Targeted Protection

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Abstract

Conventional treatments of trade and industrial policies focus on output markets, studying how policies reshape demand and productivity. I consider how output market forces interact with input market frictions, in a setting where reallocation costs differ across industry-occupation pairs. As in traditional models, industries face productivity externalities – a standard rationale for protection – and there are rich substitution patterns within and across countries. Both domestic and foreign policies reshape resource allocation and aggregate employment. The resulting productivity externalities depend on the full reallocation pattern: which industries gain resources, which lose them, and how large the flows are. Reallocation in turn depends on pairwise mobility frictions. When inputs are complementary in production, output and employment responses are determined by the slowest-moving factor. I use the calibrated model to study how US tariffs on Chinese manufacturing affect TFP and manufacturing employment in the US, China, and third countries.

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1 Introduction

Recent years have witnessed a resurgence of protectionist policies across major economies. These policies, in the form of tariffs and production subsidies, are concentrated in specific industries, such as manufacturing, semiconductors, and green energy. How do a country's output and total factor productivity (TFP) respond to protectionist policies, depending on which industry these policies are targeted toward? The conventional treatment of this question focuses on output markets – how policies reshape demand and productivity across industries. A classic economic rationale for selective protection dates back to Graham (1923): if some industries have higher returns to scale than others, subsidizing their expansion raises aggregate productivity. Productivity gains, however, crucially depend on input-market characteristics: how many resources reallocate toward protected sectors, and where are they crowded out from? A growing body of evidence documents that reallocation frictions across labor markets are large, and vary systematically with industry and occupation characteristics (Artuç et al., 2010; Autor et al., 2014; Dix-Carneiro and Kovak, 2017; Traiberman, 2019). This paper revisits protectionist policies in an environment with realistic reallocation frictions. I develop a theoretical framework which serves as an aggregation device, mapping disaggregated input- and output-market characteristics – such as productivity externalities, complementarities in consumption and production, and mobility frictions – into aggregate output and productivity. Aggregate responses depend on three features: productivity externalities in protected industries, productivity externalities in the industries they crowd out, and the magnitude of reallocation flows.

The model economy consists of multiple countries, industries, and production factors. Production factors include labor occupations and non-labor assets such as land, equipment, and structures. Workers choose their industry and occupation, and set optimal intensive-margin labor supply conditional on their occupation. Non-labor assets are optimally allocated across industries and categories, and have variable intensive-margin utilization. Labor occupations and asset types differ in their potential to generate productivity externalities as well as in their bilateral reallocation elasticities. This results in heterogeneous agglomeration and congestion forces across labor occupations and asset uses. At the same time, industries use different combinations of production factors and intermediate inputs, with varying degrees of complementarity between factors that are easier or harder to reallocate.[1]

The theoretical analysis yields two main implications. First, protectionist measures increase total factor productivity (TFP) the most when they effectively channel mobile re-

[1]To keep the analysis tractable, I focus on a log-linear approximation and abstract from transition dynamics.

sources away from low-externality uses and toward high-externality ones. Formally, a country's TFP response equals the covariance between productivity externalities generated by each factor and changes in factor quantities across uses. Importantly, productivity gains depend not only on the destination industry that resources get reallocated toward, but also on the origin uses that resources are crowded out from, and on how many resources get reallocated.

Second, resource reallocation jointly depends on factor mobility and complementarities in production. When production factors are complementary, the slowest-moving factor determines output responses. For instance, if capital does not reallocate, protectionist policies have no effect on employment and output. Protection simply raises the return to existing capital instead of drawing in new resources. Formally, I decompose quantity responses into direct effects and equilibrium feedback effects within and across factor markets. The feedback terms describe the interaction between input- and output-market forces, driven by reallocation elasticities and complementarities across the production and trade network, which generate spillovers between fast- and slow-moving factors.

Among other applications, these results help us evaluate the costs and benefits of employment protection. For example, suppose US policymakers protect manufacturing employment by imposing tariffs. When is this policy effective? And would sustaining manufacturing employment come at the cost of reducing overall TFP? If manufacturing uses both labor and capital, the effectiveness of employment protection depends on how easily capital gets reallocated and how complementary capital and labor are. The tradeoff between employment protection and aggregate productivity depends on whether the manufacturing sector expands by attracting idle manufacturing workers and machinery, or by crowding out labor and capital from sectors with higher productivity externalities.

If flow elasticities in and out of unemployment depend on the shares of employed and unemployed workers, employment responses to protectionist policies are not necessarily constant over time. For example, a large decline in U.S. manufacturing employment following the China shock does not necessarily predict a comeback of manufacturing employment when the U.S. later imposes tariffs on Chinese manufacturing goods. If, by the time tariffs are enacted, many displaced workers have already retired or transitioned to different industries, the pool of unemployed workers seeking manufacturing jobs is small. This decreases the flow elasticity into manufacturing employment. Employment protection is less effective overall, and the tradeoff against aggregate productivity is steeper.

My framework enables a cross-country general equilibrium analysis. This allows me to consider the effects of both domestic and foreign protectionist policies on each country's industrial composition, and hence on its output and productivity. My theoretical analysis

reveals that production subsidies have larger effects than trade policy, because they affect relative prices in all countries, while trade policies only affect relative prices in the home country. Moreover, production subsidies increase overall employment by raising real wages, while tariffs have the opposite effect.

In the quantitative analysis, I address questions such as: what happens to U.S. employment and TFP if China subsidizes its own tradable sector? How does the industrial composition of third countries, such as Europe or other Asian countries, respond to an increase in U.S. tariffs on Chinese manufacturing exports?

The model calibration combines several data sources and estimation strategies, to pin down expenditure shares, productivity externalities, and reallocation elasticities. Input-output linkages and value added shares are constructed from OECD Inter-Country Input-Output tables, combined with occupation-by-industry wage data. I am in the process of estimating the remaining parameters. I estimate factor-specific external economies of scale following the methodology of Bartelme et al. (2025). Labor reallocation elasticities are estimated using occupation-to-occupation and industry-to-industry worker flows from CPS data. Capital reallocation elasticities are parameterized based on industry distance in the input-output network and capital composition overlap, and estimated using Bartik-style government spending shocks and exposure to Chinese import competition as instruments.

1.1 Related Literature

This paper touches on several topics: external economies of scale as a rationale for protection, reallocation frictions, capital-labor complementarity, cross-country policy spillovers, and the incidence of trade and protectionist policies across worker groups.

The idea that external economies of scale provide a rationale for trade protection dates back to Graham (1923), and was later formalized by Ethier (1982), Krugman (1987) and Helpman and Krugman (1985). When countries have a mix of constant- and increasing-returns industries, protecting the increasing-return sector can raise national welfare.[2] Recent work by Bartelme et al. (2019) estimates scale economies across manufacturing industries, finding substantial heterogeneity. In a small open economy, they show that subsidizing sectors with higher scale elasticities increases national welfare only modestly. I find much

[2] Grossman and Rossi-Hansberg (2010) show that the case for protection only applies when externalities are national rather than international in scope. I move from the premise that external economies are domestic in scope. Lind and Ramondo (2023) and Kucheryavyy et al. (2023) study how scale effects interact with comparative advantage to determine trade patterns, assuming homogeneous scale elasticities across sectors. While these papers solve for global equilibrium as a function of fundamentals, I perform local comparative statics around an initial equilibrium – reflecting a given mix of comparative advantage and scale effects – and study the implications of heterogeneous scale elasticities.

larger gains in a multi-country general equilibrium setting, where domestic policies feed back onto foreign industry composition.[3]

A central element of my framework is the interaction between external economies of scale, imperfect factor mobility, and complementarities in production. Protectionist policies effectively reap the benefits of scale economies only if sufficient resources are able to reallocate toward increasing-return industries. Reallocation frictions are amply documented in empirical studies (Artuç et al., 2010) as well as in classic work on specific factors and slow reallocation (Mussa, 1978; Matsuyama, 1991; Krugman, 1991; Kaneda, 2003), and in the China shock literature (Autor et al., 2013; Dix-Carneiro, 2014; Caliendo et al., 2019)[4] To capture this I allow for both labor and capital mobility frictions. I also introduce heterogeneous extensive margin elasticities across factor-industry pairs. If different labor occupations and/or labor and capital are complementary, as documented by Griliches (1969), Krusell et al. (2000), and Oberfield and Raval (2014), employment and wage responses to protectionist policies are determined by the slowest moving factor. Kleinman et al. (2023) make a similar argument. In a dynamic spatial model where capital and labor adjust at different speeds, they show that capital mobility amplifies short-run labor market responses to trade shocks. In related work, Caliendo et al. (2021) study migration following EU enlargement. They emphasize that endogenous capital accumulation equalizes the welfare consequences of trade and migration in the long run.[5] While abstracting from new investment, my framework features similar complementarities between capital and labor reallocation. I allow the degree of capital-labor complementarity to vary across industries and labor occupations, with the implication that protecting industries with that jointly generate larger production externalities and toward which factors reallocate more easily is most effective at increasing aggregate output and productivity.

To provide a more accurate quantitative picture, I introduce idle capital and labor.[6] I argue that restoring idle production factors can be a valid rationale for protection, and it

[3] In related work, Fajgelbaum and Gaubert (2020) characterize optimal spatial transfers when agglomeration externalities differ across space. In my setting, agglomeration externalities differ across industries rather than across space. Accordingly, I consider trade and industrial policies rather than spatial transfers. Optimal location choices do not imply welfare equalization, therefore I study redistributive effects on top of aggregate output and productivity.

[4] See also Traiberman (2019) on trade shocks and occupational choices with human capital accumulation, Galle et al. (2023) on distributional effects of the China shock with worker heterogeneity, Dix-Carneiro and Kovak (2017) on regional dynamics following trade liberalization, and Brussevich (2018) on sectoral mobility costs.

[5] Baqaee and Malmberg (2025) take a complementary approach, showing that tariffs have a large welfare cost because they reduce overall capital accumulation, since investment goods rely heavily on imported intermediate inputs.

[6] Rodríguez-Clare et al. (2020) also allow workers to exit the labor force in response to policy changes. Relatedly, Bilal (2023) studies optimal policy with labor market frictions and adjustment dynamics.

does not come at the cost of crowding out resources from other sectors. I provide novel estimates of labor and capital reallocation elasticities.

My global general equilibrium setting allows me to revisit cross-country policy spillovers from a different angle. Following Johnson (1953), a large literature studies how trade policies in one country affect welfare abroad (Ossa, 2014; Caliendo and Parro, 2015). I add a new channel: foreign industrial policy reshapes domestic industry composition, with implications for domestic productivity and labor income inequality.

My theoretical framework offers a natural way to account for the incidence of tariffs and industrial policies across worker groups, via labor demand, asset income, and consumption prices. Borusyak and Jaravel (2021) connect the incidence of tariffs with consumption patterns across the income distribution, showing that tariffs are regressive because poor households spend a larger share of their income on tradable goods.[7] Adao et al. (2023a) develop sufficient statistics for the effects of trade shocks on labor demand in economies with input-output linkages. Adao et al. (2023b) instead show that the degree of trade protection varies much more across industries than across regions, consistent with my modeling assumptions.[8] My framework enriches earlier approaches by introducing reallocation frictions and endogenous productivity changes determined by heterogeneous scale elasticities. The incidence of protectionist policies on different workers therefore not only depends on their origin industry, but also on how much labor and capital get reallocated toward their destination industry.

Finally, a complementary literature studies tariffs in environments with sticky prices and trade imbalances (Costinot and Werning, 2025; Auclert et al., 2025; Kalemli-Özcan et al., 2025). While these papers focus on short-run macroeconomic dynamics, I focus on resource reallocation across industries with flexible prices.

