitive to this assumption. In Appendix B we solve for policy where β is unrestricted. In Section V, we use this more general setup for quantification.

the utility component that varies with the relative wage. This term corresponds to the red-dashed-border rectangle in Figure 1. The second term represents the utility component that varies negatively with the price index. This term corresponds to the negative of the brown-dashed area between the $\log A_i$ curve and zero. The sum of these components, represented by the pink shaded area, constitutes Home's indirect utility.

III Foreign Productivity Changes and Domestic Welfare

Our primary interest is to understand, good by good, how changes in foreign productivity impact domestic welfare. After describing the nature of the destruction shock, we discuss its effects on real income, leveraging the result of Equation (5) that, conditional on the A schedule, a sufficient statistic for real income is the cutoff good.

III.A The Policy Environment

We consider the impact of three types of changes in foreign productivity on domestic real income: a technology transfer (a decrease in a^*), a minor sabotage (a small increase), and a comprehensive sabotage (a significant increase). Only comprehensive sabotage involves changes in the cutoff product and thus a nontrivial reordering of the products, which we elaborate on below.

In the absence of any policy, the comparative advantage schedule is $A(i)$, where $\bar{\iota}^0$ is the equilibrium cutoff good. For the policies where Home changes Foreign productivity, we consider changes in a_i^* for a narrow band of goods where Foreign has comparative advantage: $i \in [\iota^*, \iota^* + \epsilon)$, where $\iota^* \geq \bar{\iota}^0$ and the measure of varieties affected, ϵ, is a small number greater than 0.

III.B Non-Monotonic Effects on Domestic Welfare

We now show that there exists a mass of products $[\iota^*, \iota^* + \epsilon)$ for which Home is better off if Foreign's productivity for those products is either (a) improved or (b) completely destroyed. There is an asymmetric and non-monotonic relationship between productivity changes in these products for Foreign and Home's real income: any improvement in Foreign's productivity always boosts Home's real income; conversely, a small negative shock reduces Home's real income. However, should the negative shock become sufficiently large, Home can paradoxically benefit again.

Case I: Technology Transfer—A Productivity Boost

An increase in Foreign's productivity for the mass of products in $[\iota^*, \iota^*+\epsilon)$ always improves Home's real income. Since the affected products are to the right of the free trade equilibrium, i.e. $i^* \geq \bar{\iota}^0$, improving Foreign productivity on them does not change the cutoff good $\bar{\iota}_0$ and thereby ω. However, it does expand the global Production Possibility Frontier and lower the price index. The resulting increase in Home's real income corresponds to an expansion of the pink area in Figure 2 Panel A.

Case II: Moderate Sabotage

We define *moderate* sabotage as lowering Foreign productivity for products in the range $[\iota^*, \iota^* + \epsilon)$ where the productivity drop is small enough that Home's comparative advantage in that region does not exceed $A(\bar{\iota}^0)$. As a result, moderate sabotage does not lead to any change in the equilibrium cutoff product. This case is the exact opposite of the first case: the relative wage component of Home utility remains unchanged, but the price index rises, resulting in a drop in Home utility. This is visualized in Figure 2 Panel B, where the shaded area expands.

To see how Cases I and II are related, consider a proportional schedule for policy, where Foreign's unit labor requirement a_i^* is changed to za_i^* for a fixed scalar $z \geq 0$ for all products in $[\iota^*, \iota^*+\epsilon)$. This translates into a change in $\log A(i)$ by $\log z$. Note that technology transfer is defined by a decrease in a_i^*, which implies $z \in (0, 1)$. Correspondingly, sabotage implies $z > 1$.

For any z covered by Case I and II, the real income gain is approximately:

$$\Delta U(\iota^*, \epsilon, z) \approx -\log z \times \epsilon. \tag{8}$$

The effect of z is continuous around 1: small increases in Home utility for $z < 1$, and small decreases for $z > 1$. The location of ι^* is welfare irrelevant; all that matters is the size of the productivity shock and the mass of goods affected.

Case III: Comprehensive Sabotage

Comprehensive sabotage sets Foreign productivity a_i^* to infinity for $i \in [\iota^*, \iota^* + \epsilon)$.[10] As a result, Foreign can no longer produce these products, and Home will take over their production.

Let $\hat{A}$ be the new comparative advantage schedule where goods have been rearranged, so that $\hat{A}$ is (weakly) downward sloping once again. While the rearrangement is trivially non-unique because the value is infinity for a positive mass near 0, $\hat{A}$ is:

$$\hat{A}(i) = \begin{cases} \infty & \text{if } i \in [0, \epsilon) \\ A(i - \epsilon) & \text{if } i \in [\epsilon, \iota^* + \epsilon) \\ A(i) & \text{if } i \in [\iota^* + \epsilon, 1]. \end{cases} \tag{9}$$

As visualized in Figure 3, this is a rightward shift of the A schedule up until the point $\iota^* + \epsilon$ and then a drop back to the original A schedule.

The cutoff product would shift locally to the right by ϵ if equilibrium wages stay unchanged. However, the increased production at Home leads to an improvement in Home's terms of trade, causing the relative wage ω to rise. Home therefore forgos some of its pre-

[10]Formally, the effects of any sabotage with $z > \frac{A(\bar{\iota}^0)}{A(\iota^* + \epsilon)}$ are the same as comprehensive sabotage, but it is easier to visualize the latter.

viously produced marginal goods in order to take up the sabotaged inframarginal goods. Consequently, the new cutoff shifts right by less than ϵ, i.e. $\bar{\iota} < \bar{\iota}^0 + \epsilon$.

While Home benefits from the improved terms of trade, the price index increases because Home is less productive in these sabotaged products compared to what Foreign used to be. Evaluating the net benefits of comprehensive sabotage requires comparing the benefits from improved terms of trade with the losses from increased domestic prices. Unlike in Cases I and II, the value of ι^* does matter for the welfare effects of sabotage, as the change in the price index depends on the difference in unit costs at the location of the shock.

Denote the new equilibrium cutoff on the reordered space of products under the $\hat{A}$ schedule as $\bar{\iota}$. Using the relationship between A and $\hat{A}$, the equilibrium condition that determines the new cutoff is:

$$A(\bar{\iota} - \epsilon)(1 - \bar{\iota}) = \ell\bar{\iota}. \tag{10}$$

Note that $1 - \bar{\iota}$ is still the import share for Home. We can write Home's indirect utility as

$$\begin{aligned} U(\epsilon; \iota^*) =& (1 - \bar{\iota}) \log \hat{A}(\bar{\iota}) - \int_{\bar{\iota}}^{1} \log \hat{A}(i) \mathrm{d}i \\ =& (1 - \bar{\iota}) \log A(\bar{\iota} - \epsilon) - \int_{\bar{\iota}-\epsilon}^{\iota^*} \log A(i) \mathrm{d}i - \int_{\iota^* + \epsilon}^{1} \log A(i) \mathrm{d}i, \end{aligned} \tag{11}$$

where the second line follows from a change of variables to move back to the original ordering of goods. Totally differentiating Equation (11) shows how Home's utility changes with the measure of sabotaged products:[11]

$$\Delta U^S(\epsilon; \iota^*) \approx \underbrace{\epsilon(1 - \bar{\iota}) \frac{A'(\bar{\iota} - \epsilon)}{A(\bar{\iota} - \epsilon)} \left(\frac{d\bar{\iota}}{d\epsilon} - 1 \right)}_{\text{ToT Gain}} - \underbrace{\epsilon \log \left(\frac{A(\bar{\iota} - \epsilon)}{A(\iota^* + \epsilon)} \right)}_{\text{Efficiency Cost}}. \tag{12}$$

Figure 4 reflects Equation (12) graphically. The benefits of sabotage are shown in the pink shaded area: the change in the area between the new relative wage, $\log \hat{A}(\bar{\iota})$, and the log

[11] See Appendix A for detailed derivations.

of new comparative advantage schedule, $\log \hat{A}(i)$. To a first order, this can be approximated by the rectangle that multiplies the initial import share $(1-\bar{\iota}_0)$ by the change in $\log \omega$, which is exactly the expression given by "ToT Gain" in Equation (12). Figure 4 illustrates that the improvement in terms of trade remains relatively constant regardless of where ι^* is—it depends only on the properties of A local to the initial equilibrium.

However, the loss in efficiency increases as ι^* moves rightward. The cost of sabotage is shown in the blue shaded (and hatched) area. This loss in utility occurs because as A shifts rightward goods are produced more expensively at Home. Since A shifts by ϵ, the cost can be approximated by calculating the area of the parallelogram with base ϵ and height given by $\log \hat{A}(\bar{\iota}) - \log \hat{A}(\iota^* + \epsilon)$. This is exactly the expression labeled "Efficiency Cost" in Equation (12).[12]

Visually, by moving ι^* closer to $\bar{\iota}_0$, the blue hatched area shrinks without changing the size of the pink area. Indeed, Theorem 1 shows that (close to the initial equilibrium) there is always some scope for welfare-enhancing sabotage, where the benefits outweigh the costs.

Theorem 1. (A Paradox: Increasing and Decreasing Foreign Productivity Can Both Increase Domestic Real Income)

- *Under comprehensive sabotage, for ι^* locally to the right of $\bar{\iota}^0$ (including $\bar{\iota}^0$ itself), there exists an $\epsilon > 0$ such that $U(\epsilon; \iota^*)$ is greater than the initial Laissez-Faire utility $U(\bar{\iota}^0)$.*
- *A technology transfer that improves Foreign productivity in $[\iota^*, \iota^* + \epsilon)$ also increases Home's real income.*

We refer the proof of this theorem to Appendix A. Theorem 1 presents a paradox: both technology transfer and comprehensive sabotage for the same set of products can raise Home's real income.

[12] Equation (12) is an approximation because there is also a welfare loss from the small triangle in Figure 4, traced out by the area between the original relative wage, the original A schedule, $\bar{\iota}_0$ and $\bar{\iota}$. However, as both the width and height of the triangle shrink with ϵ, it is second order.

In Appendix A, we show that the derivative $dU(\epsilon;\iota^*)/d\epsilon$ evaluated at $\epsilon = 0$ depends solely on the initial equilibrium $\bar{\iota}_0$, the shape of the A schedule at $\bar{\iota}_0$, and the location of the sabotaged products ι^*. Up to a first-order approximation, we can write Equation (12) as:

$$\Delta U^S(\iota^*, \epsilon) \approx \left.\frac{dU(\epsilon;\iota^*)}{d\epsilon}\right|_{\epsilon=0} \times \epsilon = \left[\underbrace{\frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}}}_{\text{ToT Gain}} - \underbrace{\log\frac{A(\bar{\iota}_0)}{A(\iota^*)}}_{\text{Efficiency Cost}}\right] \times \epsilon, \tag{13}$$

where $\eta = \left|\frac{d\log A}{di}\right|^{-1}$.

III.C Unpacking the Terms of Trade Gains

At first glance, the nature of the terms of trade gain in Equation (13) is challenging to map to data, as $\bar{\iota}_0$ is hard to define and $\frac{d\log A}{di}$ is difficult to measure. In Appendix D, we show that we can write the terms of trade gains as depending only on the measure of goods sabotaged and two easily-measured sufficient statistics: the trade elasticity θ and Home's import share (Φ_H).[13] In particular,

$$\text{ToT Gain} = \underbrace{\epsilon}_{\text{Extent of Sabotage}} \times \underbrace{\frac{1}{1+\theta}\frac{1}{1-\Phi_H}}_{\text{Sufficient Statistic}}. \tag{14}$$

Equation (14) has an intuitive appeal. As Home's relative wage grows, exports decline. As trade becomes more elastic (larger θ), exports decline faster as wages grow, limiting the potential growth in Home's relative wage. If Home is not very reliant on trade (so Φ_H is small), then the potential returns to any trade policy are small (Arkolakis, Costinot and Rodríguez-Clare, 2012).

[13] As in Arkolakis, Costinot and Rodríguez-Clare (2012), we define the trade elasticity as the partial equilibrium elasticity of trade shares with respect to relative costs: $\theta = \frac{\partial \frac{\Phi_H}{1-\Phi_H}}{\partial \omega}$. Note that we are slightly abusing notation, as the trade elasticity can vary depending on the equilibrium allocation (though it is constant if inverse unit costs are drawn from a Fréchet distribution). The relevant elasticity in Equation (13) is the one at the initial equilibrium.

In Appendix D, we show that our approach extends to a more general case, with trade costs and unrestricted expenditure shares across goods (β_i).[14] In this environment, the efficiency costs from sabotage are the same as those in Equation (13), but the utility gains from sabotage become

$$\text{ToT Gain} = \underbrace{\beta(\iota^*)\epsilon}_{\text{Expenditure Shift}} \times \underbrace{\frac{s_H^{-1}}{1 + (1 - \Phi_H)\theta_H + (1 - \Phi_F)\theta_F}}_{\text{Sufficient Statistic}}, \tag{15}$$

where s_H is Home's share of global production, θ_k is the trade elasticity of country k, and $\bar{\iota}_0^H$ is Home's cutoff good in the initial equilibrium. As in Equation (14), the gains from sabotage are decreasing in θ_H and θ_F and increasing in Φ_H. The extent of sabotage is no longer captured by the measure of goods sabotaged (ϵ), but by the share of expenditure shifted ($\beta(\iota^*)\epsilon$). The new terms (s_H, $\bar{\iota}_0^H$, and Φ_F) appear because trade costs create a wedge between Home's export share and global production share. Conditional on trade, a larger country (with a higher s_H) benefits less from sabotage, as the terms of trade are already favorable (Wilson, 1980).

Throughout the analysis, we assume that sabotage is costless. However, in practice, sabotage may incur costs, such as the difficulty in coordinating various stakeholders to lower foreign productivity (Clayton, Maggiori and Schreger, 2024*b*). The implications of costly sabotage are equivalent to those of comparing sabotage with technology transfer: sabotage needs to outperform some non-zero alternative (be it a cost or another beneficial policy). Thus, our results imply that sabotage is a useful policy for some goods, unless it is associated with prohibitively high costs.

[14] In Appendix C, we show that if we instead assume CES preferences across goods, then the net gains from sabotage additionally depend on the elasticity of substitution.

IV Sabotage, Technology Transfer, or Nothing?

Having shown that both technology transfer and comprehensive sabotage for the same products can benefit Home, a natural follow-up question is when one is better than the other. In this section, we characterize how the benefits of each change across the product space. As discussed in Theorem 1, the returns from sabotage, $\Delta U^S(\iota^*, \epsilon)$, decrease monotonically as ι^* moves rightward. For goods in a region close to $\bar{\iota}_0$, comprehensive sabotage increases Home's real income and does so by more than technology transfer would. For goods in a region far from $\bar{\iota}_0$, comprehensive sabotage is worse than inaction (and therefore also worse than technology transfer). Finally, there is an intermediate region where comprehensive sabotage is better than inaction, but still worse than technology transfer.[15]

In order to directly compare the policies, we focus on *fixed technological transfer*, changing a_i^* to za_i^* for $i \in [\iota^*, \iota^* + \epsilon)$. Rearranging Equation (13), and leveraging the fact that the A schedule is monotonically decreasing, we can derive three regions:

Corollary 2. (Policy Regions) *Suppose sabotaging the worst product lowers Home's real income and the technology transfer is not too large, i.e.* $-\log z < \frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}} < \log \frac{A(\bar{\iota}_0)}{A(1)}$. *There exist two critical products,* $\hat{\iota}_1$ *and* $\hat{\iota}_2$*, that solve Equations* (16) *and* (17).

- *For* $\iota^* \in (\bar{\iota}_0, \hat{\iota}_2)$*,* $\Delta U^S(\iota^*, \epsilon) > \Delta U^T(\iota^*, \epsilon) > 0$ ***(Region I)****.*
- *For* $\iota^* \in (\hat{\iota}_2, \hat{\iota}_1)$*,* $\Delta U^T(\iota^*, \epsilon) > \Delta U^S(\iota^*, \epsilon) > 0$. ***(Region II)****.*
- *For* $\iota^* \in (\hat{\iota}_1, 1)$*,* $\Delta U^T(\iota^*, \epsilon) > 0 > \Delta U^S(\iota^*, \epsilon)$. ***(Region III)****.*

As technology transfer is always preferred to inaction, we consider the regions from right to left, first discussing when sabotage is worse than inaction, and then when it is better.

Region III: Sabotage is Worse than Nothing

If the model primitives are such that $\frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}} - \log \frac{A(\bar{\iota}_0)}{A(1)} \geq 0$, then sabotaging Home's lowest comparative advantage product is better than doing nothing, and Region III is empty.

[15] Depending on parameter values, some regions may be empty.

Otherwise, there is a critical product, $\hat{\iota}_1$, that solves

$$\frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}} - \log A(\bar{\iota}_0) = -\log A(\hat{\iota}_1), \tag{16}$$

for which Home is indifferent about whether to undertake comprehensive sabotage. For all goods with $i > \hat{\iota}_1$, sabotage is worse than inaction.