2 Environment

This section describes the model environment. I consider a multi-country setting, where each country features multiple industries and primary factors. Primary factors consist in differentiated labor occupations and non-labor assets (such as land, equipment, structures). Factors are imperfectly substitutable, and each unit can choose its type subject to moving frictions. That is, workers can move across occupations and non-labor factors can be repurposed subject to frictions. A higher headcount of a given factor generates positive pro-

[7] In related work, Fajgelbaum et al. (2020) document that the 2018 US tariffs raised consumption prices relatively more in Republican-voting counties, despite targeting industries concentrated there.

[8] In related work, Ignatenko et al. (2025) quantify the welfare effects of trade policy across countries through their effect on trade imbalances and tariff rebates.

ductivity externalities on that factor itself and other factors, with different degrees across labor occupations and non-labor factors. In the theory, moving costs and external economies may indifferently apply between factor pairs or between factor-industry pairs. In the quantitative analysis I estimate non-zero moving costs across industries, as well as across labor occupations or non-labor factors. Therefore I identify factors with occupation-industry pairs and asset-industry pairs.

2.1 Production

There is a set $\mathcal{N}$ of good-producing industries, indexed by i, j. All firms in industry i have the same constant returns to scale production function:

$$Y_i = A_i G_i \left(\{L_{if}\}_{f \in \mathcal{F}}, \{X_{ij}\}_{j \in \mathcal{N}} \right)$$

where L_{if} is the quantity of primary factor f hired by the industry, X_{ij} is the quantity of intermediate input j, and A_i is exogenous productivity. The production functions allow each industry to use multiple intermediate inputs and primary factors, providing flexibility to match real-world value added shares.

All producers minimize costs given input prices. With constant returns to scale, firms within industry i use inputs in the same proportions and have equal marginal costs:

$$MC_i = \min_{\{X_{ij}\}, \{L_{if}\}} \sum_{f \in \mathcal{F}} W_f L_{if} + \sum_{j \in \mathcal{N}} P_j X_{ij} \quad \text{s.t. } G_i \left(\{L_{if}\}_{f \in \mathcal{F}}, \{X_{ij}\}_{j \in \mathcal{N}} \right) = 1 \tag{1}$$

I do not take a stance on the market structure, but impose the following assumption.[9]

Assumption 2.1. Producers price at marginal cost.

External Economies of Scale. A key feature of the model is factor-specific external economies of scale. The effective supply L_{if} of factor f depends on intensive-margin hours worked in industry i (H_{if}), extensive margin headcount in industry i (N_{if}), and endogenous factor productivity determined by external economies of scale:

$$L_{if} = N_{if} \cdot H_{if} \cdot \prod_{f' \in \mathcal{F}} N_{f'}^{\nu_{ff'}} \tag{2}$$

[9] Assumption 2.1 is satisfied, for example, under perfect competition or under monopolistic competition with appropriate cost subsidies to offset markups.

where $\nu_{ff'} \in (0,1)$ captures the productivity spillover on factor f from increasing the headcount of factor f'. This formulation allows for both own external economies – meaning that having more workers in occupation f raises productivity in that occupation ($\nu_{ff} > 0$) – and cross external economies capturing spillovers across factor-industry pairs ($\nu_{ff'} \neq 0$ for $f \neq f'$). External economies can be asymmetric, in that different factor-industry pairs may have different ν parameters.

2.2 Primary Factors and Final Users

The economy has a set $\mathcal{F} = \mathcal{L} \cup \mathcal{K}$ of primary factors, consisting of differentiated labor occupations $l \in \mathcal{L}$ and non-labor factors $k \in \mathcal{K}$ (such as land, equipment, structures). Factors can reallocate across types, subject to moving frictions. Each factor is associated with a final user $z \in \mathcal{Z}$. Labor occupations l are associated with a household that chooses an occupation, supplies labor and consumes; non-labor factors k are associated with a utilization producer that can choose to repurpose the asset and determines intensive margin supply.

I use f as a generic index for factors in $\mathcal{F}$. Likewise I denote efficiency units of both factors by L_f, factor prices per efficiency-augmented hour by W_f, and consumption/utilization by C_f, for $f \in \mathcal{L} \cup \mathcal{K}$. I use the terms hours and headcount in reference to intensive and extensive margin supply of both labor and non-labor assets.

Household preferences. Each household is born endowed with nested-logit preference shocks over labor occupations $l \in \mathcal{L}$. Conditional on choosing occupation l, households have l-specific consumption preferences and own l-specific shares in industries and non-labor factors. Heterogeneous consumption and ownership shares capture local trade costs and ownership of local land in a tractable way.

Welfare is therefore occupation-specific, given by

$$V_l = \max_{C_l, H_l} \quad C_l - \frac{H_l^{1+\varphi_l}}{1+\varphi_l} \tag{3}$$

$$\text{s.t.} \quad P_l^C C_l \leq \sum_{f \in \mathcal{F}} \hat{\Xi}_{lf} W_f L_f + \sum_{i \in \mathcal{N}} \hat{\Xi}_{li} \Pi_i + T_l \tag{4}$$

The parameters φ_l are inverse Frisch elasticities determining labor supply slopes for each occupation. The consumption aggregator $C_l \equiv \mathcal{C}_l(c_{l1}, ..., c_{lN})$ is homothetic over the set of goods produced by the economy. P_l^C is the occupation-specific price index, and $\hat{\Xi}_{li}$ are ownership shares in factors and industries. Π_i are industry profits, and T_l is net transfers.

Factor supply. Factor supply has both an intensive margin (hours or utilization) and an extensive margin (headcount). Conditional on participating in occupation f, households choose hours (the intensive margin) to equate the marginal disutility of labor to real wages:

$$H_f^{\varphi_f} = \frac{W_f \cdot \prod_{f' \in \mathcal{F}} N_{f'}^{\nu_{ff'}}}{P_f^C}. \tag{5}$$

Given optimal consumption and hours choices, households choose an occupation l to maximize utility subject to an idiosyncratic taste shock:

$$l^* = \arg\max_{l \in \mathcal{L}} \{\log V_l + \varepsilon_l\}.$$

The set of labor occupations includes unemployment $u \in \mathcal{L}$. Unemployed workers are constrained to supply zero hours ($H_u \equiv 0$), and they receive an unemployment benefit T_u financed through taxes on employed workers, such that $\sum_{l \in \mathcal{L} \setminus u} T_l = -T_u$.

The taste shocks $\{\varepsilon_l\}$ follow a Cross-Nested Logit (CNL) distribution, which captures that some occupations are closer substitutes than others. Occupations are grouped into overlapping nests $m \in \mathcal{M}$ based on similarity (e.g., by industry or skill type). The CNL structure implies that the share of workers choosing occupation l is

$$P(l) = \sum_{m \in \mathcal{M}} P(m) \cdot P(l|m), \tag{6}$$

where the probability of choosing nest m and the probability of choosing l conditional on nest m are given by

$$P(l|m) = \frac{\alpha_{lm}^{1/\mu_m} V_l^{\mu_m}}{\sum_{l'} \alpha_{l'm}^{1/\mu_m} V_{l'}^{\mu_m}}, \qquad P(m) = \frac{W_m^{1/\mu_m}}{\sum_{m'} W_{m'}^{1/\mu_{m'}}}. \tag{7}$$

The parameter $\alpha_{lm} \in [0, 1]$ captures membership of occupation l in nest m (with $\sum_m \alpha_{lm} = 1$), while $\mu_m \in (0, 1]$ governs within-nest correlation of taste shocks. Lower values of μ_m imply stronger substitutability among occupations sharing nest m. We denoted the average value of nest m by $W_m \equiv \sum_l \alpha_{lm}^{1/\mu_m} V_l^{\mu_m}$.

Non-labor factors. Non-labor factors (land, equipment, structures) are subject to analogous intensive and extensive margin supply choices. To simplify the analysis I abstract from investment and factor accumulation, and only allow for optimal utilization choices. Appendix **??** describes the modeling of non-labor factors in detail.

2.3 Policy and Equilibrium Definition.

I analyze two instruments: industrial policies and trade policies. Industrial policies take the form of proportional cost subsidies $\{-\tau_i^{ind}\}_{i\in\mathcal{N}}$ to domestic industries, fully financed by lump-sum taxes proportional to ownership shares. Trade policies consist in taxes $\{\tau_i^{tar}\}$ on domestic importers of foreign goods, entirely rebated to domestic households proportional to their initial income shares.

The general equilibrium is defined below.

Definition 2.1. Given policies $(\{\tau_i^{ind}\}, \{\tau_i^{tar}\})$, an equilibrium consists of prices $\{W_f\}$, $\{P_i\}$ and quantities $\{L_{if}\}$, $\{N_f\}$, $\{Y_i\}$, $\{X_{ij}\}$, $\{C_{ih}\}$ such that: (i) households choose occupations and maximize utility subject to budget constraints; (ii) repurposing and utilization of non-labor assets maximize returns; (iii) firms minimize costs and price at marginal cost; (iv) all markets clear.

2.4 Log-Linearized Equilibrium Conditions.

For analytical tractability, I log-linearize the model around an initial equilibrium. I first introduce notation, then derive log-linearized equilibrium conditions.

Notation. For notational convenience, I extend the set of producers $\mathcal{N}$ to include good-producing industries, factor marketplaces (which produce factor services), and final users (who produce consumption and utilization). With some abuse of notation I redefine $\mathcal{N} = \mathcal{N} \cup \mathcal{Z} \cup \mathcal{F}$.

Ω,	$\Omega_{ij} = \frac{P_j^* X_{ij}^*}{P_i^* Y_i^*}, \quad i,j \in \mathcal{N}$	Direct expenditure shares
Ψ,	$\Psi = (I - \Omega)^{-1}$	Total expenditure shares
$\boldsymbol{s}$,	$s_z = \frac{P_z^{C*} C_z^*}{\sum_{z'} P_{z'}^{C*} C_{z'}^*} \quad z \in \mathcal{Z}$	Income shares of final users
$\bar{\boldsymbol{\Psi}}$,	$\bar{\Psi}_i = \frac{P_i^* Y_i^*}{\sum_{f'} P_j^* Y_j^*} \quad i \in \mathcal{N}$	Factor income shares and industry sales shares
Ξ,	$\Xi_{zi} \equiv \left(\Xi_{zi} + \frac{T_z^*}{GDP^*}\right) \frac{\bar{\Psi}_i}{s_z} \quad z \in \mathcal{Z} \quad i \in \mathcal{N}$	Ownership share of z in i
$\boldsymbol{N^*}$,	$N_f^* = \frac{f \text{ headcount}}{\sum_{f'} f' \text{ headcount}} \quad f \in \mathcal{F}$	Headcount shares in the initial equilibrium

Table 1: Notation for expenditure and income shares.

The log-linearized model depends on ownership and expenditure shares in the initial equilibrium (denoted with starred variables). Table 1 introduces notation for expenditure

and income shares. Appendix **??** reports accounting relations connecting income shares of primary factors (the components of $\bar{\mathbf{\Psi}}$ corresponding to $\mathcal{F}$) with income shares of final users ($\boldsymbol{s}$).

Factor supply and final consumption. Intensive margin factor supply is governed by optimal consumption-leisure tradeoffs for labor occupations, and optimal utilization of non-labor assets. For each factor $f \in \mathcal{L} \cup \mathcal{K}$, intensive margin supply can be log-linearized as

$$\varphi_f h_f = w_f + \sum_{f'} \nu_{ff'} n_{f'} - p_f^C. \tag{8}$$

I indifferently denote consumption of households and utilization of non-labor assets by c_f, $f \in \mathcal{F}$. Both are subject to the same budget constraint

$$c_f = \sum_{f' \in \mathcal{F}} \Xi_{ff'} \ell_{f'} + \sum_{i \in \mathcal{N}} \Xi_{fi} \left(p_i - \sum_{j \in \mathcal{N}} \Omega_{ij} p_j \right) - p_f^C + \frac{dT_f / GDP^*}{s_f^*}. \tag{9}$$

Log-linearized changes in the value of each labor occupation and non-labor factor are given by

$$v_f = \mathcal{W}_{Cf} c_f - \mathcal{W}_{Hf} h_f, \tag{10}$$

where $\mathcal{W}_{Cf} \equiv C_f / V_f$ is the welfare weight on consumption and $\mathcal{W}_{Hf} \equiv H_f^{1+\varphi_f} / V_f$ is the welfare weight on hours.