Region II: Sabotage is Worse than Technology Transfer

& Region I: Sabotage is Better than Technology Transfer

For a fixed technology transfer schedule that changes the log comparative advantage schedule by $\log z$ for $i \in [\iota^*, \iota^* + \epsilon)$, the gain in Home utility is solely the change in the price index component:

$$\Delta U^T(\iota^*, \epsilon) = \int_{\iota^*}^{\iota^*+\epsilon} -\log z \, di = -\log z \times \epsilon.$$

The comparison between the technology transfer and comprehensive sabotage then boils down to the comparison of $-\log z$ and $\frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}} - \log \frac{A(\bar{\iota}_0)}{A(\iota^*)}$. If the technology transfer is moderate, such that $-\log z < \frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0}{1-\bar{\iota}_0})}$, there is a critical product $\hat{\iota}_2$ that solves

$$\frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}} - \log \frac{A(\bar{\iota}_0)}{A(\hat{\iota}_2)} = -\log z, \tag{17}$$

which makes Home indifferent between technology transfer and comprehensive sabotage. Note that if the technology for technology transfer is very effective, such that $-\log z \geq \frac{1}{\bar{\iota}_0 + \frac{\eta(\bar{\iota}_0)}{1-\bar{\iota}_0}}$, then Region I is empty, as Home would always prefer technology transfer to sabotage. For positive z, it is impossible for Region II to be empty if Region III is not empty, as if sabotage is worse than nothing for some goods, it must be worse than technology transfer both for those goods and for goods with slightly higher comparative advantage.

IV.A Comparative Statics

Equation (13) indicates that a more elastic comparative advantage schedule magnifies both the gains and losses from sabotage. The terms of trade gain from sabotage is increasing as wages are more responsive to increased production. The efficiency costs are increasing for any ι^* because a more elastic comparative advantage schedule implies that Home's relative unit costs fall faster in i. In order to understand which force might dominate, we parameterize the comparative advantage schedule by assuming that Home and Foreign productivities follow Fréchet distributions with a common shape parameter θ and scale parameters T and T^*. With this assumption, the trade elasticity is θ, for both Home and Foreign, which allows for straightforward interpretation. With Fréchet, the comparative advantage schedule is

$$A(i) = \left(\frac{1-i}{i}\right)^{1/\theta}\left(\frac{T}{T^*}\right)^{1/\theta}.$$

Using Equation (14) and properties of the Fréchet distribution, the effect of comprehensive sabotage on Home's utility is:

$$\Delta U^S(\iota^*,\epsilon) \approx \epsilon \times \left[\frac{1}{1+\theta}\frac{1}{1-\Phi_H} - \frac{1}{\theta}\log\left(\frac{(1-\bar{\iota}_0)/\bar{\iota}_0}{(1-\iota^*)/\iota^*}\right)\right]. \tag{18}$$

The welfare gains from technology transfer remain:

$$\Delta U^T(\iota^*,\epsilon) = -\epsilon \times \log z. \tag{19}$$

The product $\hat{\iota}_1$ at which the domestic planner is indifferent between comprehensive sabotage and inaction solves $\Delta U^S(\iota^*,\epsilon) = 0$. The product $\hat{\iota}_2$ at which the planner is indifferent between comprehensive sabotage and technology transfer solves $\Delta U^S(\iota^*,\epsilon) = \Delta U^S(\iota^*,\epsilon)$. Therefore, the cutoffs are:

$$\hat{\iota}_1 = \left[1 + \frac{\Phi_H}{1-\Phi_H}\exp\left(\frac{-\theta}{1+\theta}\frac{1}{1-\Phi_H}\right)\right]^{-1},$$

$$\hat{\iota}_2 = \left[1 + z^{-\theta} \frac{\Phi_H}{1-\Phi_H} \exp\left(\frac{-\theta}{1+\theta} \frac{1}{1-\Phi_H}\right)\right]^{-1}. \tag{20}$$

In Figure 5, we plot $\hat{\iota}_1$ and $\hat{\iota}_2$ as functions of θ for the case where Home and Foreign are symmetric.[16] In this case, Equation (18) simplifies to

$$\Delta U^S (\iota^*, \epsilon) \approx \left[\frac{2}{1+\theta} + \frac{1}{\theta} \log \frac{1-\iota^*}{\iota^*}\right] \times \epsilon. \tag{21}$$

As θ increases, the comparative advantage schedule flattens, and the change in the welfare effect of comprehensive sabotage is non-monotonic. Following Theorem 1, when ι^* is close to $\bar{\iota}_0$, the terms of trade effect dominates the efficiency loss for any θ, and comprehensive sabotage leads to net gains.[17] However, as θ increases, the potential improvement in the terms of trade diminishes, making sabotage less attractive. On the other hand, for any ι^*, as θ increases, the flatter comparative advantage schedule implies that the difference in unit costs shrinks, diminishing the efficiency loss too. Consequently, as θ increases, ΔU^S decreases for ι^* close to $\bar{\iota}_0$ but increases for ι^* far away from $\bar{\iota}_0$, as visualized in Figure 5 Panel A.

The size of the regions changes with θ. In particular,

$$\frac{\partial \hat{\iota}_1}{\partial \theta} = \frac{2e^{-\frac{2\theta}{1+\theta}}}{(1+\theta)^2 \left(e^{-\frac{2\theta}{1+\theta}} + 1\right)^2}, \qquad \frac{\partial \hat{\iota}_2}{\partial \theta} = \frac{z^{-\theta} e^{-\frac{2\theta}{1+\theta}} \left(\frac{2}{(1+\theta)^2} + \log z\right)}{\left(z^{-\theta} e^{-\frac{2\theta}{1+\theta}} + 1\right)^2}. \tag{22}$$

$\frac{\partial \hat{\iota}_1}{\partial \theta}$ is always positive, though it approaches zero as θ grows to infinity. As a result, the

[16] In the symmetric case, $\ell = 1$, and $\bar{\iota}_0 = .5$ regardless of θ, which makes the comparative statics easier to understand. In particular, $\hat{\iota}_1 = \left(e^{-\frac{2\theta}{1+\theta}} + 1\right)^{-1}$ and $\hat{\iota}_2 = \left(z^{-\theta} e^{-\frac{2\theta}{1+\theta}} + 1\right)^{-1}$.

With asymmetric countries, changing θ also alters the initial equilibrium trade shares, which is a nuisance as it directly affects the returns to sabotage. We consider the comparative statics without this nuisance and show in Appendix E that the results are equivalent if we allow countries to be of different sizes but hold the trade shares fixed. This is done by simultaneously adjusting the scale parameter when changing θ.

[17] Given the Fréchet productivity draws, comparative advantage has an ogee shape (Eaton and Kortum, 1997), so when ι^* is close to one the efficiency loss dominates and there would be a net decrease in Home's real income from comprehensive sabotage.

region where comprehensive sabotage is preferable to taking no action (the union of regions I and II) expands with θ. This is reflected in the increase of $\hat{\iota}_1$, as the green area in Figure 5 expands. The region where comprehensive sabotage is better than taking no action but worse than technology transfer (region II) also expands, indicated by the expanding orange area in Figure 5.[18]

How the region III, where comprehensive sabotage is preferable to technology transfer, changes depends on the magnitude of the technology transfer schedule. When technology transfer is relatively small compared to θ, i.e. $z < \exp(-2/(1+\theta)^2)$, $\hat{\iota}_2$ increases with θ; otherwise, it decreases (as shown in Figure 5 Panel B). Conversely, for large technology transfers (for this setup, $z > \exp(-1/2) \approx 0.6$), $\hat{\iota}_2$ always monotonically decreases with θ (as in Figure 5 Panel C).

V Quantifying The Returns to Sabotage

To conclude, we apply our theoretical results to understand the quantitative importance of sabotage. Whether sabotaging foreign chip production will ultimately raise domestic real income is theoretically ambiguous, as it depends on the relative magnitude of the terms of trade gains versus the efficiency losses. While we can leverage the sufficient statistics to quantify the terms of trade gain, the efficiency loss is determined by production cost differences at home and abroad. Costs can be difficult to intuit (or measure), which has led to debate among policy markers. For instance, the US already produces many varieties of semiconductor chips, which might suggest that comparative advantage differences are relatively small. (Fujiki, 2015). However, others argue that the sector is broadly uncompetitive (Hsieh, Lin and Shih, 2024). If provided with a measurement of costs, our setup allows for an easy estimation of the net effects of sabotage.

To better bring our approach to the data, we add three ingredients to the stylized baseline

[18]This can be seen from the fact that as θ increases, $e^{-\frac{2\theta}{1+\theta}}$ decreases, causing $\hat{\iota}_1$ to increase; for $\hat{\iota}_2$, the only difference is the additional term $z^{-\theta}$, which increases with θ since $z < 1$. Thus, $z^{-\theta}e^{-\frac{2\theta}{1+\theta}}$ cannot decrease faster than $e^{-\frac{2\theta}{1+\theta}}$, implying that $\hat{\iota}_2$ cannot increase faster than $\hat{\iota}_1$. Therefore, $\hat{\iota}_1 - \hat{\iota}_2$ increases.

setup. First, as in Equation (15), we account for trade costs, which are important in the real world. Furthermore, recognizing the absence of data on varieties at the atomistic level of the model, we allow for unrestricted expenditure coefficients for each good. This not only enhances the generality of our model but also enables us to recast the extent of sabotage in terms of expenditure.

Finally, we allow for intra-sectoral trade, a salient feature of the data (Krugman, 1980), by assuming that *within* each sector, consumers have CES demand over imperfectly substitutable Home and Foreign varieties (as in a multi-sector Armington model).

In Appendix F, we derive sufficient statistics for the welfare implications of trade in the multi-sector Armington environment. With intra-sectoral trade, two terms are needed to describe the extent of sabotage, one between sectors and one within sectors. As before, ϵ represents the measure of sectors sabotaged as before, so $\beta\epsilon$ represents the share of demand affected.

We use Δ, defined as $\Delta \equiv [m_{\iota^*+\epsilon}(1) - m_{\iota^*+\epsilon}(z)]$, to represent the change in domestic imports due to sabotage (effectively capturing how much demand is reshored), as $m_{\iota^*+\epsilon}(1)$ is the import share without sabotage, and $m_{\iota^*+\epsilon}(z)$ the share with sabotage.[19]. For example, if an industry comprises 2% of output, and half of the imports in the industry are sabotaged, then $\beta\epsilon = 0.02$ and $\Delta = m_{\iota^*}/2$. Given a within-sector elasticity of substitution σ_i, the net gains from sabotage (for small ϵ) are

$$\Delta U^S \approx \beta_{\iota^*}\epsilon \times \Bigg[\underbrace{\Delta \frac{\frac{1-s_H}{s_H} \frac{m^*_{\iota^*}(1-m^*_{\iota^*})}{m_{\iota^*}(1-m_{\iota^*})-\Delta(1-m_{\iota^*}-m^*_{\iota^*})} + 1}{1+\theta(1-\Phi_H)+\theta(1-\Phi_H\frac{s_H}{1-s_H})}}_{\text{ToT Gain}} \\ - \underbrace{\frac{1}{\sigma_{\iota^*}-1}\log\left(1+\frac{\Delta}{1-m_{\iota^*}}\right)}_{\text{Efficiency Cost}} \Bigg]. \tag{23}$$

[19] z is the increase in the Foreign unit labor requirement in industry i.

Given the extent of sabotage (represented by $\beta_{\iota^*}\epsilon$ and Δ), the returns to sabotage in Equation (23) depend on six terms: s_H, Φ_H, m_{ι^*}, $m^*_{\iota^*}$, θ, and σ_{ι^*}. Equation (23) shows that allowing for intra-sectoral trade allows for transparent quantification of relative unit costs. When varieties are imperfect substitutes, domestic consumers purchase varieties from both Home and Foreign within each sector. The *share* of varieties purchased from Home within each sector reflects Home's relative unit costs, in the spirit of Balassa (1965) and Head and Ries (2001).[20]

In this section, we first use Equation (23) to understand the potential real income gains of comprehensive sabotage across different industries, and then analyze the semiconductor industry in more detail.

V.A The Returns to Sabotage Across Industries

First, we consider the effect of comprehensive sabotage (i.e. $\Delta = m_{\iota^*}$) across industries. To calibrate the returns to sabotage across industries, we estimate s_H, Φ_H, m_{ι^*}, and $m^*_{\iota^*}$ using the WIOD.[21] In the data, the US accounted for 23% of global output (s_H), and had an import share in gross output of 7.7% (Φ_H). Appendix Table A.1 reports the American and Rest of World import shares by sector.

In order to estimate σ across industries, we leverage the fact that with CES demand, markups are constant. As a result, as in Gervais and Jensen (2019), we can estimate the elasticity of substitution of sector i, $\hat{\sigma}_i$, as the ratio of total sectoral revenue to total gross operating surplus.[22] Conventional estimates for θ are between 2 and 4 (Simonovska and Waugh, 2014; Boehm, Levchenko and Pandalai-Nayar, 2023), and we perform the calculation

[20] The cost gap cannot be easily estimated from a baseline Dornbusch, Fischer and Samuelson (1977) environment, where domestic and foreign varieties are perfect substitutes. In this environment, Home either imports none of a variety or all of it. As a result, all that can be inferred from Home importing a good is that Foreign's unit price is lower than Home's, but not by how much.

[21] We use the most recent year of the WIOD, 2014.

[22] We use the 2017 BEA tables to estimate σ_i for each BEA industry. As the BEA classifications are more disaggregated than the WIOD, we take a weighted average of BEA sectoral elasticities for each WIOD industry, where the weights are value added shares. The resulting elasticities are reported in Appendix Table A.1 and the magnitudes are in line with other estimates (Broda and Weinstein, 2006).

in Equation (23) using both values.

Tables 1 and 2 display the effects of sabotage of shifting 1% of expenditure across industries.[23] The benefits of sabotage depend crucially on the trade elasticity (as do the gains from trade, as in Arkolakis, Costinot and Rodríguez-Clare 2012). If θ is smaller, then sabotage tends to be more beneficial.

The terms of trade gains are predominantly a function of aggregate characteristics and thus vary little across sectors. The estimated terms of trade gains are smaller than those implied by Equation (15), because the US tends to produce a substantial amount of nearly every industry at Home, highlighting the quantitative importance of accounting for intra-industry trade.[24]

Due to heterogeneity in elasticities of substitution and revealed relative costs, the efficiency costs vary substantially across sectors. In manufacturing, the costs of sabotage are largest for pharmaceutical products and textiles. On net, the gains from comprehensive sabotage are positive in every sector except fishing and aquaculture. The gains tend to be larger in agriculture and services than in manufacturing. The gains for computer, electronic, and optical products are around 0.21% to 0.56%, which is approximately the average across all sectors.

V.B An Application to Semi-Conductors

We conclude by examining the semiconductor sector specifically. We consider the relationship between Δ and the effect on real income, as an open question remains regarding how much the actual CHIPS Act substantively disrupted foreign productivity (Crosignani et al., 2024; Liu, 2024).

While semiconductors (identified by NAICS 334413) is too disaggregated a sector to be reported in the WIOD, it is important enough that the relevant estimates are available

[23] We only display industries where the US's current import share is at least 5%.

[24] For comparison, the TOT gains implied by Equation (15) are between 0.50 and 0.91, depending on θ. Indeed, the gains only vary across sectors because of intra-industry trade. Equation (15) shows that the terms of trade gains are the same across sectors if Home and Foreign produce perfect substitutes.

from recent government reports. Specifically, we find that the elasticity of substitution in semiconductors is estimated to be 3.22, the total share of semiconductors in consumption is 0.5%, and the US imports 57% of its chips from abroad while foreigners import 9% of theirs from the US (Bureau of Economic Analysis, 2017; Jones et al., 2023; Grossman, Blevins and Sutter, 2023).

Figure 6 shows the effect on real income for different values of Δ. Consistent with Theorem 1, the effects of foreign productivity interventions are non-monotonic in Δ. Large technology transfers consistently raise real income.[25] Large ("comprehensive") sabotage also raises real income. However, intermediate levels of sabotage lower real income.[26] If θ is large, sabotage tends to lower real income, and even large amounts of sabotage increase real income by less than small amounts of technology transfer.

VI Discussion

In this paper, we study the implications of industrial sabotage for the patterns of trade and real income. While these policies have objectives beyond industrial policy, we provide several key theoretical and quantitative takeaways for their design. First, consistent with policy intuition, lowering foreign productivity should be "comprehensive," as half-measures may not be enough. Domestic real income only increases if the productivity loss is substantial enough to shift production to Home. This differs from the intuition for tariffs, where a smaller-than-optimal tariff is still better than none.

Second, sabotage works best when targeted at goods where comparative advantage differences are small. Sabotage lowers the production possibility frontier and raises the price index, making it relatively more beneficial when targeted at products where unit labor costs are similar and therefore these effects are minimized. For some sectors, sabotage raises

[25] Unlike in the pure Dornbusch, Fischer and Samuelson (1977) environment, with imperfect substitutes, small amounts of technology transfer can lower domestic real income, as there is a terms of trade loss as domestic consumers shift their consumption to imports.

[26] For reference, China's global market share in semiconductors is 22% (Semiconductor Industry Association, 2023).

domestic real income, while in others, where comparative advantage differences are large, sabotage lowers real income.

We contrast sabotage with its opposite: raising Foreign's productivity (which we call "technology transfer"). Raising Foreign productivity for goods they are already producing generally increases real incomes. As a result, there are many goods for which, somewhat paradoxically, either raising or (comprehensively) lowering foreign productivity raises domestic real income. For goods where comparative advantage differences are small, sabotage may dominate technology transfer. However, where comparative advantage differences are large, technology transfer raises domestic real income more than sabotage.

The shape of the comparative advantage schedule affects the benefits of sabotage relative to technology transfer. A steeper schedule raises the terms of trade benefit from sabotage but also exacerbates the efficiency losses. We show how to quantify the costs and benefits of industrial sabotage as a function of commonly-measured trade statistics.

We are motivated by recent policy efforts to hamstring foreign production of key products, such as the CHIPS Act. Quantitatively, a key takeaway from our results is that these types of policies can improve real income for the US *if* they are comprehensive enough. Small amounts of sabotage can lower domestic real income, by raising prices without reshoring many goods.

An important overarching question for this paper is the role that geopolitical tools play for trade. Understanding the role of comparative advantage is key for evaluating these tools. That said, we abstract from the ability of Foreign to retaliate.[27] We also abstract from the domestic planner having access to standard trade instruments. A natural follow-up question would be the joint design of sabotage and tariffs, as exemplified by the CHIPS Act, which included provisions for both.

[27]One consideration is that while "trade war" is used as somewhat metaphorical phrase to describe non-cooperative tariff setting (Grossman and Helpman, 1995), a "sabotage war" may lead to actual war.

References

Adão, Rodrigo, Arnaud Costinot, and Dave Donaldson. 2017. "Nonparametric Counterfactual Predictions in Neoclassical Models of International Trade." *American Economic Review*, 107(3): 633–689.

Antràs, Pol, Stephen J Redding, and Esteban Rossi-Hansberg. 2023. "Globalization and Pandemics." *American Economic Review*, 113(4): 939–981.

Arad, Ruth W, and Arye L Hillman. 1979. "Embargo Threat, Learning and Departure from Comparative Advantage." *Journal of International Economics*, 9(2): 265–275.

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare. 2012. "New Trade Models, Same Old Gains?" *American Economic Review*, 102(1): 94–130.

Baier, Scott L, and Jeffrey H Bergstrand. 2001. "The growth of world trade: tariffs, transport costs, and income similarity." *Journal of international Economics*, 53(1): 1–27.

Balassa, Bela. 1965. "Trade liberalisation and "revealed" comparative advantage 1." *The manchester school*, 33(2): 99–123.

Bartelme, Dominick G, Arnaud Costinot, Dave Donaldson, and Andres Rodriguez-Clare. 2024. "The Textbook Case for Industrial Policy: Theory Meets Data." *Working Paper.*

Becko, John Sturm. 2024. "A Theory of Economic Sanctions as Terms-of-Trade Manipulation." *Journal of International Economics*, 103898.

Becko, John Sturm, and Daniel O'Connor. 2024. "Strategic (Dis) Integration." *Working Paper.*

Bhagwati, Jagdish, Arvind Panagariya, and Thirukodikaval N Srinivasan. 2002. "The Muddles Over Outsourcing." *Journal of Economic Perspectives*, 18(4): 93–114.

Blalock, Garrick, and Paul J Gertler. 2008. "Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers." *Journal of International Economics*, 74(2): 402–421.

Bloomberg News. 2022. "'No Possibility of Reconciliation' as US Chip Rules Slam China." *Bloomberg.*

Boehm, Christoph E, Andrei A Levchenko, and Nitya Pandalai-Nayar. 2023. "The long and short (run) of trade elasticities." *American Economic Review*, 113(4): 861–905.

Broda, Christian, and David E Weinstein. 2006. "Globalization and the Gains from Variety." *The Quarterly Journal of Economics*, 121(2): 541–585.

Bureau of Economic Analysis. 2017. "Supply-Use Tables." *https://www.bea.gov/industry/input-output-accounts-data.*

Clayton, Christopher, Matteo Maggiori, and Jesse Schreger. 2024*a*. "A Framework for Geoeconomics." *Working Paper.*

Clayton, Christopher, Matteo Maggiori, and Jesse Schreger. 2024*b*. "A Theory of Economic Coercion and Fragmentation." *Working Paper.*

Costinot, Arnaud, Dave Donaldson, Jonathan Vogel, and Ivan Werning. 2015. "Comparative Advantage and Optimal Trade Policy." *Quarterly Journal of Economics*, 130(2): 659–702.

Crosignani, Matteo, Lina Han, Marco Macchiavelli, and André F Silva. 2024. "Geopolitical Risk and Decoupling: Evidence from US Export Controls." *Federal Reserve Bank of New York Staff Reports, No. 1096.*

Dekle, Robert, Jonathan Eaton, and Samuel Kortum. 2008. "Global Rebalancing with Gravity: Measuring the Burden of Adjustment." *IMF Staff Papers*, 55(3).

De Souza, Gustavo, Naiyuan Hu, Haishi Li, and Yuan Mei. 2024. "(Trade) War and Peace: How to Impose International Trade Sanctions." *Journal of Monetary Economics*, 103572.

Dietzenbacher, Erik, Bart Los, Robert Stehrer, Marcel Timmer, and Gaaitzen J. de Vries. 2013. "The Construction of World Input-Output Tables in the WIOD Project." *Economic Systems Research*, 25(1): 71–98.

Dornbusch, Rudiger, Stanley Fischer, and Paul Anthony Samuelson. 1977. "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods." *American Economic Review*, 67(5): 823–839.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." *Econometrica*, 70(5): 1741–1779.

Eaton, Jonathan, and Samuel S Kortum. 1997. "Technology and Bilateral Trade." *Working Paper.*

Errico, Marco, and Danial Lashkari. 2024. "The Quality of US Imports and the Consumption Gains from Globalization." *Working Paper.*

Felbermayr, Gabriel, Aleksandra Kirilakha, Constantinos Syropoulos, Erdal Yalcin, and Yoto V Yotov. 2020. "The Global Sanctions Data Base." *European Economic Review*, 129: 103561.

Fujiki, Christine. 2015. "The U.S. Semiconductor Industry is one of the Most Competitive Manufacturing Industries in the United States." *Semiconductor Industry Association.*

Gervais, Antoine, and J Bradford Jensen. 2019. "The tradability of services: Geographic concentration and trade costs." *Journal of International Economics*, 118: 331–350.

Giorcelli, Michela. 2019. "The Long-Term Effects of Management and Technology Transfers." *American Economic Review*, 109(1): 121–152.

Goldberg, Pinelopi, Réka Juhász, Nathan Lane, Giulia Lo Forte, and Jeff Thurk. 2024. "Industrial Policy in the Global Semiconductor Sector." *Working Paper.*

Gomory, Ralph E, and William J Baumol. 2001. *Global Trade and Conflicting National Interests.* MIT Press.

Grant, Matthew, and Anson Soderbery. 2024. "Heteroskedastic supply and demand estimation: Analysis and testing." *Journal of International Economics*, 150: 103817.

Grossman, Alice B., Emily G. Blevins, and Karen M. Sutter. 2023. "Semiconductors and the Semiconductor Industry." *Congressional Research Service R47508.*

Grossman, Gene M, and Elhanan Helpman. 1995. "Trade Wars and Trade Talks." *Journal of Political Economy*, 103(4): 675–708.

Grossman, Gene M, Elhanan Helpman, and Hugo Lhuillier. 2023. "Supply Chain Resilience: Should Policy Promote International Diversification or Reshoring?" *Journal of Political Economy*, 131(12): 3462–3496.

Hawkins, Mackenzie, Cagan Koc, and Yuki Furukawa. 2024. "US to Seek Curbs on ASML, Tokyo Electron Support for China's AI Memory Chips." *Bloomberg.*

Head, Keith, and John Ries. 2001. "Increasing returns versus national product differentiation as an explanation for the pattern of US–Canada trade." *American Economic Review*, 91(4): 858–876.

Hicks, John R. 1953. "An Inaugural Lecture: I. Introductory Remarks. II. The Long-Run Dollar Problem." *Oxford Economic Papers*, 5(2): 117–135.

Hirschman, Albert O. 1945. *National Power and the Structure of Foreign Trade.* Univ of California Press.

Hsieh, Chang-Tai, Burn Lin, and Chintay Shih. 2024. "How America's CHIPS Act Hurts Taiwan." *Project Syndicate.*

Irwin, Douglas A. 1996. "The U.S.-Japan Semiconductor Trade Conflict." In *The Political Economy of Trade Protection.* , ed. Anne O. Krueger, 5–14. University of Chicago Press.

Irwin, Douglas A, and Peter J Klenow. 1994. "Learning-by-Doing Spillovers in the Semiconductor Industry." *Journal of Political Economy*, 102(6): 1200–1227.

Javorcik, Beata, Lucas Kitzmueller, Helena Schweiger, and Muhammed A Yıldırım. 2024. "Economic Costs of Friendshoring." *The World Economy.*

Johnson, Harry G. 1955. "Economic Expansion and International Trade 1." *The Manchester School*, 23(2): 95–112.

Johnson, Simon, Lukasz Rachel, and Catherine Wolfram. 2024. "A Theory of Price Caps on Non-Renewable Resources." *Working Paper.*

Jones, Lin, Sarah Krulikowski, Nathan Lotze, and Samantha Schreiber. 2023. "U.S. Exposure to the Taiwanese Semiconductor Industry." U.S. International Trade Commission Economics Working Paper Series 2023-11-A.

Jones, Ronald W. 1979. "Technical Progress and Real Incomes in a Ricardian Trade Model." *International Trade: Essays in Theory, Amsterdam: North-Holland.*

Jones, Ronald W, and Roy J Ruffin. 2008. "The Technology Transfer Paradox." *Journal of International Economics*, 75(2): 321–328.

Juhász, Réka, Nathan Lane, Emily Oehlsen, and Verónica C Pérez. 2023. "The Who, What, When, and How of Industrial Policy: A Text-Based Approach." *Working Paper.*

Kleinman, Benny, Ernest Liu, and Stephen J Redding. 2023. "International Friends and Enemies." *Working Paper.*

Krugman, Paul. 1980. "Scale Economies, Product Differentiation, and the Pattern of Trade." *American Economic Review*, 70(5): 950–959.

Leibovici, Fernando, and Ana Maria Santacreu. 2021. "International Trade of Essential Goods during a Pandemic." *Federal Reserve Bank of St. Louis Working Paper.*

Li, Bo, and Michela Giorcelli. 2023. "Technology Transfer and Early Industrial Development: Evidence from the Sino-Soviet Alliance." *Working Paper.*

Liu, Ernest, and David Yang. 2024. "International Power." *Working Paper.*

Liu, Qianer. 2024. "China On Cusp Of Next-Generation Chip Production Despite US Curbs." *Financial Times.*

Matsuyama, Kiminori. 2000. "A Ricardian Model with a Continuum of Goods under Nonhomothetic Preferences: Demand Complementarities, Income Distribution, and North-South Trade." *Journal of political Economy*, 108(6): 1093–1120.

Mayer, Wolfgang. 1977. "The National Defense Tariff Argument Reconsidered." *Journal of international economics*, 7(4): 363–377.

Morgan, T Clifton, Constantinos Syropoulos, and Yoto V Yotov. 2023. "Economic Sanctions: Evolution, Consequences, and Challenges." *Journal of Economic Perspectives*, 37(1): 3–29.

Opp, Marcus M. 2010. "Tariff Wars in the Ricardian Model with a Continuum of Goods." *Journal of International Economics*, 80(2): 212–225.

Raimondo, Gina M. 2023. "Statement Before the Senate Committee on Commerce, Science, and Transportation: "CHIPS and Science Implementation and Oversight"'."

Samuelson, Paul A. 2004. "Where Ricardo and Mill Rebut and Confirm Arguments of Mainstream Economists Supporting Globalization." *Journal of Economic perspectives*, 18(3): 135–146.

Semiconductor Industry Association. 2023. *Semiconductor Industry Association Factbook.* Washington, D.C.:Semiconductor Industry Association.

Simonovska, Ina, and Michael E Waugh. 2014. "Trade Models, Trade Elasticities, and the Gains From Trade." National Bureau of Economic Research.

Soderbery, Anson. 2015. "Estimating Import Supply and Demand Elasticities: Analysis and Implications." *Journal of International Economics*, 96(1): 1–17.

Sullivan, J. 2022. "Remarks by National Security Advisor Jake Sullivan at the National Security Commission on Artificial Intelligence Global Emerging Technology Summit." *https://www.whitehouse.gov/nsc/briefing-room/2021/07/13/remarks-by-national-security-advisor-jake-sullivan-at-the-national-security-commission-on-artificial-intelligence-global-emerging-technology-summit/.*

The Economist. 2024. "Russia is Ramping up Sabotage Across Europe." *The Economist.*

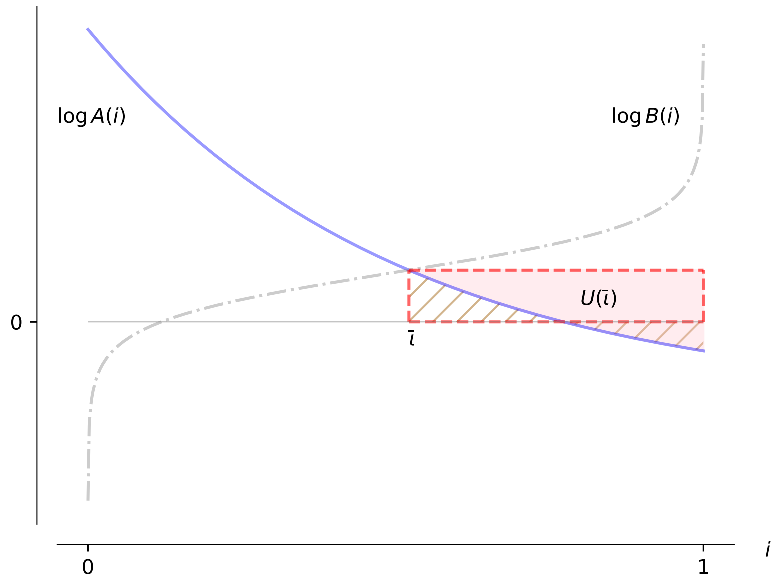
Thoenig, Mathias. 2024. "Trade Policy in the Shadow of War: A Quantitative Toolkit for Geoeconomics." *Working Paper.*

Thomas, Christopher A. 2021. "Lagging but Motivated: The State of Chinas Semiconductor Industry." *Brookings Institution.*

Traiberman, Sharon, and Martin Rotemberg. 2023. "Precautionary Protectionism." *Journal of International Economics*, 145: 103836.

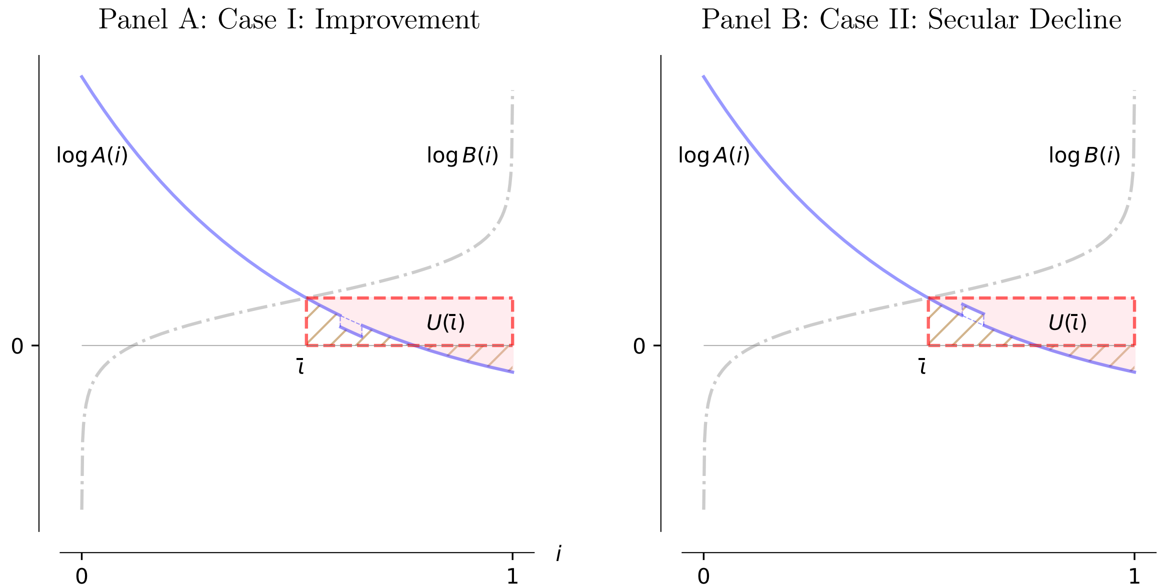
Wilson, Charles A. 1980. "On the General Structure of Ricardian Models with a Continuum of Goods: Applications to Growth, Tariff Theory, and Technical Change." *Econometrica*, 48(7): 1675–1702.