Log-linearizing optimal extensive margin supply choices for labor and non-labor assets yields relations between headcount changes and value differentials across factor types. Denoting the log-headcount change of factor f by n_f, and the log-value change as v_f, we can write these relations as:

$$n_f = \sum_{f' \in \mathcal{F}} \theta_{ff'} \; v_{f'} \tag{11}$$

where $\theta_{ff'}$ governs the extensive-margin flow elasticity from factor f to factor f'. The CNL structure implies that for $f \neq f'$:

$$\theta_{ff'} = P(f') + \sum_m P(m|f)(1 - \mu_m) P(f'|m) \tag{12}$$

with diagonal elements $\theta_{ff} = -\sum_{f' \neq f} \theta_{ff'}$. This structure ensures that θ satisfies two zero-sum properties. First, $\sum_{f'} \theta_{ff'} = 0$ for all f, capturing that only relative values matter. Second, $\sum_{f'} N_{f'}^* \theta_{f'f} = 0$ for all f, capturing that total headcount and total asset stock are fixed.

Pricing. Assumption 2.1 implies that prices equal marginal costs. Log-linearizing equation (1) allows us to relate marginal costs with factor and input prices. For each industry $i \in \mathcal{N}$ we have

$$p_i = mc_i = \sum_{f \in \mathcal{F}} \Psi_{if} w_f + \sum_{j \in \mathcal{N} \setminus \mathcal{F}} \Psi_{ij} p_j. \tag{13}$$

Expenditure switching and market clearing. The relative demand for goods and factors responds to relative prices, as governed by CES aggregators in production and consumption. Total quantity produced must satisfy market clearing. Given purchaser i's substitution elasticities σ^i_{jk} between inputs j and $k \in \mathcal{N}$, and denoting by x_{ij} the log changes in input quantities purchased by $i \in \mathcal{N}$ from $j \in \mathcal{N}$, expenditure switching and market clearing conditions yield the demand system

$$\begin{aligned} x_{ij} - x_{ik} &= -\sigma^i_{jk} (p_j - p_k) \quad \forall i, j, k \in \mathcal{N} && \text{expenditure switching} \\ y_i &= \sum_{j \in \mathcal{N}} x_{ij} \quad \forall i \in \mathcal{N} && \text{market clearing.} \end{aligned} \tag{14}$$

3 An Illustrative Example

Before presenting general analytical results, I illustrate the main economic mechanisms using a simplified economy with two countries, two industries, and two factors in each industry. This proof of concept demonstrates how external economies of scale, capital mobility, and protectionist policies interact to determine aggregate output, aggregate productivity, and labor income in each country.

I consider an economy with two equal-sized countries, United States (US) and China (CHN). Each country has two industries, Semiconductors (S, with high external economies) and Manufacturing (M, with low external economies). Industries produce using local Labor and Capital. I assume externalities only happen across factors located in the same country.

I study two policy interventions: Chinese industrial policy, consisting in subsidies to Chinese producers, and US trade policy, consisting in tariffs on imported Chinese goods. Both policies are aimed at sustaining protected producers in the respective country. As we will see, the two policies achieve a similar objective but with different incidences on the domestic and foreign economy. I consider how each performs, depending on the strength of external economies in semiconductors and manufacturing, extensive margin factor supply responses, and capital-labor complementarity.

This section relies on model simulations. Section 4 provides formal analytical results. Table 2 reports parameter values for the simplified model.

Parameter	Description	Value
β_H	Home bias in consumption	0.7
γ	Wealth effect in labor supply	1
φ_L	Inverse Frisch elasticity (labor)	2
φ_K	Utilization elasticity (capital)	2
θ_{EE}	Extensive margin E-to-E flow elasticity	0.9
θ_{EU}	Extensive margin E-to-U flow elasticity	0.01
θ_K	Extensive margin capital reallocation elasticity	θ_{EU}
$\bar{\nu}$	Average external economy	0.2
ν^R	External economy in S relative to M ($\nu_{SS} - \nu_{MM}$)	0.2
ν^X	Cross-external economies (ν_{SM}, ν_{MS})	0.2
σ_{KL}	Capital-labor substitution	

Table 2: Baseline parameter values for the two-country economy.

3.1 Comparative Statics

I present two different scenarios, corresponding to two distinct rationales for protection. First, I consider protection of the semiconductor industry. By assumption this industry has higher external economies of scale, therefore both countries can increase local factor productivity by shifting resources toward this industry. I study how the effectiveness of protectionist policies depends on labor and capital mobility frictions.

Second, I consider protection of the manufacturing industry. While this industry generates lower productivity externalities, there might still be a rationale for protection, to the extent that increasing domestic competitiveness draws unemployed workers back into the labor force. If worker flows mostly happen along the unemployment margin, rather than crowding out resources from the semiconductor industry, protecting the manufacturing industry boosts domestic employment without compromising productivity externalities.

Exploiting externalities. A large literature, started by Graham (1923) and Ethier (1982), makes the case for protecting industries with higher returns to scale. I highlight that the outcome of protectionist policies depends on factor mobility as well as relative economies of scale across industries.

I start by considering the effect of protecting the semiconductor industry on total factor productivity (TFP) in the US and China. As indicated in table 2, manufacturing has weaker external economies than semiconductors. When a country protects its own semiconductor industry, domestic labor and capital reallocate toward this industry. This raises domestic TFP, because resources are attracted into the industry with higher scale economies. Foreign

TFP experiences the opposite effect, as resources move away from the high-return industry due to increased competition.

Section 4 will formalize this intuition, showing that each country's TFP depends on the covariance between productivity externalities and factor reallocation. Reallocating resources toward the semiconductor industry yields a positive covariance, increasing TFP. The effect is larger when externalities in the two industries are more heterogeneous.

Figure 1 provides an illustration. The left panel shows responses in the US economy, while the right panel shows responses in the Chinese economy. The vertical axis reports changes in TFP, while the horizontal axis reports relative external economies in manufacturing versus semiconductors. Solid lines represent Chinese industrial policy, while dashed lines represent US trade policy. The blue, red, and yellow lines correspond to increasing capital mobility.

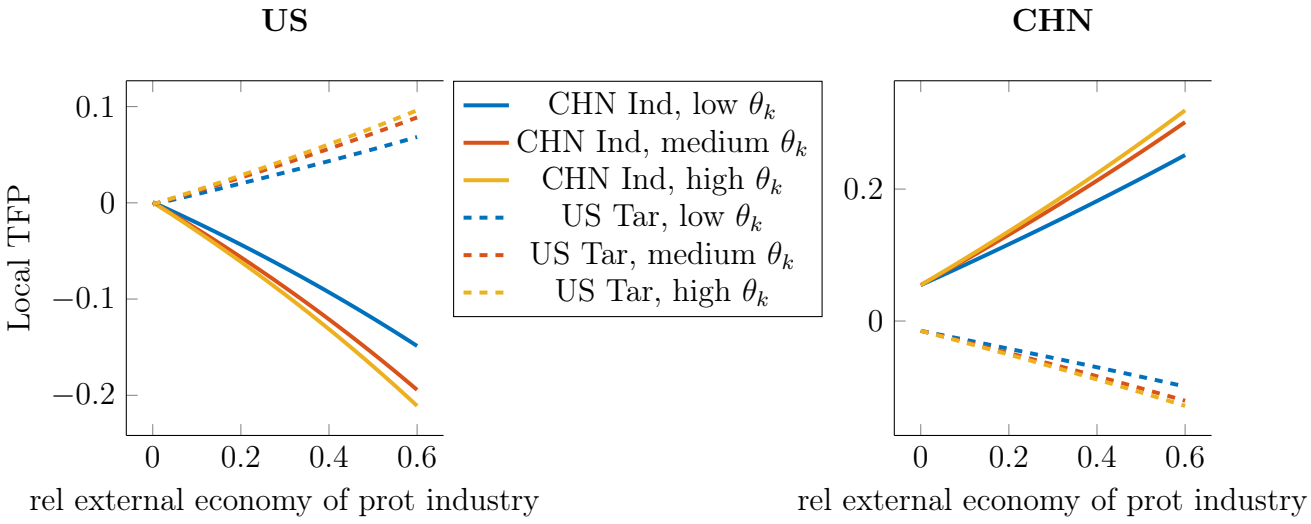


Figure 1: Response of TFP, for varying rel external economy of prot industry

All productivity effects are increasing in the differential externality between manufacturing and semiconductors. Responses to trade and industrial policies have the same sign, but different magnitude. Industrial policy has a larger incidence on the domestic country, while trade policy has a larger incidence on the foreign country. Industrial policies have larger effects overall, because they affect relative prices in all countries, while trade policies only affect relative prices in the domestic country. Factor mobility amplifies productivity changes, by speeding up resource reallocation.

Figure 2 instead shows TFP changes for different values of capital-labor substitutability (increasing from blue to red to yellow line). As expected, for given capital mobility, aggregate productivity responds by more when capital and labor are more substitutable. This happens

because higher substitutability allows the protected industry to expand production by hiring a larger quantity of mobile factors.

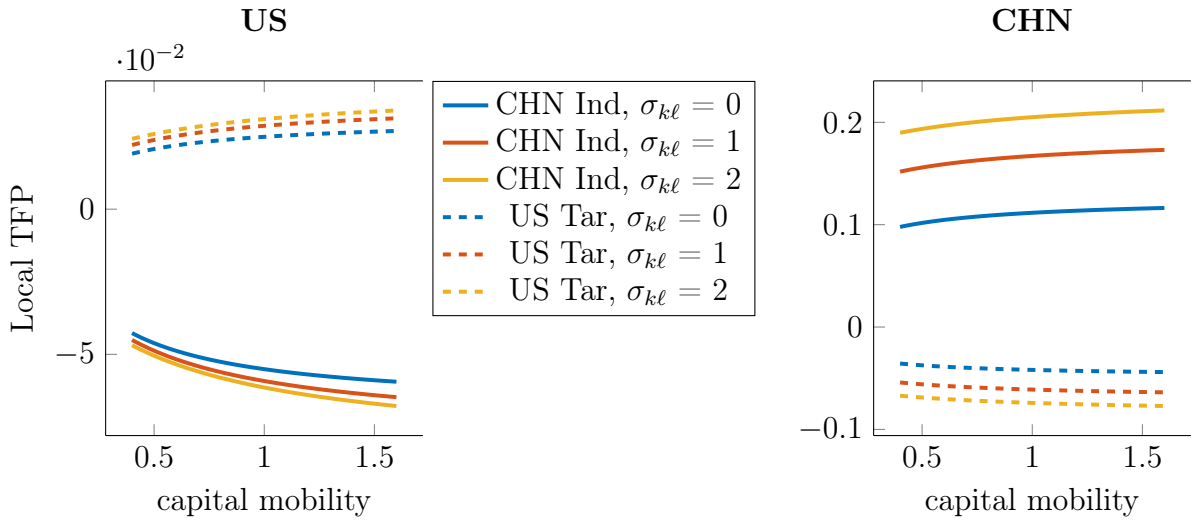


Figure 2: Response of Local TFP, for varying capital mobility

I next turn to studying the response of GDP. Unlike TFP, GDP depends not only on productivity but also on intensive margin factor supply. By subsidizing costs, industrial policies reduce consumption prices relative to wages. This boosts labor supply in all countries. In our example the intensive margin response is strong enough to counteract TFP changes, if externalities are not too different across industries. Vice versa, trade policies increase consumption prices and therefore reduce intensive margin supply in both countries.