Figure 1: Depiction of the Gains From Trade



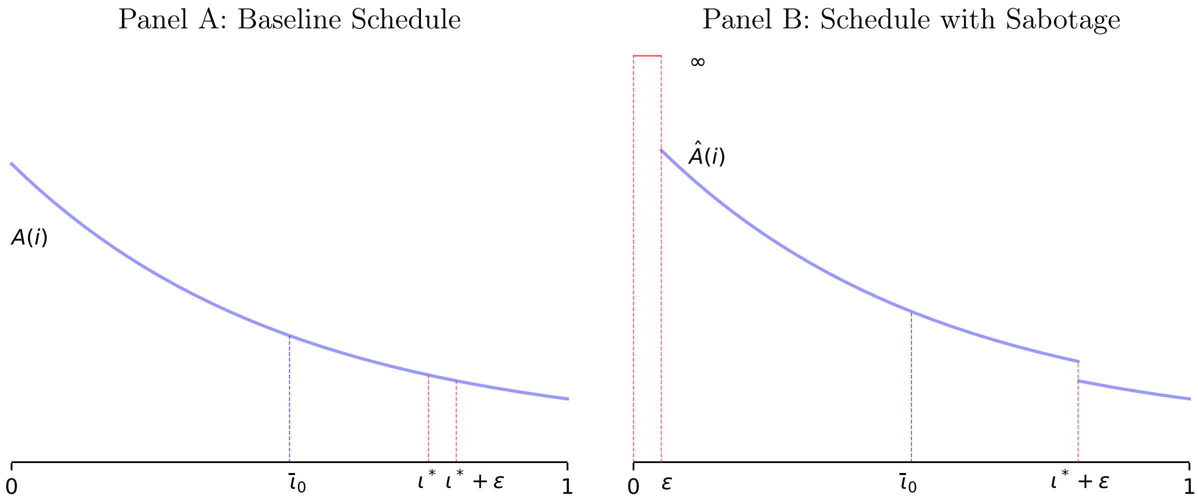
Notes: This figure visualizes the components of Home's utility function from equation (7). The log B schedule is characterized by $\log B(i) = \log\left(\frac{\ell \cdot i}{1-i}\right)$. The intersection of the log A schedule and the log B schedule determines the equilibrium cutoff $\bar{\iota}$. The red-dashed rectangle represents the relative wage component of utility, while the (signed) brown-hashed area represents the negative of the price index component. Their sum, depicted by the pink shaded area, thus captures Home's gains from trade.

Figure 2: Effects of Technology Transfer and Minor Sabotage



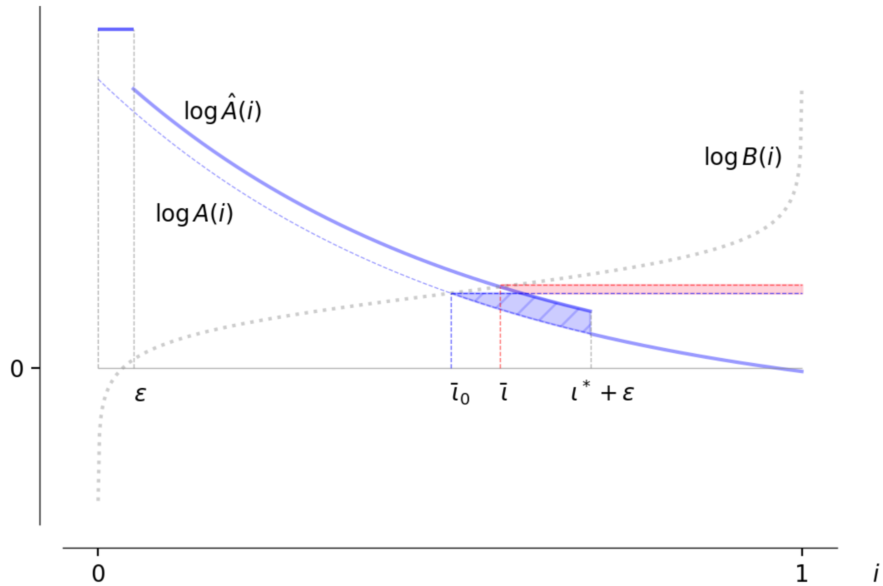
Notes: This figure illustrates the impact of the first two types of foreign productivity shocks on domestic welfare. Panel A depicts an increase in Foreign's productivity, and Panel B a secular decrease. The log B schedule is characterized by $\log B(i) = \log\left(\frac{\ell \cdot i}{1-i}\right)$. As in Figure 1, the red-dashed rectangle represents the relative wage component of utility, while the (signed) brown-hashed area represents the negative of the price index component. Their sum, depicted by the pink shaded area, thus captures Home's gains from trade.

Figure 3: Illustration of Comprehensive Sabotage



Notes: This figure demonstrates how the destruction shock affects the comparative advantage schedule. Panel A shows the original schedule A, with $\bar{\iota}^0$ as the cutoff product in the initial Laissez-Faire equilibrium. In Panel B, the destruction shock sets Foreign productivity to zero for products in the red segment, resulting in an infinite comparative advantage of Home. We reorder products in a way that the new comparative advantage schedule $\hat{A}$ is decreasing in i.

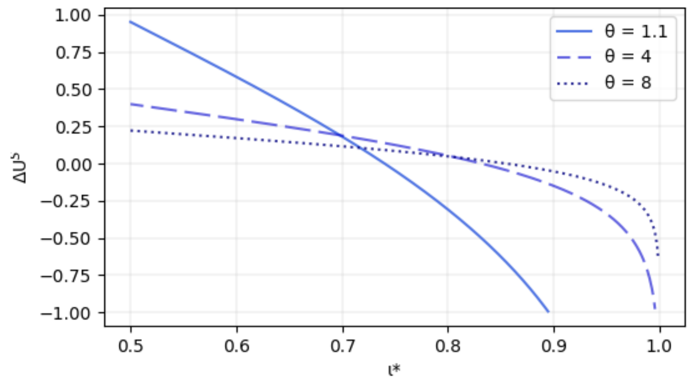
Figure 4: Effects of Comprehensive Sabotage



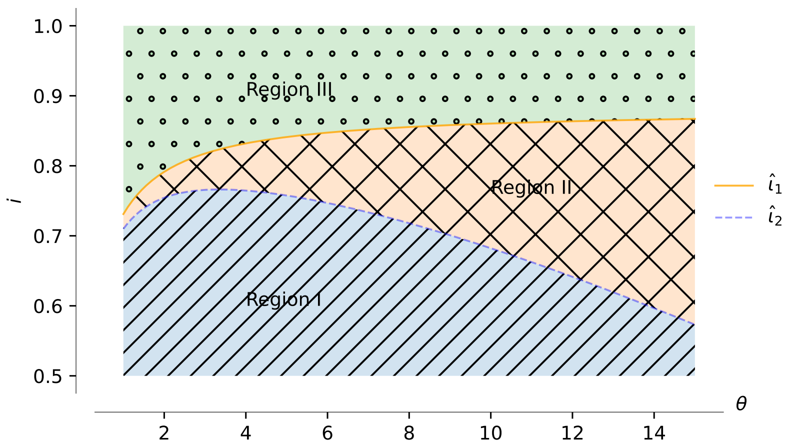
Notes: This figure illustrates effects of a policy that lowers Foreign's productivity between ι^* and $\iota^* + \epsilon$ to zero. $\log \hat{A}(i)$ is the new comparative schedule that decreases in i. The blue dashed curve is the original log comparative advantage schedule $\log A(i)$. The gray dotted curve is the log B schedule, characterized by $\log B(i) = \log\left(\frac{\ell \cdot i}{1-i}\right)$. $\bar{\iota}^0$ is the cutoff product in the initial Laissez-Faire equilibrium. $\bar{\iota}$ is the cutoff product in the new equilibrium after sabotage. The red shaded area represents the benefits, while the blue shaded and hatched area indicates the losses, of comprehensive sabotage.

Figure 5: Depiction of the Fréchet Cases

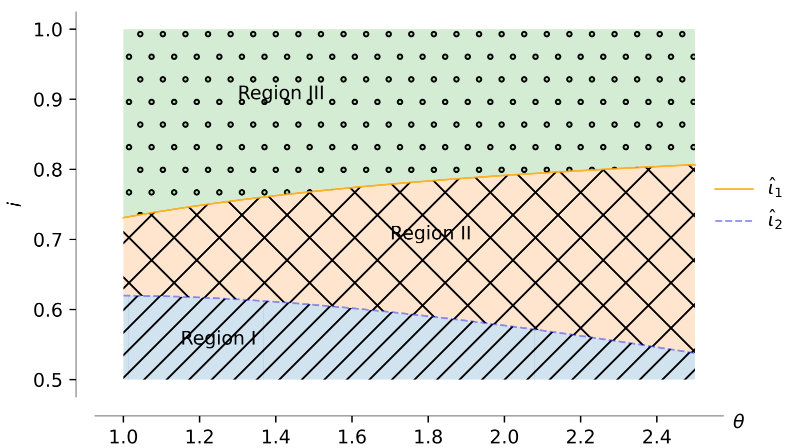
Panel A: Gains from Sabotage



Panel B: Small Technology Transfer

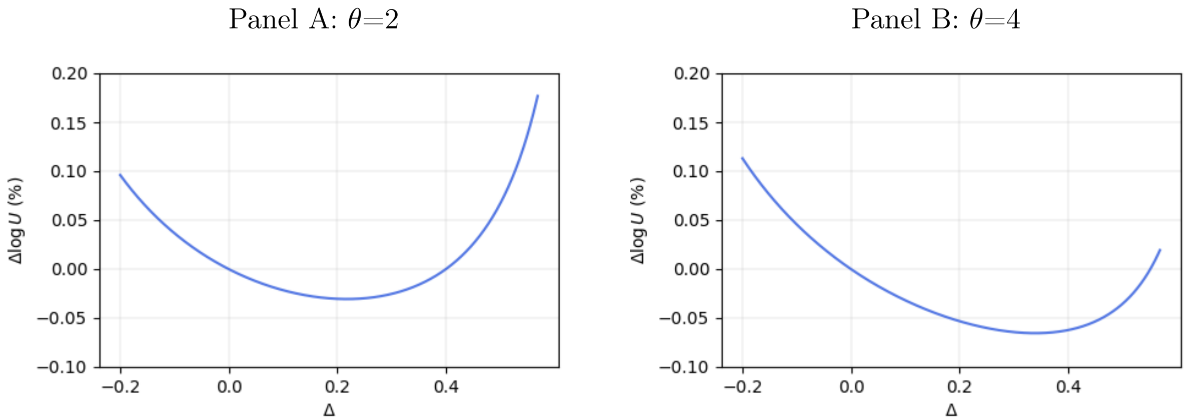


Panel C: Large Technology Transfer



Notes: Panel A demonstrates how the gains from sabotage change with ι^* under different values of θ for the Fréchet case. Panels B and C illustrate the changes in cutoff products as θ increases with proportional technology transfer, following equation (20). The solid orange curve represents the cutoff product $\hat{\iota}_1$, at which Home is indifferent between comprehensive sabotage and taking no action. The dashed blue curve indicates the cutoff product $\hat{\iota}_2$, at which Home is indifferent between comprehensive sabotage and technology transfer. The blue, line-hatched area represents "Region I," where comprehensive sabotage is preferred over technology transfer. The orange, cross-hatched area denotes "Region II," where comprehensive sabotage is worse than technology transfer but better than taking no action. The green, circle-hatched area represents "Region III," where comprehensive sabotage is worse than taking no action. Panel A shows the case for small technology transfers, while Panel B shows the case for large technology transfers.

Figure 6: Gains From Sabotaging Foreign Chips



Notes: This figure shows the calibrated effect (positive values on the y-axis for gains and negative values for losses) of sabotaging the semiconductor industry, as in Equation (23). Panel A presents the effect of sabotage when $\theta = 2$, and Panel B presents the effect when $\theta = 4$. A value of $\Delta < 0$ indicates technology transfer (as Home's import share increases), while $\Delta > 0$ indicates sabotage. By construction, Δ cannot exceed 0.57, which is the current import share for the sector.

Table 1: Effects of Sabotage at $\theta = 2.0$

Industry	ToT Gain	Efficiency Cost	Net
Agriculture			
Crop and animal production	0.71	0.08	0.63
Forestry and logging	0.75	0.08	0.67
Fishing and aquaculture	0.75	0.46	0.29
Manufacturing			
Mining and quarrying	0.75	0.29	0.46
Food products, beverages, and tobacco products	0.71	0.06	0.64
Textiles, wearing apparel, and leather products	0.83	0.33	0.50
Wood, and products of wood and cork	0.72	0.09	0.64
Paper and paper products	0.71	0.06	0.65
Coke and refined petroleum products	0.69	0.32	0.37
Chemicals and chemical products	0.72	0.25	0.47
Pharmaceutical products	0.72	0.35	0.37
Rubber and plastic products	0.73	0.09	0.63
Other non-metallic mineral products	0.73	0.07	0.66
Basic metals	0.75	0.16	0.59
Fabricated metal products	0.72	0.06	0.66
Computer, electronic, and optical products	0.78	0.22	0.56
Electrical equipment	0.79	0.21	0.58
Machinery and equipment n.e.c.	0.74	0.07	0.66
Motor vehicles, trailers, and semi-trailers	0.75	0.22	0.53
Other transport equipment	0.65	0.04	0.61
Furniture; other manufacturing	0.73	0.13	0.61
Services			
Waste management	0.70	0.08	0.62
Air transport	0.67	0.11	0.56
Architectural and engineering activities	0.68	0.02	0.66
Advertising and market research	0.68	0.05	0.63
Other professional, scientific, and technical activities	0.71	0.03	0.68
Administrative and support service activities	0.70	0.04	0.66

This table quantifies Equation (23), as discussed in the text. For each WIOD industry, the first column shows the pass-through of comprehensive sabotage to the terms of trade, the second column the passthrough to the increase in the price index, and the third column shows the net effect on real income. We assume for this table that $\theta = 2$, as in Boehm, Levchenko and Pandalai-Nayar (2023).

Table 2: Effects of Sabotage at $\theta = 4.0$

Industry	ToT Gain	Efficiency Cost	Net
Agriculture			
Crop and animal production	0.40	0.08	0.31
Forestry and logging	0.42	0.08	0.34
Fishing and aquaculture	0.42	0.46	-0.05
Manufacturing			
Mining and quarrying	0.42	0.29	0.13
Food products, beverages, and tobacco products	0.40	0.06	0.33
Textiles, wearing apparel, and leather products	0.47	0.33	0.13
Wood, and products of wood and cork	0.40	0.09	0.32
Paper and paper products	0.39	0.06	0.33
Coke and refined petroleum products	0.39	0.32	0.07
Chemicals and chemical products	0.40	0.25	0.15
Pharmaceutical products	0.40	0.35	0.05
Rubber and plastic products	0.41	0.09	0.31
Other non-metallic mineral products	0.41	0.07	0.34
Basic metals	0.42	0.16	0.26
Fabricated metal products	0.40	0.06	0.34
Computer, electronic, and optical products	0.43	0.22	0.21
Electrical equipment	0.44	0.21	0.23
Machinery and equipment n.e.c.	0.41	0.07	0.34
Motor vehicles, trailers, and semi-trailers	0.42	0.22	0.20
Other transport equipment	0.36	0.04	0.33
Furniture; other manufacturing	0.41	0.13	0.28
Services			
Waste management	0.39	0.08	0.31
Air transport	0.38	0.11	0.26
Architectural and engineering activities	0.38	0.02	0.36
Advertising and market research	0.38	0.05	0.33
Other professional, scientific, and technical activities	0.40	0.03	0.37
Administrative and support service activities	0.39	0.04	0.35

This table quantifies Equation (23), as discussed in the text. For each WIOD industry, the first column shows the pass-through of comprehensive sabotage to the terms of trade, the second column the passthrough to the increase in the price index, and the third column shows the net effect on real income. We assume for this table that $\theta = 4$, as in Simonovska and Waugh (2014).

Online Appendices

A Proof of Theorem 1: Increasing and Decreasing Foreign Productivity Can Both Increase Domestic Real Income

Proposition 1. *Under comprehensive sabotage, for ι^* right locally to $\bar{\iota}^0$ (including $\bar{\iota}^0$ itself),* $\frac{dU(\epsilon;\iota^*)}{d\epsilon}\Big|_{\epsilon=0} > 0$.

Proof. First, noting that $\bar{\iota}$ is an equilibrium object that changes with ϵ, we differentiate Equation (11) to arrive at :

$$\begin{aligned}\frac{dU(\epsilon;\iota^*)}{d\epsilon} &= (1-\bar{\iota})\frac{A'(\bar{\iota}-\epsilon)}{A(\bar{\iota}-\epsilon)}\left(\frac{d\bar{\iota}}{d\epsilon}-1\right) \\ &- \frac{d\bar{\iota}}{d\epsilon}\log A(\bar{\iota}-\epsilon) \\ &+ \log A(\bar{\iota}-\epsilon)\left(\frac{d\bar{\iota}}{d\epsilon}-1\right) + \log A(\iota^*+\epsilon). \end{aligned} \tag{22}$$

To prove Proposition 1, we rearrange (22) as follows:

$$\frac{dU}{d\epsilon} = (1-\bar{\iota})\frac{A'(\bar{\iota}-\epsilon)}{A(\bar{\iota}-\epsilon)}\left(\frac{d\bar{\iota}}{d\epsilon}-1\right) - \log\frac{A(\bar{\iota}-\epsilon)}{A(\iota^*+\epsilon)}.$$

The second term is negative because $\bar{\iota}-\epsilon < \bar{\iota}^0 \leq \iota^* < \iota^*+\epsilon$, while the first term will soon be proved positive.

To do that, completely differentiate the equilibrium condition (10) on wages to get

$$(1-\bar{\iota})A'(\bar{\iota}-\epsilon)\left(\frac{d\bar{\iota}}{d\epsilon}-1\right) - [A(\bar{\iota}-\epsilon)+\ell]\frac{d\bar{\iota}}{d\epsilon} = 0.$$

Rearranging to solve for the derivative:

$$\frac{d\bar{\iota}}{d\epsilon} = \frac{(1-\bar{\iota})A'(\bar{\iota}-\epsilon)}{(1-\bar{\iota})A'(\bar{\iota}-\epsilon)-[A(\bar{\iota}-\epsilon)+\ell]}. \tag{23}$$

Plugging this into the expression for the derivative of U:

$$\begin{aligned}\frac{dU(\epsilon;\iota^*)}{d\epsilon} =&(1-\bar{\iota})\frac{A'(\bar{\iota}-\epsilon)}{A(\bar{\iota}-\epsilon)}\frac{A(\bar{\iota}-\epsilon)+\ell}{(1-\bar{\iota})A'(\bar{\iota}-\epsilon)-[A(\bar{\iota}-\epsilon)+\ell]} - \log\frac{A(\bar{\iota}-\epsilon)}{A(\iota^*+\varepsilon)} \\ =&\frac{1}{\bar{\iota}}\frac{(1-\bar{\iota})A'(\bar{\iota}-\epsilon)}{(1-\bar{\iota})A'(\bar{\iota}-\epsilon)-[A(\bar{\iota}-\epsilon)+\ell]} - \log\frac{A(\bar{\iota}-\epsilon)}{A(\iota^*+\epsilon)},\end{aligned}$$

where the second line follows from plugging in the equilibrium condition (10). Define $\eta = \left|\frac{d\log A}{d\log i}\right|^{-1}$ to be the inverse elasticity of the comparative advantage schedule with respect to

i. Plugging this definition into the above yields,

$$\frac{dU(\epsilon;\iota^*)}{d\epsilon} = \frac{1}{\bar{\iota} + \frac{\bar{\iota}-\epsilon}{1-\bar{\iota}} \times \eta(\bar{\iota}-\epsilon)} - \log \frac{A(\bar{\iota}-\epsilon)}{A(\iota^*+\epsilon)}.$$

At $\epsilon = 0$, $\bar{\iota} = \bar{\iota}^0$. Evaluating the derivative at this point, we have

$$\left.\frac{dU(\epsilon;\iota^*)}{d\epsilon}\right|_{\epsilon=0} = \frac{1}{\bar{\iota}^0 + \frac{\bar{\iota}^0}{1-\bar{\iota}^0} \times \eta(\bar{\iota}^0)} - \log \frac{A(\bar{\iota}^0)}{A(\iota^*)}.$$

The first term is positive as long as the comparative advantage schedule is not horizontal (i.e., $\eta(\bar{\iota}^0)$ is finite). The second term starts as 0 when $\bar{\iota}^0 = \iota^*$ and decreases as ι^* increases. Therefore, for ι^* not too big, the positive term dominates, and $\left.\frac{dU(\epsilon;\iota^*)}{d\epsilon}\right|_{\epsilon=0} > 0$. □

Now we present the proof of Theorem 1.

Proof. Notice that when $\epsilon = 0$, the destruction shock applies to only an infinitesimal mass of products, leaving the equilibrium unaffected. And so, $U(\epsilon = 0;\iota^*)$ equals the Laissez-Faire utility for any values of ι^*. Combining this with Proposition 1, we have that $U(\epsilon;\iota^*) > U(\bar{\iota}^0)$ for some small ϵ. This completes the proof for the first part of the theorem. The second part follows from the discussion for Case I in Section III.B. □

B Variable β Case

In this section, we consider the general case where β_i varies across goods. The equilibrium condition without sabotage is:

$$A(\bar{\iota}_0) \times \int_{\bar{\iota}_0}^{1} \beta(i)di - \ell \int_0^{\bar{\iota}_0} \beta(i)di = 0.$$

Now suppose that sabotage of size ϵ takes place on the point ι^*. We will assume that $\bar{\iota} \leq \iota^* + \epsilon$ and verify that this will be the case, at least for small ϵ. The equilibrium after sabotage is given by,

$$A(\bar{\iota}-\epsilon) \times \left[\int_{\bar{\iota}}^{\iota^*+\epsilon} \beta(i-\epsilon)di + \int_{\iota^*+\epsilon}^{1} \beta(i)di\right] - \ell\left[1 - \int_{\bar{\iota}}^{\iota^*+\epsilon} \beta(i-\epsilon)di - \int_{\iota^*+\epsilon}^{1} \beta(i)di\right] = 0,$$

where we have rewritten Foreign's import share as one minus Home's import share. Rearranging,

$$(A(\bar{\iota}-\epsilon)+\ell) \times \left[\int_{\bar{\iota}-\epsilon}^{\iota^*} \beta(i)di + \int_{\iota^*+\epsilon}^{1} \beta(i)di\right] = \ell.$$

Differentiating with respect to ϵ yields,

$$\begin{aligned} 0 =& A'(\bar{\iota}-\epsilon)\left(\frac{d\bar{\iota}}{d\epsilon} - 1\right) \times \left[\int_{\bar{\iota}}^{\iota^*} \beta(i-\epsilon)di + \int_{\iota^*+\epsilon}^{1} \beta(i)di\right] + \\ & (A(\bar{\iota}-\epsilon)+\ell) \times \left[-\beta(\bar{\iota}-\epsilon) \times \left(\frac{d\bar{\iota}}{d\epsilon} - 1\right) - \beta(\iota^*+\epsilon)\right]. \end{aligned}$$

Rearranging,

$$\frac{d\bar{\iota}}{d\epsilon} = \frac{A'(\bar{\iota}-\epsilon)\Phi_H(\iota^*,\bar{\iota},\epsilon) + (\beta(\iota^*+\epsilon)-\beta(\bar{\iota}-\epsilon))(A(\bar{\iota}-\epsilon)+\ell)}{A'(\bar{\iota}-\epsilon)\Phi_H(\iota^*,\bar{\iota},\epsilon) - \beta(\bar{\iota}-\epsilon)(A(\bar{\iota}-\epsilon)+\ell)}, \tag{24}$$

where Φ_H is Home's import share. Notice that if $\beta = 1\ \forall i$ then Equation (24) reduces to Equation (23). In general, Equation (24) is not signed. If demand near the point of marginal sabotage is very large relative to demand near the new equilibrium cutoff, then this number may be negative. Graphically, this is because the B schedule may shift to the left so much that after shifting the A schedule rightward, the new equilibrium cutoff point is still to the left. Note that this would still increase the terms of trade through the effect on the B schedule. Regardless, the derivative is strictly bounded by 1, so that the new cutoff shifts out strictly less than ϵ, verifying our conjecture that $\bar{\iota}+\epsilon < \iota^*+\epsilon$, even if $\iota^* = \bar{\iota}_0$.

To understand the conditions under which sabotage can raise real income, we consider the same limiting argument as before and take $\epsilon \to 0$. Taking this limit yields,

$$\left.\frac{d\bar{\iota}}{d\epsilon}\right|_{\epsilon=0} = \frac{A'(\bar{\iota}_0)\Phi_H(\bar{\iota}_0) + (\beta(\iota^*)-\beta(\bar{\iota}_0))\,(A(\bar{\iota}_0)+\ell)}{A'(\bar{\iota}_0)\Phi_H(\bar{\iota}_0) - \beta(\bar{\iota}_0)(A(\bar{\iota}_0)+\ell)}.$$

If $\iota^* = \bar{\iota}_0$ then the new term in the numerator disappears and this is almost exactly the same as the case for $\beta = 1$ except for the presence of $\beta(\bar{\iota}_0)$ in the denominator. This adjusts the change in the cutoff for the shift in the B schedule. If β is very large at the initial cutoff, then the cutoff shifts less—this is because the marginal good requires a good deal of resources to manufacture at Home, so not many goods can be "taken." On the other hand, if β is very large at the initial cutoff, the derivative becomes close to 1, suggesting as much expenditure is taken as sabotaged since it requires very few resources to shift the marginal products home. Welfare is given by

$$U(\epsilon;\iota^*) = \log A(\bar{\iota}-\epsilon)\times\left[\int_{\bar{\iota}-\epsilon}^{\iota^*}\beta(i)di + \int_{\iota^*+\epsilon}^{1}\beta(i)di\right] - \int_{\bar{\iota}-\epsilon}^{\iota^*}\beta(i)\log A(i)di - \int_{\iota^*+\epsilon}^{1}\beta(i)\log A(i)di.$$

Differentiating with respect to ϵ yields :

$$\begin{aligned}\frac{dU}{d\epsilon} =& \frac{A'(\bar{\iota}-\epsilon)\Phi_H(\iota^*,\bar{\iota},\epsilon)}{A(\bar{\iota}-\epsilon)} \times \left(\frac{d\bar{\iota}}{d\epsilon}-1\right) + \log A(\bar{\iota}-\epsilon)\times\left[\beta(\bar{\iota}-\epsilon) - \beta(\bar{\iota}-\epsilon)\frac{d\bar{\iota}}{d\epsilon} - \beta(\iota^*+\epsilon)\right] + \\ & \beta(\bar{\iota}-\epsilon)\log A(\bar{\iota}-\epsilon)\left(\frac{d\bar{\iota}}{d\epsilon}-1\right) + \beta(\iota^*+\epsilon)\log A(\iota^*+\epsilon) \\ =& \frac{A'(\bar{\iota}-\epsilon)\Phi_H(\iota^*,\bar{\iota},\epsilon)}{A(\bar{\iota}-\epsilon)} \times \left(\frac{d\bar{\iota}}{d\epsilon}-1\right) - \beta(\iota^*+\epsilon)\log\left[\frac{A(\bar{\iota}-\epsilon)}{A(\iota^*+\epsilon)}\right].\end{aligned}$$

This is similar to the expression for $\beta = 1$ except that now the second term is multiplied by $\beta(\iota^*+\epsilon)$. This second term is the cost of doing sabotage—it reflects the relative resource cost at the new equilibrium of shifting ι^* Home. The first term reflects the gain in ToT and is always positive. If we take the limit to $\epsilon \to 0$ we have,

$$\frac{dU}{d\epsilon}\Big|_{\epsilon=0} = \beta(\iota^*)\left[\frac{1}{A(\bar{\iota}_0)}\frac{A'(\bar{\iota}_0)\Phi_H(\bar{\iota}_0)(A(\bar{\iota}_0)+\ell)}{A'(\bar{\iota}_0)\Phi_H(\bar{\iota}_0)-\beta(\bar{\iota}_0)(A(\bar{\iota}_0)+\ell)} - \log\left(\frac{A(\bar{\iota}_0)}{A(\iota^*)}\right)\right].$$

1. For ι^* near $\bar{\iota}_0$, sabotage will always improve Home's real national income.
2. Only demand near the cutoff matters for determining the region where a small amount of sabotage is beneficial.

C CES Preferences

In this section we extend the framework to allow for more general CES preferences. Let σ be the elasticity of substitution. For any amount of sabotage at the point ι^*, including $\epsilon = 0$, we have the following expression for the price index:

$$P = \Bigg(\omega^{1-\sigma}\left\{\int_0^{\epsilon}\beta(\iota^*+i)a(\iota^*+i)^{1-\sigma}di + \int_0^{\bar{\iota}_1-\epsilon}\beta(i)a(i)^{1-\sigma}di\right\} + \int_{\bar{\iota}_1-\epsilon}^{\iota^*}\beta(i)a^*(i)^{1-\sigma}di + \int_{\iota^*+\epsilon}^{1}\beta(i)a^*(i)^{1-\sigma}di + \Bigg)^{1/(1-\sigma)}$$

To keep the derivations organized, define the first term in brackets to be N_H and the second term in brackets to be N_D so that, $P = (\omega^{1-\sigma}N_H + N_F)^{1/(1-\sigma)}$. Similarly, $P_H = \omega N_H^{1/(1-\sigma)}$ and $P_F = N_D^{1/(1-\sigma)}$. To begin the derivations, we begin with utility to identify those objects we will need to better understand in equilibrium, then turn to equilibrium equations and their derivatives with respect to ϵ. Log utility is now given by

$$\log U = \log\omega - \frac{1}{1-\sigma}\left(\omega^{1-\sigma}N_H + N_F\right).$$

Differentiating with respect to ϵ yields,

$$\begin{aligned}
\frac{d\log U}{d\epsilon} =& \frac{d\log\omega}{d\epsilon} - \\
& \frac{1}{1-\sigma}\times\frac{1}{P^{1-\sigma}}\times\left\{(1-\sigma)\omega^{-\sigma}N_H\frac{d\log\omega}{d\epsilon} + \omega^{1-\sigma}\frac{dN_H}{d\epsilon} + \frac{dN_F}{d\epsilon}\right\} \\
=& \frac{d\log\omega}{d\epsilon}\times\left(1 - \frac{\omega^{1-\sigma}N_H}{P^{1-\sigma}}\right) - \frac{1/(1-\sigma)}{P^{1-\sigma}}\times\left\{\omega^{1-\sigma}\frac{dN_H}{d\epsilon} + \frac{dN_F}{d\epsilon}\right\} \\
=& \Phi_H\frac{d\log\omega}{d\epsilon} - \\
& \frac{1/(1-\sigma)}{P^{1-\sigma}}\times\Bigg\{\omega^{1-\sigma}\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)^{1-\sigma} + \omega^{1-\sigma}\beta(\bar{\iota}_1-\epsilon)a(\bar{\iota}_1-\epsilon)^{1-\sigma}\times\left[\frac{d\bar{\iota}_1}{d\epsilon} - 1\right] - \\
& \beta(\bar{\iota}_1-\epsilon)a^*(\bar{\iota}_1-\epsilon)^{1-\sigma}\times\left[\frac{d\bar{\iota}_1}{d\epsilon} - 1\right] - \beta(\iota^*+\epsilon)a^*(\iota^*+\epsilon)^{1-\sigma}\Bigg\} \\
=& \Phi_H\frac{d\log\omega}{d\epsilon} - \frac{1/(1-\sigma)}{P^{1-\sigma}}\times\Big\{\beta(\iota^*+\epsilon)(\omega^{1-\sigma}(a(\iota^*+\epsilon)^{1-\sigma} - a^*(\iota^*+\epsilon)^{1-\sigma}) +
\end{aligned}$$

$$\beta(\bar{\iota}_1-\epsilon)\times\left[\frac{d\bar{\iota}_1}{d\epsilon}-1\right]\times\underbrace{\left(\omega^{1-\sigma}a(\bar{\iota}_1-\epsilon)^{1-\sigma}-a^*(\bar{\iota}_1-\epsilon)^{1-\sigma}\right)}_{=0}\Bigg\}$$

$$=\Phi_H\frac{d\log\omega}{d\epsilon}-\frac{\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)^{1-\sigma}\omega^{1-\sigma}}{P^{1-\sigma}}\times\frac{1-\left(\frac{A(\iota^*)}{A(\bar{\iota}_1-\epsilon)}\right)^{1-\sigma}}{1-\sigma},$$

where the penultimate line and the final substitution both exploit the equilibrium condition that $A(\bar{\iota}_1-\epsilon)=\omega$. The expression above is a natural extension of the Cobb-Douglas case. The first term remains the change in the terms of trade multiplied by the import share. The second term is now the expenditure share (valued at Home prices) spent on the sabotaged good—reducing to $\beta(\iota^*)$ if $\sigma=1$—multiplied by a cost term that depend on the ratio of comparative advantage at the point of sabotage to the equilibrium cutoff—simplifying to $\log A(\bar{\iota}_1-\epsilon)/A(\iota^*)$ if $\sigma=1$ (with the limit coming from above as $\sigma>1$).