Figure 3 illustrates these effects. The left panel shows US outcomes, while the right panel shows Chinese outcomes. Solid lines show the effect of Chinese subsidies to the semiconductor industry, while dashed lines show the effect of US tariffs. The blue, red, and yellow lines consider scenarios with low, medium, and high capital mobility. Like for TFP, the effect of protectionist policies on domestic and foreign GDP is larger when capital is more mobile, because more resources are crowded into the domestic semiconductor industry and out of the foreign one.

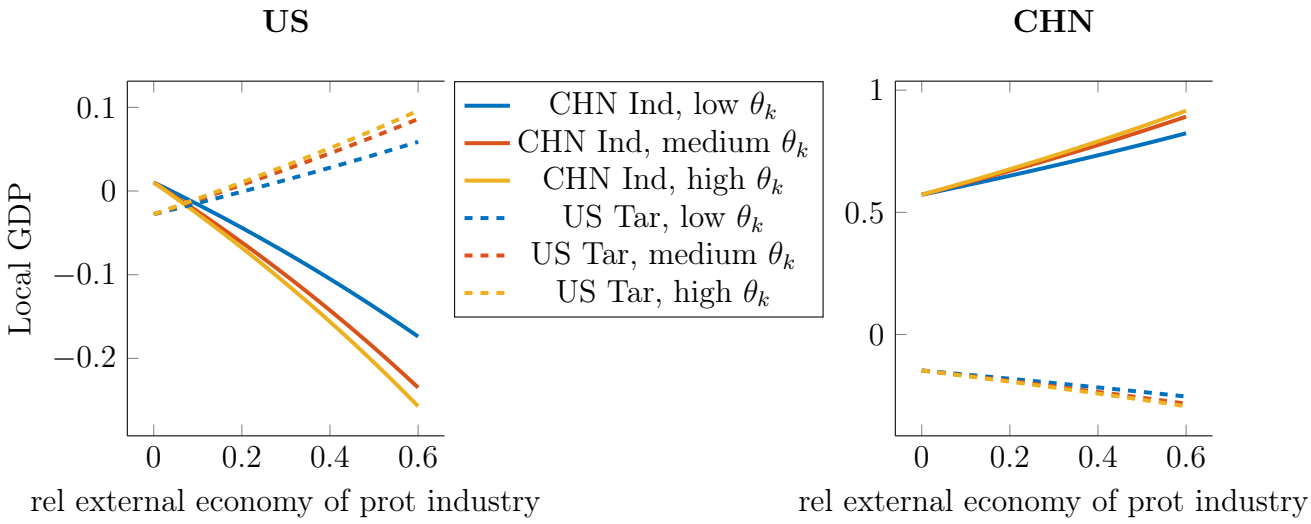


Figure 3: Response of GDP, for varying rel external economy of prot industry

Sustaining domestic manufacturing employment. Figure 1 illustrates how protecting industries that generate larger externalities boosts domestic productivity, and vice versa. The argument relies on the assumption that protecting one industry crowds out labor and capital from other industries. This argument however ignores the fact that protection not only crowds out resources from other industries, but it also crowds in resources from unemployment.

Figure 4 considers the effect of protecting the manufacturing industry on TFP (on the vertical axis). The horizontal axis represents capital mobility, while the blue, red, and yellow lines correspond to different labor reallocation elasticities. In the blue line, workers are mostly crowded in from unemployment. In the yellow line, workers are mostly crowded out from the semiconductor industry. As expected, the cost of protecting domestic manufacturing employment is higher when labor and capital are mostly crowded out from the semiconductor industry. When workers are mostly crowded in from unemployment, protecting the manufacturing industry might raise domestic TFP even though this industry generates weaker productivity externalities.

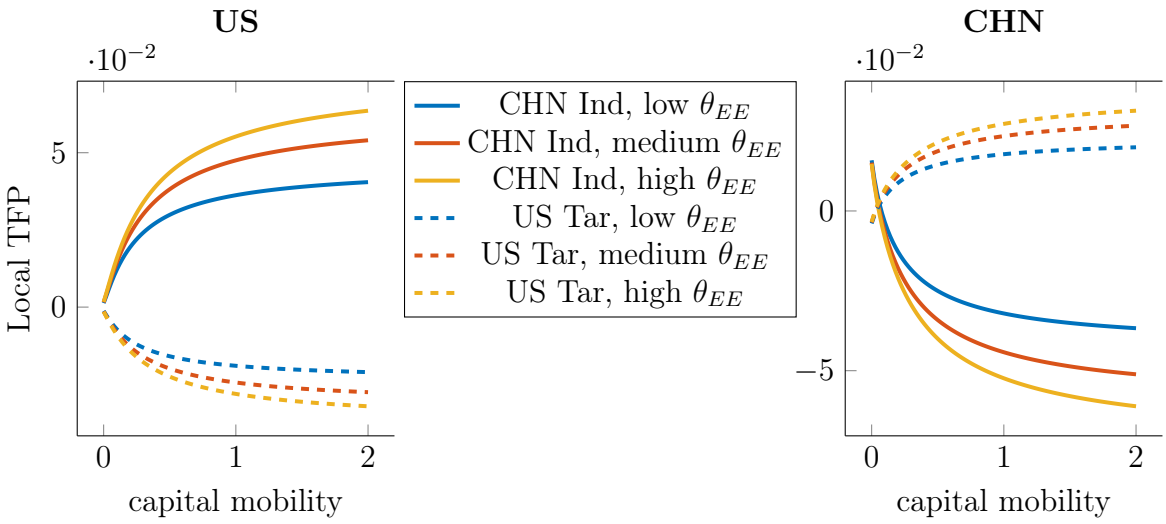


Figure 4: Response of TFP, for varying capital mobility

Extensive margin elasticities $\theta_{ff'}$ vary over time, because they depend on the share N^* of workers in each occupation and on the share of unemployed workers. Figure 5 considers the response of US manufacturing employment under two different scenarios. I refer to the first scenario (red lines) as the China shock. China starts subsidizing its own manufacturing sector, and US manufacturing workers flow into unemployment with a high elasticity θ_{EU}. The dashed line represents worker outflows toward the semiconductor industry, while the dotted line represents outflows into unemployment. The solid line represents the total outflow.

In the second scenario (blue lines) the US offers delayed tariff protection to the manufacturing industry. This takes place at a time when unemployed workers have retired, moved, or become detached from the labor market. In this scenario the pre-intervention share of unemployed manufacturing workers is low, so that the inflow elasticity from unemployment θ_{EU} is also low. Correspondingly, the worker inflow into manufacturing in response to trade protection is much smaller than the outflow in response to the China shock.

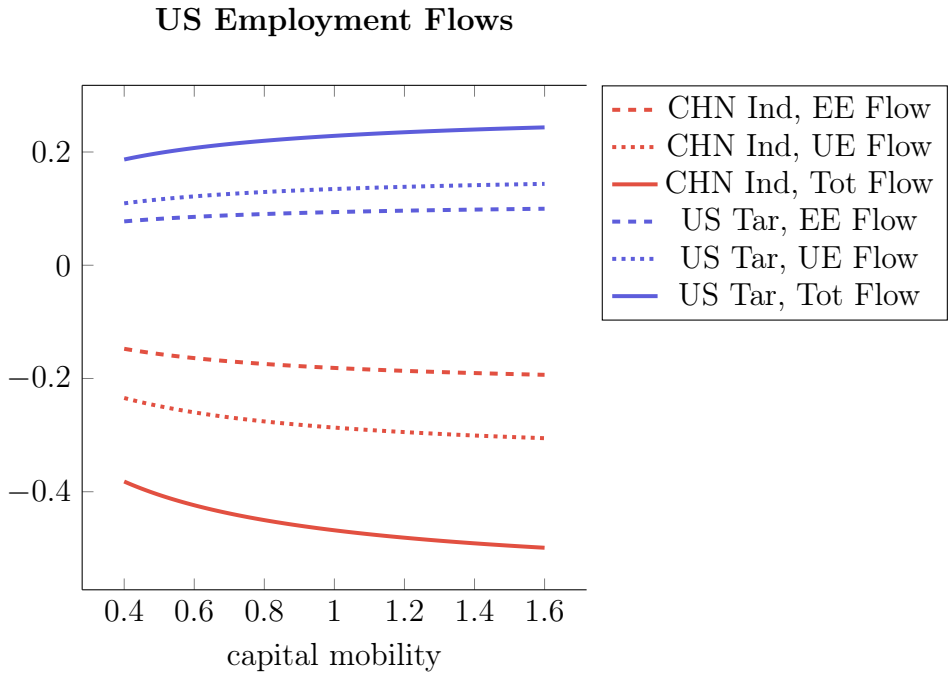


Figure 5: US Employment Flows

The economic mechanisms highlighted in these model simulations generalize to a richer environment with many industries, factors, and regions. The next section derives their analytical counterpart in a general setting.

4 Analytical Results

This section derives analytically the economic mechanisms illustrated in the model simulations. Returning to the general framework of section 2, I describe how factor-specific economies of scale, reallocation elasticities, and intensive-margin supply elasticities interact to determine the responses of TFP, GDP, and relative labor income across countries and occupations. I start by relating changes in TFP and GDP with changes in factor-level wages and headcount. I then solve for endogenous wage and headcount responses to policies.

Notation. For notational convenience, I collect variables pertaining to different groups of agents (primary factors, industries, final users) into vectors, where each component corresponds to an individual agent within the group. As a preliminary result, proposition 4.1 translates the log-linearized equilibrium conditions from section 2 into this vector notation.

In the vector representation prices and quantities are related via matrix elasticities, which capture own effects and across-agent spillovers. Table 3 below defines these matrix elasticities. For any matrix $\mathcal{M}$, I use subscripts to denote sub-components corresponding to specific agent groups. For example, $\mathcal{M}_{:\mathcal{F}}$ denotes the columns corresponding to primary factors, while $\mathcal{M}_{\mathcal{Z}:}$ denotes the rows corresponding to final users.

Proposition 4.1. Log-linearized equilibrium. *The log-linearized equilibrium is characterized by four vector equations:*

$$\boldsymbol{p} = \Psi_{:\mathcal{F}}\, \boldsymbol{w} + \Psi \boldsymbol{\tau} \qquad \textit{pricing} \tag{15a}$$

$$\boldsymbol{\ell} = \mathbf{1}\bar{\ell} - \Sigma_p\, \boldsymbol{p} \qquad \textit{relative demand} \tag{15b}$$

$$\boldsymbol{n} = \Theta_n \mathcal{V}\, \boldsymbol{n} + \Theta_p\, \boldsymbol{p} \qquad \textit{extensive margin supply} \tag{15c}$$

$$\boldsymbol{h} = \Phi^{-1}\boldsymbol{w} + \Phi^{-1}\mathcal{V}\, \boldsymbol{n} - \Phi^{-1}\Omega_{\mathcal{Z}:}\boldsymbol{p} \qquad \textit{intensive margin supply} \tag{15d}$$

where $\boldsymbol{\ell}$ denotes factor supply in efficiency units:

$$\boldsymbol{\ell} = \boldsymbol{h} + (I + \mathcal{V})\, \boldsymbol{n}. \tag{16}$$

Proof. The system (15) directly follows from equations (8) - (14). Appendix **??** provides full derivations. Matrix elasticities are defined in table 3. □

Intensive margin supply	$\Phi_{ff} = \varphi_f$, $\Phi_{ff'} = 0$
Extensive margin supply	$(\Theta_n)_{ff'} \equiv \sum_{g\in\mathcal{F}} \theta_{fg} \frac{\partial \log V_g}{\partial \log N_{f'}}$, $\quad (\Theta_p)_{fi} \equiv \sum_{f'\in\mathcal{F}} \theta_{ff'} \frac{\partial \log V_{f'}}{\partial \log P_i}$
External economies	$\mathcal{V}_{ff'} = \nu_{ff'}$
Relative factor demand	$\Sigma_p = (\Sigma_p)_{fi}$ (see appendix **??**)
Leontief inverse	$\Psi \equiv (I - \Omega)^{-1}$, $\Omega_{ij} \equiv \frac{P_j X_{ij}}{P_i Y_i}$
Factor income shares	$\bar{\boldsymbol{\Psi}}_{\mathcal{F}} \equiv \frac{W_f L_f}{GDP}$

Table 3: Definition of matrix elasticities.