To solve for $\frac{d\log\omega}{d\epsilon}$ we take the derivatives of several equilibrium conditions. First, turning to the optimal sourcing condition, we have,

$$A(\bar{\iota}_1-\epsilon)=\omega.$$

This is exactly as before, and yields the convenient identity:

$$\frac{d\iota_1}{d\epsilon}-1=-\eta(\iota_1-\epsilon)\frac{d\log\omega}{d\epsilon},$$

where $\eta=|A'/A|^{-1}$. Equilibrium is the same as before,

$$\omega/\ell=\frac{1-\Phi_H}{\Phi_H}.$$

With CES preferences we have that,

$$\frac{1-\Phi_H}{\Phi_H}=\frac{\omega^{1-\sigma}N_H}{N_F}.$$

Hence,

$$\omega^\sigma/\ell=\frac{N_H}{N_F}.$$

And so,

$$\begin{aligned}\sigma\frac{d\log\omega}{d\epsilon}=&\frac{1}{N_H}\frac{dN_H}{d\epsilon}-\frac{1}{N_F}\frac{dN_F}{d\epsilon}\\=&\frac{1}{N_H}\times\left(\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)^{1-\sigma}+\beta(\bar{\iota}_1-\epsilon)a(\bar{\iota}_1-\epsilon)^{1-\sigma}\times\left[\frac{d\bar{\iota}_1}{d\epsilon}-1\right]\right)-\\&\frac{1}{N_F}\times\left(-\beta(\bar{\iota}_1-\epsilon)a^*(\bar{\iota}_1-\epsilon)^{1-\sigma}\times\left[\frac{d\bar{\iota}_1}{d\epsilon}-1\right]-\beta(\iota^*+\epsilon)a^*(\iota^*+\epsilon)^{1-\sigma}\right)\\=&\frac{1}{N_H}\times\Bigg\{\beta(\iota^*+\epsilon)\left[a(\iota^*+\epsilon)^{1-\sigma}+a^*(\iota^*+\epsilon)^{1-\sigma}\frac{N_H}{N_F}\right]+\end{aligned}$$

$$\beta(\iota_1-\epsilon)\left[a(\bar{\iota}_1-\epsilon)^{1-\sigma}+a^*(\bar{\iota}_1-\epsilon)^{1-\sigma}\frac{N_H}{N_F}\right]\times\left[\frac{d\bar{\iota}_1}{d\epsilon}-1\right]\Bigg\}$$

$$=\frac{1}{N_H}\times\Bigg\{\beta(\iota^*+\epsilon)\left[a(\iota^*+\epsilon)^{1-\sigma}+a^*(\iota^*+\epsilon)^{1-\sigma}\frac{N_H}{N_F}\right]-$$

$$\beta(\iota_1-\epsilon)\left[a(\bar{\iota}_1-\epsilon)^{1-\sigma}+a^*(\bar{\iota}_1-\epsilon)^{1-\sigma}\frac{N_H}{N_F}\right]\times\eta(\iota_1-\epsilon)\frac{d\log\omega}{d\epsilon}\Bigg\}$$

$$=\frac{1}{N_H}\times\Bigg\{\beta(\iota^*+\epsilon)\left[a(\iota^*+\epsilon)^{1-\sigma}+a^*(\iota^*+\epsilon)^{1-\sigma}\frac{N_H}{N_F}\right]-$$

$$\beta(\iota_1-\epsilon)a(\bar{\iota}_1-\epsilon)^{1-\sigma}\left[1+A(\bar{\iota}_1-\epsilon)^{1-\sigma}\frac{N_H}{N_F}\right]\times\eta(\iota_1-\epsilon)\frac{d\log\omega}{d\epsilon}\Bigg\}.$$

Using the fact that $A(\bar{\iota}_1-\epsilon)=\omega$ in equilibrium, and trade balance, we can rearrange this expression to,

$$\frac{d\log\omega}{d\epsilon}=\frac{\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)\left(1+A(\iota^*+\epsilon)^{1-\sigma}\frac{\omega^\sigma}{\ell}\right)}{N_H\sigma+\beta(\iota_1-\epsilon)a(\iota_1-\epsilon)^{1-\sigma}\eta(\iota_1-\epsilon)\left(1+\frac{\omega}{\ell}\right)}.$$

At first glance this expression is unwieldy. However, it will have a convenient interpretation once we substitute in the appropriate trade elasticity. The ratio of imports to domestic absorption is given by,

$$\frac{\Phi_H}{1-\Phi_H}=\frac{N_D}{\omega^{1-\sigma}N_H}.$$

Recall that the trade elasticity is the partial elasticity of this ratio with respect to to an *exogenous* shock to relative prices, ω. In any equilibrium we have, $N_F=\int_{A^{-1}(\omega)}^1\beta(i)a^*(i)^{1-\sigma}di$ and $N_H=\int_0^{A^{-1}(\omega)}\beta(i)a(i)^{1-\sigma}di$, with a,a^* and β properly redefined in the case of a shock—for the purposes of the trade elasticity explicitly rewriting out the redefinition will be irrelevant. Taking the logarithm, we have,

$$\frac{\partial\log{}^{\Phi_H}/_{1-\Phi_H}}{\partial\omega}=\frac{\sigma-1}{\omega}-\frac{1}{N_F}\beta(\bar{\iota})a^*(\bar{\iota})^{1-\sigma}\frac{1}{A'(\bar{\iota})}-\frac{1}{N_H}\beta(\bar{\iota})a(\bar{\iota})^{1-\sigma}\frac{1}{A'(\bar{\iota})}.$$

Rearranging we have,

$$\theta\equiv\frac{\partial\log{}^{\Phi_H}/_{1-\Phi_H}}{\partial\log\omega}=(\sigma-1)+\beta(\bar{\iota})a(\bar{\iota})^{1-\sigma}\eta(\bar{\iota})\times\left(1+\frac{\omega}{\ell}\right)\frac{1}{N_H},$$

where we exploit that $A(\bar{\iota})^{1-\sigma}N_H/N_F=\omega^{1-\sigma}N_H/N_F-\omega/\ell$. Hence,

$$N_H\times(\theta-\sigma+1)=\beta(\bar{\iota})a(\bar{\iota})^{1-\sigma}\eta(\bar{\iota})\times\left(1+\frac{\omega}{\ell}\right).$$

Plugging this back into the expression for the change in log relative wages yields,

$$\frac{d\log\omega}{d\epsilon}=\frac{\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)\left(1+A(\iota^*+\epsilon)^{1-\sigma}\frac{\omega^\sigma}{\ell}\right)}{N_H(1+\theta)}.$$

To finalize our expression, we note that $1/N_H = \omega^{1-\sigma}/P^{1-\sigma} \times 1/(1-\Phi_H)$. Hence,

$$\frac{d\log\omega}{d\epsilon} = \frac{\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)\omega^{1-\sigma}}{P^{1-\sigma}} \frac{\left(1 + A(\iota^*+\epsilon)^{1-\sigma}\frac{\omega^\sigma}{\ell}\right)}{(1-\Phi_H)(1+\theta)}.$$

Finally we can plug this back into the utility expression, yielding:

$$\frac{d\log U}{d\epsilon} = \frac{\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)\omega^{1-\sigma}}{P^{1-\sigma}} \times \left\{ \frac{\Phi_H + \Phi_H A(\iota^*+\epsilon)^{1-\sigma}\frac{\omega^\sigma}{\ell}}{(1-\Phi_H)(1+\theta)} - \frac{1 - \left(\frac{A(\iota^*)}{A(\bar{\iota}_1-\epsilon)}\right)^{1-\sigma}}{1-\sigma} \right\}.$$

To arrive at our final expression, we substitute in that $\omega = A(\bar{\iota}_1 - \epsilon)$ and that $\omega/\ell = (1-\Phi_H)/\Phi_H$. And so,

$$\frac{d\log U}{d\epsilon} = \underbrace{\frac{\beta(\iota^*+\epsilon)a(\iota^*+\epsilon)\omega^{1-\sigma}}{P^{1-\sigma}}}_{\text{Expenditure Shift}} \times \left\{ \underbrace{\frac{\Phi_H + (1-\Phi_H)\left(\frac{A(\iota^*+\epsilon)}{A(\bar{\iota}_1-\epsilon)}\right)^{1-\sigma}}{(1-\Phi_H)(1+\theta)}}_{\text{Sufficient Statistic}} - \underbrace{\frac{1-\left(\frac{A(\iota^*+\epsilon)}{A(\bar{\iota}_1-\epsilon)}\right)^{1-\sigma}}{1-\sigma}}_{\text{Productivity Loss}} \right\}. \tag{25}$$

The expenditure shift has the same interpretation as in Equation (15): the expenditure share on the newly sabotaged good (valued at Home prices). The final term is the productivity loss from sabotage, and converges to $\log A(\bar{\iota}_1-\epsilon)/A(\iota^*+\epsilon)$ as $\sigma \to 1$. The sufficient statistic term captures the terms of trade gains from sabotage. If $\sigma = 1$, this collapses exactly to the same expression as in the Cobb Douglas case, where the sufficient statistics are the import share and the trade elasticity. With more general CES preferences, one also needs to know the elasticity of substitution and the change in relative unit costs that will occur between the sabotaged good and the transferred good. While in the CES case the comparative advantage terms now show up in the terms of trade gains, relative to the Cobb-Douglas case, the only additional parameter needed to measure the net gains from sabotage is the elasticity of substitution.

Note that in the special case where the sabotaged good is the good right on the comparative advantage cutoff ($\iota^* = \bar{\iota}_0$), the comparative advantage term cancels from the sufficient statistic and it collapses to the term in the Cobb-Douglas case.

However, while our initial approach is not quite salvaged we can *still* write the expression as the difference of two terms (now setting $\epsilon = 0$):

1. A term that depends *only* on observable aggregate quantities and the trade elasticity
2. A term that depends *only* on the change in relative prices, $[A(\iota^*)/A(\iota_0)]^{1-\sigma}$, and parameters.

Specifically we can write

$$\left.\frac{d\log U}{d\epsilon}\right|_{\epsilon=0} = \frac{\beta(\iota^*)a(\iota^*)\omega^{1-\sigma}}{P^{1-\sigma}} \times \left\{ \frac{\Phi_H}{(1-\Phi_H)(1+\theta)} - \left(\frac{A(\iota^*)}{A(\bar{\iota}_0)}\right)^{1-\sigma} \frac{(1+\theta-\sigma)+1}{(\sigma-1)(1+\theta)} + \frac{1}{\sigma-1} \right\}. \tag{26}$$

The first term in braces is obviously positive. If $1+\theta > \sigma$,[28] then whether the second term is positive or negative depends on whether $A(\iota^*)/A(\bar{\iota}_0)$ is larger than a cutoff. If σ is known then we can still characterize the scope for sabotage given any A schedule and β.

D Trade Costs + Sufficient Statistics

Consider the DFS model with iceberg trade costs, denoted by τ. Home will import whenever $wa_i > w^* a_i^* \tau$ and Foreign will import whenever $\tau w a_i < w^* a_i^*$. Trade balance remains the same. Hence, the equilibrium conditions are now given by,

$$A(\bar{\iota}_0^H) = \omega/\tau$$
$$A(\bar{\iota}_0^F) = \omega\tau$$
$$wL\Phi_H = w^* L^* \Phi_F,$$

where the import shares are defined as,

$$\Phi_H = \int_{\bar{\iota}_0^H}^1 \beta_i di$$
$$\Phi_F = \int_0^{\bar{\iota}_0^F} \beta_i di.$$

With trade costs, one has that,

$$U = \Phi_H \log(\omega/\tau) - \int_0^1 \beta_i m_i \log A_i di,$$

where the expression is identical to the previous expression except that τ now lowers the gains from trade. Sabotage has the same structure as before. The only difference is that we need to replace A with $\hat{A}$ in the above conditions. We may rewrite the equilibrium conditions after sabotage as,

$$A(\bar{\iota}_1^H - \epsilon) = \omega/\tau$$
$$A(\bar{\iota}_1^F - \epsilon) = \omega\tau$$
$$\omega\Phi_H = \ell\Phi_F.$$

The trade shares are:

$$\Phi_H = \int_{\bar{\iota}_1^H - \epsilon}^{\iota^*} \beta(i)di + \int_{\iota^* + \epsilon}^1 \beta(i)di$$
$$\Phi_F = \int_0^{\epsilon} \beta(\iota^* + i)di + \int_{\epsilon}^{\bar{\iota}_1^F - \epsilon} \beta(i)di.$$

[28]This is not an uncommon requirement, for instance it is necessary for Eaton and Kortum (2002).

Finally, utility is given by,

$$U = \Phi_H \log(\omega/\tau) - \left[\int_{\bar{\iota}_1^H-\epsilon}^{\iota^*} \beta(i)\log A(i)di + \int_{\iota^*+\epsilon}^{1} \beta(i)\log A(i)di\right]$$

In order to derive the impact of sabotage on real income we to begin by differentiating utility. In this case,

$$\begin{aligned}\frac{dU}{d\epsilon} =&\Phi_H \frac{d\omega}{d\epsilon}\frac{1}{\omega} + \log\left(\omega/\tau\right) \times \frac{d\Phi_H}{d\epsilon} - \\ &\left[-\beta(\bar{\iota}_1^H-\epsilon)\log(A(\bar{\iota}_1^H-\epsilon)) \times \left(\frac{d\bar{\iota}_1^H}{d\epsilon}-1\right) - \beta(\iota^*+\epsilon)\log A(\iota^*+\epsilon)\right].\end{aligned}$$

To proceed we differentiate Φ_H:

$$\frac{d\Phi_H}{d\epsilon} = -\beta(\bar{\iota}_1^H-\epsilon) \times \left(\frac{d\bar{\iota}_1^H}{d\epsilon}-1\right) - \beta(\iota^*+\epsilon).$$

We substitute this into the expression above and use the fact that in equilibrium $A(\bar{\iota}_1^H-\epsilon) = \omega/\tau$ to dramatically simplify the derivative of utility:

$$\frac{dU}{d\epsilon} =\Phi_H \frac{d\omega}{d\epsilon}\frac{1}{\omega} - \beta(\iota^*+\epsilon)\log\left(\frac{A(\bar{\iota}_1^H-\epsilon)}{A(\iota^*+\epsilon)}\right).$$

To determine is $d\omega/d\epsilon$, we first show how $\bar{\iota}_1^H$ and $\bar{\iota}_1^F$ shift. By differentiating the consumers' optimality conditions we have,

$$\begin{aligned}\frac{d\omega}{d\epsilon} =&\tau A'(\bar{\iota}_1^H-\epsilon) \times \left[\frac{d\bar{\iota}_1^H}{d\epsilon}-1\right] \\ \frac{d\omega}{d\epsilon} =&\frac{1}{\tau} A'(\bar{\iota}_1^F-\epsilon) \times \left[\frac{d\bar{\iota}_1^F}{d\epsilon}-1\right].\end{aligned}$$

Through the cutoff, we can use these expressions to rewrite how import shares change as a function of change in relative wages:

$$\begin{aligned}\frac{d\Phi_H}{d\epsilon} =& -\beta(\bar{\iota}_1^H-\epsilon) \times \left(\frac{d\bar{\iota}_1^H}{d\epsilon}-1\right) - \beta(\iota^*+\epsilon) \\ =& -\frac{\beta(\bar{\iota}_1^H-\epsilon)}{\tau A'(\bar{\iota}_1^H-\epsilon)}\frac{d\omega}{d\epsilon} - \beta(\iota^*+\epsilon) \\ \frac{d\Phi_F}{d\epsilon} =&\beta(\iota^*+\epsilon) + \beta(\bar{\iota}_1^F-\epsilon) \times \left(\frac{d\bar{\iota}_1^F}{d\epsilon}-1\right) \\ =&\frac{\tau\beta(\bar{\iota}_1^F-\epsilon)}{A'(\bar{\iota}_1^F-\epsilon)}\frac{d\omega}{d\epsilon} + \beta(\iota^*+\epsilon).\end{aligned}$$