Equation (15a) states that good prices depend on factor prices $\boldsymbol{w}$ and cost taxes/subsidies $\boldsymbol{\tau}$, directly and through input-output linkages, as captured by the Leontief inverse Ψ. Equation (15b) instead connects the relative demand for primary factors with relative prices. The elasticity Σ_p combines expenditure switching and market clearing conditions in (14) at all tiers of the production network, aggregating them according to each tier's expenditure and sales shares. Equation (15c) governs extensive margin supply, and follows from combining

extensive margin flows (11) with value changes (10). The term $\Theta_n \mathcal{V}\boldsymbol{n}$ balances agglomeration and congestion forces. Reallocation elasticities Θ act as a congestion force, while externalities $\mathcal{V}$ are an agglomeration force. As headcount increases, external economies raise productivity, attracting more workers. The term $\Theta_p \boldsymbol{p}$ captures how price changes affect the relative value of different labor occupations and non-labor assets, through changes in relative real wages and income rebates from non-labor factors. Finally, equation (15d) determines intensive margin supply. Hours worked increase with own wages ($\Phi^{-1}\boldsymbol{w}$) and decrease with consumption prices ($\Phi^{-1}\Omega_{\mathcal{Z}:}\boldsymbol{p}$). External economies ($\Phi^{-1}\mathcal{V}\boldsymbol{n}$) reduce wages per physical hour, given the compensation $\boldsymbol{w}$ of efficiency-augmented hours.

4.1 Local and Global Aggregates

Propositions 4.2 and 4.3 below connect changes in factor prices and headcount with country-level GDP and TFP. The responses of factor prices and headcount to policies are derived in section 4.2 below. Prior to stating the propositions, I introduce standard definitions of regional GDP, TFP, and income shares.

Definition 4.1. Regions. A region $\mathcal{R}$ is a subset of factors, $\mathcal{R} \subseteq \mathcal{F}$.

Definition 4.2. Regional GDP and income shares. *Nominal GDP* in region $\mathcal{R}$ is the total nominal income of factors $f \in \mathcal{R}$:

$$\text{nGDP}_{\mathcal{R}} \equiv \sum_{f \in \mathcal{R}} W_f L_f.$$

The change in region $\mathcal{R}$ *real GDP* is the income-weighted change in factor-level efficiency units:

$$\Delta \log \text{GDP}_{\mathcal{R}} \equiv \sum_{f \in \mathcal{R}} \frac{W_f^* L_f^*}{nGDP_{\mathcal{R}}^*} \Delta \log L_f,$$

where starred variables denote initial values.

The vector of *factor income shares* relative to region $\mathcal{R}$ nominal GDP is denoted by $\bar{\boldsymbol{\Psi}}_{\mathcal{R}}$, such that

$$\left(\bar{\Psi}_{\mathcal{R}}\right)_f \equiv \frac{W_f L_f}{nGDP_{\mathcal{R}}} = \frac{\bar{\Psi}_f}{\sum_{f' \in \mathcal{R}} \bar{\Psi}_{f'}}.$$

Definition 4.3. Regional employment. The change in region $\mathcal{R}$ *aggregate employment* is the income-weighted average employment change of factors $f \in \mathcal{R}$:

$$d \log \text{E}_{\mathcal{R}} \equiv \sum_{f \in \mathcal{R}} \left(\bar{\Psi}_{\mathcal{R}}\right)_f (h_f + n_f).$$

Definition 4.4. Regional TFP. The change in region $\mathcal{R}$'s *total factor productivity* (TFP) is given by the change in regional GDP relative to regional employment:

$$\Delta \log \text{TFP}_{\mathcal{R}} \equiv \Delta \log \text{rGDP}_{\mathcal{R}} - \Delta \log E_{\mathcal{R}}$$

Lastly, I introduce notation for a covariance operator used in the derivations below.

Definition 4.5. Covariance Operator. Consider unit-sum weights $\boldsymbol{w} \in \mathbb{R}^M$, $\boldsymbol{w} \in [0,1]$, and matrices $X \in \mathbb{R}^{Q \times M}$, $Y \in \mathbb{R}^{M \times P}$. The covariance operator $Cov_{\boldsymbol{w}}(X,Y) \in \mathbb{R}^{Q \times P}$ is defined as

$$[Cov_{\boldsymbol{w}}(X,Y)]_{ij} \equiv \sum_{k=1}^{M} w_k X_{ik} Y_{kj} - \left(\sum_{k=1}^{M} w_k X_{ik}\right)\left(\sum_{k=1}^{M} w_k Y_{kj}\right) \tag{17}$$

Proposition 4.2 starts by characterizing regional TFP changes. It establishes that, when producers price at marginal cost, changes in TFP only depend on extensive margin factor reallocation.

Proposition 4.2. Regional TFP. *Consider any region $\mathcal{R}$. Denote by $\left(\bar{\mathcal{V}}_{\mathcal{R}}\right)_f \equiv \sum_{f' \in \mathcal{R}} \left(\bar{\Psi}_{\mathcal{R}}\right)_{f'} \mathcal{V}_{f'f}/N_f^*$ the average externality generated by a unit of factor $f \in \mathcal{F}$ on factors $f' \in \mathcal{R}$. Under assumption 2.1, TFP in region $\mathcal{R}$ increases if and only if workers and non-labor factors reallocate toward occupations which produce a larger externality on $\mathcal{R}$:*

$$d \log TFP_{\mathcal{R}} = Cov_{\boldsymbol{N}^*}\left(\bar{\boldsymbol{\mathcal{V}}}_{\mathcal{R}}, \boldsymbol{n}\right). \tag{18}$$

Proof. Equation (18) follows from definition 4.4, $d \log \text{TFP}_{\mathcal{R}} = \bar{\Psi}_{\mathcal{R}}(\boldsymbol{\ell} - \boldsymbol{n} - \boldsymbol{h})$, combined with the definition of efficiency units (16). To express $d \log \text{TFP}_{\mathcal{R}}$ as a covariance, we used the assumption that total headcount is constant ($\boldsymbol{N}^* \boldsymbol{n} = \boldsymbol{0}$). □

Proposition 4.2 shows that, when firms price at marginal costs, changes in regional TFP are entirely driven by extensive margin reallocation. Intuitively, under assumption 2.1 resources are allocated efficiently given factor productivity. Market prices, however, do not account for the productivity externality that materializes when factors reallocate toward occupations with higher external economies. Equation (18) makes this precise. TFP increases when the covariance between factor-level externalities on the region of interest $\bar{\mathcal{V}}_{\mathcal{R}}$ and headcount changes $\boldsymbol{n}$ is positive.

As an illustration, consider the example from section 3. Semiconductors generate larger external economies than manufacturing ($\nu_{SS} > \nu_{MM}$), and protecting the domestic semiconductor industry draws labor and capital toward it (so that $n_S > 0 > n_M$). The covariance in (18) is positive and domestic TFP rises.

Proposition 4.3 characterizes the response of regional GDP.

Proposition 4.3. Regional GDP. *Consider any region $\mathcal{R}$. Assume for simplicity $\bar{\mathbf{\Psi}}_{\mathcal{R}} = \boldsymbol{N}^*_{\mathcal{R}}$ in the initial equilibrium.*[10] *Denote the average intensive margin elasticity in region $\mathcal{R}$ by $\bar{\Phi}^{-1} \equiv \sum_{f \in \mathcal{R}} \frac{\left(\bar{\Psi}_{\mathcal{R}}\right)_f}{\varphi_f}$. Region $\mathcal{R}$'s GDP response is given by*

$$\begin{aligned} d\log GDP_{\mathcal{R}} = &\left(1 + \bar{\Phi}^{-1}\right) d\log TFP_{\mathcal{R}} + Cov_{\bar{\mathbf{\Psi}}_{\mathcal{R}}}\left(\Phi^{-1}, d\log \textit{ factor productivity}\right) \\ &- \bar{\Phi}^{-1} \cdot d\log \textit{avg consumption tax} - Cov_{\bar{\mathbf{\Psi}}_{\mathcal{R}}}\left(\Phi^{-1}, d\log \textit{consumption tax}\right) \\ &+ \bar{\Phi}^{-1} \cdot d\log \textit{avg terms of trade} + Cov_{\bar{\mathbf{\Psi}}_{\mathcal{R}}}\left(\Phi^{-1}, d\log \textit{terms of trade}\right), \end{aligned} \tag{19}$$

where

$$\begin{aligned} d\log \textit{ factor productivity}_f &\equiv \mathcal{V}_{f:}\boldsymbol{n} \\ d\log \textit{avg consumption tax} &\equiv \bar{\mathbf{\Psi}}_{\mathcal{C}}\boldsymbol{\tau} \\ d\log \textit{consumption tax}_f &\equiv \mathbf{\Psi}_{\mathcal{C}_f,:}\boldsymbol{\tau} \\ d\log \textit{avg terms of trade} &\equiv \bar{w}_{\mathcal{R}} - \bar{\mathbf{\Psi}}_{\mathcal{C}\mathcal{F}}\boldsymbol{w} \\ d\log \textit{terms of trade}_f &\equiv w_f - \mathbf{\Psi}_{\mathcal{C}_f\mathcal{F}}\boldsymbol{w}. \end{aligned}$$

Proof. Following definition 4.2, the GDP response in region $\mathcal{R}$ is equal to the weighted average change in efficiency units: $d\log \text{GDP}_{\mathcal{R}} = \bar{\mathbf{\Psi}}_{\mathcal{R}}\boldsymbol{\ell}$. Efficiency units in turn depend on hours and headcount through (16), while hours are pinned down by optimal intensive margin supply (15d). Combining (16) and (15d) allows us to express changes in efficiency units in terms of headcount, factor prices, and policies:

$$\boldsymbol{\ell} = \left[I + \left(I + \Phi^{-1}\right)\mathcal{V}\right]\boldsymbol{n} + \Phi^{-1}\left(I - \Psi_{\mathcal{Z}\mathcal{F}}\right)\boldsymbol{w} + \Phi^{-1}\Psi_{\mathcal{Z}:}\boldsymbol{\tau}.$$

Aggregating according to factor income shares $\bar{\mathbf{\Psi}}_{\mathcal{R}}$ and using the covariance operator in definition 4.5 yields the result. □

In equation (19), aggregate GDP in region $\mathcal{R}$ depends on changes in productivity, subsidies, and terms of trade faced by $\mathcal{R}$'s factors. The GDP response is amplified when these changes are positively correlated with intensive margin supply elasticities.

The first line in (19) tells us that GDP increases proportionally with TFP, and GDP changes are amplified by the endogenous intensive margin supply response. As factors be-

[10] Without this assumption, equation (19) would have an additional term XXX.

come more productive, they find it optimal to work more hours, as governed by the intensive margin supply elasticity $\bar{\Phi}^{-1}$. Through the second term, GDP increases by more when elastically supplied factors become relatively more productive.

The second line says that protectionist policies $\boldsymbol{\tau}$ create a wedge between factor prices and final consumption prices. If protectionist policies reduce consumption prices for given factor prices ($\bar{\boldsymbol{\Psi}}_{\mathcal{C}}\boldsymbol{\tau} < 0$), real wages increase. Therefore workers and non-labor factors optimally supply more hours. This raises overall employment, thereby increasing GDP. The effect is amplified when real wages increase by more for factors with more elastic intensive margin supply, as captured by the covariance term.

The third line captures changes in terms of trade. If factor income in region $\mathcal{R}$ increases by more than consumption prices ($\bar{w}_{\mathcal{R}} > \bar{\boldsymbol{\Psi}}_{\mathcal{CF}}\boldsymbol{w}$), workers and non-labor factors optimally supply more hours. The response of GDP is amplified when terms of trade improve by more for factors with more elastic intensive margin supply, as governed by the covariance term.

Finally, proposition 4.4 characterizes relative GDP responses across countries, and relative employment responses across occupations within a country.

Proposition 4.4. Cross-sectional responses. *The change in region $\mathcal{R}$'s GDP relative to global GDP is given by*

$$\text{GDP}_{\mathcal{R}} - \text{GDP}_{world} = \underbrace{-\bar{\boldsymbol{\Sigma}}^{\mathcal{R}}\left(\boldsymbol{\tau} + \boldsymbol{\tau}^{tar}\right)}_{\text{direct demand effect}} \quad \underbrace{-\bar{\boldsymbol{\Sigma}}^{\mathcal{R}}_{:\mathcal{F}}\boldsymbol{w}}_{\text{expenditure switching}}, \tag{20}$$

where $\bar{\boldsymbol{\Sigma}}^{\mathcal{R}} \equiv \bar{\boldsymbol{\Psi}}^{T}_{\mathcal{R}}\Sigma\Psi$ governs changes in the demand for region-$\mathcal{R}$ factors relative to global output. Within each region $\mathcal{R}$, cross-sectional efficiency units follow a similar decomposition:

$$\boldsymbol{\ell} - \mathbf{1}\text{GDP}_{\mathcal{R}} = \underbrace{-\Sigma^{\mathcal{R}}\left(\boldsymbol{\tau} + \boldsymbol{\tau}^{tar}\right)}_{\text{direct demand effect}} \quad \underbrace{-\Sigma^{\mathcal{R}}_{\mathcal{F}}\boldsymbol{w}}_{\text{expenditure switching}}, \tag{21}$$

where we normalized factor demand elasticities $\Sigma^{\mathcal{R}} \equiv \Sigma\Psi - \mathbf{1}\bar{\boldsymbol{\Sigma}}^{\mathcal{R}}$ relative to the region-$\mathcal{R}$ average.

Proof. Both equations follow directly from (15b) and (15a). □

Cross-sectional responses in equations (20) and (21) reflect direct demand effects and expenditure switching. Through the direct effect, protectionist policies change relative good prices for given factor prices, thereby shifting relative factor demand. Relative demand shifts in turn lead to changes in relative factor prices, as derived in corollary 4.1 below. This determines an expenditure switching effect, which partially counteracts the direct demand shift.

For example consider US tariffs on Chinese goods, as in section 3. Through the direct demand effect in (20), tariffs raise the relative price of Chinese goods, shifting demand toward US products. This increases US GDP relative to global GDP. However, the demand shift raises US wages ($w_{US} > 0$), making US goods more expensive. Through expenditure switching, this partially offsets the initial demand shift toward US producers. The same logic applies within the US economy, as captured by (21). Suppose the US targets protection toward manufacturing goods, so that demand increases for manufacturing workers relative to semiconductor workers. As manufacturing wages rise relative to semiconductor wages, expenditure switching partially counteracts the direct demand effect, dampening the increase in manufacturing employment.

4.2 Endogenous Price and Quantity Responses

Propositions 4.2, 4.3 and 4.4 express TFP and GDP as a function of headcount $\boldsymbol{n}$ and factor prices $\boldsymbol{w}$. This subsection derives endogenous headcount and factor price responses to protectionist policies. To build to this result, I condense the log-linearized equilibrium system (15) into a set of supply and demand curves for labor occupations and non-labor assets. Intersecting demand and supply curves then allows me to decompose equilibrium price and quantity responses into direct policy exposures and feedback effects.

The feedback effects capture several forces, including expenditure switching across goods, intensive margin supply responses, and the balance between agglomeration and congestion forces determining extensive margin responses. Proposition 4.5 summarizes these forces into a set of headcount demand and supply slopes. Headcount demand is flatter for factors that are less substitutable or have inelastic intensive margin supply. Headcount supply is flatter for factors that are more mobile or face larger productivity externalities. As corollary 4.1 illustrates, flatter demand curves are associated with larger quantity and price responses, while flatter supply curves are associated with larger quantity responses and smaller price responses.

Proposition 4.5 starts by deriving demand and supply curves for primary factors. For convenience, I express them in terms of headcount and wages per efficiency unit. Prices, hours worked, and efficiency units can be derived from (15) and (16).

Proposition 4.5. Demand and supply for primary factors. *Headcount $\boldsymbol{n}$ and wages per efficiency unit $\boldsymbol{w}$ are related by the following demand and supply curves:*

$$\boldsymbol{n} = -\Sigma_{\cdot\mathcal{F}}\,\boldsymbol{w} - \Sigma\boldsymbol{\tau} \qquad \textit{demand curves} \tag{22}$$

$$\boldsymbol{n} = \Theta_{\cdot\mathcal{F}}\boldsymbol{w} + \Theta\boldsymbol{\tau} \qquad \textit{supply curves.} \tag{23}$$

Assuming $\bar{\mathbf{\Psi}}_{\mathcal{F}} = \boldsymbol{N}^*$*, we denoted*[11]

$$\Sigma \equiv \left(I + \left(I + \Phi^{-1}\right)\mathcal{V}\right)^{-1}\left[\Sigma_p + \Phi^{-1}\left(XX - \Omega_{\mathcal{Z}:}\right)\right]\Psi$$
$$\Theta \equiv \left(I - \Theta_n\mathcal{V}\right)^{-1}\Theta_p\Psi.$$

Proof. Headcount demand curves are obtained by combining relative factor demand (15b), intensive margin supply (15d), and pricing (15a). This implies a downward-sloping relationship between factor headcount and factor prices. Even though, strictly speaking, this relationship depends on intensive margin supply adjustments, we refer to it as a demand curve.

Headcount supply curves are obtained by combining optimal extensive margin supply (15c) with pricing (15a). Appendix **??** reports full derivations. □

Equation (22) shows that protectionist policies act as a factor demand shifter, by changing good prices for given factor prices (see proposition 4.1). The demand elasticity Σ accounts for several forces. First, the product $\Sigma_p\Psi$ accounts for the pass-through Ψ of factor prices and policies into good prices, and implied expenditure switching effects. Second, the term $\left(I + \left(I + \Phi^{-1}\right)\mathcal{V}\right)^{-1}$ accounts for external economies $\mathcal{V}$. External economies make demand curves flatter, meaning that headcount demand increases by less as factor prices decline, because external economies increase efficiency units for given headcount. Last, the terms in Φ^{-1} account for optimal intensive margin adjustments. Intensive margin adjustments make headcount demand steeper, meaning that headcount demand increases by more as factor prices decline, because lower factor prices reduce intensive margin supply for given headcount.

The supply slope Θ depends on reallocation elasticities $\theta_{ff'}$. Larger reallocation elasticities mean headcount is more responsive to welfare differential, implying flatter supply curves. The term $\Theta_p\Psi$ captures the response of headcount to factor prices and policies, through changes in real wages. The real wage of a factor f is increasing in its own wage, and decreasing in the wage of other factors. The relative real wage of a factor f is also increasing in the incidence of production subsidies on f's consumption basket relative to the consumption basket of other factors. The multiplier $\left(I - \Theta_n\mathcal{V}\right)^{-1}$ instead accounts for the balance between agglomeration and congestion forces. Reallocation elasticities $\theta_{ff'}$ act

[11] The general case with $\bar{\mathbf{\Psi}}_{\mathcal{F}} \neq \boldsymbol{N}^*$ requires

$$\Sigma \equiv \left(I + \left(I + \Phi^{-1}\right)\mathcal{V}\right)^{-1}\left(I - \mathbf{1}\left(\bar{\mathbf{\Psi}}_{\mathcal{F}}^T - \boldsymbol{N}^*\right)\right)^{-1}\left[\Sigma_p + \Phi^{-1}\left(XX - \Omega_{\mathcal{Z}:}\right)\right]\Psi.$$

as a congestion force, while external economies of scale $\mathcal{V}_{ff'}$ act as an agglomeration force. As headcount for a factor f increases, productivity gains from external economies make reallocating toward f more attractive, thereby offsetting the wage pressure from increased employment. This makes factor supply curves flatter for given reallocation elasticities.

Changes in factor demand and supply interact to determine equilibrium responses. Corollary 4.1 decomposes headcount and factor price changes into direct policy exposures and equilibrium adjustments.

Corollary 4.1. Factor prices and headcount. *For any $F \times F$ matrix $\mathcal{M}$ such that $\bar{\mathbf{\Psi}}_{\mathcal{F}}^T \mathcal{M} = \mathbf{0}^T$ and $\mathcal{M}\mathbf{1} = \mathbf{0}$, denote the partial inverse $\hat{\mathcal{M}} \equiv \left(\mathbf{1}\bar{\mathbf{\Psi}}_{\mathcal{F}}^T + \mathcal{M}\right)^{-1}$. Headcount responses are given by*

$$\begin{aligned} \boldsymbol{n} = &- \underbrace{\left(I + \Sigma_{:\mathcal{F}}\hat{\Theta}_{:\mathcal{F}}\right)^{-1}}_{\text{GE propagation}} \underbrace{\Sigma\boldsymbol{\tau}}_{\text{demand exposure}} \\ &+ \underbrace{\left(I + \Theta_{:\mathcal{F}}\hat{\Sigma}_{:\mathcal{F}}\right)^{-1}}_{\text{GE propagation}} \underbrace{\Theta\boldsymbol{\tau}}_{\text{supply exposure}} . \end{aligned} \tag{24}$$

Factor price responses are $\boldsymbol{w} = -\hat{\Sigma}_{:\mathcal{F}}\left(\boldsymbol{n} - \Sigma\boldsymbol{\tau}\right) = \hat{\Theta}_{:\mathcal{F}}\left(\boldsymbol{n} - \Theta\boldsymbol{\tau}\right)$.

Proof. The result follows directly from solving the simultaneous equations (22) and (23). □

Direct exposure terms in (24) capture headcount demand and supply shifts. Through the term $\Sigma\boldsymbol{\tau}$, protectionist policies shift relative factor demand by changing relative good prices for given factor prices. Through the term $\Theta\boldsymbol{\tau}$, protectionist policies shift relative factor supply by changing the relative real wages of different labor occupations and asset uses, at constant factor prices.

The propagation terms capture equilibrium supply and demand adjustments. As policies shift up relative demand for some factor, its required return increases according to its supply slope. This counteracts the initial demand change. Likewise, as policies shift up the supply of some factor, its relative return declines according to its demand slope. Again, this counteracts the initial supply shift. Counterbalancing equilibrium effects are stronger when factors have steeper demand and supply curves – that is, when goods and factors are easily substitutable (high Σ) or when extensive margin reallocation is limited (high Θ).