Finally, we can put this together in market clearing to determine $d\omega/d\epsilon$. In particular,

$$\begin{aligned}
0 =& \frac{d\omega}{d\epsilon}\Phi_H + \omega\frac{d\Phi_H}{d\epsilon} - \ell\frac{d\Phi_F}{d\epsilon} \\
=& \frac{d\omega}{d\epsilon}\Phi_H + \omega \times \left\{ -\frac{\beta(\bar{\iota}_1^H - \epsilon)}{\tau A'(\bar{\iota}_1^H - \epsilon)}\frac{d\omega}{d\epsilon} - \beta(\iota^* + \epsilon) \right\} - \ell \left\{ \frac{\tau\beta(\bar{\iota}_1^F - \epsilon)}{A'(\bar{\iota}_1^F - \epsilon)}\frac{d\omega}{d\epsilon} + \beta(\iota^* + \epsilon) \right\} \\
=& \frac{d\omega}{d\epsilon}\Phi_H + \left\{ -\beta(\bar{\iota}_1^H - \epsilon)\frac{\omega/\tau}{A'(\bar{\iota}_1^H - \epsilon)}\frac{d\omega}{d\epsilon} - \omega\beta(\iota^* + \epsilon) \right\} - \frac{\ell}{\omega} \left\{ \beta(\bar{\iota}_1^F - \epsilon)\frac{\omega\tau}{A'(\bar{\iota}_1^F - \epsilon)}\frac{d\omega}{d\epsilon} + \omega\beta(\iota^* + \epsilon) \right\} \\
=& \frac{d\omega}{d\epsilon}\Phi_H + \left\{ -\beta(\bar{\iota}_1^H - \epsilon)\frac{A(\bar{\iota}_1^H - \epsilon)}{A'(\bar{\iota}_1^H - \epsilon)}\frac{d\omega}{d\epsilon} - \omega\beta(\iota^* + \epsilon) \right\} + \frac{\ell}{\omega} \left\{ -\beta(\bar{\iota}_1^F - \epsilon)\frac{A(\bar{\iota}_1^F - \epsilon)}{A'(\bar{\iota}_1^F - \epsilon)}\frac{d\omega}{d\epsilon} - \omega\beta(\iota^* + \epsilon) \right\} \\
=& \frac{d\omega}{d\epsilon}\Phi_H + \left\{ \beta(\bar{\iota}_1^H - \epsilon)\eta(\bar{\iota}_1^H - \epsilon)\frac{d\omega}{d\epsilon} - \omega\beta(\iota^* + \epsilon) \right\} + \frac{\ell}{\omega} \left\{ \beta(\bar{\iota}_1^F - \epsilon)\eta(\bar{\iota}_1^F - \epsilon)\frac{d\omega}{d\epsilon} - \omega\beta(\iota^* + \epsilon) \right\},
\end{aligned}$$

where $\eta = |A'/A|^{-1}$. rearranging,

$$\frac{d\omega}{d\epsilon} = \frac{\beta(\iota^* + \epsilon)(\omega + \ell)}{\Phi_H + \beta(\bar{\iota}_1^H - \epsilon)\eta(\bar{\iota}_1^H - \epsilon) + \frac{\ell}{\omega}\beta(\bar{\iota}_1^F - \epsilon)\eta(\bar{\iota}_1^F - \epsilon)}.$$

Plugging this into the derivative of utility we arrive at our nearly final expression,

$$\frac{dU}{d\epsilon} = \beta(\iota^* + \epsilon) \times \left\{ \frac{\Phi_H\frac{\omega+\ell}{\omega}}{\Phi_H + \beta(\bar{\iota}_1^H - \epsilon)\eta(\bar{\iota}_1^H - \epsilon) + \frac{\ell}{\omega}\beta(\bar{\iota}_1^F - \epsilon)\eta(\bar{\iota}_1^F - \epsilon)} - \log\left(\frac{A(\bar{\iota}_1^H - \epsilon)}{A(\iota^* + \epsilon)}\right) \right\}.$$

At $\epsilon = 0$ we have,

$$\left.\frac{dU}{d\epsilon}\right|_{\epsilon=0} = \beta(\iota^*) \times \left\{ \frac{\Phi_H\frac{\omega+\ell}{\omega}}{\Phi_H + \beta(\bar{\iota}_0^H)\eta(\bar{\iota}_0^H) + \frac{\ell}{\omega}\beta(\bar{\iota}_0^F)\eta(\bar{\iota}_0^F)} - \log\left(\frac{A(\bar{\iota}_0^H)}{A(\iota^*)}\right) \right\}. \tag{27}$$

To further simplify this expression we use the formula for the trade elasticity. In a conventional gravity regression, the trade elasticity is defined as,

$$\theta^j = -\frac{d\log\frac{\Phi_j}{1-\Phi_j}}{d\log\tau}.$$

We can solve this in our model at $\epsilon = 0$. For Home we have,

$$\begin{aligned}
\frac{d\frac{\Phi_H}{1-\Phi_H}}{d\tau} =& -\frac{1}{(1-\Phi_H)^2}\beta(\bar{\iota}_0^H) \times \frac{-\omega/\tau^2}{A'(\bar{\iota}_0^H)} \\
=& -\frac{1}{(1-\Phi_H)^2}\beta(\bar{\iota}_0^H) \times \frac{-A(\bar{\iota}_0^H)/\tau}{A'(\bar{\iota}_0^H)} \\
=& -\frac{1/\tau}{(1-\Phi_H)^2}\beta(\bar{\iota}_0^H)\eta(\bar{\iota}_0^H).
\end{aligned}$$

And so,

$$\theta^H = \frac{1}{\Phi_H(1-\Phi_H)}\beta(\bar{\iota}_0^H)\eta(\bar{\iota}_0^H).$$

Similarly, one can derive,

$$\theta^F = \frac{1}{\Phi_F(1-\Phi_F)}\beta(\bar{\iota}_0^F)\eta(\bar{\iota}_0^F).$$

Finally, we use two equilibrium identities:

$$\ell/\omega = \Phi_H/\Phi_F$$
$$(\omega+\ell)/\omega = s_H^{-1},$$

where s_H is Home's share in global income. Plugging this into Equation (27) gives:

$$\begin{aligned}\frac{dU}{d\epsilon}\Big|_{\epsilon=0} =& \beta(\iota^*) \times \left\{ \frac{\Phi_H \frac{\omega+\ell}{\omega}}{\Phi_H + \beta(\bar{\iota}_0^H)\eta(\bar{\iota}_0^H) + \frac{\ell}{\omega}\beta(\bar{\iota}_0^F)\eta(\bar{\iota}_0^F)} - \log\left(\frac{A(\bar{\iota}_0^H)}{A(\iota^*)}\right)\right\} \\ =& \beta(\iota^*) \times \left\{ \frac{s_H^{-1}}{1+(1-\Phi_H)\theta_H + (1-\Phi_F)\theta_F} - \log\left(\frac{A(\bar{\iota}_0^H)}{A(\iota^*)}\right)\right\}.\end{aligned}$$

Notice that if $\tau = 1$ we have that $\Phi_F = (1-\Phi_H)$, a single trade elasticity, θ, and we have that $s_H = 1-\Phi_H$. Plugging this in Equation (28) yields the special case for free trade:

$$\frac{dU}{d\epsilon}\Big|_{\epsilon=0} = \beta(\iota^*) \times \left\{ \frac{1}{(1-\Phi_H)(1+\theta)} - \log\left(\frac{A(\bar{\iota}_0^H)}{A(\iota^*)}\right)\right\}. \quad (28)$$

In much of the trade literature, θ is assumed to be constant. This will be true with Fréchet distributed productivities across goods. In this case, one has that the terms of trade gains from sabotage (ignoring the cost) are given by,

$$\text{ToT Gain} \approx \underbrace{\beta(\iota^*)\epsilon}_{\text{Expenditure Shift}} \times \underbrace{\frac{s_H^{-1}}{1+\theta\times(2-\frac{\Phi_H}{1-s_H})}}_{\text{Sufficient Statistic}}.$$

For fixed Φ_H and θ, the gains to sabotage may be larger or smaller with trade costs than without. Mathematically, it depends on s_H relative to ϕ_H. In the Fréchet case, this will further boil down to ℓ/t, where ℓ is the population ratio and t is the ratio of absolute advantages. A more straightforward statement is that for a fixed θ, the gains are always declining in trade costs. However, trade costs change both Φ and s_H. So comparing the free trade and costly trade returns at a fixed Φ implicitly changes other parameters. This is discussed further in E.

E Comparative Statics Details

In this section, we derive the comparative statics described in Section IV.A in more generality. Under Fréchet distributed productivity, we have

$$dU^S\left(\iota^*, \epsilon\right)/d\epsilon\bigg|_{\epsilon=0} = \frac{1}{1+\theta}\frac{1}{1-\Phi_H} - \frac{1}{\theta}\log\left(\frac{(1-\bar{\iota}_0)/\bar{\iota}_0}{(1-\iota^*)/\iota^*}\right).$$

Rearranging, and exploiting the fact that $\bar{\iota}_0 = 1-\Phi_H$, yields the cutoff where sabotage raises real income:

$$\hat{\iota}_1 = \left[1 + \frac{\Phi_H}{1-\Phi_H}\exp\left(\frac{-\theta}{1+\theta}\frac{1}{1-\Phi_H}\right)\right]^{-1}.$$

For the Fréchet distribution, we have that $A(i) = ((1-i)/i)^{1/\theta} \times t$ where $t = (T/T^*)^{1/\theta}$ is the ratio of mean productivities across countries. Notice that t depends on θ, but this is because T it needs to be rescaled as θ moves to keep absolute advantage constant. Thus, we treat t as the primitive. With this in mind, one can solve for the equilibrium from the fact that,

$$\omega(1-\bar{\iota}_0) = \ell\bar{\iota}_0.$$

Plugging in yields,

$$\bar{\iota}_0 = \frac{(\ell/t)^{\frac{\theta}{1+\theta}}}{1+(\ell/t)^{\frac{\theta}{1+\theta}}}.$$

We can also recover,

$$\omega = (\ell/t)^{-1/(1+\theta)}.$$

Since equilibrium prices and quantities only depend on the ratio ℓ/t, we normalize $\ell = 1$ for simplicity. Thus, t being large can either reflect Home being large or Home being productive, these are symmetric in the model. In data, presumably ℓ is easily measured and therefore constant regardless of the trade elasticity, and so t reflects productivity. With this in mind, we can write,

$$\Phi_H = \frac{1}{1+t^{\frac{1+\theta}{\theta}}}.$$

In performing comparative statics on our sufficient statistic, one can consider, at least, two questions involving θ:

1. What is the effect of changing θ, holding fixed trade shares (implicitly shifting t).

2. What is the effect of changing θ, holding fixed t (shifting Φ).

As Φ is measured in data, there is appeal in the first question: given the data, what changes about the extent of possible sabotage given a change in parameters? We define the extent of sabotage as,

$$\frac{\hat{\iota}_1 - \bar{\iota}_0}{1-\bar{\iota}_0},$$

and so our comparative static of interest is given by,

$$\frac{d(\text{Extent of Sabotage})}{d\theta} = \frac{d\hat{\imath}_1/d\theta}{\Phi_H}.$$

This yields,

$$\frac{d(\text{Extent of Sabotage})}{d\theta} = \frac{\frac{\Phi_H}{1-\Phi_H}\exp\left(\frac{-\theta}{1+\theta}\frac{1}{1-\Phi_H}\right)}{\Phi_H(1-\Phi_H)(1+\theta)^2\left(\frac{\Phi_H}{1-\Phi_H}\exp\left(\frac{-\theta}{1+\theta}\frac{1}{1-\Phi_H}\right)+1\right)^2}.$$

Setting $\Phi_H = 1/2$ yields the result in the main text. Even in the general case, the extent of sabotage is always increasing in θ holding Φ fixed. One can similarly derive the change in indifference between sabotage and technology transfer, $\frac{d\hat{\imath}_2}{d\theta}$. Following an analogous set of derivations,

$$\frac{d\hat{\imath}_2}{d\theta} = \frac{z^{-\theta}\frac{\Phi_H}{1-\Phi_H}\exp\left(\frac{-\theta}{1+\theta}\frac{1}{1-\Phi_H}\right)\times\left(\frac{1}{1-\Phi_H}\frac{1}{(1+\theta)^2}+\log z\right)}{\left(z^{-\theta}\frac{\Phi_H}{1-\Phi_H}\exp\left(\frac{-\theta}{1+\theta}\frac{1}{1-\Phi_H}\right)+1\right)^2}.$$

For $z < 1$, the sign is ambiguous, but for $z \leq \exp\left(-\frac{1}{1-\Phi_H}\frac{1}{(1+\theta)^2}\right)$, $\hat{\imath}_2$ shifts in. Otherwise, $\hat{\imath}_2$ shifts out, as illustrated in the main text. Thus, the results in Section IV.A hold more generally than in the case that $\ell = 1$.

F Generalized Preferences

In this Section, we show how to extend Equation (15) to more general environments, which we use for the quantification in Section V.B. First, we show how the terms of trade can be measured under extremely general assumptions: utility is log-linear in relative wages and the price index, and the trade elasticity is known. However, without more restrictions, measurement requires either ex-post knowledge (the change in the foreign import share due to the policy) or knowledge of relative unit costs for the cut-off good.

We then turn to a fairly general environment, where there are a continuum of sectors (as in Dornbusch, Fischer and Samuelson 1977) with CES demand within each sector (as in a multi-sector Armington model). In this environment, the gains from sabotage can be captured by the same moments as in Section V: trade shares, trade elasticities, and the extent of sabotage.

F.A Sabotage With Log-Linear Utility

We suppose that consumers have a utility function that admits the following log-linear representation:

$$\log U = \log \omega - \log P,$$

where $\log \omega$ is Home's relative wage and P is an ideal price index. Differentiating utility with respect to ϵ gives,

$$\frac{d\log U}{d\epsilon} = \frac{d\log\omega}{d\epsilon} - \frac{\partial \log P}{\partial \log \omega}\frac{d\log\omega}{d\epsilon} - \frac{d\log P}{d\epsilon}.$$

From Shepard's Lemma, $\partial \log P / \partial \log \omega$ is Home's domestic absorption share, $1-\Phi_H$. Hence,

$$\frac{d \log U}{d\epsilon} = \Phi_H \frac{d \log \omega}{d\epsilon} - \frac{d \log P}{d\epsilon}. \tag{29}$$

Equation (29) shows that the effect of any shock to fundamentals can be decomposed into the effects of the shock on the terms of trade and the price index. Hence, to understand the effect of sabotage we need to understand these two objects. The goal of this section is to show we can quantify two elasticities using standard data moments.

We start by considering the change in the relative wage before turning to the change in the price index. We start with trade balance:

$$\omega \Phi_H = \ell \Phi_F.$$

Taking the log and rearranging gives:

$$\log \omega + \log \Phi_H - \log \ell - \log \Phi_F = 0.$$

Differentiating, noting that the partial derivative w/r/t $\log \omega$ refers to the partial equilibrium response of import shares to an exogenous shock in relative prices yields,

$$\frac{d \log \omega}{d\epsilon} + \frac{\partial \log \Phi_H}{\partial \log \omega}\frac{d \log \omega}{d\epsilon} + \frac{d \log \Phi_H}{d\epsilon} - \frac{\partial \log \Phi_F}{\partial \log \omega}\frac{d \log \omega}{d\epsilon} - \frac{d \log \Phi_F}{d\epsilon} = 0.$$

The trade elasticity that is typically estimated is the response of import shares relative to the domestic absorption share following an exogenous change in relative prices. Mapping this to the above derivative implies that $\theta_H = (1-\Phi_H)\frac{\partial \log \Phi_H}{\partial \log \omega}$ and $\theta_F = -(1-\Phi_F)\frac{\partial \log \Phi_F}{\partial \log \omega}$. Plugging in and rearranging yields,

$$\begin{aligned}
\frac{d \log \omega}{d\epsilon} &= \frac{\frac{d \log \Phi_F}{d\epsilon} - \frac{d \log \Phi_H}{d\epsilon}}{1 + \theta_H(1-\Phi_H) + \theta_F(1-\Phi_F)} \\
&= \frac{\frac{d\Phi_F}{d\epsilon}\frac{1}{\Phi_F} - \frac{d\Phi_H}{d\epsilon}\frac{1}{\Phi_H}}{1 + \theta_H(1-\Phi_H) + \theta_F(1-\Phi_F)} \\
&= \frac{1}{\Phi_H}\frac{\frac{\Phi_H}{\Phi_F}\frac{d\Phi_F}{d\epsilon} - \frac{d\Phi_H}{d\epsilon}}{1 + \theta_H(1-\Phi_H) + \theta_F(1-\Phi_F)} \\
&= \frac{1}{\Phi_H}\frac{\frac{1-s_H}{s_H}\frac{d\Phi_F}{d\epsilon} - \frac{d\Phi_H}{d\epsilon}}{1 + \theta_H(1-\Phi_H) + \theta_F(1-\Phi_F)},
\end{aligned} \tag{30}$$

where s_H is Home's share in global output. Equation (30) shows that the gains from sabotage will depend on (a) easily computed aggregate moments in the data and (b) the change in imports on account of sabotage. The latter force is impossible to measure ex-ante without some structure. To see this, it is helpful to assume that goods are perfect substitutes, as in Dornbusch, Fischer and Samuelson (1977).