Spillover effects and complementarities. Expanding the equilibrium solution as a geometric sum reveals the interactions between demand and supply responses of different pro-

duction factors. Focusing on a factor f, we have

$$\begin{aligned} n_f = &- \underbrace{(\Sigma\boldsymbol{\tau})_f}_{\text{direct}} + \underbrace{\sum_{f' \in \mathcal{F}} (\Sigma_{:\mathcal{F}})_{ff'} (\hat{\Theta}_{:\mathcal{F}})_{f':} \Sigma\boldsymbol{\tau}}_{\text{first-round GE}} - \dots \\ &+ \underbrace{(\Theta\boldsymbol{\tau})_f}_{\text{direct}} - \underbrace{\sum_{f' \in \mathcal{F}} (\Theta_{:\mathcal{F}})_{ff'} (\Sigma_{:\mathcal{F}})_{f:'} \Theta\boldsymbol{\tau}}_{\text{first-round GE}} + \dots \end{aligned} \tag{25}$$

The direct effect reflects the policy's immediate impact on each factor f's demand and supply. In the first line, first-round equilibrium effects capture how demand shifts affect required wages across all factors f', through the supply slope $\Theta_{:\mathcal{F}}$. This in turn feeds back into demand for factor f, through own and cross-effect $(\Sigma_{:\mathcal{F}})_{ff'}$. In the second line, first-round equilibrium effects capture how supply shifts affect the market wages of all factors, through the demand slope $\hat{\Sigma}_{:\mathcal{F}}$. This in turn feeds back into the supply of factor f, through own and cross-effects $(\Theta_{:\mathcal{F}})_{ff'}$. Higher-order terms capture subsequent rounds of adjustment.

Example 4.1 illustrates demand and supply spillovers across factors in a simplified setting.

Example 4.1. Demand and supply spillovers. Let's restrict attention to a single industry i, using two factors: labor ℓ with expenditure share s_ℓ, and capital k with expenditure share s_k. Demand and supply curves for this industry and for its own labor and capital relative to other goods and factors are determined by the following equations:

$$\begin{aligned} p &= s_\ell w_\ell + s_k w_k && \text{(pricing)} \\ n_\ell &= \Theta_{\ell\ell} w_\ell && \text{(labor supply)} \\ n_k &= \Theta_{kk} w_k && \text{(capital supply)} \\ n_\ell - n_k &= -\eta(w_\ell - w_k) && \text{(input demand)} \\ s_\ell n_\ell + s_k n_k &= -\tau - \sigma p && \text{(final good demand)} \end{aligned}$$

Suppose the government increases protection, in the form of cost subsidies $\tau < 0$. As a direct effect, this increases demand for both labor and capital. Suppose that labor is fairly mobile, while capital is not ($\Theta_{\ell\ell} >> \Theta_{kk}$). For a given demand change, the return to capital in the protected industry increases relative to the workers' wages ($w_k >> w_\ell$). If labor and capital are less substitutable than final products ($\sigma > \eta$), a higher cost of capital reduces labor demand, partially offsetting the direct effect:

$$n_\ell = - \underbrace{\sigma}_{\Sigma_{\ell i}} \tau - \underbrace{(s_\ell \sigma + s_k \eta)}_{\Sigma_{\ell\ell}} w_\ell - \underbrace{s_k(\sigma - \eta)}_{\Sigma_{\ell k}} w_k.$$

Figure 6 illustrates the argument. The left panel plots demand and supply for capital, while the right panel plots demand and supply for labor. A cost subsidy shifts demand for both capital and labor from D (pink line) to D' (teal line). Because capital supply is inelastic, the cost of capital increases much more than the cost of labor ($\Delta w_k >> \Delta w_\ell$). A higher cost of capital feeds back into labor demand, shifting it down to D''_ℓ (purple line).

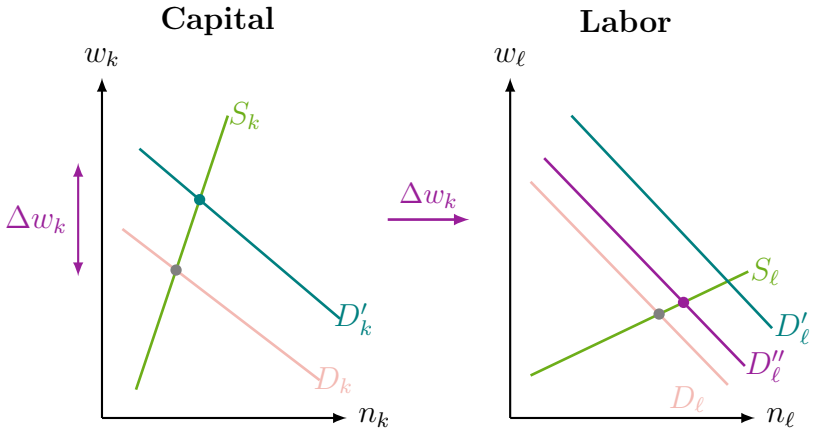


Figure 6: Constrained capital supply limits employment responses to protection.

Finally, corollary 4.2 characterizes how headcount responses change with underlying primitives.

Corollary 4.2. Comparative statics. *Denote direct demand and supply shifts by* $\boldsymbol{\mathcal{E}}_D \equiv \Sigma\boldsymbol{\tau}$ *and* $\boldsymbol{\mathcal{E}}_S \equiv \Theta\boldsymbol{\tau}$. *Likewise, denote equilibrium feedback effects by* $\mathcal{X}_D \equiv -\Sigma_{\mathcal{F}}\hat{\Theta}_{\mathcal{F}}$ *and* $\mathcal{X}_S \equiv -\Theta_{\mathcal{F}}\hat{\Sigma}_{\mathcal{F}}$. *Consider any parameter* $\xi \in \{\sigma^i_{jk}, \theta_{ff'}, \nu_{ff'}, \Omega_{ij}, \varphi_f\}$. *The partial derivative of headcount responses* $\boldsymbol{n}$ *with respect to* ξ *is given by*

$$\partial \boldsymbol{n} = \sum_{x \in \{D,S\}} (I - \mathcal{X}_x)^{-1} \left[\partial \boldsymbol{\mathcal{E}}_{\boldsymbol{x}} + Cov_{\boldsymbol{N}^*}\left(\partial \mathcal{X}_x, \boldsymbol{n}\right)\right] \tag{26}$$

Corollary 4.2 states that parameter changes lead to larger headcount responses when either direct shifts $\boldsymbol{\mathcal{E}}_x$ become larger, or when equilibrium feedback effects $\mathcal{X}_x$ become stronger for factors with large initial responses. Example 4.2 provides an illustration.

Example 4.2. Capital mobility and labor demand. Consider an increase in the mobility of non-labor assets, $f \in \mathcal{K}$. We can represent this as an increase in $\Theta_{ff'}$ for $f, f' \in \mathcal{K}$, flattening the supply curves of non-labor factors. Let's compute how this influences the response of labor occupations $f \in \mathcal{L}$ to policy-induced demand shifts. For simplicity, assume that non-labor factors are not subject to external economies ($\mathcal{V}_{\mathcal{K}:} = \mathbb{O}$ and $\mathcal{V}_{:\mathcal{K}} = \mathbb{O}$) and utilization bundles have no direct or indirect labor content ($\Psi_{\mathcal{K}\mathcal{L}} = \mathbb{O}$). Given headcount

responses $\boldsymbol{n} = \left(I + \Sigma_{\mathcal{F}}\hat{\Theta}_{\mathcal{F}}\right)^{-1}\Sigma\boldsymbol{\tau}$ to demand shifts at initial parameter values, let's study how propagation effects depend on $\Theta_{\mathcal{K}\mathcal{K}}$. Equation (26) implies

$$\partial \boldsymbol{n}_{\mathcal{L}} = \underbrace{\left[\left(I + \Sigma_{\mathcal{F}}\hat{\Theta}_{\mathcal{F}}\right)^{-1}\Sigma_{\mathcal{F}}\hat{\Theta}_{\mathcal{F}}\right]_{\mathcal{L}\mathcal{K}}}_{-\text{ spillover from } \mathcal{K} \text{ to } \mathcal{L}} \cdot \underbrace{\partial\Theta_{\mathcal{K}\mathcal{K}} \cdot \hat{\Theta}_{\mathcal{K}\mathcal{K}} \cdot \boldsymbol{n}_{\mathcal{K}}}_{\text{change in } \mathcal{K} \text{ response}}. \tag{27}$$

In equation (27), the change in employment responses is inversely proportional to the spillover from non-labor factors onto labor occupations, as defined in equation (25). Suppose reallocation frictions decline for some non-labor factor $f' \in \mathcal{K}$ ($\partial\Theta_{f'\mathcal{K}} \cdot \hat{\Theta}_{\mathcal{K}\mathcal{K}} \cdot \boldsymbol{n}_{\mathcal{K}} > 0$). Labor occupations $f \in \mathcal{L}$ that are complementary with f' – meaning $\left(I + \Sigma_{\mathcal{F}}\hat{\Theta}_{\mathcal{F}}\right)^{-1}_{f:}\Sigma_{\mathcal{F}}\hat{\Theta}_{:f'} > 0$ – initially faced a negative spillover and will now have larger responses. Conversely, labor occupations that are substitutes with f' and had a positive spillover will now face smaller responses.

5 Calibration and Quantitative Results

This section describes the data sources and calibration strategy for the full quantitative model. I calibrate the model to the world economy, featuring 8 regions, with 18 industries and 10 ISCO-based occupation categories per region. Following the theoretical framework, I identify labor factors with occupation-industry pairs. Non-labor factors are industry-specific assets, whose characteristics depend on the industry's composition of non-labor value added across major categories (light equipment, heavy equipment, structures, and intellectual property).

5.1 Data Sources

The model requires data on domestic and foreign expenditure shares in production and consumption, intensive and extensive margin supply elasticities, external economies of scale, and demand elasticities. I illustrate each set of parameters below.

Expenditure shares in consumption and production. Household expenditure shares are obtained from the final consumption column of the OECD ICIO tables. I assume a common consumption basket for each country, abstracting from within-country heterogeneity in consumption patterns.

I compute expenditure shares on intermediate inputs and value added in production from the OECD Inter-Country Input-Output (ICIO) tables. The ICIO covers 76 countries

and 45 industries at the ISIC Rev. 4 classification level, providing bilateral trade flows and intermediate input usage for each country-industry pair.

Expenditure shares on primary factors by industry i and factor type f are constructed from multiple sources. EU KLEMS and ICIO data provide industry-level labor shares in total value added. The Occupational Employment and Wage Statistics (OEWS) provides a breakdown of cost shares across labor occupation by industry for the United States. I use information for the US, combined with country-level harmonized employment counts and wages by occupation from ILOSTAT, to impute industry-by-occupation expenditure shares in total labor value added for non-US countries. With a raking and scaling procedure, I rescale occupation shares uniformly across industries to match country-by-occupation income shares from ILOSTAT, and set the relative expenditure shares of different industries on a given occupation to reproduce the US benchmark.

Expenditure shares on non-labor assets in each industry are computed as the residual of value added after subtracting labor compensation. Each industry employs a single composite capital type, whose characteristics are calibrated based on the industry's capital composition (see below). I decompose capital into four asset categories (light equipment, heavy equipment, structures, and intellectual property) using EU KLEMS data.

Table 4 summarizes the data sources for expenditure shares in production and consumption.

Table 4: Summary of Input-Output Data Sources

Object	**Source**	**Coverage**
Input-Output Matrix	OECD ICIO	76 countries × 45 industries
Labor Compensation	EU KLEMS, OECD STAN	Developed economies
Occupation × Industry Wages	Eurostat SES, BLS OEWS	Europe, United States
Employment by Occupation	ILOSTAT	Global
Consumption Shares	OECD ICIO (final demand)	76 countries
Bilateral Trade Flows	OECD ICIO	76 countries

Reallocation Elasticities (work in progress) I estimate extensive margin flow elasticities for both labor and non-labor factors.

Labor flow elasticities are estimated using matched monthly files from the Current Population Survey (CPS), which track individual workers' transitions across industries and occupations in the US. For lack of better data, I apply US values to all countries. The identification strategy exploits two sources of variation.

I instrument for industry-level labor demand changes using exposure to Chinese import competition, following Autor et al. (2013). This identifies the gradient of flow elasticities

with respect to distance in the space of industry characteristics. Second, I combine O*NET task content measures with changes in task content driven by routine-biased technological change, following Autor and Dorn (2013). This identifies the gradient of flow elasticities with respect to occupation distance.

I map estimated flow elasticities into the cross-nested logit structure as follows. Occupations are grouped into overlapping nests $m \in M$ based on industry and task similarity. The membership shares α_{fm} are set based on industry and O*NET task content of occupation f and nest m, normalized so that $\sum_m \alpha_{fm} = 1$. The nesting parameters $\mu_m \in (0, 1]$ govern substitutability within each nest, with lower values indicating stronger substitutability. I calibrate μ_m to match the estimated gradient of flow rates with respect to task distance: occupations that are closer in task space (and thus share more nests with higher membership shares α_{fm}) exhibit higher bilateral flow rates.

The model also includes non-employment as an occupation choice. I estimate flow elasticities between employment and non-employment using CPS data, exploiting variation in local labor market conditions. Specifically, I use CPS matched monthly files to measure occupation-specific transition rates between employment and non-employment (θ_{EU} and θ_{UE}). I instrument for local labor demand using Bartik-style shift-share instruments based on national industry employment growth interacted with local industry composition.

Estimating reallocation elasticities for non-labor factors poses additional challenges. Time-series measures of industry-specific returns to non-labor assets are not readily available, therefore I approximate them using profit rates $(P_i Y_i - W_i L_i)/(P^K K_i)$. This captures industry-specific variation, with the drawback of conflating returns to capital with markups.

I parameterize flow elasticities according to a measure of industries' distance in the input-output network, and of overlap in their capital composition. To estimate these elasticities, I exploit two sources of variation. First, I use Bartik-style government spending shocks, interacting national changes in defense and non-defense procurement with industries' historical exposure to government demand. Second, I use exposure to Chinese import competition as in Autor et al. (2013). Both instruments generate plausibly exogenous variation in industry-specific capital returns, allowing me to estimate how capital flows respond to return differentials. The structural form assumes $\Theta^K_{ij} = f(\text{similarity}_{ij}; \lambda) \cdot \mu_i \cdot \nu_j$, where similarity is measured by proximity in the input-output network and asset-type overlap. The model also allows for idle capital as a "non-employment" state for capital. The flow elasticities into the idle state are backed out residually from the constraint $\Theta^K \mathbf{1} = \mathbf{0}$. The steady-state share of idle capital $N^*_{K,\text{idle}}$ and the flow elasticities out of idle state and into the various industries are backed out residually from the eigenvector condition $\boldsymbol{N}^*_K \Theta^K = \mathbf{0}$, where Θ^K includes flows to and from the idle state.

External Economies of Scale (work in progress) My framework features factor-augmenting productivity externalities, allowing for both own effects and spillovers across factors. To estimate these externalities, I follow a similar method as Bartelme et al. (2025). Bartelme et al. (2025) estimate industry-specific scale elasticities using a gravity-based identification strategy. To correct for endogeneity between productivity and scale, they instrument for domestic industry size using foreign market access. They then infer country-by-industry log productivity from a standard gravity equation, and regress it on instrumented log sector size to estimate how industry-level productivity responds to changes in scale. While this approach does not clearly distinguish between internal and external economies of scale, I adopt it as the best approximation in the literature.

I adapt the strategy to estimate occupation-level externalities, including both own effects and cross-occupation spillovers. I group occupations into skill categories (e.g., high-skill cognitive vs. low-skill manual based on ISCO classification) and parameterize the externality matrix as:

$$\nu_{ff'} = \bar{\nu} + \nu^{skill} \cdot \text{skill intensity}(f) + \nu^{own} \cdot \mathbf{1}_{f=f'} + \nu^{cross} \cdot \text{similarity}(f, f'),$$

where similarity is measured by overlap in task content from O*NET. This parsimonious specification allows me to estimate a small number of parameters ($\bar{\nu}$, ν^{skill}, ν^{own}, ν^{cross}) while generating a full matrix of externalities across all 10 occupations.

For capital I calibrate external economies based on IP intensity, positing that IP-intensive industries exhibit stronger agglomeration effects:

$$\nu_{K,i} = \bar{\nu}_K + \nu^{IP} \cdot \left(s_i^{IP} - \bar{s}^{IP}\right) + \nu_K^{own} \cdot \mathbf{1}_{f=f'} + \nu_K^{cross} \cdot \text{similarity}(f, f')$$

where s_i^{IP} is industry i's IP share of capital, $\bar{s}^{IP}$ is the income-weighted average, and similarity is measured based on the industries' shares in various capital types.

Intensive margin factor supply. I set the inverse intensive margin labor supply elasticity $\varphi = 2$. This is consistent with the estimates in Chetty (2012).

For capital utilization, I estimate the curvature of utilization costs φ_k from time series data (work in progress). I allow φ_k to vary by asset type. The industry-specific $\varphi_{k,i}$ is then computed as the composition-weighted average: $\varphi_{k,i} = \sum_k s_i^k \cdot \varphi_k$, where s_i^k is industry i's cost share of asset type k.

5.2 Quantitative Results

For illustration, I present results from a simplified three-region model (US, China, rest of world). Production shares, intermediate linkages, and labor shares are calibrated from data as described above. Substitution elasticities are calibrated to external estimates. Other parameters are set to placeholder values pending completion of the estimation.

In the figures below, I consider a US trade policy consisting in 1% tariffs on Chinese imports of manufacturing goods. I assume manufacturing has lower productivity externalities than the rest of the economy, so that there is a tradeoff between protecting manufacturing employment and increasing overall TFP.

The baseline panel shows outcomes with all parameters at reference values. Higher capital mobility amplifies employment responses, more so when capital and labor are complementary. Both capital mobility and productivity externality differentials steepen the employment-productivity tradeoff. Larger reallocation elasticities to and from unemployment instead make this tradeoff flatter.

The US trade policy affects both China and the rest of the world. China faces opposite effects as the US, because its manufacturing sector contracts. In this calibration, the rest of the word instead faces similar – although smaller – effects as the US. Even though Chinese manufacturing products get redirected to third countries, overall Chinese competition in manufacturing declines, because the Chinese manufacturing sector becomes smaller overall.

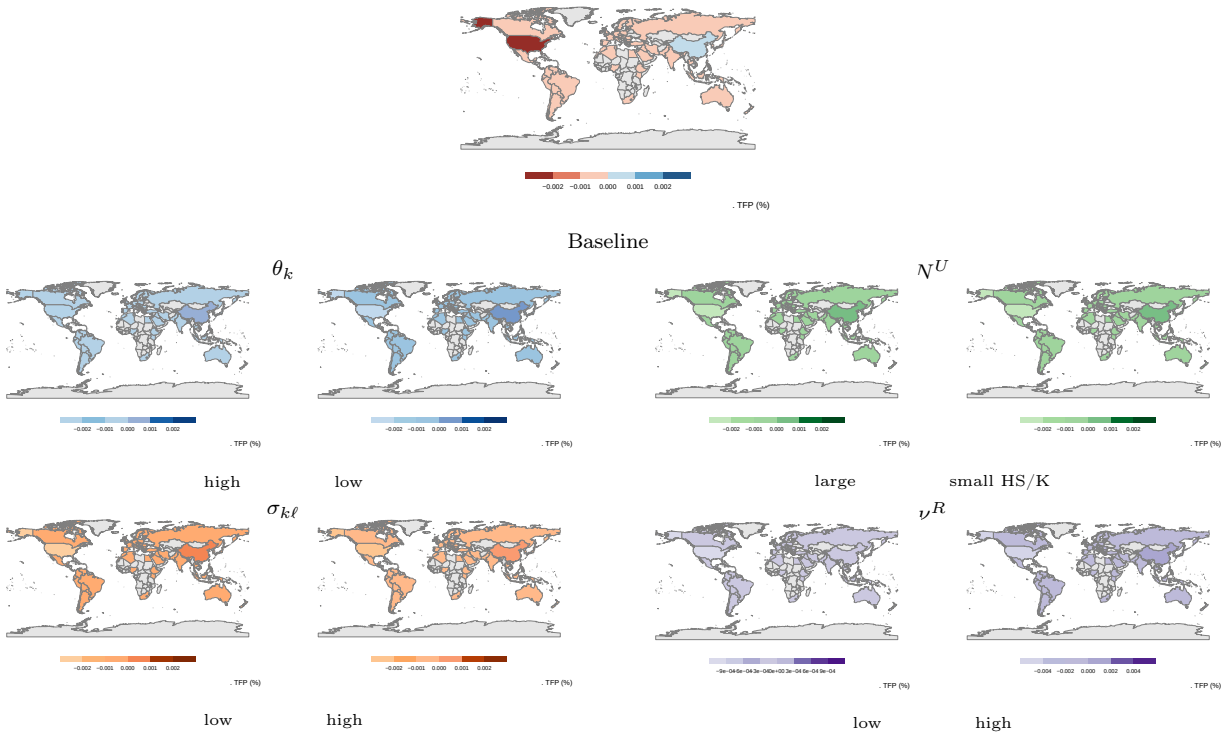


Figure 7: TFP: US Trade Policy

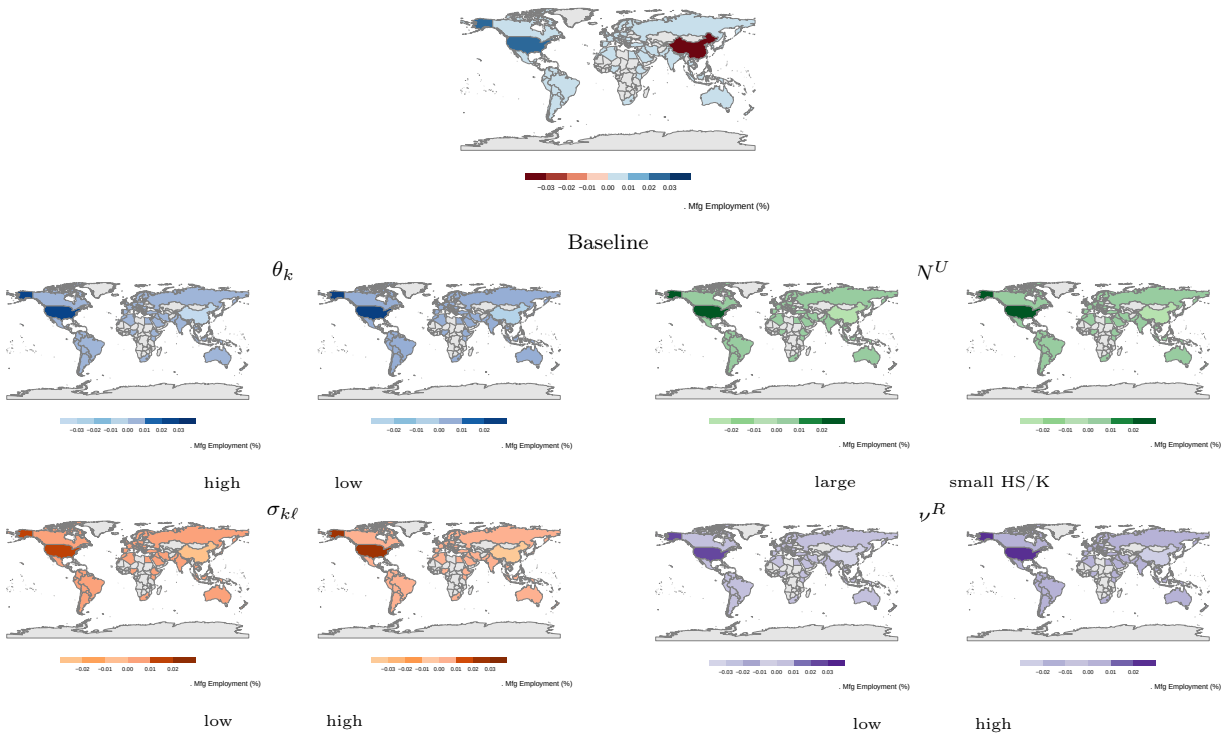


Figure 8: Mfg. Employment: US Trade Policy

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Appendix