In this case *if* sabotage is comprehensive, then the change in Foreign's import share is exactly $\beta(\iota^* + \epsilon)$—the expenditure share of the good shifted Home. Note that Home's change in imports is exactly the opposite, as they stop spending that expenditure abroad. With comprehensive sabotage,

$$\frac{d\log\omega}{d\epsilon} = \frac{\beta(\iota^*+\epsilon)}{\Phi_H}\frac{\frac{1-s_H}{s_H}+1}{1+\theta_H(1-\Phi_H)+\theta_F(1-\Phi_F)} = \frac{\beta(\iota^*+\epsilon)}{\Phi_H}\frac{s_H^{-1}}{1+\theta_H(1-\Phi_H)+\theta_F(1-\Phi_F)},$$

so the terms of trade is exactly the same as in Equation (15). On the other hand, if sabotage is not comprehensive, there is no change in imports, and so relative wages do not change.

As a result, $\frac{d\Phi_F}{d\epsilon}$ is discontinuous (at the cutoff where sabotage becomes comprehensive). Identifying the location of the cutoff depends on the shape of the A schedule *globally*, and so cannot be easily measured from the data without additional assumptions.

F.B Multi-Sector Armington

As in Section V, we assume that there are a continuum of sectors and workers have Cobb-Douglas preferences across sectors, with expenditure weights β_i and iceberg trade costs τ. However, we now allow foreign and domestic varieties to be imperfect substitutes: workers have CES demand across foreign and domestic varieties within each sector, with a sector-specific elasticity of substitution σ_i. As before, define z as the shift in Foreign's unit input requirement, where sabotage implies that $z > 1$. In this case we have,

$$\begin{aligned}
\log P &= \int_0^1 \beta_i \log[p_i/\beta_i]di \\
p_i &= \left((\omega a_i)^{1-\sigma_i} + (\tau z a_i^*)^{1-\sigma_i}\right)^{\frac{1}{1-\sigma_i}} \\
m_i(z) &= \frac{(\tau z a_i^*)^{1-\sigma_i}}{(\omega a_i)^{1-\sigma_i} + (\tau z a_i^*)^{1-\sigma_i}} \\
m_i^*(z) &= \frac{(\tau\omega a_i)^{1-\sigma_i}}{(\tau\omega a_i)^{1-\sigma_i} + (z a_i^*)^{1-\sigma_i}}.
\end{aligned}$$

Multiplying the numerators and denominators by by $1/a_i^{1-\sigma_i}$ (and pulling out policy-invariant constants), gives:

$$\begin{aligned}
\log P &= \int_0^1 \beta_i \log p_i di \\
p_i &= \left(\omega^{1-\sigma_i} + (\tau z A_i)^{1-\sigma_i}\right)^{\frac{1}{1-\sigma_i}} \\
m_i(z) &= \frac{(\tau z A_i)^{1-\sigma_i}}{\omega^{1-\sigma_i} + (\tau z A_i)^{1-\sigma_i}} \\
m_i^*(z) &= \frac{(\tau\omega)^{1-\sigma_i}}{(\tau\omega)^{1-\sigma_i} + (z A_i)^{1-\sigma_i}}.
\end{aligned}$$

Integrating,

$$\Phi_H = \int_0^1 \beta_i m_i(z) di,$$

and similarly for Foreign. For sabotage we have,

$$\Phi_H = \int_0^{\iota^*} \beta_i m_i(1)di + \int_{\iota^*}^{\iota^*+\epsilon} \beta_i m_i(z)di + \int_{\iota^*+\epsilon}^{1} \beta_i m_i(1)di.$$

and similarly for Foreign. Hence,

$$\begin{aligned}\frac{d\Phi_H}{d\epsilon} =& \beta(\iota^* + \epsilon)[m_{\iota^*+\epsilon}(z) - m_{\iota^*+\epsilon}(1)] \\ \frac{d\Phi_F}{d\epsilon} =& \beta(\iota^* + \epsilon)[m^*_{\iota^*+\epsilon}(z) - m^*_{\iota^*+\epsilon}(1)].\end{aligned}$$

Plugging in we have that the total gain term is given by,

$$\Phi_H \frac{d\log\omega}{d\epsilon} = \beta(\iota^* + \epsilon)\frac{\frac{1-s_H}{s_H}[m^*_{\iota^*+\epsilon}(z) - m^*_{\iota^*+\epsilon}(1)] + [m_{\iota^*+\epsilon}(1) - m_{\iota^*+\epsilon}(z)]}{1 + \theta_H(1-\Phi_H) + \theta_F(1-\Phi_F)}.$$

In the original Dornbusch, Fischer and Samuelson (1977) set-up, because goods were perfect substitutes, if Home imported from a given sector, it would not export in that sector. However, with imperfect substitutes there is two-way trade: within a sector, Home and Foreign consume from varieties from both Home and Foreign. To capture this notion, define $\Delta \equiv [m_{\iota^*+\epsilon}(1) - m_{\iota^*+\epsilon}(z)]$ to be the shift in Home's import share back to Home. For example, if sabotage is comprehensive, so that $m_{\iota^*+\epsilon}(\infty) = 0$, then $\Delta = m_{\iota^*+\epsilon}(1)$—so that all of Home's import expenditures are shifted Home. In this case we have,

$$\Phi_H \frac{d\log\omega}{d\epsilon} = \beta(\iota^* + \epsilon)\frac{\frac{1-s_H}{s_H}[m^*_{\iota^*+\epsilon}(z) - m^*_{\iota^*+\epsilon}(1)] + \Delta}{1 + \theta_H(1-\Phi_H) + \theta_F(1-\Phi_F)}. \tag{31}$$

$\Delta\epsilon$ captures the scope for sabotage, with Δ being the within-industry shift, and ϵ reflecting the measure of industries affected. Note that in the case of perfect substitutes, $\Delta = 1$ so all sabotage occurs on the extensive margin.

Equation (31) cannot be taken immediately to the data, much like Equation (30), as $[m^*_{\iota^*+\epsilon}(z) - m^*_{\iota^*+\epsilon}(1)]$, the change in Foreign imports after sabotage, cannot be directly measured ex-ante. However, in the spirit of Head and Ries (2001) and Dekle, Eaton and Kortum (2008), the counterfactual change in Foreign imports can be written in terms of Δ and initial shares. For simplicity, we write $m^*_{\iota^*+\epsilon}$ without an argument to refer to the case of no sabotage (this is observed in the data), and consider the case where $\epsilon \to 0$.

From CES, we can rewrite $m^*_{\iota^*}(z)$ in terms of unit labor requirements, relative wages, and trade costs. As a result,

$$\Delta = m_{\iota^*} - \frac{(\tau z A_i)^{1-\sigma_i}}{\omega^{1-\sigma_i} + (\tau z A_i)^{1-\sigma_i}}.$$

Rearranging, the implied change in fundamentals is given by

$$(zA_{\iota^*})^{1-\sigma_{\iota^*}} = \left(\frac{\omega}{\tau}\right)^{1-\sigma_{\iota^*}} \times \frac{m_{\iota^*} - \Delta}{1 - m_{\iota^*} + \Delta}.$$

We can therefore solve for post-sabotage Foreign imports as a function of ex-ante observables (and the scope of sabotage):

$$m^*_{\iota^*}(z) = \frac{(\tau\omega)^{1-\sigma_{\iota^*}}}{(\tau\omega)^{1-\sigma_{\iota^*}} + (zA_{\iota^*})^{1-\sigma_{\iota^*}}} \tag{32}$$

$$= \frac{1}{1 + \tau^{2(\sigma_{\iota^*}-1)} \frac{m_{\iota^*}-\Delta}{1-m_{\iota^*}+\Delta}}. \tag{33}$$

Equation (32) also cannot be taken to data, as we do not know τ. However, to remove the trade costs, we use can the Head-Ries index at the initial shares and simplify:

$$\begin{aligned} m^*_{\iota^*}(z) =& \frac{1}{1 + \frac{m_{\iota^*}-\Delta}{1-m_{\iota^*}+\Delta} \times \frac{(1-m_{\iota^*})(1-m^*_{\iota^*})}{m_{\iota^*}m^*_{\iota^*}}} \\ =& \frac{(1-m_{\iota^*}+\Delta)m_{\iota^*}m^*_{\iota^*}}{(1-m_{\iota^*}+\Delta)m_{\iota^*}m^*_{\iota^*} + (m_{\iota^*}-\Delta)(1-m_{\iota^*})(1-m^*_{\iota^*})} \\ =& \frac{(1-m_{\iota^*}+\Delta)m_{\iota^*}m^*_{\iota^*}}{m_{\iota^*}(1-m_{\iota^*}) - \Delta(1-m_{\iota^*}-m^*_{\iota^*})}. \end{aligned}$$

The change in Foreign imports is therefore:

$$m^*_{\iota^*}(z) - m^*_{\iota^*} = m^*_{\iota^*} \times \left(\frac{(1-m_{\iota^*}+\Delta)m_{\iota^*}}{m_{\iota^*}(1-m_{\iota^*}) - \Delta(1-m_{\iota^*}-m^*_{\iota^*})} - 1 \right) \tag{34}$$

$$= \frac{\Delta m^*_{\iota^*}(1-m^*_{\iota^*})}{m_{\iota^*}(1-m_{\iota^*}) - \Delta(1-m_{\iota^*}-m^*_{\iota^*})}. \tag{35}$$

Plugging Equation (34) into Equation (31) gives:

$$\frac{1}{\Phi_H}\frac{d\log\omega}{d\epsilon}\bigg|_{\epsilon=0} = \underbrace{\beta_{\iota^*}\Delta}_{\text{Expenditure Shift}} \times \underbrace{\frac{\frac{1-s_H}{s_H}\frac{m^*_{\iota^*}(1-m^*_{\iota^*})}{m_{\iota^*}(1-m_{\iota^*})-\Delta(1-m_{\iota^*}-m^*_{\iota^*})} + 1}{1+\theta_H(1-\Phi_H)+\theta_F(1-\Phi_F)}}_{\text{ToT Gain}}. \tag{36}$$

Equation (36) shows that the pass-through now depends on sufficient statistics, initial trade shares of the sabotaged good, and the counterfactual shift in expenditure. Note that for *complete* sabotage, where $\Delta = m_{\iota^*}$, the import-share dependent term simplifies to $(1-m^*)/m$ at ι^*. With free trade, Equation (36) reduces to the ratio of unit costs at the sabotaged good raised to the CES elasticity, which is similar to the case in Appendix C, where demand is CES across varieties.

Equation (36) shows how wages respond to sabotage. We now turn to the costs, $\frac{d\log P}{d\epsilon}$. We can consider the change in the price index for sabotage = z relative to no sabotage (the change in unit costs = 1)

$$\frac{d\log P}{d\epsilon} = \beta_{\iota^*+\epsilon}\log(p_{\iota^*+\epsilon}(z)/p_{\iota^*+\epsilon}(1)).$$

Evaluating at $\epsilon = 0$ and plugging in can rearrange this as,

$$\begin{aligned}
\frac{d\log P}{d\epsilon} =& \frac{\beta_{\iota^*}}{1-\sigma_{\iota^*}} \log\left(\frac{\omega^{1-\sigma_{\iota^*}} + (\tau z A_{\iota *})^{1-\sigma_{\iota^*}}}{\omega^{1-\sigma_{\iota^*}} + (\tau A_{\iota *})^{1-\sigma_{\iota^*}}}\right) \\
=& \frac{\beta_{\iota^*}}{1-\sigma_{\iota^*}} \log\left(\frac{(\omega^{1-\sigma_{\iota^*}} + (\tau z A_{\iota *})^{1-\sigma_{\iota^*}})/\omega^{1-\sigma_{\iota^*}}}{(\omega^{1-\sigma_{\iota^*}} + (\tau A_{\iota *})^{1-\sigma_{\iota^*}})/\omega^{1-\sigma_{\iota^*}}}\right) \\
=& \frac{\beta_{\iota^*}}{1-\sigma_{\iota^*}} \log\left(\frac{(1-m_{\iota^*}(z))^{-1}}{(1-m_{\iota^*}(1))^{-1}}\right) \\
=& \frac{\beta_{\iota^*}}{\sigma_{\iota^*}-1} \log\left(\frac{1-m_{\iota^*}(z)}{1-m_{\iota^*}(1)}\right) \\
=& \frac{\beta_{\iota^*}}{\sigma_{\iota^*}-1} \log\left(\frac{1-m_{\iota^*}+\Delta}{1-m_{\iota^*}}\right) \\
=& \frac{1}{\sigma_{\iota^*}-1} \log\left(1+\frac{\Delta}{1-m_{\iota^*}}\right). \qquad (37)
\end{aligned}$$

Notice that in the case of perfect substitutes, in the first line, a limiting argument for $\sigma_i \to 1$ shows that *if* sabotage is comprehensive, then the cost is the change in the relative unit cost when production changes location. If sabotage is not comprehensive (or there is a tech transfer), then the change is $\log z$ as in the main text.

When varieties are not perfect substitutes within a sector, measuring the returns to sabotage does not require directly measuring relative unit costs, as initial import shares reveal the difference in unit costs (in the spirit of Balassa 1965). However, one must know the Armington elasticity of the sabotaged sector, which is not directly observed in data though it is well-studied (Broda and Weinstein, 2006; Soderbery, 2015; Jones et al., 2023; Errico and Lashkari, 2024; Grant and Soderbery, 2024).

Combining Equations (36) and (37) gives the full welfare effects of sabotage:[29]

$$\Delta U^S \approx \beta_{\iota^*}\Delta\epsilon \times \frac{\frac{1-s_H}{s_H}\frac{m^*_{\iota^*}(1-m^*_{\iota^*})}{m_{\iota^*}(1-m_{\iota^*})-\Delta(1-m_{\iota^*}-m^*_{\iota^*})}+1}{1+\theta(1-\Phi_H)+\theta(1-\Phi_H\frac{s_H}{1-s_H})} - \frac{\beta_{\iota^*}\epsilon}{\sigma_{\iota^*}-1}\log\left(1+\frac{\Delta}{1-m_{\iota^*}}\right). \qquad (38)$$

[29] We also plug in, due to market clearing, $\Phi_F = \Phi_H \frac{s_H}{1-s_H}$, and assume that $\theta_H = \theta_F$.

Table A.1: Import Shares and Elasticities of Substitution Across Industries

Industry	m_{US}	m_{ROW}	σ_i
Agriculture			
Crop and animal production	0.09	0.02	2.07
Forestry and logging	0.26	0.02	4.98
Fishing and aquaculture	0.25	0.01	1.63
Mining and quarrying	0.28	0.02	2.14
Manufacturing			
Food products, beverages and tobacco products	0.08	0.02	2.26
Textiles, wearing apparel and leather products	0.65	0.01	4.18
Wood, and of products of wood and cork	0.13	0.01	2.59
Paper and paper products	0.13	0.04	3.35
Coke and refined petroleum products	0.12	0.05	1.40
Chemicals and chemical products	0.23	0.04	2.02
Pharmaceutical products	0.24	0.05	1.77
Rubber and plastic products	0.20	0.02	3.37
Other non-metallic mineral products	0.17	0.01	3.71
Basic metals	0.26	0.01	2.96
Fabricated metal products	0.15	0.02	3.88
Computer, electronic and optical products	0.50	0.04	4.12
Electrical equipment	0.48	0.02	4.06
Machinery and equipment n.e.c.	0.31	0.04	6.03
Motor vehicles, trailers and semi-trailers	0.35	0.03	2.95
Other transport equipment	0.18	0.12	5.98
Furniture; other manufacturing	0.30	0.05	3.87
Services			
Waste management	0.14	0.05	2.94
Air transport	0.19	0.10	2.92
Architectural and engineering activities	0.06	0.05	3.61
Advertising and market research	0.05	0.05	2.21
Other professional, scientific and technical activities	0.06	0.01	3.16

For each WIOD industry, the first column shows the US import share from the Rest of World (m_{US}), the second column the Rest of World import share from the US (m_{ROW}), and the third column shows the estimated sectoral elasticities of substitution (σ_i), as described in the text. We only include sectors where $m_{US} > 0.05$. Source: World Input-Output Database, BEA Supply & Use Tables.